SCOTTISH HOSPITALS INQUIRY

Bundle of document for Oral hearings commencing from 13 May 2025 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 46 – Volume 3

Correspondence on Potentially Deficient Features

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NHS Greater Glasgow and Clyde

New South Glasgow Hospitals (NSGH) Project

INVITATION TO PARTICIPATE IN COMPETITIVE DIALOGUE

VOLUME 2/1

EMPLOYER'S REQUIREMENTS (Hospitals)

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Section 1.0 Development Context

1.1 Introduction

The provision of new facilities at the Southern General Hospital site in Glasgow represents the second phase of the Acute Services Strategy of the Board.

As illustrated in Appendix A, the Hospital Campus extends to some 28.6 hectares and is located within the Govan area, lying to the south-west of Glasgow City Centre adjacent to the residential neighbourhood of Drumoyne and the industrial areas of Shieldhall and King George V Dock. The site is located 500 metres south of the River Clyde. The sites northern boundary is defined by Renfrew Road/Govan Road with the eastern boundary defined by Moss Road/A739 (Clyde Tunnel approach road). Langlands Drive and residential developments delineate the southern boundary and Hardgate Road runs north-westwards to identify the western boundary of the Hospital Campus.

The Site extends to some 8.6 hectares and is located in the west-central area of the Hospital Campus (see Appendix A). The Site is bounded by operational healthcare buildings to three sides, with boundaries to neighbouring industrial areas to the north/north-west. The existing buildings within the Site (excluding the Surgical Block) are to be demolished by the Board in advance of the scheme, as described in Section 2.3 below.

The scheme includes the provision of 1,109 adult and 240 children's beds. The bed numbers are illustrated in *Table 1 – Proposed Bed Numbers – Adult and Children's Hospitals.* Key elements of the project include:

a. Development of an integrated adult acute and children's hospital proving the full range of acute health services;

b. Development of a new Laboratory facility including Mortuary and Post-Mortem Services, Biochemistry, Microbiology, Haematology and Medical Genetics;

c. Provision of a rooftop helipad; and

d. The supply and installation of Group 1 equipment, location and/or fitting of Group 2 equipment supplied by the Board and provision of structural, space and services requirements to support Group 3 and 4 equipment.

It should be noted that Information Management and Technology (IM&T) is outwith the project, the Board is procuring software and end-use hardware as part of a separate IM&T project. The Contractor shall, however, provide the required space within the building and the requisite hard infrastructure and containment, in accordance with Section 8.0 and Appendix M, to support the Board IM&T requirements

Adult Hospital		**Children's Hospital**	
Specialty	**Beds**	**Specialty**	**Beds**
General Medicine (incl MHDU + AAU)	405	Inpatient (incl critical care areas) (*12 beds in maternity facility)	193*
CCU	20	Short-stay (observation ward)	20
Stroke	26	Day Care/Day Surgery	27
Haematology	14	**Total Inpatient Beds**	**240**
Dermatology	18		
Nephrology	80		
Geriatric Medicine	93		
Surgery & Vascular (incl AAU)	164		
Urology	39		
Orthopaedics/rehab	139		
ENT	31		
ITU	20		
SHDU	23		
Clyde/Contingency	37		
Total Inpatient Beds	**1,109**		

Table 1 – Proposed Bed Numbers – Adult and Children's Hospitals

1.2 Accommodation Overview

1.2.1 New Adult Hospital

This will provide A&E services and acute specialist in-patient care as well as medical day services and out-patient clinics serving the local population.

Key components of the facility will include:

a. In Patient Accommodation
Surgical beds (general surgery, orthopaedics, urology, vascular, ENT and renal); Medical beds; Acute Assessment Unit – 118 beds, ICU/HDU/CCU – 79 beds, Acute Stroke – 26 Beds and Care of the Elderly 93 beds;

b. Out Patient Accommodation
Full range of general outpatient clinics including, among others, diabetic unit, respiratory, orthopaedics and urology;

c. Day Services
22 medical day bed area; 30 station dialysis unit;

d. Treatment & Diagnostic Services
Emergency Department, 20 operating theatres, imaging, and endoscopy;

e. Clinical Support Services
Pharmacy dispensary, medical physics, medical illustration. Laboratory services linked to the hospital by underground route and pneumatic tube system, aseptic unit within the children's hospital. The pneumatic system to extend across the abutment with maternity and the link to neurosciences to provide for expansion of the system to these areas; and

f. Non Clinical Support Services
Main entrance, medical records, administration, chaplaincy, social work, staff changing, switchboard, estates, facilities, security, catering, portering, domestic, management and energy centre.

1.2.2 New Children's Hospital

This will provide A&E services and a comprehensive range of inpatient and day case specialist medical and surgical paediatric services on a local, regional and national basis. The new development will also have outpatient facilities. The care strategy is that all of Glasgow's Children's Services (up to the age of 16 and up to 18 years where appropriate) will be provided at the New Children's Hospital. Of the 240 beds planned, around 20% of the beds will be for day patients and the balance for in-patient requirements.

Key components of the facility will include:

a. Outpatient Accommodation
Full range of Children's outpatient clinics including audiology, general paediatrics, orthopaedics, ENT etc;

b. Day Services
Circa 10 medical day beds; 4 dialysis stations and circa 25 day surgery beds;

c. Treatment & Diagnostic
Accident and Emergency, minor injuries, Imaging, 9 theatres, rehabilitation;

d. Clinical Support Services
Aseptic unit, pharmacy, medical physics, medical illustration (laboratory services linked to hospital by underground route and pneumatic tube system – tube system to be extended across abutment with maternity/neo-natal to provide for potential expansion of the system); and

e. Non Clinical Support Services
Facilities, ancillary services, administration, spiritual services, medical records, staff change, staff dining.

1.2.3 **Laboratory Facilities**

The new facilities will be one of two major Laboratory sites in Glasgow (the other at Gartnavel General). The services planned to be delivered from the new Laboratory build at the New South Glasgow Hospitals include Biochemistry, Microbiology, Haematology, Medical Genetics, Mortuary and Post Mortem. The mortuary and post mortem facilities include the re-provision of the Glasgow City mortuary which also provides forensic services for the City of Glasgow. The Employer's Requirements in relation to the laboratory facilities form Volume 2/2 of the ITPD and laboratories (buildability and interfaces) shall form a workstream of competitive dialogue between the Board and bidders.

1.2.4 **Facilities Management Building and Energy Centre**

These key support accommodation areas shall be developed in line with the operational needs of the Board and the energy strategy adopted for the project. The Facilities Management accommodation is located in the Laboratory building and the requirements in this regard are included in Volume 2/2 of this ITPD.

1.2.5 **Retained Services**

The Southern General Hospital site will retain approximately 630 beds within the institute of neurological sciences, Maternity, Spinal Injuries and Langlands buildings. The Langlands facility provides older people's services, dermatology and services for the young physically disabled.

1.3 **Elements of Procurement**

1.3.1 As detailed in Volume 1 of the ITPD, the procurement is following a competitive dialogue route. The areas for inclusion in the competitive dialogue have been established, with the following topics identified:

a. Design;

b. Logistics;

c. Laboratories (incl FM accommodation); and

d. Commercial.

Volume 1 of the ITPD provides further detail on the scope, extent and requirements of the competitive dialogue, including identification of the issues and aspects of each topic that shall be considered.

1.3.2 As detailed in Volume 1 of the ITPD, the Works are comprised of several Stages, namely:

a. Stage 1 – Laboratory Design & Construction;

b. Stage 2 – Hospitals Detail Design to FBC;

c. Stage 3 – Construction of Hospitals; and

d. Stage 3A – Landscaping Completion (including demolition).

Section 2.0 Responsibilities of the Parties

2.1 Introduction

The Board wish to procure Works which shall enable it to carry out its clinical functions, to combat health acquired infection and to maintain physical assets and clinical and non-clinical functionality with ease; and it shall be the responsibility of the Contractor to deliver a design and construction solution that optimises these requirements. The Board wish to provide its clinical functions in a high quality care environment which is accessible to the community, welcoming, safe and aesthetically pleasing. Innovative design and construction proposals, which as a minimum meet the requirements of the Works Information, Site Information and Employer's Requirements are sought from the Contractor.

2.2 Responsibilities of the Contractor

The Contractor shall be responsible for the following:

2.2.1 Providing Works that are fit for purpose;

2.2.2 Meeting all of the requirements of the Board stated in the Works Information, Site Information and Employer's Requirements as a minimum requirement;

2.2.3 The tasks, risks and aspects of the project identified as owned by the Contractor in the Risk Register;

2.2.4 Assisting the Board with the management of the risks identified as owned by the Board in the Risk Register;

2.2.5 Working with the Board and it's advisers in fulfilling all of the requirements and good practice inherent in the NEC3 contract;

2.2.6 Compliance with the requirements of the Construction (Design & Management) Regulations;

2.2.7 Providing a design that meets the relationships identified in the Adjacency Matrix;

2.2.8 Diverting the culverts that cross the Site and the other remaining services;

2.2.9 Obtaining all Consents required for the construction of the Works, including but not limited to the under noted. With regard to the under noted the Contractor shall provide to the Board copies of the following documents within 10 working days of all purification and discharge notices from date of issue by the appropriate authority:

2.2.9.1 Planning Approvals;

2.2.9.2 Building Warrant (incl Stage applications if applicable);

2.2.9.3 Building Warrant – Certificates for full occupancy;

2.2.9.4 Pre-construction Information and Construction Phase Health &Safety Plan;

2.2.9.5 Health and Safety File;

2.2.9.6 Utilities Suppliers Consents;

2.2.9.7 Other Local Authority Consents, including Building Control, Roads Construction Consent, Fire Strategy etc;

2.2.9.8 Certification for PMG installation;

2.2.9.9 Relevant Civil Aviation Authority and Strathclyde Fire and Rescue documentation in relation to the provision by the Contractor of a rooftop helipad;

2.2.10 Procuring that the Works are at all times performed:

a. In compliance with all Law and Consents;

b. In a manner that is not likely to be injurious to health or to cause damage to property;

c. Without injury, nuisance, interruption to, or other detriment of the existing clinical and support services current on the site;

d. In a manner consistent with the Quality Plans;

e. Except to the extent expressly stated to the contrary in the Works Information, Site Information or Employer's Requirements in compliance with all NHS Mandatory Documentation, NHS Guidance Documentation and Additional Guidance contained in Section 5.1;

f. In a manner consistent with the Board discharging its statutory duties and other functions undertaken by it as the same may be notified to the Contractor from time to time;

g. In accordance with all British and European Standards; and

h. In accordance with Good Industry Practice.

2.3 Responsibilities of the Board

The Board is responsible for the following:

2.3.1 The provision of the area of the Site agreed between the Board and the Contractor clear of buildings and known utilities unless otherwise illustrated. This to include the grubbing out and removal of foundations and underbuildings. Remaining utilities to be addressed by the Contractor are identified on the drawing illustrating same in Appendix M; and

2.3.2 The provision of access (agreed by the Board in writing in advance) to areas of the Hospital Campus to allow the Contractor to make utility connections, corridor/building linkages and other relevant activities identified to carry out the Works.

Section 3.0 The Site

3.1 The Site

The Site is located at 1345 Govan Road within the Hospital Campus. The boundary of the Site is identified in Appendix A.

Site Investigation (SI) work has been undertaken by the Board. The relevant SI information and associated interpretative reporting is located in Appendix N.

3.2 Travel Plan

The draft Travel Plan developed by the Board is located in Appendix W.

3.3 Planning

Outline planning permission has been secured by the Board (a copy of the communication issued by GCC in relation to the permission is attached at Appendix D.1). The outline permission has forty-three conditions attached and was conditional to the Section 75 Agreement being concluded in respect of transportation issues.

The Section 75 Heads of Terms (HoTs) are agreed between the Board and the Council, the HoTs for a proposed Fastlink service will be concluded by the Board as an aspect of the masterplanning prior to the conclusion of the competitive dialogue process.

The status of planning matters are identified in Appendix D.2, with details of the Masterplanning carried out by the Board in Section 7.0 of the ERs. As noted in Section 2.2, above, the Contractor is responsible for gaining and discharging Detailed Planning Approval.

3.4 Live Hospital Site

The Hospital Campus is a live hospital site, and as such will place restrictions on the Contractor in the construction of the Works. Essential 'blue light' and other access routes will require to be unobstructed by the Contractor 24hours per day, every day.

The 'blue light' and other access routes/site constraints are identified in Appendix A.

3.5 Other Projects On-Site

In addition to the ongoing access and operational requirements of the Board to deliver medical and related services, there shall be other construction projects and programmes ongoing on the Hospital Campus at varying times when the Contractor will be constructing the Works. This may include (but not be limited to) works to create a new-neo natal facility, multi-storey car parks and university facilities as well as a variety of site enabling, ongoing maintenance, utilities and demolitions works.

3.6 Site Logistics

Site Logistics shall form a Dialogue Issue during the Bid Period, this will include discussions in respect of both the live hospital site and other projects on-site, with relevant responsibilities, interface protocols, communications plans and emergency/contingent planning to be discussed and agreed with the Board.

Section 4.0 General Design Requirements

The following section provides an overview of the Board's key objectives for the Works. The Contractor's proposals should clearly demonstrate cognisance of these objectives in relation to the design and the construction process. In particular, the operational, functional and equipment issues contained in the Employer's Requirements must, as a minimum standard, be met by the design and construction solutions of the Contractor. Further to this, the Contractor shall ensure the design delivers a solution which indicates acknowledgement and understanding of the types of patients that are planned for the facility.

The Contractor must take cognisance of the following documentation in his design solutions and shall require to demonstrate in his bid return strategies to embrace the ethos of the documentation in the development of the design:

a. Scottish Government's Policy and Design Quality for NHSScotland;

b. The NHS Greater Glasgow and Clyde Design Action Plan;

c. Achieving Excellence in Design Toolkit (AEDET Evolution);

d. Scottish Planning Policy SPP6; and

e. Planning Advice Note 84.

Further, the Contractor shall design the Works to address the following issues:

4.1 Uses

4.1.1 Functional Requirements

The design of the Works shall:

a. Function efficiently, effectively and economically;

b. Optimise the Board's operating costs;

c. Demonstrate that the design fully reflects the special needs for each patient group in terms of access, functional relationships and planning. Patient groups are described and their particular requirements are defined in the Clinical Output Specifications in Appendix B and the mandatory and relevant guidance listed in Section 5.1. The facility as a whole should be fully accessible to the widest variety of patient groups, ambulatory, assisted and non ambulatory patients of all ages providing access to specialist services led by medical staff, allied health professionals and nursing staff;

d. Interface easily with other service providers in particular the wider services provided by the Board; and

e. The design shall be able to do this in terms of environment, scale, comfort, privacy, reassurance, style and security.

4.1.2 Human Dignity

To achieve appropriate levels of privacy, the Contractor shall provide Works which allow adequate space around patients. This may include space for relatives to sit with patients, adequate space between chairs, and seating in rest bays along corridors to provide rest places along the route of the patient / visitor journey. The privacy afforded to patients, staff and visitors shall not be compromised by inappropriate or inadequate sound reduction measures in the design or in the build standard.

Sill heights for windows shall enable outward visibility, in particular for children, patients in wheelchairs and in beds. Special consideration shall be given to the needs of the elderly and those with poor sight. Some doors and internal glazed screens shall require vision panels or other glazing systems, which may be obscured or controlled for privacy. The ability to use vision panels to view objects / small children on the other side is desirable.

4.1.3 Functional Relationships

The design shall offer all users of the Works the highest level of efficiency in their operations by way of relationships and adjacencies between functional units. Layouts shall reflect the workflow and logistics inherent in the Clinical Output Specifications in Appendix B; the parameters identified in the Adjacency Matrix; and the requirements of the housekeeping and domestic staff, catering, staff welfare and related management needs.

4.1.4 Work Flows & Logistics

Workflows within and between departments shall be direct and the routes for patients and staff as short as possible. Internal traffic cross-flows which could be inefficient or conducive to the transmission of micro-organisms either through airborne or other means shall be avoided.

The movement of people and the distribution of supplies and waste shall be carefully considered and the circulation routes shall be clear and appropriately sized, with the use of automated material transfer systems where relevant.

4.1.5 Adaptability & Expansion

The design shall consider the needs for departments to be adapted or expanded. This will require a range of approaches to be taken including the allocation of soft space adjacent to clinical spaces. The design shall demonstrate that potential change or expansion has been considered by the provision of adequate space either at the external perimeter and / or between functions and departments.

The structural grid, construction technique, structure, service penetration and engineering services strategy shall demonstrate that the design proposals for expansion, adaptation and flexibility are co-ordinated.

The provision of engineering, telecommunications infrastructure and building services shall be appropriate for the provision of anticipated changes in medical equipment.

4.2 Spaces

4.2.1 Space Standards

The Contractor shall provide designs which are efficient, economical and flexible for immediate and future use, and which can be managed efficiently to cope with seasonal and strategic variations in activity.

Appropriate space provision shall be given to circulation, waiting and sub-waiting space for the movement of patients, pedestrians and the storage and transportation of goods.

Space shall be considered to allow informal discussion, therapy and interaction within open and reception areas in the clinical environment, such as consultation and main waiting and reception areas. Consideration shall also be given to making use of open space areas within clinical areas and main circulation routes for 'break-away' space such as corridor recesses and courtyards.

The Contractor shall recognise that patients' and staff's perception of the spaces created may assist with their feeling of belonging and of not being intimidated, and may help with their orientation, mobility, confidence, privacy and their ability to socialise.

4.2.2 Floor Layouts

The design of departmental and unit layouts shall reflect the demand for space defined by occupancy and usage as described in the Clinical Output Specifications and reflected in the Exemplar Design/SoA. Where areas and shape of rooms results in undesirable spaces, the Contractor shall discuss with the Board alternative solutions, which may or may not result in shared space providing a more appropriate environment as well as optimising the available use of space. These may include locker rooms, sitting areas, seminar rooms etc.

4.2.3 Character & Innovation

4.2.4 Excellence for Patients

The design of buildings, external and internal appearance as well as the design of the external works, and landscape can have a positive or a negative effect upon patient care, staff experience at the work place and the way NHS healthcare buildings are perceived. The Contractor shall develop design solutions which by the use of materials, lighting, shape, scale, mass and form of the building elements make a positive contribution to engendering well-being of patients and staff.

4.2.5 Healthcare Excellence

Healthcare buildings should fit within their community and be compatible in design and the use of materials with their neighbourhood and have a strong NHS identity. The Contractor shall develop building design solutions that:

Reinforce the dependability and reassurance that the NHS means to the local community;

Respect their local environment but at the same time make a positive contribution to the urban context that they are in;

Clearly expresses their function in external and internal appearance;

Allows patient diagnostic and treatment areas that can be differentiated in design concept and detail from inpatient areas; and

Reflect that design considerations such as the distribution, size and proportion of windows and the use of materials can reflect the clinical function.

These elements shall be expressed in the scale and mass of the buildings, as well as the disposition of functions.

4.2.6 Architectural Vision

The Contractor shall develop building design solutions, which create an ordered composition of building elements in a stimulating form that successfully combines good standards of space, height, form, scale and use of materials and colours / images with associated functional requirements and its surroundings.

4.2.7 Stimulating Design

The Contractor shall develop building design solutions which create a high quality, good working environment, both externally and internally, which shall provide a reassuring, enjoyable, convenient and safe environment for all patients, their families, visitors and staff. This objective shall not be in conflict with the desire to produce a stimulating design. The Contractor shall meet this objective and shall develop a design which will not date and be capable of coping with future changes in a way that does not destroy the original design vision / concept. Further, the design shall incorporate best practice in terms of aspects of design that positively impact on health and recovery.

4.2.8 Design Innovation

Innovation in design can range from whole concepts of healthcare facilities' planning, distribution of functions etc to detail design of components, materials, spaces, use of technology etc. The Contractor shall develop designs at the concept level which shall translate the NHS modernisation agenda, and new forms of service delivery into new and innovative building solutions.

4.2.9 Recognisable Quality

The Board expects high quality design to match the best national standards of healthcare provision it intends to implement.

Materials shall be substantial and of high quality. They shall be carefully detailed and constructed such that the quality is appreciated throughout the life of the Works. They shall retain their appearance within a compatible maintenance regime. For example, detailing of external materials shall not cause unsightly staining.

The lifecycle plan and design detailing shall allow for replacement of elements in a way that does not impair design quality or service provision. A schedule of required life expectancies of building elements can be found in Section 5.3.

4.3 Citizen Satisfaction

4.3.1 Design Concept

The visual forms shall enhance the sense of place. They shall make best advantage of the environmental qualities of the Works and the wider Site.

The design concept shall be clear, and will not be compromised by the subsequent detailed design development. The design concept shall be complete and well balanced, with all parts relating to the whole.

4.3.2 Scale & Proportion

Appropriate scale and proportions shall reflect the human scale, adjoining urban surroundings and any existing buildings / structures retained on the Site. Plant rooms, lift and stair towers shall express form and function, but they shall not be perceived as dominating and oppressive.

4.3.3 Composition

The composition of the buildings shall be complete, cohesive and well balanced in massing. The visual form shall enhance the Site and sense of place. This can be done in a number of ways including by linkages to surroundings in plan form, expressions in the design of local character and including natural features of the Site in the composition.

The overall form of the buildings shall be designed to demonstrate the special needs of the function of each unit. The design shall clearly express in the form of the buildings the individuality and special nature of parts of the Works, yet the parts should harmonise with the Works and the overall site. The Contractor should give particular consideration to the architectural composition and expression of the following key aspects of the facility;

a. The form of the Adult Acute and Children's Hospital while mutually compatible should have an identifiably distinct character expressed both externally and internally as befits the nature of the patient groups; and

b. The Contractor will be require to ensure that the new Works are consistent with the overall masterplan strategy and with the existing facilities on the site, as such particular consideration should be given to the adjoining neonatal unit (which requires to be co-joined by an abutment) and the provision of a link to the institute of neurological sciences.

4.3.4 Aesthetics

The overall visual form of the buildings shall combine good standards of space, height, form and scale. The form of the buildings shall appeal to the aesthetic senses of patients, visitors and staff as follows:

The lines of the design shall clearly define forms and surfaces of the buildings;

The skyline shall reflect the mass of the buildings but not be out of scale and dominating;

The sky line shall not be monotonous;

The solid forms shall be in scale and have harmonious shapes; and

The interplay of light and shade shall add to the definition of the building form and the balance between solid and glazed elements should be carefully considered.

4.3.5 Colour & Texture

Colour decoration and motifs shall be used to facilitate identity of the Works; and its designated areas / zones and in addition improve wayfinding. It can also be used to create an immediate and distinct 'image' of the Works to visitors, which is interesting and stimulating.

The use of colour shall be co-ordinated and adapted with the lighting to the activities of each area, toned down in certain areas e.g., quiet areas, seminar rooms; but bright and stimulating in others, such as waiting and corridor areas.

The Board shall be entitled to choose the colour scheme in consultation with the Contractor and the Contractor shall liaise with the Board and nominated User groups and other representatives (e.g. BATH – Better Access To Health) in this regard.
An interior designer shall be included in the Contractor's design team to secure a clear co-ordination of the interior materials within the Works, matching the furniture, furnishings and equipment being procured by the Board. The colour scheme should be selected with due regard to integration with the Art Strategy as identified in Section 7.17.

4.4 Internal Environment

4.4.1 Quality Environment

The design of the Works shall create a high quality, good working environment, both externally and internally which will provide a reassuring, enjoyable, convenient and safe environment for all patients, their families, visitors and staff.

4.4.2 Light & Colour

The design shall provide quiet, comfortable areas with pleasing outlook easily accessible from clinical areas where patients and their families / visitors can "escape" from the clinical environment. Such areas may facilitate informal discussions with health professionals in the future, and be equipped for play / recreation. Where possible natural sunlight is to be brought into areas. The Contractor shall liaise with the Board and nominated User groups and other representatives (e.g. BATH – Better Access To Health) with regard to light and colour aspects.

4.4.3 Views

The Works shall provide quiet, comfortable areas with pleasing outlooks and easy access from clinical areas.

4.4.4 Internal Wayfinding

Design solutions shall incorporate an integrated, comprehensive wayfinding strategy that enables patients, visitors and staff to self-navigate with ease and lack of stress throughout the buildings.

The wayfinding strategy shall be designed to meet the needs of patients and visitors but routes shall be clearly defined to ensure that parts of the buildings that are restricted to staff are not used as short cuts by patients and visitors. The use of enclosed internal courtyards as an integral part of a route shall be considered. The Contractor shall liaise with the Board and nominated User groups and other representatives (e.g. BATH – Better Access To Health) with regard to the use and detailing of internal wayfinding.

Internal signage shall be easily understood and consistent throughout the journey from the entrance to the department reception and on to rooms. It shall not create clutter and the use of pictograms and graphic art should be considered.

Proposals shall be developed which acknowledge the multi-sensory process used in wayfinding and which address the need of people with impairment in touch, smell, sight or sound. The proposals should be developed with due regard to the requirements of the NHS Identikit guidance.

4.4.5 Internal Spaces

All internal spaces shall be well planned and appropriate within clinical areas.

Some spaces shall be designed to encourage social interaction for patients, visitors and staff.

Public spaces shall be used to integrate the various parts of the buildings, and shall be designed to avoid being a space joined by long, narrow corridors.

4.5 Urban & Social Integration

4.5.1 The Contractor should recognise that the design of the new hospital offers the opportunity for a responsive design which addresses the requirement for the sharing of Works with the wider community for the mutual benefit of both the functioning hospital campus and the local community at large.

Embodied in this approach will be the Travel Plan which addresses issues of local and regional access to the new Works in terms of

a. Car parking provision;

b. Public Transport Nodes;

c. Distance to Local Amenities;

d. Pedestrian routes and links;

e. Facilities for cyclists; and

f. Segregation of emergency servicing and visitor access routes.

The Contractor's objective should be to create an easily accessible healthcare facility which incorporates a Green Transport Strategy, segregates traffic flows and prioritises pedestrian routes. The strategy will require to be jointly developed by the Contractor in conjunction with the Board and Glasgow City Planning Authority taking cognisance of the Board's site-wide masterplan requirements.

Given the nature of the patient group, the children's hospital shall be extensively accessed by family groups and parents at varying time of night and day. Accessibility and amenity in design should take cognisance of this consideration.

The Contractor should consider opportunities in the building for third party development of support facilities such as retail outlets, cafes, health clubs, sports injury clinics, gymnasiums etc.

4.5.2 Sense of Place

The Works shall be designed to compliment and enhance the quality of the design in the locality in which it is sited. It shall create a welcoming, inclusive and vibrant environment, and shall enable easy access by the communities and groups who will use it. It shall be seen as a leading edge community resource reflecting the objectives of a modern NHS in the regeneration of healthcare facilities.

The Works shall be organised to establish a continuity of building frontage and a clear definition of public and private spaces. The viewing of service areas or more "industrial" looking parts of the Works from public entrances or from adjoining public spaces shall be avoided.

4.5.3 Good Neighbour

The Contractor shall ensure they are considered as a 'good neighbour' throughout design and construction periods. It shall add value to the neighbourhood, not detract nor be a nuisance. The Contractor shall register with and fully comply with the requirements of the Considerate Constructors Scheme. All sites registered with the Scheme are monitored by an experienced industry professional to assess their performance against the eight point Code of Considerate Practice which includes the categories Considerate, Environment, Cleanliness, Good Neighbour, Respectful, Safe, Responsible and Accountable.

The three main areas that the Scheme's Code covers are:

a. The Environment: Registered sites should do all they can to reduce any negative effect they have on the environment. They should work in an environmentally conscious, sustainable manner;

b. The Workforce: Registered sites should provide clean, appropriate facilities for those who work on them. Works should be comparable to any other working environment;

c. The General Public: Registered sites should do all they can to reduce any negative impact they may have on the area in which they are working. Sites should aim to leave a positive impression on those they affect.

The Contractor shall provide Works which contribute to improving civic design, sensitive to its relationship with its surroundings, public transport and overall visual impact.

4.5.4 Neighbourhood & Community

The building height, volume and skyline shall relate well to the surrounding environment.

The design shall reflect the importance of the project in the context of community healthcare in the heart of an urban conurbation. Attention shall be paid to detail in the elevations, to ensure that blandness and lack of relief is avoided.

The form of development shall follow any changing topography across the Site, neighbouring properties, existing streetscape and landscape. The design of the Works shall be sensitive to and maximise existing Site features. It is envisaged that the buildings should compliment other new building developments in the area.

4.5.5 Site Fit

New buildings, parking areas, other infrastructure and services shall be located with regard to the existing landscape and topography. Amenity space shall be planned around the buildings at appropriate places.

The Contractor shall ensure that the design of the Works shall take account of the ecological and landscape features of the Site and maximise the retention of trees. There shall be a clear programme for future environmental improvements e.g., an arboricultural strategy for tree management and replanting, dedicated access to external grounds by patients, visitors, local communities and staff.

The design of the Works shall identify areas of the Site as possible expansion zones.

Suitable provision shall be made for refuse storage including provision of appropriate refuse bins and recycling facilities. Full details to be submitted to, and approved by the planning authority prior to the commencement of works

4.5.6 Hard & Soft Landscaping

The landscaping scheme shall be of a high quality. It shall assist in knitting the Works into its surroundings, and provide an interlinked network of attractive public spaces for amenity and circulation for use by patients, staff and visitors. The soft landscape design and choice of species shall be sympathetic to the character of the existing parkland landscape.

External hard and soft landscaping (including courtyards) shall be designed for therapeutic use and provide patient access. The landscape scheme shall facilitate security of pedestrians and avoid 'No-Go' areas. The design shall contribute to improving the environment of the local community.

Both hard and soft landscaping design require to specifically accommodate the needs of children and family groups, particularly in the areas adjacent to/around the children's hospital.

Courtyards adjacent to the amenity area require to be accessible to patients, visitors and staff, with the Contractor to co-ordinate fire escape solutions to support this function.

A comprehensive and integrated landscape strategy taking into account the existing landscape features shall be developed. A clear strategy shall be developed for appropriate formal and informal treatment of public and private areas.

For further detailed landscaping scheme requirements refer to Sections 7.13 and 7.14.

4.6 AEDET and ASPECT

Healthcare building design frequently involves complex concepts which are difficult to measure and evaluate. In order to assist both the Board and the Contractor, the Board expects the Contractor to utilise the Achieving Excellence Design Evaluation Toolkit, more commonly known as AEDET Evolution and the associated supplementary tool ASPECT which are recognised as the exemplars of Design Quality Indicator (DQI) tools.

AEDET and ASPECT are to be used to assist in achieving the appropriate level of project design management and will be specifically directed towards achieving excellence in design rather than ensuring compliance with legislation, regulation and guidance. The toolkit poses a series of clear, non-technical statements, encompassing the three key areas of Impact, Build Quality and Functionality as a tool for evaluating the quality of design in healthcare buildings which have been evolved from sources including the Commission for Architecture and the Built Environment (CABE) and the Construction Industry Council (CIC) to establish an industry-wide framework for assessing design.

AEDET shall be used at various stages during the design – as the level of detail of the information available increases it should be possible to respond to more of the statements in the tool. As a minimum AEDET assessments will take place on the return bids as well as in preparation for FBC.

To complement AEDET Evolution, the Department of Health (England) Estates and Facilities Directorate has developed the ASPECT toolkit. ASPECT stands for A Staff and Patient Environment Calibration Tool and is based on a database of over 600 pieces of research. That research deals with the way the healthcare environment can impact on the levels of satisfaction shown by staff and patients and on the health outcomes of patients and the performance of staff. This research and the ASPECT toolkit itself are set out under 8 headings. When used to support AEDET Evolution ASPECT enables the user to score the Staff and Patient Environment Heading of AEDET Evolution in a more detailed, accurate way.

Section 5.0 General Design & Construction Requirements

5.1 Minimum Design & Construction Standards

5.1.1 NHS Publications

General

5.1.1.1 The Board has considered the documentary advice and guidance provided by Health Facilities Scotland and the Facilities Directorate of the Department of Health in relation to Health Building Notes ("HBN"), Health Technical Memoranda ("HTM"), Fire Practice Notes ("FPN") and other National Health Service published material.

5.1.1.2 The Contractor in carrying out of the Works shall comply with the requirements of the documents listed in *Table 2 – NHS Mandatory Documentation* in Section 5.1.2. Specific statements of compliance form an aspect and element of the bid return and evaluation process and requirements, with the requirement for bidders to clarify their approach during the bid period as an aspect of the dialogue process.

5.1.1.3 The Contractor in carrying out the Works shall have regard to and take into consideration the requirements of the documents listed *Table 3 - NHS Guidance Documentation* in Section 5.1.3. Specific statements of compliance form an aspect and element of the bid return and evaluation process and requirements, with the requirement for bidders to clarify their approach during the bid period as an aspect of the dialogue process.

5.1.1.4 Documents listed in *Tables 2 and 3* (together part of "NHS Publications") are deemed to include all volumes, supplements and any other associated requirements, unless specific volumes, parts or the like are specifically noted or noted as excluded.

5.1.1.5 Any reference to HTM/HBN is deemed to include SHTM/SHPN. The requirements of SHTM/SHPN shall take precedence over HTM/HBN unless expressly required otherwise by the Board and noted in *Table 2 or 3.* Presently *Tables 2 and 3* include reference to HTMs in relation to services systems. It is the intention of the Board that the new SHTMs in these areas, due for release by HFS late April/early May 2009, will be adopted and require to be complied with, as shall other SHTMs issued during the procurement process (subject to 5.1.9 below) – this to be clarified by the Board during the bid period. Current draft documentation is marked in *Tables 2 and 3* in blue shading.

5.1.1.6 In the event of any conflict (including differing requirements or interpretations) between the requirements of the documents listed in *Table 2 or Table 3* and the requirements of building control officers, such conflict should be highlighted to the Board for agreement and resolution. The Contractor shall notify the Board in writing of any such conflict as soon as he becomes aware of same;

5.1.1.7 In the event of any conflict between the requirements of the documents listed in *Table 2 or Table 3* or any other drawn or written information issued by the Board and the Schedule of Accommodation (SoA) information issued by the Board in this ITPD, the SoA identifies the minimum area requirements of the Board (in relation to room sizes).

5.1.1.8 In the event of any conflict between the requirements of the documents listed in *Table 2 or Table 3* and any written or drawn information issued to the Contractor by the Board in this ITPD, the information issued by the Board shall take precedence.

5.1.1.9 All references in these Employer's Requirements to NHS Facilities Scotland Requirements, building and engineering standards, Building Regulations, legislation,

Statutory Requirements, Codes of Practice, Department of Health publications, NHS Publications and other published guidance shall be deemed to mean those in place at the date of signing the construction contract. Any date reference in *Table 2 or Table 3*, therefore, may be replaced/read as that in place at the date of signing the construction contract.

5.1.1.10 Except as noted in 5.1.7 or 5.1.8 above, the Contractor shall provide Works which comply at all times with the requirements of *Table 2, Table 3* and the Additional Guidance identified at Section 5.1.4.

5.1.2 **NHS Mandatory Documentation**

In relation to the architectural design, structural design, and services design of the new buildings comprised in the Works, the documents listed in the following *Table 2* below set out that guidance which the Board considers to be mandatory.

Document	Title
CEL 25	Fire Safety policy for NHS Scotland 2008
SHTM 81	Fire Precautions in new hospitals Version 3
SHTM 82	Alarm and detection systems Version 2
SHTM 82 SUPP A	Automatic fire control systems and voice alarm systems
SHTM 83	Fire safety in healthcare premises - general fire precautions Version 2
SHTM 85	Fire precautions in existing hospitals Version 3
SHTM 86	Fire risk assessment Part 2 Healthcare Premises Version 4
SHTM 87	Textiles and furniture Version 2
HTM 05 – 01	Firecode – Fire safety in the NHS
HTM 05 – 02	Firecode – Fire safety in the NHS
HTM 05 – 03 (incl.)	Firecode – Fire safety in the NHS
HSANs	All published Health and Safety Action Notices
NHSE 10	Cubicle Rails
NHSE HN04	Curtain Tracks
NHSE HN03	Centre Pivot Window
SAN05/08	Flooring Materials
SN(01)01	Cubicle Rail
HVHNs	All published High Voltage Hazard Notices
SHTM	EnCOde – making energy work in healthcare
	EnCOde resource material
CEL 18	Healthcare Associated Infection: SHFN 30 and HAI SCRIBE Implementation Strategy
	HAI SCRIBE
SHFN 30	Infection Control in the built environment:design and planning.

Document	Title
	Access Audit Survey Toolkit V1
	Access Audit Checklist V1
	Fully Accessible Toilets
	SHFN 14 Disability Access
	SHFN Access audits of primary healthcare facilities
SFPN 3	Escape bed lifts Version 2
SFPN 4	Hospital main kitchens Version 2
SFPN 5	Commercial enterprises on hospital premises Version 2
HBN 04-01	Adult in-patient Facilities
HBN 00-04	Common activity spaces: circulation areas
HBN 15 – 03	Hospital helipads
SHTM 00	Scottish Health Technical Memorandum 00: Best practice guidance for healthcare engineering
SHTM 2005	Building Management Systems Parts 1 – 4
HTM 06-01 Part A	Part A Elec Services Supply and Distribution
HTM 06-01 Part B	Part B Elec Services Supply and Distribution
Draft for Consultation SHTM 06-01 Part A	Part A Elec Services Supply and Distribution
Draft for Consultation SHTM 06-01 Part B	Part B Elec Services Supply and Distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 3 of 4): Validation and verification Electrical services: supply and distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 4 of 4): Operational management Electrical services: supply and distribution
SHTM 2009	Pneumatic Tube Systems Parts 1 – 2
SHTM 2010	Sterilization Parts 1 – 6
SHTM 2011	Emergency Electrical Services Parts 1 – 4
SHTM 2014	Abatement of Electrical Interference Parts 1 – 4
SHTM 2015	Bedhead services
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	SHTM 2015 forms
SHTM 2020	Electrical safety code for low voltage systems
	Volume 1 Operational management
	SHTM Volume 1 forms
	HTM Volume 2 forms

Document	Title
SHTM 2021	Electrical safety code for high voltage systems
	Part 1 Overview and management responsibilities
	Part 2 Operational management
	SHTM 2021 forms
HTM 02-01 Part A	Medical gas pipeline systems : Part A
HTM 02-01 Part B	Medical gas pipeline systems : Part B
Draft for Consultation SHTM 02-01 Part A	Medical gas pipeline systems : Part A
Draft for Consultation SHTM 02-01 Part B	Medical gas pipeline systems : Part B
SHTM 2022 March 2004	Supp 1 Dental compressed air and vacuum systems
	SHTM 2022 forms
SHTM 2023	Access and accommodation for engineering services
	Part 1 Overview and management responsibilities
	Part 2 Good practice guide
SHTM 2024	Lfts
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	Part 3 Validation and verification
	Part 4 Operational management
	SHTM 2024 forms
HTM 03-01	Specialised Ventilation for Healthcare Premises
HTM 03-01 Part B	Specialised Ventilation for Healthcare Premises Part B
HTM 03-01 Part A	Specialised Ventilation for Healthcare Premises Part A
Draft for Consultation SHTM 03-01 Part A	Specialised Ventilation for Healthcare Premises Part A
Draft for Consultation SHTM 03-01 Part B	Specialised Ventilation for Healthcare Premises Part B
	SHTM 2025 forms
SHTM 2027	Hot and cold water supply, storage and mains services
	Part 1 Overview and management responsibilities
	Part 4 Validation and verification
HTM 04-01 Part A	Control of Legionella...drinking systems Part A
HTM 04-01 Part B	Control of Legionella...drinking systems Part B
Draft for Consultation SHTM 04-01 Part A	Control of Legionella...drinking systems Part A
Draft for Consultation SHTM 04-01 Part B	Control of Legionella...drinking systems Part B

Document	Title
SHTM 2030	Washer disinfectors
	Part 1 Design considerations
	Part 2 Operational management
	Part 3 Validation and verification
SHFN	Access Audit Survey Toolkit V1
SHFN	Access Audit Checklist V1
SHFN	Fully Accessible Toilets
SHFN 14	Disability Access
SHFN	Access audits of primary healthcare facilities
SFPN 3	Escape bed lifts Version 2
SFPN 4	Hospital main kitchens Version 2
SFPN 5	Commercial enterprises on hospital premises Version 2
HBN 00 -02	Sanitary spaces
HBN 04-01	Adult in-patient Facilities
HBN 00-04	Common activity spaces: circulation areas
HBN 15 – 03	Hospital helipads
SHTM 00	Scottish Health Technical Memorandum 00: Best practice guidance for healthcare engineering
SHTM 2005	Building Management Systems: Parts 1 – 4 (incl)
HTM 06-01 Part B	Part B Elec Services Supply and Distribution
HTM 06-01 Part A	Part A Elec Services Supply and Distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 3 of 4): Validation and verification Electrical services: supply and distribution
SHTM 2007	Scottish Health Technical Memorandum 2007 (Part 4 of 4): Operational management Electrical services: supply and distribution
SHTM 2009	Pneumatic Tube Systems: Parts 1 – 2 (incl)
SHTM 2010	Sterilization: Parts 1 – 6 (incl)
SHTM 2011	Emergency Electrical Services: Parts 1 – 4 (incl)
SHTM 2014	Abatement of Electrical Interference: Parts 1 – 4 (incl)

Document	Title
SHTM 2015	Bedhead services
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	SHTM 2015 forms
SHTM 2020	Electrical safety code for low voltage systems
	Volume 1 Operational management
	SHTM Volume 1 forms
	HTM Volume 2 forms
SHTM 2031	Clean steam for sterilization
SHTM 2035	Mains signalling
	Part 1 Overview and management responsibilities
	Part 2 Design considerations
	Part 3 Validation and verification
SHTM 2040	The control of legionellae in healthcare premises – a code of practice
	Part 1 Overview and management responsibilities
	Part 4 Validation and verification
	Part 5 Good practice guide
	Part 6 supplementary guidance applicable to intermittently used healthcare premises
	SHTM 2040 forms
HTM 08-01	Acoustics
MEIGaN	Medical Electrical Installation Guidance Notes (MEIGaN)
SHTM 54	User Manual
SHTM 55	Windows
SHTM 56	Partitions
SHTM 57	Internal glazing
SHTM 58	Internal doorsets
SHTM 59	Ironmongery
SHTM 60	Ceilings
SHTM 61	Flooring
SHTM 62	Demountable storage systems
SHTM 63	Fitted storage systems
SHTM 64	Sanitary assemblies

Document	Title
SHTM 66	Cubicle curtain track
SHTM 67	Laboratory fitting out systems
HTM 68	Duct and Panel assemblies
SHTM 69	Protection
Draft for Consultation SHTM 87	Textiles & Furniture

Table 2 – NHS Mandatory Documentation

5.1.3 **NHS Guidance Documentation**

In relation to the architectural design, structural design, and services design of the new buildings comprised in the Works, the documents listed in the following *Table 3* set out that guidance which the Board considers to be guidance.

Document	Title
	NHSSCOTLAND National Cleaning Services Specification
SFPN 6	The prevention and control of deliberate fire-raising in NHS Scotland healthcare premises Version 3
SFPN 10	Laboratories on hospital premises
SFPN 11	Reducing unwanted fire signals in healthcare premises
SHGN	Magnetic Resonance Imaging
SHGN	"Safe" hot water and surface temperatures
SHGN	Static discharges
SHGN	Structured cabling for IT systems
SHTN 2	Domestic Hot and Cold Water Systems for Scottish Health Care Premises
SHTN 4	General Purpose Estates and Facilities Model Safety Permit-to-Work System
SHTN 5	The Operation and Management of Emergency Electrical Generators in Scottish Healthcare Premises
SHTN 6	The Safe Operation and Maintenance of Thermostatic Mixing Valves
SHPN 03	General Design Guidance
SHPN 06 Part 1	Facilities for diagnostic imaging and interventional radiology
SHPN 08	Facilities for rehabilitation services
SHPN 13 Part 2	Decontamination Facilities: Local Decontamination Units
SHPN 20	Facilities for mortuary and post mortem room services
SHPN 22	Accident and emergency facilities for adults and children

Document	Title
SHPN 27	Intensive care unit
SHPN 28	Facilities for cardiac services
SHPN 35	Accommodation for people with mental illness
SHPN 52	Accommodation for day care: Day surgery unit
SHPN 52	Accommodation for day care: Endoscopy unit
SHPN 52	Accommodation for day care: Medical investigation and treatment unit
SHPN 54	Facilities for cancer care centres - design and briefing guide
Draft for Consultation SHPN 06 Part 2	Facilities for Diagnostic Imaging
Draft for Consultation SHPN 23	Hospital Accommodation for Children and Young People
Draft for Consultation SHPN 28	Facilities for Cardiac Services
Draft for Consultation SHPN 57	Facilities for Critical Care
	Wayfinding: Effective Wayfinding and Signing Systems guidance for healthcare
	Handover checklist for buildings
HBN 04 Supp	Isolation facilities in acute settings
HBN 06	Facilities for diagnostic imaging and interventional radiology
HBN 06 Vol 2	PACS and specialist imaging
HBN 06 Vol 3	Extremity and open MRI
HBN 08	Facilities for rehabilitation services
HBN 10	Catering department
HBN 12	Out-patients department
HBN 22	Accident and emergency facilities for adults and children
HBN 23	Hospital accommodation for children and young people
HBN 26	Operating Departments – Facilities for Surgical Procedures
HBN 28	Facilities for Cardiac Services
HBN 29	Accommodation for pharmaceutical services
HBN 37	In-patient facilities for older people
HBN 40 Vol 1	Common activity spaces: public areas
HBN 40 Vol 2	Common activity spaces: treatment areas
HBN 40 Vol 3	Common activity spaces: staff areas

Document	Title
HBN 45	External works for health buildings
HBN 51	Accommodation at the main entrance of a District General Hospital
HBN 52 Vol 1	Accommodation for day care: Day surgery unit
HBN 52 Vol 1 Supp 1	Review of schedules of accommodation
HBN 52 Vol 3	Accommodation for day care: Medical investigation and treatment unit
HBN 54	Facilities for cancer care centres
HBN 57	Facilities for critical care
HBN 00 -02	Sanitary spaces
HBN 00 – 07	Resilience planning for the healthcare estate
HBN 07 – 01	Satellite dialysis units
HBN 07 – 02	Main renal units
HBN 09 – 02	Maternity care facilities
HBN 14 – 01	Pharmacy and radiopharmacy
HFN 05	Design against crime: a strategic approach to hospital planning (now archived)
NHS Estates Improving the Patient Experience	Friendly healthcare environments for children and young people
NHS Estates Improving the Patient Experience	Welcoming Entrances and reception areas
NHS Estates Improving the Patient Experience	The Art of Good Health : Using visual arts in healthcare
NHS Estates Improving the Patient Experience	The Art of Good Health : A practical guide

Table 3 - NHS Guidance Documentation

5.1.4 **Additional Guidance**

5.1.4.1 Further to the requirement noted in Section 2.2, that the Contractor shall comply with all Law and Consents, and the requirements in relation to NHS Mandatory Documentation and NHS Guidance Documentation above, the Contractor shall also comply with the standards and documents listed below.

a) Health and Safety Legislation, including Construction (Design and Management) Regulations 2007;

b) The Technical Standards complying with the Building Standards (Scotland) Regulations 1990 as amended by all subsequent Amendment Regulations;

c) Disability Discrimination Act 1995;

d) Current British Standards, European Standards, and Codes of Practice, as appropriate;

e) Strathclyde Fire Brigade and the Glasgow City Council's Fire Officer requirements;

f) The Board's Approved Codes of Practice, Procedure and Policy documents as listed in Appendix G;

g) Control of Substances Hazardous to Health;

h) Health Department Letters (or Management Executive Letters) as appropriate published by SEHD;

i) NHS QIS (Quality Improvement Scotland) 2003;

j) NHS Model Engineering Specifications;

k) The Building (Scotland) Act 2003;

l) The Building (Scotland) Regulations 2004;

m) Requirements of the utilities companies;

n) Building Research Establishment Digest Recommendations;

o) Local Bye-Law and Regulations;

p) Scottish Centre for Infection and Environmental Health guidance / recommendations;

q) All other bodies and authorities having jurisdiction;

r) Secure by Design;

s) The Ionising Radiations Regulations 1999 (IRR99);

t) The Radioactive Substances Act (1993);

u) Medical and Dental Guidance Notes: A good practice guide on all aspects of ionising radiation protection in the clinical environment, Institute of Physics and Engineering (IPEM), York, 2002;

v) Various related to the additional security required re use of radioactive materials e.g. IRR99, RSA93, NHS Security Management guidance note 001/2004;

w) Guidelines for the use of PET-CT in Children (UK PET-CT Advisory Board), British Nuclear Medicine Society (BNMS), London, 2008;

Healthcare interpretation of IEE Guidance Note 7 (Chapter 10) and IEC 60364-7-710 for Electrical Installations in Medical Locations. Annex to MEIGaN, Leeds, June 2005;

x) Releasing Time To Care (RTTC): The Productive Ward (NHS Innovations, 2008);

z) Delivering Quality & Value, Institute for Modernisation & Improvement;

aa) The Internal Environment: Evaluation of the King's Fund, Enhancing the Healing Environment Programme (NHS Estates, 2004);

bb) Lighting and colour for hospital design, Dalke et. Al. (NHS Estates, 2004);

cc) The role of hospital design in the recruitment, retention and performance of NHS nurses in England, CABE, July 2004;

dd) Notes for Guidance on the Clinical Administration of Radiopharmaceuticals and Use of Sealed Radioactive Sources, Administration of Radioactive Substances Advisory Committee (ARSAC);

ee) Provision of Paediatric Radionuclide Imaging Services, British Nuclear Medicine Society (BNMS), London, 2003;

ff) Published papers on operational radiation safety e.g. Zanzonico P et al, Operational Radiation Safety for PET-CT, SPECT-CT and cyclotron facilities. Health Physics 2008;

gg) Standards for Intensive Care Units, A Joint Document for the Intensive Care Society and the Intercollegiate Board for Training in Intensive Care Medicine, May 2006;

hh) Leather P, Pyrgas M, Beale D and Lawrence C. Windows in the Workplace: Sunlight, View and Occupational Stress. Environment and Behaviour 1998; 30: 739 – 762;

ii) Leslie RP. Capturing the Daylight Dividend in Buildings: Why and How? Building and Environment 2003; 38: 381 – 385;

jj) Heerwagen J. Green Buildings, Organizational Success and Occupant Productivity. Building Research and Information 2000; 28: 353 – 367;

kk) National Overview – Adult Renal Services (March, 2003) NHS Quality Improvements Scotland;

ll) Adult Renal Services (Feb, 2002) Clinical Standards Board for Scotland;

mm) Treatments of Adults & Children with Renal Failure – Standards & Audit Measures, 3rd Edition, Renal Association (August, 2002);

In addition the renal COS notes that water treatment should reach a minimum of the following standards:

nn) The higher European Pharmacolela (EP) XV1 standard :'Water for diluting concentrated haemodialysis solutions';

oo) ISO 13959: 'Water for haemodialysis and related therapies' or
AAMI (Association for the Advancement of Medical Instrumentation) standards; and

pp) European Renal Association Best Practice Guidance – 4th Edition 2007. NB New guidelines are due in 2009 and should be considered at that time.

5.1.4.2 The Contractor shall provide to the Board at Completion a certificate confirming that the Works comply with the requirements of NHS Scotland Firecode.

5.1.4.3 The Contractor shall provide all fixed and portable fire fighting equipment to comply with statutory requirements and the requirements and recommendations of NHS Scotland Firecode.

5.1.4.4 The Contractor shall ensure that the Works comply with the relevant requirements of Building Better Healthcare Volume 3 (published by NHS Estates); except insofar as there are NHS Scotland publications, which shall take precedence over the respective elements of Building Better Healthcare.

5.2 Hierarchy of Standards

5.2.1 Where there is any conflict between two or more documents, the more onerous standard shall be complied with by the Contractor, at no additional cost to the Board.

5.2.2 NHS Scotland standards shall take precedence over equivalent NHS England & Wales standards unless the NHS England & Wales standard is specifically identified in *Table 2 or Table 3*.

5.2.3 In certain instances, NHS Publications include a number of options or alternative solutions. Where the Board has defined their preference in *Table 2, Table 3* or in these Employer's Requirements the Contractor shall adopt these preferences as a mandatory requirement. As is noted in 5.1.1.2 and 5.1.1.3, the Contractor shall identify their interpretation and choice (of any options within documents) in NHS Publications during the bid period (to which the Board will review and respond) with compliance statements required in their bid return.

5.2.4 While the Board has placed a clear obligation on the Contractor in relation to NHS Publications, it also wishes to acknowledge that in certain cases the subject matter, guidance and advice included therein has been further developed and improved since the date of publication. While applying the foregoing as a base position, the Board does not wish to limit the use of current best practice or innovation in relation to the adoption of design standards. Consequently, the Board therefore wishes the Contractor to actively engage the Board in an on-going dialogue during the design process in order for the Board to review and agree to any proposed alternatives.

5.2.5 The Board considers NHS Publications reflect minimum standards and any alternatives proposed by the Contractor shall provide an equivalent or enhanced level of service and quality.

5.2.6 Further to the statements above in relation to NHS Publications, it should be noted that the Schedules of Accommodation (SoA) in Appendix C take precedence with regard to room sizes. The room sizes therein must be provided by the Contractor as a minimum requirement.

5.2.7 Further to the statements above in relation to NHS Publications, the following hierarchy of other design related documents shall apply (in order of precedence):

a. 1:50 drawings;

b. Room Data Sheets; and

c. Equipment Lists.

5.3 Life Expectancies & Lifecycle Requirements

5.3.1 The buildings, including building services components, shall be designed with materials, components and techniques that are readily available, reliable, sustainable and easily maintainable in use. The Board supports buildings constructed of proven technology components, with high life expectancy, leading to minimum cost in use.

5.3.2 Good Industry Practice for a design life at Completion for the elements listed below shall as a minimum be as indicated in the table below:

Table 1 – Component Life Expectancies

Building Element	Expectancy
Structure, including substructure	70 years
Floor structure	70 years
Roof structure	70 years
Drainage and below ground civil engineering infrastructure	70 years
External walls	45 years
External openings, windows, doors and curtain walling	25 years
Roof finishes	40 years
External Wall finishes	25 years
External hard surfaces (inc roads/carparking/footpaths etc)	Not less than 20 years to first maintenance
Internal partitions including openings	30 years
Internal doors	15 years
Internal finishes	15 years
Internal fixtures and fittings	15 years
Ironmongery	15 years
Engineering plant Volume B	CIBSE Guide
Engineering services distribution systems Volume B	CIBSE Guide

5.3.3 The Contractor shall demonstrate that the theoretical design life proposed for any element will be achieved.

5.3.4 Materials and components forming part of the Works, which require maintenance and replacement within the life of the Works, shall be selected, located and fixed in such a way as to minimise future inconvenience, disruptions and to avoid temporary closure of the Works.

5.3.5 Lifecycle Costs

5.3.5.1 It is a requirement of the Bid that a detailed Life Cycle Cost Plan (LCCP) be provided for the new facilities – it is envisaged that 3no.separate LCC Plans will be required for the project;

a. Acute Adult Hospital;

b. Childrens Hospital; and

c. Laboratory Block.

NB – it is assumed that External Works and FM/Energy Centre etc buildings will be separately identified and incorporated into the Acute Adult Hospital LCCP.

5.3.5.2 It is a requirement that the LCCP's be produced in accordance with the methodology as detailed in the following documentation;

a. BS ISO 15686 – 5 2008; Building & Construction Assets – Service Life Planning – Part 5 – Life Cycle Costing; and

b. Standardized Method of Life Cycle Costing for Construction Procurement

5.3.5.3 LCCP submissions to follow the formats as detailed in the above documentation, utilising the following base criteria:

Table 2 – Life Cycle Cost Plan component elements

REF	ELEMENT	DESCRIPTION	REQUIREMENT
1.0	Design Life	n.a.	60 years
2.0	LCCP Duration	Period to be considered within LCCP (NB – excluding Construction Period)	30 and 60 years
3.0	Discount Rate	NVP rate	3.5%
4.0	Base Date	Base Date for Costs	Acute & Childrens Hospitals – 1Q2015 Laboratory Block – 1Q2012
5.0	Client On Costs	Bidders to **exclude** Client On Costs to LCCP values	n.a.
6.0	LCCP inclusions	Schedule of LCC Information and Assumptions	
6.1	LCCP Summary Sheet	Elements for inclusion in Life Cycle Cost Plan	All as detailed in Standardized Method Appendix F.3&4, with the following **exclusions:** 1.3 – Client Definable Costs 2.7 – Client Definable Costs 3.1.2 – Internal Cleaning 3.1.3 – Specialist Cleaning 3.3. – Administrative Costs 3.4 – Overhead Costs 3.5 – Taxes 3.6 – Client Definable Costs. 4.17 Occupancy Costs 5.3 – Reinstatement & Dilapidations 5.4 – Client Definable Costs

6.2	LCCP Data Sheets		Data sheets to itemise: • Component Description • Work Description • Quantity • Unit • Component Cost Rate (£) • % Allowance of Cost Rate for Replacement • % Allowance for Replacement • Replacement Factor • Life Expectancy of Component • Number of Replacements • Cost per Replacement (£) • Total Cost of Replacement (£)
			All above elements to be provided in BCIS Elemental format
6.3	FM Data Sheets (Hard FM only)	Bidders to allow for the following FM Services: • Minor replacements, repairs & maintenance costs • Unscheduled repairs, replacement & maintenance costs • Grounds Maintenance	Data sheets to itemise: • Management Costs • Staff/Contracted Costs • Materials • Equipment Bidders to **exclude** Client On Costs to FM Services values

5.3.3.4 Although the Contractor will not be involved in the provision of FM Services, the proposed Design will impinge on the Boards operation of the facilities, and to this end the evaluation of the Bidders overall submission will take into account proposals to minimise the potential operating costs;

5.3.3.5 Bidders should therefore indicate where measures in relation to the following criteria have been utilised

a. 'Spend to Save' specification enhancement;

b. Design detailing;

c. Controls;

d. Standardisation; and

e. Modular construction.

5.3.3.6 All Innovation & Sustainability initiatives proposed by the Bidder, should be supported by a full Lifecycle Cost Plan as detailed above, and include;

a. Items as detailed in Section 6.1/2 – of the above LCC table;

b. Projected Energy & Carbon savings;

c. Payback period; and

d. Items as detailed in Section 6.1/3 – FM Data Sheets of the above LCC table.

5.3.3.7 The Bidders attention is drawn to the BREAAM LCC requirements, which need to be encompassed as part of the overall LCCP submission – all as detailed in Appendix U.

5.3.3.8 In connection with the above, and for bid comparison purposes, Energy consumption/savings calculations should utilise the following base cost and associated allowances;

a. Electrical consumption – 10p / KwH;

b. Gas consumption – 3.5p / KwH;

c. Oil consumption – 41p / litre;

d. Water consumption – £2.20 / m3;

e. Waste material disposal (bagged) – £60/ton;

f. Carbon production/reduction data to be provided to support above proposals; and

g. Payback periods to be provided.

5.4 Integration of Design

The Contractor is responsible for the integration of the various aspects and elements of the design of the Works.

5.4.1 Architectural / Structural Interface

5.4.1.1 Structural floors shall be designed to have penetrable zones co-ordinated with the modular framework for partitions and services.

5.4.1.2 Structural timber floors shall not be permitted.

5.4.1.3 Columns shall be located in-so-far, as is reasonably practical to coincide with corridor walls in order to minimise intrusion into rooms or corridors. The relationship of column ducts and walls shall permit clear internal room surfaces and not obstruct equipment or fittings.

5.4.1.4 As far as practical, the walls to vertical service shafts shall be non-load bearing and therefore maximising opportunity for future services installation, alteration and maintenance.

5.4.1.5 The elevation design shall facilitate distribution of services at the building perimeter.

5.4.2 **Integration with Engineering Services**

5.4.2.1 Internal walls, partition systems, ceiling voids and service risers shall be capable of integrating services, e.g. wiring, plumbing, medical gases and service terminals as required without detriment to the performance of any building services and other Works performance criteria such as fire resistance or acoustic properties. Services shall be co-ordinated and a satisfactory means of maintenance access shall be provided.

5.4.2.2 So far as is reasonably practicable, vertical service shafts shall not be surrounded by load bearing structural walls, to facilitate services installation and future alterations.

5.4.2.3 The Contractor shall be responsible for bunding and waterproof slab construction above theatres and in plant rooms to provide resilience and avoid flooding whilst ensuring functionality of engineering services.

5.4.3 **Manual Handling**

5.4.3.1 The Contractor, in the design of the Works, shall give due consideration to the obligations contained in the Manual Handling Regulations 1992 and ensure the appropriate allocation of space and structural capacity for the inclusion of mechanical devices, i.e. fixed and mobile hoists, robotic equipment and all FM, staff and patient lifts.

5.5 Sustainability

5.5.1 The Board has a significant asset base and, as a responsible healthcare provider and employer, it is committed to sustainability and carbon reduction in line with relevant and appropriate guidance and directives in this area. The Board has targeted an 'Excellent' BREEAM rating for the Project.

5.5.2 The specific sustainability considerations with regard to the Project and the requirements of the Contractor in this respect are detailed in Section 10.0 and Appendix M.

5.6 Control of Infection

5.6.1 Prevention and control of infection shall remain a primary consideration of the Contractor in the design and construction of the Works. The whole hospital design shall place a high priority on infection prevention and control in relation to the movement of goods and in particular the segregation as far as is reasonably practicable of clean linen, food trolleys and the removal of waste, soiled linen and empty food trolleys. The Contractor will be required to demonstrate to the satisfaction of the Board's Infection Control Team that the design and construction of the Works fully reflects and incorporates the following key infection control challenges;

a) Segregation of clean and dirty – laundry, food, healthcare waste;

b) Ventilation system – including the use of natural ventilation in relation to the affect by neighbourhood sources of environmental pollution;

c) Selection of Fixtures/fittings/flooring that are easy to clean and maintain;

d) Appropriate Isolation facilities;

e) Incorporation of appropriate workflows;

f) Handwash hygiene;

g) Wastewater and sewage/body fluid disposal;

h) Heating and lighting;

i) Water systems;

j) Food preparation.

5.6.2 The Contractor shall provide that all aspects of the Works allow the control and management of an outbreak and spread of infectious diseases in accordance with the following;

a. Infection Control in the Built Environment: Design and Planning (SHFN 30);

b. NHS Scotland HAI Scribe (Healthcare Associated Infection System for Controlling Risk In the Built Environment);

c. Scottish Infection Manual – 'Managing the Risk of HAI in NHS Scotland';

d. Guidance provided by Clinical Standards Board NHS QIS;

e. Textiles and Furniture (SHTM 87);

f. Ventilation in Healthcare Premises (SHTM 2025); and

g. The location of maintenance access to services and requirements of SHTM2023.

5.7 Design for Disability

5.7.1 The design shall comply with the requirements of the Disability Discrimination Act 1995, and take full consideration of HFN14 "Disability access", HFN20 "Access audits for primary healthcare facilities" and BS 8300:2001 “Design of buildings and their approaches to meet the needs of disabled people – code of practice”. Further guidance is provided in the NHS publication "Doubly Disabled: Equality for disabled people in the new NHS - Access to services”.

5.7.2 The Contractor shall ensure that the design and functionality of the Works meets the requirements of the Disability Discrimination Act 1995 as relevant and set standards of best practice to enable full access and use of the services and facilities available.

5.7.3 Entrances to the Works shall be clearly identified to promote ease of wayfinding and distinctive ‘landmarks’ shall be incorporated into the design particularly for the main entrances.

5.7.4 The Works’ environment, both externally and internally, shall be designed to be accessible to everyone. The journey onto the Site, from pedestrian / vehicle routes, through the main receptions, into the Works and to the desired locations shall follow a safe, logical and clear system.

5.7.5 Attention shall be paid in the design to all aspects of the physical environment relating to the accessibility of the Works as follows:

a. Access to buildings, such as level or ramped entry;

b. Emergency evacuation arrangements, in particular for the visually impaired, the disabled and the frail, such as fire refuges or alternative escape routes for people with mobility impairments;

c. The accessibility of external paths and landscaping;

d. Circulation within buildings, including their interior layout;

e. Effective lighting and signage and colour or tone contrast on doors to aid orientation;

f. Desks, laboratory benches, work surfaces and reception desks at varying or flexible heights;

g. Appropriate seating;

h. Accessible toilets; and

i. Convenient and reserved parking spaces for those who need them.

5.7.6 The Contractor shall ensure, as far as practically possible, that the Works design draws upon and endeavours to further develop improve and exceed current best practice and standards achieved in other similar projects, and incorporates full accessibility for the prospective patient groups, staff and public. This shall include aspects of both physical environment and visual and audio aids to enable full use of the Works for all groups. This philosophy of design shall be extended across all parts of the Works including access to the landscaped and external areas as well as the essential patient treatment and residential areas.

5.7.7 The Contractor shall ensure the design complies with the general accessibility ethos detailed above, whilst also addressing the detailed requirements listed elsewhere. It should be noted

that the requirements detailed are not exhaustive, and it is also recognised that specific clinical needs will determine the nature and design of Works in some areas.

In particular it is highlighted that the Works will be used by a high proportion of wheelchair users. The Contractor shall ensure that any fire evacuation procedures take full account of this.

In meeting the overarching obligations with respect to accessibility, The Contractor shall comply with the following non-exhaustive list of standards:

a. BS8300:2001 "Design of buildings and their approaches to meet the needs of disabled people – Code of practice";

b. HFN 14 "Disability Access" and HFN20 "Access audits for primary healthcare Facilities";

c. HFN 20 "Access audits for primary healthcare Facilities" ;and

d. HFN 21 "Car parking".

5.7.8 BS8300:2001 is widely referred to by consultants advising on general building design in relation to the Disability Discrimination Act (1995). The Contractor shall therefore refer to this document and give full regard to its standards. It will, however be necessary to match the standards of BS8300 with others laid down in NHS guidance notes etc.

5.7.9 The Contractor shall also comply with further guidance contained in the NHS publication "Doubly Disabled: Equality for disabled people in the new NHS - Access to services".

5.7.10 The obligations with respect to accessibility, as described in this Part 8 Section 3, are intended to reinforce the principles established within BS8300. Some, however, stand as requirements that deliberately exceed the minimum stated within BS8300. For the avoidance of doubt, specific accessibility requirements listed in this Part 8 Section 3 shall take precedence over the standards laid down in BS8300.

5.8 Equipment Requirements

5.8.1 The Equipment List is contained in Appendix F. This identifies equipment by Group (for pricing in bid returns), with location of equipment ascertained via the ADB Room Data Sheets (for all rooms) and exemplar 1:50s for those drawn at this stage. Group 1 Equipment shall be supplied and fitted by the Contractor, with Group 2 Equipment provided "free issue" to the Contractor by the Board and fitted by the Contractor. The Board are responsible for the supply and installation of Group 3 and Group 4 Equipment.

5.8.2 Notwithstanding the party who provides/supplies equipment, the Contractor shall identify and provide all necessary fixings and supports (to walls, ceilings and floors) connections and infrastructure (including supply, extraction and removal of waste) for all items of equipment listed in Appendix F.

5.8.3 The Contractor shall provide a suitable environment for each item of equipment as set out in the Room Data Sheets, this shall include accounting for temperature and ventilation requirements.

5.8.4 For the avoidance of doubt, this requirement specifically includes MEIGaN compliance and specialist service requirements by the Contractor, including for example 3-phase electrical supply, surge protection, standby power supply, ups, special water supply requirements and separation of contaminated waste.

5.8.5 For the avoidance of doubt, this requirement specifically includes the installation of renal water equipment and supplies by the Contractor to the meet the requirements of the Board.

5.8.6 Irrespective of the party responsible for the supply, installation, maintenance and replacement of each item of equipment, the Contractor shall provide Works that satisfy the following criteria:

a) allow Equipment and associated systems to be installed, commissioned, operated, maintained and replaced in accordance with:

   i) Good Industry Practice;

   ii) Manufacturer's instructions; and

   iii) The Board's, statutory health and safety requirements.

b) Allow Equipment and associated systems to operate efficiently, effectively and in accordance with its intended function for the whole of its design life when operated in accordance with the manufacturer's requirements;

c) Take due account of the impact on the environmental conditions within the Works;

d) Take due account of the potential impact of future equipment changes through either refresh or replacement. In particular, allowance for equipment of different sizes, weights, service requirements or environmental impacts;

e) Allow the Board to provide their Clinical and Non-Clinical Services with a minimum of disruption during installation, commissioning, operation, maintenance and replacement; and

f) Provide safe and unencumbered access for maintenance and replacement of equipment during the buildings life, to include pulley hoists, barrier walkways and

landings and reinforced routes and areas as necessary to assist the safe removal and replacement.

5.8.7 The construction, structure, plant and services shall be designed to meet the specific requirements for Special Equipment and associated services. The design of the Works shall meet these requirements with regards to mechanical and electrical servicing, wall and floor loads, structural movement and deflections, the need for special (including protected) floors, wall supports, ceiling grids and other such measures to allow for the installation, maintenance and replacement of Special Equipment and associated services. Specific Special Equipment is identified in Appendix F.2. The particular interface arrangements between the Contractor and the Board with regard to the provision and fit-out of Special Equipment shall be finalised during the Competitive Dialogue process.

5.8.8 The Contractor shall not change the Group designation of any Equipment. The Equipment List issued at Appendix F.1 shall be priced and submitted in the bid return with no additions, omissions or changes unless requested in writing by the Board as an aspect of the bid period.

5.8.9 The procurement, delivery and installation of Group 2 Equipment shall be as follows:

a) The Contractor shall procure and deliver, or arrange for the delivery to Site, all Group 2 Equipment to a secure central holding area (suitable for the equipment to be stored) to be provided by the Contractor. The holding area requires to be accessible by vans, 7t trucks and articulated vehicles – with vehicle movements in the operation of dropping off or picking up from the holding area to be managed by the Contractor;

b) The off loading or up loading of any Group 2 Equipment will be attended by the Contactor who shall acknowledge receipt of every delivery and sign the relevant delivery receipts to that effect. The Contractor shall manage and carry out the conveying of all Group 2 Equipment into the holding area;

c) The Contractor shall manage the movement and delivery of all Group 2 Equipment from the holding area to the point of installation in time for installation the same day;

d) The Contractor shall prepare and maintain a log of all Group 2 Equipment delivered to Site in an electronic and paper format, providing monthly updates to the Board of the status of delivered, stored and installed Group 2 Equipment; and

e) Should the Contractor arrange for a secure central holding area off or adjacent to the Site the Contractor remains responsible for the Group 2 Equipment that has been delivered and the movement of same to the Site for installation.

5.9 Materials

5.9.1 The Contractor shall ensure that all materials incorporated into the Works shall comply with the requirements of the Construction Products Regulations 1991, and all aspects of the Employer's Requirements.

5.9.2 The Contractor shall ensure that all products and materials to be incorporated into the Works shall be new unless otherwise agreed by the Board.

5.9.3 Where materials and components are not specifically identified as complying with the Construction Products Regulations 1991, The Contractor shall ensure that they comply with the relevant British Standards and Codes of Practice.

5.9.4 The Contractor shall ensure that the whole quantity of each product and material required to complete the Works is of a consistent type, quality and overall appearance and is fit for its intended purpose. The Contractor shall ensure all products and materials are handled, stored, prepared and used or fixed strictly in accordance with the manufacturers' written instructions or recommendations and not be damaged when incorporated into the Works.

5.9.5 The Contractor shall not construct the Works utilising substances which are hazardous to health, including but not limited to substances referred to as being hazardous to health and safety in "The Control of Substances Hazardous to Health Regulations 2002".

5.9.6 The Contractor shall not specify or include products or materials that do not comply with relevant British or European Standards, Codes of Practice or which are generally known within the European Union at the time of specification to be deleterious to health and safety or to the durability of buildings and / or other structures and / or finishes and / or equipment, plant and machinery in the particular circumstances in which they are used. Such materials include but are not limited to:

a) High alumina cement in structural elements;

b) Marine aggregates or their derivatives where the chloride iron content by mass of cement exceeds the requirements of Table 4 of BS 5328: Part 1;

c) Aggregates where the drying shrinkage characteristics, when tested in accordance with BS 812: Part 120, exceed a value of 0.05%;

d) Aggregates for use in reinforced concrete which do not comply with BS 882 or with the provisions of BS 8110;

e) Water used in construction or manufacture which is not clean, fresh or free from chemical or organic impurities or does not otherwise comply with BS 3148;

f) Concrete where the total mass of the reactive alkali in the concrete mix exceeds the recommendations set out in the Concrete Society Technical Report No 30;

g) Woodwool slabs in permanent formwork to concrete or in structural elements;

h) Calcium chloride in admixtures for use in reinforced concrete or reinforced masonry construction;

i) Calcium silicate bricks incorporated within any load-bearing part of the structures, or other areas of the construction which are deemed to be load-bearing in any way;

j) Asbestos or asbestos-containing products;

k) Lead, or any material containing lead, which may be ingested, inhaled or absorbed, except where copper alloy fittings containing lead are specifically required in drinking water pipework by any statutory requirement or in architectural design features (e.g. weather flashings, radiation protection);

l) Urea formaldehyde foam, or materials which may release formaldehyde in quantities which may be hazardous with reference to the limits set from time to time by the HSE, at the time of incorporation in to the Works comprising the project;

m) Softwood used externally, except for non structural landscaping or in areas agreed with the Board (e.g. pressure treated pine decking);

n) Slipbricks;

o) Polyisocyanurate foam;

p) Polyurethane foam;

q) Extruded polystyrene other than low ozone depletion materials;

r) Other substances, which at the time of their incorporation into the project, have been designated by the Building Research Establishment and published in their Digest, as deleterious to health and safety or deleterious to the building fabric, including both substructure and superstructure, in the particular circumstances in which these substances are used;

s) Products associated with the destruction or depletion of tropical rain forest or threatened animal species;

t) Products or manufacturing processes which cause the emission of pollutants, armful radiation or ozone depleting chemicals, as identified in the Montreal Protocol;

u) Use of noxious substances including DoE “Red List” and EC “List 1” substances;

v) Materials which are generally composed of mineral fibres, either man-made or naturally occurring, which have a diameter of 3 microns or less and a length of 200 microns or less, or which contain any fibres not sealed or otherwise stabilised to ensure that fibre migration is prevented;

w) Lightweight or air-entrained concrete bricks;

x) Iberian roof slates; and

y) Fibrous boards, including MDF board, in any external construction work.

5.9.7 The Contractor shall obtain confirmation that all timbers are “Certified Wood”.

5.9.8 The Contractor shall certify at Completion that none of the materials, products or constructions listed has been used in the construction of the Works, or incorporated in them, other than where specific written consent from the Board has been obtained. The Contractor shall also notify the Board of any other material which may become designated as prohibited at any time after incorporation into the project, during the Defects Period.

5.9.9 The Contractor shall provide samples and prepare mock-ups of external cladding systems or building components as requested by and for the approval of the Board as follows;

a) Sample panel of curtain walling/external wall construction, nom 4m x 4m to include a sample window and any associated bris soleil or sun shading detail. To remain as reference sample until envelope complete;

b) All external finishes;

c) External and internal doorsets;

d) External and Internal windows and curtain walling, including all standard ironmongery;

e) Ironmongery;

f) Typical bed head arrangement for Adult and Children's Wards (could be part of mock up);

g) Nurses Station design and materials – mock up;

h) Floor, wall and ceiling finishes – samples and colour schemes indicating interior design strategy intent;

i) Light fitments;

j) Power, voice and data switches outlets etc;

k) Sanitaryware, taps outlets and IPS proposals, (part of a mock up);

l) All signage and Wayfinding proposals;

m) Lifts and other key M&E installations;

n) Wall protection and handrail systems;

o) Public art; and

p) Hard and soft landscape proposals and external works.

5.10 Energy Strategy

5.10.1 In accordance with best practice, the Contractor shall consider key design features including, but not limited to:

a) Use of passive ventilation where appropriate whilst minimizing mechanical cooling;

b) Use of heat recovery for exhaust air;

c) Use of redesigning processes and products to close the technical loop using recovered and bio-based materials;

d) Use of natural daylight into areas which require continuous illumination such as central/circulation areas;

e) Use of natural daylight through maximum use of lighting dimmer controls; and

f) Implementation of renewable energy sources – solar, wind, landfill gas, biomass and low impact hydroelectric, geothermal, low carbon heating systems and heat pumps.

5.10.2 The Contractor shall demonstrate that their proposals will effectively reduce water consumption below the average consumption data contained in SHTM 2027 for the type of accommodation being developed by the Board. The Contractor's proposals shall include estimated consumption for the Works in Litres/Bed/Day and measures that they propose allowing the Board to minimise consumption.

5.10.3 In the consideration of design for energy generation and use Bidders are requested to be aware of and consider possibilities around alignment with the "Sustainable Glasgow" initiative. The Bidders are to demonstrate such consideration and report on their findings. The contact point for Sustainable Glasgow is:

Richard Bellingham
Senior Research Fellow
Energy Policy
Fraser of Allander Institute
University of Strathclyde
[redacted]

5.10.4 The Contractor shall submit a Mandatory Variant bid providing for a Maximum Temperature provision (26degC).

5.10.5 The specific energy requirements of the Board are detailed in Section 8.0 and Appendix M.

5.11 Fire Strategy

5.11.1 Fire safety in the proposed facility shall be controlled by Building Regulation, Health Technical Memoranda Firecode, and Fire Practice Notes, subject to approval by the Board's Fire Safety Advisor.

5.11.2 The Contractor must comply with the requirements of these publications, as a minimum standard, although it is recognised that alternative solutions based on a fire engineering approach may be more appropriate to the Contractor's design. Should the Contractor pursue an alternative approach it shall be their responsibility for meeting the minimum standards set out in the publications, fully satisfying the regulatory authorities of the appropriateness of its proposals and obtaining the necessary approvals.

5.11.3 The Contractor is required to prepare a Fire Safety Strategy document, including Fire Strategy drawings to demonstrate compliance with the relevant regulations. This document shall cover all aspects of fire safety, fire fighting and building management, including compartmentation and the ventilation implications of the Building.

5.11.4 The Contractor shall be required to ensure that all premises to be occupied by the Board have been appraised prior to occupation by competent persons appointed by the Board for compliance with Firecode and all Legislation are being met and shall provide the Board with an Annual Certificate of Firecode Compliance. For the avoidance of doubt the Contractor shall provide all fixed and portable fire fighting equipment to comply with statutory requirements and those of NHS Scotland Firecode. For the avoidance of doubt the Contractor requires to accommodate all fire fighting equipment which will be located within secure lockable containers housed in the wall construction, and operated by the same key throughout the development.

5.11.5 The Contractor shall provide a fully operational fire alarm system to meet the needs of the Works.

5.11.6 The specific requirements of the Board with regard to Fire Strategy are detailed in Appendix R.

5.12 Flexibility and Adaptability

5.12.1 The Contractor shall in the design of the Works consider opportunities which present themselves for the future expansion of Clinical and Non-Clinical Services.

5.12.2 The Contractor shall ensure, as far as is practical, that the Works structure and envelope, services, partitioning, ceiling, and flooring systems are consistent with a co-ordinated methodology which facilitates future flexibility for re-planning and change in the layout of departments, rooms, services outlets and equipment. In particular, it shall be possible to install or relocate fittings, fixtures, equipment and service outlets with minimum disruption to the use of the Works.

5.12.3 The design for the Works shall take full account of, but not be limited to:

a) Changes in technology, both clinical and non-clinical (e.g. systems of care and volume of work);

b) Building structures shall be designed by the Contractor to facilitate ease of alteration to the internal layout of the building, or to its plant, services or equipment, during the lifetime of the buildings. This shall be achieved by;

i. Selecting structural forms in which future builderworks holes for building services distribution, both vertically and horizontally (including ductwork), or equipment, may be cut simply and economically, minimising the installation of secondary framing;

ii. Providing knock out panels to permit the formation of holes not exceeding 150x150mm through suspended floors, adjacent to 50% of the internal columns on all floors. These knock out panels shall be positioned close to columns distributed across all areas of each floor;

iii. Designing the floors for imposed loadings that will permit the reallocation of space within the Works, so that each area of floor is structurally capable of supporting the imposed loads of offices, wards, corridors, general storage areas or waiting areas, together with their appropriate partition walls, finishes, ceilings, services and medical Equipment;

iv. Providing removable access panels within the structure, where these are required for the installation or removal of plant, services or equipment;

v. Internal room walls to be constructed such that they can be readily removed or altered i.e. the structure is not reliant on the walls for structural stability;

vi. Designing the structure of the buildings so that any future extensions can be constructed and brought into service with minimum disruption to the operation of the Works; and

vii. Designing plant space and riser space so that a future 25% services capacity expansion can be accommodated.

5.12.4 The structure and foundations of the buildings shall be designed by the Contractor to permit the construction in the future of further accommodation by extending the buildings horizontally or constructing further new buildings adjacent to them.

5.13 Facilities Management

5.13.1 The SoA and exemplar design have taken cognisance of the operational requirements and space/location requirements of the Board. The Contractor requires to comply with as well as design the Works to support and comply with the Board Policies (contained in Appendix P).

5.13.2 The specific requirements with regard to automatic material handling equipment (robotics), and the development of the Board's requirements and design in that regard, will be addressed during the competitive dialogue process. Details with regard to automatic material handling equipment is contained in Appendix M.

5.13.3 The Board shall have personnel integrated into the project development and the Works operations in relation to familiarisation and FM operations. The Contractor shall at all times liaise and support the integration and requirements of the Board in this respect at no additional cost.

5.13.4 The Contractor is required to provide space for maintainable, replaceable building services and plant.

5.13.5 The Contractor shall ensure that plant and equipment is suitably identified in line with the NHSScotland asset management system or equal and approved system/technologies.

5.14 Design Development

5.14.1 The bid period has specific bid return requirements (detailed in Volume 3 of the ITPD) with regard to written and drawn design information. Once the Contractor is appointed, the period to Full Business Case (FBC) approval comprises design development of the Contractor's Proposals in relation to the Hospitals, concurrent with the design and construction of the Laboratories. The design development to FBC will be fully programmed and demonstrable in a priced Activity Schedule forming an aspect of the bid returns from bidders.

5.14.2 The procedure for the review of design development will be agreed with the Contractor prior to the return of bids and the commencement of the design development.

5.14.3 The Contractor shall, as a minimum requirement, provide the information detailed in Appendix K (Design Development) as an output of Stage 2 (Hospitals Detailed Design to FBC). The satisfactory production of completed Appendix K information to the Board is one of the pre-conditions to the approval to proceed to Stage 3. More information relating to Stages 2, 3 and 3A are contained in Volume 1 of the ITPD.

5.15 Extended Defects Period

5.15.1 Due to a number of factors, including double-running/transition from other hospital sites, the Board are desirous of a defects period that provides management and physical benefits to the Project. In this regard a period in excess of the 'traditional' one year defects will be sought, with particular associated requirements in relation to:

a) Training and handover to Board personnel;

b) Correction times/periods for defects;

c) Seasonal commissioning;

d) Management activities; and

e) Performance requirements.

5.15.2 Volume 1 of the ITPD details further particular Extended Defects Period (EDP) requirements of the Board and identifies that this will form an aspect of Competitive Dialogue with bidders under the Commercial workstream.

5.16 Critical Failures

5.16.1 The Board require that the Works have inherent aspects of resilience to critical failures and mitigate operational interruptions.

5.16.2 In this regard, the Board have identified particular considerations and requirements that the Contractor shall adopt and develop as an aspect of bid return and design development. In addition to the resilience requirements of NHS Publications and the design requirements stated elsewhere in the Employer's Requirements, specific areas that the Board have prepared as exemplary are identified in Appendix X (Critical Failures).

5.16.3 The Contractor is required to comply with the provisions of Appendix X in their design, as well as provide for a developed strategy in relation to mitigation of critical failures in their bid return.

Section 6.0 Construction Phase Requirements

6.1 Site Logistics, Welfare and Board Accommodation

6.1.1 The Contractor is responsible for the provision of all temporary site accommodation/welfare and associated requirements, including the provision of car parking for site operatives during the design and construction stages. All such accommodation requires to be metered to provide readings of all utilities usage separately at any time.

6.1.2 No Contractor staff or personnel (including any sub-contractors, suppliers, supply chain members or other personnel providing any goods or services to the Contractor) are allowed to park on the Hospital Campus (except where attending as a patient or visiting/assisting a patient) during the Works.

6.1.3 The Board require the Contractor to provide dedicated site accommodation for the exclusive use of the Board and its representatives. This requires to be in the immediate environs of the Contractor accommodation on/adjacent to the Site to support joint working and meetings, but must facilitate segregation such that the Board area has a dedicated access for their use.

6.1.4 The Board require dedicated fully serviced accommodation including:

a) an open plan area with workstations, sockets and IT + telecoms connections for 10 persons;

b) an open plan area with workstations, sockets and IT + telecoms connections for 20 persons;

c) cellular offices with workstations, sockets and IT + telecoms connections for 5 persons;

d) a meeting room to accommodate 15 persons, serviced with sockets and IT + telecoms connections;

e) a suitably serviced room to accommodate a 1GB router;

f) secure wireless connectivity;

g) male, female and disabled toilet facilities;

h) a kitchen area with seating for 10 persons; and

i) adjacent dedicated parking for 30 cars.

6.1.5 The Contractor accommodation adjacent but separate from the Board accommodation will provide shared meeting rooms for 30, 20 and 10 persons separately as a minimum requirement.

6.1.6 The provision of site welfare and accommodation will form an aspect of Competitive Dialogue with the Board under the Logistics workstream. This workstream will also consider other logistics issues such as deliveries to site, site traffic and storage provision. The specific logistics, requirements, constraints and parameters of these aspects of the Project will be discussed and considered in detail to allow the generation of relevant information and potential solutions by bidders for the Board to consider and discuss. This will include proposals for the location of welfare, storage and parking solutions as well as layouts for site accommodation and welfare.

6.1.7 Further, specific requirements of the Planners to be met by the Contractor are identified in the Outline Planning document in Appendix D.1.

6.1.8 The Contractor shall be responsible for the cost provision and maintenance of all site signs and hoardings during the construction phase of the works. The requirements of NHS Scotland signage guidelines will require to be met by the Contractor, for the avoidance of doubt the key requirements are as follows;

a) Principal signage required at 3 no.key locations around the site as NHS Scotland signage guidelines;

b) Principal signage size will be no less that 6 x 4 metres;

c) NHS Greater Glasgow and Clyde identity prominently displayed (no less that 350mm in height) on hoardings enclosing entirety of site;

d) Graphics should be made from vinyl or other suitably durable material; and

e) All hoardings must be 2400mm high solid panels (metal or timber) with viewing panels painted white and maintained in good condition, free from graffiti and posters at all times.

6.1.9 All signage to include space for signage boards provided by the Board project manager for display and use – particular numbers and sizing of boards in this regard to be clarified to bidders by the Board.

6.2 Site Preparation Works

6.2.1 The Contractor shall be responsible for identifying and undertaking all preparation works necessary in order to make the Site suitable for the development of the Works. These works shall be undertaken prior to commencement of, or integrated with, the Stage 1 and Stage 3 activities.

6.2.2 For the avoidance of doubt, this obligation covers but is not necessarily limited to:

a) The identification of all protected trees to be removed from the Site by virtue of their condition and / or position in relation to the proposed Works. The Contractor shall be responsible for seeking the approval of Glasgow City Council for any such removal proposals, and the proposed mitigation / replacement strategy, in accordance with the conditions of Glasgow City Council's requirements and the associated Local Plan;

b) The identification and implementation of protective measures required to remaining trees, including their root systems, in accordance with BS 5837:2005, "Guide for trees in relation to construction";

c) In accordance with the Wildlife & Countryside Act 1981, any tree felling and shrub clearance shall be carried out outside the bird breeding season (March to August). Contractors shall take due cognisance of this requirement in any work programming. Where this is not possible a qualified ecologist shall be appointed to examine all potential breeding sites before any clearance takes place. If occupied nests are found, clearance and felling works shall cease until the nest is no longer in use. The contractor shall formally confirm to the Planning Authority in writing if clearance is in order following the ecologist's inspection;

d) Japanese Knotweed (JK) - Areas of the site have been the subject of contamination by Japanese Knotweed. The Board have embarked on a programme of eradication, details of which will be made available to the Contractor. The Contractor shall be

required to dig up any JK plant material and transport to a separately identified bunded area on the site (to be formed by the Contractor) where the JK shall be treated by the Board. The Contractor shall provide wheel washing provision for the vehicles utilised in the transportation and removal of JK (including Board vehicles involved in ultimate removal from the site);

e) The identification, decommissioning, removal and / or protection / relocation of live (and used), live (and redundant) or redundant (and disconnected) buried services crossing the Site;

f) The identification and removal of old foundations, drainage runs, basement structures and other below ground obstructions present following demolition of previous structures occupying the Site that are not removed by the Board (e.g. some steam duct lines);

g) Upon the finding of any medical waste or other contaminants on the site the Contractor shall advise the Board of such discovery for discussion and agreement of the necessary removal and/or protection steps to be taken; and

h) Diversion of the culverts.

6.2.3 Where relevant, the Contractor shall carry out all site preparation works (if necessary) in accordance with BS 6187:2000 “Code of Practice for Demolition” and the following:

a) Issue a method statement identifying the scope and methodology for undertaking the enabling works (if any), for approval by the Board in accordance with (TBC);

b) Break up and remove offsite all foundations, temporary accommodation, and other below ground and surface obstructions in accordance with, but not limited to, BS5528 “Demolition in open spaces”;

c) Decommission and / or break up and remove all redundant underground structures, chambers and redundant surface water and foul water drains, telecommunications, electric cables, gas mains, water mains and ducts within the Site. For the avoidance of doubt, this obligations includes for making safe all redundant works left in-situ, and sealing of voids, where left, against vermin;

d) Protect remaining services against damage or disruption; and

e) Minimise vibration and noise produced by the demolition works, and agree appropriate limits for such with the Board and neighbours.

6.3 Workmanship, Construction Accuracy & Tolerances

6.3.1 The Contractor shall ensure that general workmanship conforms to current revisions of BS 8000: – “Workmanship on Building Sites”, which covers typical building construction activities. Where specialist design proposals require construction activities outside the scope of this document, The Contractor shall propose specific quality procedures relating to these activities based on Good Industry Practice current at the time, as a minimum.

6.3.2 The buildings and the external works shall be designed and set out by The Contractor in accordance with BS 5606:1990 “Guide to Accuracy in Building”.

6.3.3 In some situations the tolerances identified in BS 5606 may not be appropriate for the particular elements or combination of elements in the Works. Where special levels of accuracy are required in relation to The Contractor’s proposals these shall be stated by The Contractor. The Contractor shall consider the recommended procedure set out in Figure 8, Section 4, Appendix B, of BS 5606.

6.3.4 The Contractor shall identify critical dimensions and setting out points on all its drawn information.

6.3.5 The Schedule of Accommodation contained in Appendix C of the Employers Requirements details the number and net floor area (as defined in paragraph 2 below) of the all relevant rooms or spaces in the Works, and the Gross Floor Area (as defined in paragraph 2 below) of the departments within The Works.

6.3.6 The actual floor area (as constructed) of a room or space may vary by up to 2% less or greater than the net floor area of the relevant room or space recorded on the Schedule of Accommodation (which actual floor area shall be measured on the same basis as that referred to in the definition of net floor area in paragraph 2 below) always provided that the proportion of the room remains generally unchanged. However the Contractor should note that the Single Bedrooms (as constructed) are required as a minimum to comply with the Schedule of Accommodation space requirements.

6.3.7 The net floor areas of rooms and spaces/departments and the other areas shown in the Schedule of Accommodation shall only be amended insofar as an Approved Project Managers Change Instruction varies such areas.

6.3.8 The Contractor will remain entirely responsible for procuring that the net floor areas of rooms and spaces/departments as shown in the Schedule of Accommodation applicable to the Works are capable of being achieved within the total gross floor area of the Works specified in such Schedule of Accommodation. The overall as built net floor area of the Works shall be not less than the total net floor area shown in the Schedule of Accommodation by more than1%.

6.3.9 The net floor areas of the individual rooms and spaces listed in this Schedules of Accommodation shall be calculated using a manually operated electronic measurement computer programme from a Computer Aided Design (CAD) system.

6.3.10 The number and identification of rooms listed on a department by department basis in the Schedule of Accommodation are as noted and identified on the 1:200 Departmental Layout plans identified in Appendix I.

6.3.11 For the duration of the Works the Contractor shall;

a) maintain computerised electronic versions of the Schedule of Accommodation and shall regularly update the areas shown in the Schedule of Accommodation from time to time in order to, inter alia, properly record the net floor areas and gross floor areas stated in all items of Design Development;

b) Afford the Board's Representative and Project Manager an opportunity to access and view such computerised Schedule of Accommodation at any time during normal working hours; and

c) As soon as reasonably practicable following finalisation of the 1:50 scale Room Layout Drawings, shall prepare and issue to the Board (in hard copy and electronic format) the final Schedule of Accommodation for the Works.

6.3.12 In connection with the above the following definitions apply;

a) Net floor area

In relation to a room the area bounded by the internal face of the walls or partitions enclosing the room. Or in relation to the space the area bounded by the internal face of

the walls or partitions and boundary(s) to any adjoining space(s). This area shall be measured elctronically from the approved plans that relate to the room or space. The net floor area is measured with deductions for:

i) column encasures

ii) pipe boxing

iii) service zones

b) for the avoidance of doubt the actual floor area may not be the net floor area of the room or space. The net floor area shall include the area of furniture, fittings and equipment within the room or space;

c) The net floor area for the department will be the sum of the individual net floor areas for the relevant rooms;

d) Gross floor area

Gross Departmental Area means the area bounded by the internal face of the external walls, centre line of partitions or boundary to adjoining departmental and/or communication space(s) that enclose that department. This area shall be measured electronically from the 1:200 scale Department Layout Plan that relates to the department. The Gross floor area shall include all elements of construction, spaces or rooms and circulation, but exclude:

i. service ducts

ii. lift shafts or other communication spaces contained within the boundary of the department.

e) Other areas means all other areas not included in a department, the balance of all service ducts, lift shafts, communication spaces (not included in department areas), corridors, plant rooms and the like measured electronically on the same basis as a Department from the 1:200 scale Department Layouts. The department areas are identified in Appendix I;

f) In relation to the Works, the Gross floor area is the sum of items d) and e) above; and

g) The departmental areas are identified in Appendix C.

6.3.13 Control of Noise & Dust

6.3.13.1 The attention of The Contractor is drawn to the provisions of Section 60 of the Control of Pollution Act 1974, with reference to the control of noise and dust in relation to any construction works. Where such works are adjacent to occupied property, The Contractor shall ascertain from the relevant authorities what requirements or restrictions, if any, shall apply, particularly in relation to Aspergillus. The restrictions may relate to the type of plant to be used, siting of plant, methods of working to be adopted, the hours of work permissible and may, in addition, impose a maximum noise level that must not be exceeded.

6.3.13.2 The Contractor shall make applications as early as possible to the utility company for the relevant connections in order to avoid the use of site generators.

6.3.14 The Contractor shall fit compressors, percussion tools and vehicles with effective silencers of a type recommended by the manufactures of the compressors, tools or vehicles but in any event to the requirements of BS 5228: Part 1: 1997 in accordance with Good Industry Practice.

6.3.15 Any equipment of a semi-permanent nature used by the Contractor, which produces noise on a regular basis, shall be positioned to cause the minimum disturbance to adjacent areas in agreement with the relevant authorities. The Contractor shall take all reasonable measures throughout the course of the Works to prevent the egress of water, dust, debris or any microbiological contamination out of the Site and into adjacent buildings. In particular, the Contractor shall establish any specific requirements for the control of dust identified.

6.3.16 The Contractor must comply with the specific planning requirements with regard to the control of noise and dust.

6.3.17 Continuity of Existing Services

6.3.18 The Contractor shall plan and execute the Works to ensure the Works activities do not affect the operational continuity of the Hospital Campus and the immediate neighbours to the Site.

6.3.19 The Contractor shall ensure that all reasonable safeguards are incorporated to ensure continuity of utility supplies to the Hospital Campus and adjacent users of the Site in-so-far as they may be affected by the Works. For the avoidance of doubt, utility supplies include, but are not limited to, gas, medical gases and air, electricity, water, sewerage and communications services.

6.4 Live Hospital Site

6.4.1 The Hospital Campus is a live hospital site, and as such will place restrictions on the Contractor in the construction of the Works.

6.4.2 As is noted in Section 6.1, above, logistics of the Site will form a workstream under the Competitive Dialogue to take place between the Board and the Contractor and this will extend to the consideration, discussion and agreement in regard to particular constraints, routes, timings and the like that will and will not be possible in the carrying out of the Works due to the 'live' nature of the environment.

6.4.3 Specific site constraints and access type requirements of the Hospital Campus and the Site have been considered in advance by the Board. These are contained in Appendix A and identify, amongst other issues, 'blue light' routes, FM delivery points and roadways that require to be unobstructed by the Contractor 24hours per day, every day.

6.4.4 The use of tower cranes on site by the Contractor may be restricted by the Board, Planners and the CAA. The Contractor is required to establish any relevant constraints and shall be responsible for implementation of craneage as permitted. This will include no oversailing of areas out with the Site and shall require the Contractor to demonstrate his management proposals in this regard, including modelling of swing-arcs and the like. Specific CAA requirement for aircraft warning lights are to be installed by the Contractor with regard to temporary and permanent structures. This will extend to, but may not be limited to, tower cranes, the flue to the new energy centre, other flues and chimneys to the Works;

6.4.5 In addition to the physical logistics and constraints in respect of the live hospital environment, the Contractor shall require to observe and comply fully with specific Board Policies for the duration of the Works when on the Hospital Campus or Site. The relevant Board Policies are listed in Appendix P.

6.4.6 The Contractor will require to carry out dilapidation surveys prior to the commencement of the Works, during the Works and at the completion of the Works – the extent, format and location of such to be agreed with the Board. Hard and electronic copies of all dilapidation surveys to be provided to the Board by the Contractor.

6.4.7 An aspect of the surveys to be carried out by the Contractor prior to the commencement of the Works is a full photographic survey of the boundary of the site, adjacent buildings, main roadways and approach roadways. Hard and electronic copies of all photo surveys to be provided to the Board by the Contractor.

6.5 Standardisation and Prefabrication (incl modular and off-site)

6.5.1 In order to take advantage of the repetitive nature of construction, maximise productivity and efficiency and minimise construction periods and waste, consideration shall be given to off-site prefabrication. It shall specifically be applied to repetitive elements e.g., sanitary assemblies, bathrooms or complex equipment such as plant assemblies.

6.5.2 The Contractor shall where reasonably practicable use standardised and / or pre-fabricated components and elements of construction which improve product quality, guarantee consistency of performance, optimise maintenance, and provide for reasonable flexibility for future changes, ease of replacement and value for money.

6.5.3 The use of standardised / prefabricated elements and building components to achieve good quality control, ease and speed of installation and flexibility for future use are welcomed. Their use shall not constrict the Board achieving clinical functionality and offer value for money. Items which may be considered include, bathroom pods, bedroom pods and other repetitive elements.

6.6 Room Mock-ups

6.6.1 The Contractor shall construct exemplar room mock-ups during the design development stage of the Works (Stage 2) for the hospitals. This will allow the Board's Representative to witness the quality standards of workmanship according to Good Industry Practice. Exemplar typical room mock-ups will be constructed for the rooms listed below in order to demonstrate important or unusual design elements of rooms i.e. integral bespoke furniture.

6.6.2 The Contractor shall provide mock-ups of the following rooms for use in the design development and approval process:

a) Single bedroom (standard) with en-suite (adult hospital);

b) Single bedroom with pull down bed for parents (children's hospital);

c) Single bed space (Critical Care) including all services and screening; and

d) Any modular accommodation proposed by the Contractor.

6.6.3 During the construction phase of the Works (Stage 3), the Contractor shall prepare a number of exemplar rooms as part of the Quality Control process, this is in addition to or a development of the mock ups noted above. The Contractor shall provide exemplar rooms of the following rooms:

a) Generic treatment room;

b) Single bedroom (standard) with en-suite;

c) Standard Outpatient Consulting Room;

d) Theatre suite;

e) Renal dialysis station and example of renal media panel;

f) Staff base; and

g) Reception point/counter.

6.6.4 These will establish minimum quality standards for the main areas and shall include main building services elements including lighting, heating, staff call, fire alarms, patient entertainment systems and all power and data accessories. This shall, where appropriate, include 3D computer illustrations.

6.6.5 The exemplar rooms to be prepared in the construction phase of the Works (Stage 3) shall portray doors, windows and the principal fitments and furniture. They shall allow definition of floors and walls, reflect the ceiling arrangements and identify the engineering services terminals. These shall be provided in a timely manner, to ensure they add value to the design development and approval process. The Contractor shall agree the content of and construct the exemplar mock-up rooms to a timetable to be agreed with the Board.

6.7 Witnessing and Testing

6.7.1 Witnessing and testing duties will be carried out by the Supervisor, all as detailed in relevant Clauses of the current NEC3 Engineering and Construction Contract, namely;

TITLE	DESCRIPTION	CLAUSE REFERENCE(S)	SUPERVISOR and CONTRACTOR DUTIES
Section 1	General	10.1; 11.2(6); 13.1; 13.3; 13.6; 14.1; 14.2; 14.4	10.1 – to act as stated in the contract and in a spirit of mutual trust and co-operation. 13.1 – to communicate in a form which can be read, copied and recorded. 13.3 – to reply to a communication within the period for reply 13.6 – to issue certificates to the Project Manager and Contractor 14.1 – Contractors duty to provide the works and be responsible for design. 14.2 – to notify the Contractor before delegating any actions or cancelling any delegation. 14.4 – replacement of Supervisor.
Section 2	Contractors Main Responsibilities	27.2; 27.3	Contractor's duties in relation to site access/action on legitimate instructions
Section 3	Time	n.a.	
Section 4	Testing and Defects	40.3; 40.5; 41.1; 42.1; 42.2; 43.1; 43.3	40.3 – to notify the Contractor of his tests and inspections before they start and afterwards of the results. 40,5 – to do tests and inspections without causing unnecessary delay to work or payment. 41.1 – to notify the Contractor of the results of the test or inspection on Plant and Materials required by the Works Information to be tested or inspected before delivery. 42.1 – instruct the Contractor to search for a Defect and to give reasons for searches which are instructed. 42.2 – to notify the Contractor of defects found before the Defects Date. 43.1 Contractor duty to correct Defects whether notified by Supervisor or not.

			43.3 – to issue the Defects Certificate at the later of the Defects Date and the last Defect Correction Period.
TITLE	**DESCRIPTION**	**CLAUSE REFERENCE(S)**	**SUPERVISOR and CONTRACTOR DUTIES**
Section 5	Payments	50.1	Project Manager duty in relation to assessing amounts due.
Section 6	Compensation Events	60.1(6)(8)(10)(11); 61.1	Actions/inactions of Supervisor in connection with Compensation Events.
Section 7	Title	70.1; 71.1	70.1 – Supervisor signing for marked Plant and Materials outside Works Area. 71.1 – Contractor action to allow Supervisor signing for marked Plant and Materials outside Works Area.
	Dispute Resolution	W1.3(5); W2.3(4)	Actions/inactions of Supervisor in connection with dispute Resolution Procedure.

6.7.2 It is envisaged that the Supervisor role will be carried out by a number of delegated parties – parties will be delegated by named Supervisor all as Clause 14.2, and are likely to comprise the following;

a) Civil & Structural Engineering;

b) Mechanical & Electrical Services;

c) Board Personnel (FM Services); and

d) Civil/M&E/Fabric Clerks of Works

6.7.3 In relation to the above duties as detailed under Section 4 – Testing and Defects, the Supervisor will carry out the following functions;

a) Design Compliance Check

i) Review the Design Data and detailed design information for general compliance with the terms of the Contract;

b) Procedure Review

i) review the quality assurance procedures proposed by the Contractor before work begins on the Laboratory and Hospital sites and review the operation of the procedures at regular intervals during The Works;

ii) regularly check to see whether the procedures employed by the Contractor are generally in accordance with the terms of the Contract; and

iii) review the proposed procedures and programmes for testing, commissioning and hand-over of The Works.

c) Construction Review

To the extent necessary to carry out the services referred to in Section 4 of the NEC3 Contract:-

i) enter the Laboratory and Hospital sites to monitor The Works to view the general state and progress of the Works to review overall workmanship, samples of goods and materials used or about to be used in The Works and to ascertain generally that the terms of the Contract have been and are being complied with by the Contractor;

ii) the frequency and timing of the Supervisor's visits are dependent on the progress of construction on the Laboratory and Hospital sites;

iii) regularly check to see whether the Contractor's work is being undertaken in accordance with Method Statements, Works Information and in a workmanlike manner;

iv) witness the testing, review and consider the suitability of all M & E and Building Management Systems, test results and certificates and other procedures within the Contractor's commissioning activities (all test results and certificates and other relevant commissioning and snagging paperwork to be collated by Independent Commissioning Engineer and provided to the Supervisor). In the event that a test carried out by the Contractor does not satisfy the terms of the Contract, check to see whether suitable remedial actions have been implemented and satisfactory results have been obtained on any re-tests;

v) generally inspect rectification works which have previously prevented the Supervisor from issuing a Defects Certificate; and

vi) undertake a visual inspection as appropriate of The Works before hand-over, to see whether the appearance is generally acceptable and in accordance with the terms of the Contract.

d) Reports

i) Report on the status of The Works following each site visit (and at any other time as appropriate) identifying any work that is non-compliant with the Contract; and

ii) Produce a weekly report following each site visit to ensure that the Employer is kept fully and properly informed on all aspects of the Works.

e) Familiarisation with Other Project Documents

i) The Supervisor shall familiarise itself with the Design Data and the Project Documents to the extent necessary to carry out the Supervisor role as provided for in accordance with the terms of the Contract;

f) Familiarisation with Quality Manuals

i) The Supervisor shall familiarise itself with and understand the Quality Manuals for the design and construction of the Project as set out in the Contract;

g) Monitoring and Inspection Procedure

i) The Supervisor and the Contractor shall agree an ongoing monitoring and inspection procedure, with reference to the Contract's key construction and

commissioning activities and the completed Works, and shall operate the same so as to ensure the efficient monitoring of construction and the efficient operation of activities;

h) Certification

i) The Contractor shall give the Supervisor (and Project Manager) sufficient notice in accordance with the Contract, of the date (the Completion Date") when it anticipates that Completion in respect of any Project Phase will be achieved;

ii) The Supervisor shall issue the relevant Defects Completion Certificate(s) in accordance with Clause 43.3 of the Contract; and

iii) As soon as practicable following the issue by the Project Manager of the Completion Certificate in respect of the final Project Phase to be completed in accordance with the Construction Programme, the Supervisor shall (provided that the Contractor has complied with its obligations to remedy any works listed in the Defects List) issue a final Defects Certificate.;

i) Snagging Items

i) The Contractor shall produce a Snagging Protocol detailing the process and individual party inputs, to cover the Phases of the Works. It is expected that this Protocol will be developed in conjunction with all interested parties e.g.:

- Board Representatives/Users/FM Team
- Supervisor
- Independent Commissioning Engineer
- The Contractor

and be provided at least six months prior to Phase Completion Date(s);

ii) The Contractor will provide for a computer/software based integrated snagging management system to be utilised during the snagging process, Provision to include all necessary peripheral equipment (PDA/Pens) and include for necessary training for Board Users and their advisors;

iii) The system will be managed and maintained by the Contractor, with appropriate access granted to project personnel; and

iv) Under the NEC3 Contract, there will be a "zero defects" approach to the project, and the Snagging Protocol will reflect this approach;

j) Notification of Completion of Defects

i) The Supervisor shall when requested by The Contractor attend any meetings convened about any part of the Works for the purpose of inspecting whether the Defects items applicable thereto have been remedied and/ or rectified; and

ii) The Supervisor shall issue a Defects Certificate, with copies of such notification also being issued, once all the works and other activities required in order to remedy and/or rectify Defects have been completed to the standards required by the Contract;

k) Miscellaneous

The Supervisor shall:

i) monitor the progress of the Contractor's design production;

ii) observe and monitor mock-ups, fabrication, construction and installation works on the Sites so as to satisfy itself that the Works comply with the Contract;

iii) audit the Contractor's Quality Assurance and the Contract control systems and procedures;

iv) issue Defect/Non-compliance notices and oversee the resolution of non-compliant matters;

v) review the commissioning of components of the Works in accordance with Contract/Works Information (as appropriate). The Supervisor will audit and monitor the commissioning work and report on the commissioning and testing of the Works;

vi) inspect and sign for marked up Plant & Materials outside of Works Area in accordance with Clauses 41.1/70.1/71.1; and

vii) hold regular meetings to discuss compliance and progress matters with the Employer and his Technical Advisors and the Contractor and attend meetings between the Employer and the Contractor as appropriate.

6.7.4 In order to assist the Supervisor in the performance of the above duties, the Contractor shall, as a minimum provide the following information;

a) the Accepted Programme;

b) copies of the Contractor's working programmes showing when the Contractor intends to carry out key activities whether off or on Site;

c) copies of all relevant documentation in connection with Plant & Materials outside of Works Area;

d) copies of such working drawings, schedules and specifications prepared for tender issue to the Contractor's sub-contractors as may reasonably be required by the Supervisor;

e) access to designs, drawings and documents register, technical and audit reports, consents, certificates and specifications to a level necessary to allow the Supervisor to assess compliance;

f) copies of correspondence relating to Building Control matters;

g) access to all quality control and quality assurance records, including procedures and method statements for the Project;

h) copies of all non-compliance reports generated by the Contractor and evidence of the clearance of the same;

i) copies of commissioning reports;

j) access to draft and final building/O&M manuals at the same time as the same are required to be provided to The Contractor under the Contract and otherwise as may reasonably be required by the Supervisor;

k) a copy of the health and safety plan and health and safety file and access to safety reports;

l) The Contractor's progress reports;

m) Any available completion check-lists prepared by the Contractor;

n) Change orders/requests prepared by the Contractor relating to the Works;

o) Copies of any reference or notice of intention to refer a dispute to the dispute resolution procedure in relation to the Works; and

p) The Defects List.

6.8 Commissioning and Handover

6.8.1 It is envisaged that the Contractor will appoint an Independent Commissioning Engineer to manage/programme/collate all M&E Testing and Commissioning processes, all as detailed in Appendix M, M&E3 Section 5 of the Employers Requirements

6.8.2 The Contractor will be required to provide the following in relation to the Commissioning and Handover process.

a) Final Commissioning Programme

i) A Final Commissioning Programme shall be prepared for each Phase to replace the Outline Commissioning Programme. The Final Commissioning Programme relating to the relevant Phase shall be prepared in consultation with the Board, in accordance with the requirement of the Completion Process;

b) Pre-Completion Commissioning

i) The Contractor's Pre-Completion Commissioning shall comprise the activities described as such in Table A Commissioning – Outline Commissioning Programme;

ii) The Contractor shall give written notice to the Project Manager/Supervisor and the Board's Representative of the commencement of The Contractor's Pre-Completion Commissioning in respect of each Phase when The Contractor (acting reasonably) considers that it shall commence The Contractor's Pre-Completion Commissioning in respect of the relevant Phase;

iii) The Contractor shall, at the times set out in the Final Commissioning Programme (and in relation to Manufacturer's Training, Induction Training and Building Familiarisation, when the Board Employees are made available for training by the Board pursuant to the Manufacturer's Training Programme, Staff Familiarisation Training Programme, Induction Programme and/or Staff Training Programme, as appropriate) undertake and complete The Contractor's Pre-Completion Commissioning in respect of the relevant Phase;

iv) The Board's Commissioning shall comprise the activities identified as such in Table A Commissioning – Outline Commissioning Programme;

v) The Contractor shall give written notice to the Board's Representative of the date upon which the Board shall be entitled to commence the Board's Commissioning in respect of each Phase, such notice to be given at least 1 month prior to the date when The Contractor (acting reasonably) considers that the Board should commence the Board's Commissioning in accordance with the Final Commissioning Programme; and

vi) The Board shall undertake and complete the Board's Commissioning for the relevant Phase, within the time period permitted within the Final Commissioning Programme, the Manufacturer's Training Programme, Staff Familiarisation Training Programme, the Induction Programme and/or Staff Training Programme (as appropriate) and shall comply with the Contractor's Site Rules and shall not cause any damage to the Works and/or Facilities or delay to the Works, in the carrying out of such activities;

c) Completion

i) The Contractor shall, no later than two months prior to the date that it anticipates (acting reasonably) a Phase will achieve the Completion Date, notify the Supervisor and the Board's Representative of such anticipated completion;

e) Post Completion Commissioning

i) The Contractor's Post Completion Commissioning shall comprise the activities identified as such in Table A Commissioning – Outline Commissioning Programme;

ii) The Contractor shall undertake and complete the Contractor's Post Completion Commissioning for the relevant Phase as follows:

- in relation to staff training, when Board Employees are made available to The Contractor for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Programme and/or Staff Training Programme (as appropriate);
- in relation to clinical cleans, in accordance with the Final Commissioning Programme;
- The Board's Post Completion Commissioning shall comprise the activities identified as such in Table A Commissioning – Outline Commissioning Programme; and
- The Board shall undertake and complete the Board's Post-Completion Commissioning for the relevant Phase in accordance with the Final Commissioning Programme, Training Release Schedule, Induction Programme, Staff Familiarisation Programme and/or Staff Training Programme (as appropriate) and shall not cause damage to the Facilities in the carrying out of such activities.

e) Equipment and Training

i) The Contractor shall not clean, or move to enable general cleaning, items of equipment so identified by the Board unless in agreement with the Board's Representative. This shall include but not be limited to:

- physiological monitoring equipment;
- patient medical equipment when in use (e.g. respirators, air tanks, infusion pumps);
- department based computers, visual display units and radiographic equipment or machine consoles including anything bearing radiation or hazard Warning signs; and
- equipment that is plugged in for re-charging; and

ii) The Board shall ensure that any equipment of the Board that is transferred from an existing site is cleaned and disinfected prior to being transferred to the Facility.

OUTLINE COMMISSIONING PROGRAMME

Table A: Commissioning

Area comprised within a Phase	**Pre Completion Commissioning**		**Post Completion Commissioning**	
	The Contractor's Pre-Completion Commissioning	**Board Commissioning**	**The Contractor's Post Completion Commissioning**	**Board Post Completion Commissioning**
Rooms/areas which only contain the Contractor's equipment and movable equipment to be installed/commissioned by the Contractor in accordance with Appendix F (*Equipment*)	The Contractor to install Board Specialist Equipment as required in accordance with Appendix F2 (*Equipment*) The Contractor to commission and test equipment as required in accordance with Appendix F (*Equipment*) The Contractor to carry out Handover clean The Contractor to carry out Staff Familiarisation Training when Board Employees are made available to The Contractor by the Board for training, in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme,	Board to make available Board Employees for training in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme, Induction Programme and/or Staff Training Programme. The Board shall witness such testing as required by Approved Persons e.g.: • medical gas testing including provision of gas for such testing purposes • Clinical Cleaning in accordance with The Board's obligations as set out in the Completion Criteria of The Supervisor Contract.	The Contractor to train Board Employees made available for training pursuant to the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme The Contractor to carry out Clinical Clean in accordance with the Commissioning Programme Clinical Clean of Board Equipment	Board to install, commission and test equipment as required pursuant to Appendix F (*Equipment*) and the Commissioning Programme Board to make available Board Employees for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme Board decant of patients to be carried out in accordance with the Commissioning Programme

Area comprised within a Phase	Pre Completion Commissioning		Post Completion Commissioning	
	The Contractor's Pre-Completion Commissioning	**Board Commissioning**	**The Contractor's Post Completion Commissioning**	**Board Post Completion Commissioning**
	Induction Programme and/or Staff Training Programme			
Rooms/areas which contain items of fixed equipment which are installed/commissioned by the Contractor and items of fixed equipment which are installed/commissioned by the Board in accordance with Appendix F (Equipment)	The Contractor fixed equipment installed, connected, commissioned and tested in accordance with Appendix F (Equipment) and the Commissioning Programme The Contractor to carry out Handover clean Completion of Works after Board Equipment installation The Contractor to insure Equipment in accordance with Appendix F (Equipment) The Contractor to carry out Staff Familiarisation Training when Transferring Board Employees are made	Board Specialist Equipment and fixed equipment installed, connected, commissioned and tested in accordance with Appendix F (Equipment) and the Commissioning Programme Board fixed equipment protected/mothballed until after the Phase Completion Date for the relevant Phase Board to protect and maintain the Board Equipment placed, and / or installed. Board to make available Board Employees for training in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme, Induction Programme and/or Staff	The Contractor to train Board Employees made available for training pursuant to the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme The Contractor to carry out Clinical Clean in accordance with the Commissioning Programme Clinical Clean of Board equipment	Board to install, commission and test equipment as required pursuant to Appendix F (Equipment) and the Commissioning Programme Board to make available Board Employees for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme Board decant of patients to be carried out in accordance with the Commissioning Programme

Area comprised within a Phase	Pre Completion Commissioning		Post Completion Commissioning	
	The Contractor's Pre-Completion Commissioning	**Board Commissioning**	**The Contractor's Post Completion Commissioning**	**Board Post Completion Commissioning**
	available to The Contractor by the Board for training, in accordance with the Staff Familiarisation Training Programme, Manufacturer's Training Programme, Induction Programme and/or Staff Training Programme	Training Programme. The Board shall witness such testing as required by Approved Persons e.g.: • Medical gas testing including provision of gas for such testing purposes • Clinical Cleaning in accordance with The Board's obligations as set out in the Completion Criteria of The Supervisor Contract.		
ICT Board are responsible for installing hardware (server, PCs printers etc) and the Contractor responsible for infrastructure (containment, cabling, computer rooms etc)	The Contractor infrastructure installed, commissioned and tested in accordance with Employers Requirements (*ICT*)	Board hardware installed, commissioned and tested (Network, servers, critical clinical workstations) in accordance with Employers Requirements (*ICT*) and the Commissioning Programme	The Contractor to train Board Employees made available for training pursuant to the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme The Contractor to carry out Clinical Clean in accordance with the Commissioning Programme	Board hardware installed, commissioned and tested in accordance with Employers Requirements (*ICT*) and in accordance with the Commissioning Programme Board to make available Board Employees for training in accordance with the Training Release Schedule, Induction Programme, Staff Familiarisation Training Programme and/or Staff Training Programme

OUTLINE COMMISSIONING PROGRAMME

Completion Process

A. Final Commissioning Programme

A.1 The Final Commissioning Programme shall be in accordance with the Outline Commissioning Programme and shall impose no greater or more onerous obligation on the Board or the Contractor than those set out in the Outline Commissioning Programme, unless otherwise agreed. The Final Commissioning Programme shall be developed by the Contractor in conjunction with and having consulted:

1.1.1 the Contractor;
1.1.2 the Board;
1.1.3 the Supervisor; and
1.1.4 the Board's FM Team.

A.2 The draft Final Commissioning Programme shall contain, amongst other things, full details of the following (including timing and sequence of events) for each Phase:

1.1.5 Contractor's Pre Completion Commissioning;
1.1.6 Board's Commissioning;
1.1.7 Contractor's Post Completion Commissioning;
1.1.8 the Board's Post Completion Commissioning; and
1.1.9 the Supervisor's Completion Criteria applicable to the relevant Phase.

A.3 The Contractor shall provide the Board with a draft of the Final Commissioning Programme relating to each Phase not less than 12 months prior to the anticipated Phase Completion Date.

A.4 If the Board has any comments on the draft Final Commissioning Programme, it shall issue comments on the draft Final Commissioning Programme to The Contractor on receipt of the draft Final Commissioning Programme by the Board from The Contractor, pursuant to paragraph 1.3 of this section (Outline Commissioning Programme).

A.5 If the Board raises comments on the draft Final Commissioning Programme in accordance with paragraph 1.4 of this section (Outline Commissioning Programme), the parties shall meet in good faith to discuss the terms of the Final Commissioning Programme), in order to agree the terms of the Final Commissioning Programme.

A.6 If the parties cannot agree the content of the Final Commissioning Programme, the matter shall be referred for determination in accordance with the Dispute Resolution Procedure.

A.7 Where any amendments to the scope and/or timing of the Board's Commissioning and/or the Board's Post Completion Commissioning are agreed or determined pursuant to paragraph 1.5 and/or 1.6 of this section (Outline Commissioning Programme) such change shall be treated as a Compensation Event.

OUTLINE COMMISSIONING PROGRAMME

Staff Familiarisation Training

B. Manufacturers' Training

B.1 The Contractor shall provide Technical Manufacturer's Training to such numbers of Board Employees as is agreed between the parties as being appropriate to allow for a cascade training regime, in accordance with the Manufacturer's Training Programme, which shall be submitted for agreement with the Board 4 months prior to a Phase Completion Date. The training shall be carried out prior to each Phase Completion Date, in accordance with the durations per system required pursuant to Table 1 (Outline Commissioning Programme), and in accordance with the Manufacturer's Training Programme. The Contractor shall only be responsible for those Board Employees directly trained by it. Systems requiring such manufacturer's training and thus more direct staff exposure to the manufacturer, are listed (but are not limited to those set out in) in Table 1 (Outline Commissioning Programme). The Board shall make available the relevant staff for training in accordance with the Manufacturer's Training Programme.

C. Building Familiarisation Training

C.1 Building Familiarisation Training shall be provided to each Board Employee by The Contractor to provide staff with general building and Site Familiarisation, general Site orientation and Building Health and Safety Induction. This shall be organised in small groups for half a day so that the impact on the existing sites is minimised, and subject to paragraph 2.2 below, shall comprise part of The Contractor's Post Completion Commissioning "Building Familiarisation"). The Building Familiarisation shall be programmed on a training plan, prepared by The Contractor and agreed with the Board not less than 40 Business Days of the anticipated Phase Actual Completion Date.

C.2 Board Employees at each Phase Completion Date shall receive this training leading up to their transfer, in a time period agreed with the Board and shall comprise part of the Contractor's Pre Completion Commissioning.

C.3 The Board shall make available the relevant staff for training in accordance with the Staff Familiarisation Training Programme.

D. Department Induction

D.1 Board Employees shall receive a department induction prior to the Relevant Service Transfer Date. This training (comprising two half days) shall be provided by the Contractor at the existing sites. Should the Board require this to be undertaken off site the costs associated with this shall be borne by the Board. This training shall cover department operational procedures and risk assessments.

D.2 The Induction Training shall be programmed and set out in a Training Plan with the Board Employees receiving the training in the period leading up to the Relevant Service Transfer Date. The Training Plan shall take into account the Board's responsibility for delivering the Services at the existing sites and shall therefore be designed to limit the impact on operational delivery and shall be prepared by The Contractor and agreed by the Board not less than 12 months prior to the anticipated Phase Completion Date.

D.3 The Board shall make available the relevant staff for training in accordance with the Induction Programme.

Table 1: Systems requiring staff direct manufacturers' training (to familiarise Transferring Board Employees with new plant and equipment)

Systems	CarPark Operative	Switchboard Operator	Receptionist	Helpdesk Operative	Security Officer	Porters	SoftFM Managers	SoftFM Supervisors	Energy Manager	HardFM Managers	HardFM Supervisors	Technicians	Electrical Craftspersons	Mechanical Craftspersons	Building Craftspersons	Maintenance Assistants	Administrators
Access Control	1				1		1	1									
CCTV (Operator)	1				1		1	1									
CCTV (Maintenance)										1	1	1	1				
Other Alarms	1	1	1	1	1												
Switchboard System		2	2	2													
Helpdesk System (Front Line process)		2	2	2													
Helpdesk System (Workload & record keeping process)							2	2		2	2						
Helpdesk System (Task Management & Feedback))						1	1	1		1	1	1	1	1	1	1	
Passenger Lift Evacuation (Competent Person)										1	1	1	1	1		1	
Passenger Lift Evacuation (SOP)	½	½	½	½						½	½	½	½	½	½	½	
Computer Aided Facilities Management System		2		2			2	2		2	2	2	2	2	2	2	
Asset Management System							2	2	2	2	2						
MiCAD									2	2	2	1	1	1	1		
Training in construction & operation of PPM									2	2	1	1	1	½	½	½	

Scheduling																	
AHU									1	1	1	1	1	1			
Airtube (Operator)						½	1	1			1	1	1	1			
Airtube (Maintenance)										1	1	1	1	1			
Systems	**CarPark Operative**	**Switchboard Operator**	**Receptionist**	**Helpdesk Operative**	**Security Officer**	**Porters**	**SoftFM Managers**	**SoftFM Supervisors**	**Energy Manager**	**HardFM Managers**	**HardFM Supervisors**	**Technicians**	**Electrical Craftspersons**	**Mechanical Craftspersons**	**Building Craftspersons**	**Maintenance Assistants**	**Administrators**
Auto Doors/Barriers										½	½	½	½	½	½		
BMS									2	2	2	2	2	2			
BMS Access Control (Operator)	1				1		1	1		1	1						
BMS Access Control (Maintenance)										2	2	2	2	2			
BMS Technology maintenance/trouble shooting									3	3	3	3	3				
BMS Technology Input/output Alarms & Scheduling									2	2	2	2	2				
BMS Technology - Report writing									2	2	2						
BMS Energy Management & metering functions									3	3	3	1	1	1			
Boilers MTHW									1	1	1	1	1	1			
Chillers/Local DX Units									1	1	1	1	1	1			

CHP									1	1	1	1	1	1			
Fire Systems	1	1	1	1	1					2	2	2	2	2	2		2
Generators									½	1	1	1	1	1			
Systems	**CarPark Operative**	**Switchboard Operator**	**Receptionist**	**Helpdesk Operative**	**Security Officer**	**Porters**	**SoftFM Managers**	**SoftFM Supervisors**	**Energy Manager**	**HardFM Managers**	**HardFM Supervisors**	**Technicians**	**Electrical Craftspersons**	**Mechanical Craftspersons**	**Building Craftspersons**	**Maintenance Assistants**	**Administrators**
Refrigeration									1	1	1	1	1	1			
Security Systems (Operational)	1			1	1		1	1		1	1						
Security Systems (Maintenance)										1	1	1	1				
Renewable Energy resources – where provided				1		1			3	3	3	3	3	3	1	1	
Decontamination – RO Plant operation & maintenance.				1		1			1	1	1	1	1	1	1		
Sterilisers/Washer Disinfectors										1	1	1		1			
Switchgear HV											1	1					
HV infrastructure and operation											1	1					
Switchgear LV										1	1	1	1				
LV infrastructure and operation										1	1	1	1				

UPS/Battery Cubicles										½	½	½	½				
MGPS infrastructure and operation										1	1	1		1			
Robotics							1			1	1	1	1				
Nurse Call											1	1	1				

6.8.3 Handover Procedures

6.8.3.1 The Contractor's Commissioning Programmes to include for sign off of relevant Testing and Commissioning elements by other parties, e.g.:

a) Board Approved Parties

i) Fire Officer;

ii) Control of Infection Officer;

iii) Radiation Protection Officer; and

iv) Medical Gases Officer;

b) Supervisor; and

c) Independent Commissioning Engineer

6.8.3.2 It will be the Contractors responsibility to programme the above sign off requirements to ensure relevant Completion Date achieved.

6.8.3.3 In connection with the above, the Supervisor will expect the Contractor to provide the following documentation in connection with Handover/Completion;

6.8.4 General

6.8.4.1 General Requirements

The Contractor shall provide such labour, materials, stores, test equipment, tools, instruments, apparatus and assistance as are reasonably required for the purpose of the inspection by the Supervisor and shall be responsible for the provision of such electricity, fuel, water and other consumables and materials as may be reasonably required for the same. Invitations shall be furnished to the Board, its Project Manager and the Supervisor to witness such works inspections, testing and commissioning activities as the Board deems necessary. Adequate notice of testing shall be given.

6.8.4.2 The Contractor shall ensure that major items of plant shall be tested at the works for both performance and safety prior to dispatch. Major items of plant shall include, but not be limited to, the following: boiler plant, generators, chillers/refrigeration machinery, large pumps, HV/MV switchgear, large pressure vessels etc. The Contractor shall arrange to witness all factory testing and shall furnish the Board, its Project Manager and the Supervisor with the opportunity to witness all factory testing, and sign off marked items of Plant and Materials. The Board, its Technical Advisors and the Supervisor shall be given at least fourteen days notice of such testing.

6.8.5 Works inspection, testing and acceptance activities

6.8.5.1 Completion Criteria

6.8.5.2 The Contractor shall demonstrate that the following criteria have been achieved:

6.8.5.3 The building is structurally complete, all external fabric is complete and internally all the finishes are complete in accordance with the ADB Room Data Sheets;

6.8.5.4 All incoming Utilities including all associated back up systems is tested, commissioned and operational;

6.8.5.5 The Mechanical and Electrical plant and systems operate satisfactorily in accordance with the specified design criteria, and the ADB Room Data Sheet;

6.8.5.6 The Building Management System is complete, tested, commissioned and operational;

6.8.5.7 All furniture and equipment shown on the Loaded Room Layout drawings (as supplemented by Appendix F (Equipment) have been installed (and commissioned if appropriate);

6.8.5.8 The Board has been supplied with keys, access codes, swipe cards and other access devices for access to and within the Works;

6.8.5.9 Safe access and egress to and within the relevant Laboratory and Hospital sites has been established;

6.8.5.10 The relevant Laboratory and Hospital sites shall be free from all surplus materials, plant and equipment that could materially affect the completion of the Tests on Completion and shall comply with the standards and requirements of Section 3;

6.8.5.11 All internal and external drainage systems are installed and are operational;

6.8.5.12 External works as appropriate have been completed and are available for use by the Board;

6.8.5.13 All hard-landscaped external works, including roads, car parks, pavements and boundary walls/fences are complete and available for use by the Board;

6.8.5.14 Lift and Escalator systems are complete, commissioned and operational;

6.8.5.15 All building directional departmental, general information and room numbering signage as indicated within Employers Requirements/the Contractor Proposals and/or Reviewable Design Data and necessary to all the operational Services to commence has been provided and installed. This includes both internal and external signage;

6.8.5.16 The Fire Management Strategy has been finalised, The Contractor to complete and submit fire safety risk assessment in accordance with the Fire (Scotland) Act 2005;

6.8.5.17 The Fire Detection, Alarm and Suppression Systems are complete, tested commissioned and operational

6.8.5.18 All External Lighting is installed, tested, commissioned and operational;

6.8.5.19 All IT and Communication Systems are complete, tested, commissioned and operational;

6.8.5.20 All Security and Surveillance Systems, Access Controls and Call Alarms are complete, tested, commissioned, operational and available for use by the Board;

6.8.5.21 Acoustic Testing has been completed to prove compliance with the Employers Requirements and the Contractor Proposals;

6.8.5.22 The medical gas and vacuum system is complete, tested, commissioned and witnessed by NHS Greater Glasgow and Clyde's Chief Pharmacist and Medical Gases Approved Person;

6.8.5.23 A proving and training period for the Board has been offered by the Contractor, and subject to the Board making themselves available within agreed timescales, this training has been completed;

6.8.5.24 A proving and training period for the Service Provider has been completed;

6.8.5.25 The Contractor has provided all documentation to the Supervisor in accordance with the Supervisor's Contract and Section 4; and

6.8.5.26 A draft hard copy and electronic format of the relevant As Built Specification Documents, Operational & Maintenance Manuals and Health & Safety Files for the Facilities (containing, as a minimum, all the testing and commissioning information so far as it is reasonably practicable) have been issued by the Building Contractor.

6.8.6 Clinically clean

6.8.6.1 On completion of the Works, The Contractor shall provide the Facilities as "clinically clean" in accordance with NHS Scotland National Cleaning Services Specification and to the satisfaction of the NHS Greater Glasgow and Clyde's Control of Infection Officer.

6.8.7 Testing and commissioning documentation

6.8.7.1 All documentation associated with the Tests on Completion shall be collected and collated by the Contractor/Independent Commissioning Engineer and shall be presented as a bound, indexed document to the Board. The following list is indicative of the test documentation expected to be provided:

Test Documentation
Building Warrant Completion Certificates
Evidence that all Conditions attached to the detailed Planning Consent have been discharged to the satisfaction of the Local Authority.
Roads Construction Consents
Design Warrants
Flushing Cleaning and Chlorination test certificates
Boiler Plant Manufacturers Factory Test and Commissioning Sheets in accordance with CIBSE Commissioning Code B, including all steam systems
Ductwork Systems pressure test and volume flow rate Certificates
Laundry Equipment Commissioning Certificate
Kitchen Equipment Commissioning Certificate
Electrical Installation Completion and Inspection Certificates in accordance with BS 7671 and

Test Documentation
NICEIC requirements
Robotics Equipment Commissioning Certificate
Lighting and Power Certificate of Test
Fire and Intruder Alarms Commissioning Certificates, including intruder detection and alarm, access control system(s)
General Electrical Earth Loop and Insulation Resistance Test Sheets
Testing of all hot water service thermostatic mixing valves (TMV's) in accordance with BS6700 and tests to comply with HSE Document L8 and HGN 'Safe Hot Water and Surface Temperatures
Emergency Lighting Completion and Test Certificates
Certificate of Compliance/Testing of Radiation protection
Security Systems Commissioning Certificates
Certificate of Soundness Testing of Gas Installation
Gas Pipework Pressure Test and Purge Certificates
Medical Gas Pipework Pressure Test and Purge/Commissioning Certificates
Fire Suppression System Certificates (in accordance with BS6266 and tests to comply with CIBSE Guidance E)
Fire Alarm Sound Record Sheets
Lighting Calculation Sheets and Lux Level Test Results (Internal & External)
Machine (Generator/UPS/CHP etc) Specialist Commissioning and Factory Test Sheets
Acoustic Test sheets (in accordance with BS 5821)
Lift Commissioning in accordance with BS EN 81 and Factory Test Sheets
Lightning Protection Risk Analysis and Test/Commissioning Sheets
Boiler Plant Manufacturers Factory Test and Commissioning Sheets in accordance with CIBSE Commissioning Code B
Works pressure test certificates for all pressure vessels
Mechanical Pipework Systems Pressure Tests
A/C Equipment Performance Tests
Condensate Clearance Tests for A/C Equipment
BMS/EMS Tests/Commissioning Records in accordance with CIBSE Commissioning Code C
Air Distribution Systems in accordance with CIBSE Commissioning Code A
Water Systems (heating & domestic water) in accordance with CIBSE Commissioning Code W
Legionellae Testing (to include an organic check on the incoming mains) within tolerances given in HSE ACOP test sheets
Domestic water systems bacteriological quality test sheets
Rainwater harvesting systems test and completion and bacteriological quality test sheets
Plant (Calorific, Treatment etc.) Specialist Commissioning and Factory Test Sheets
Nurse Call Test Certificate
Disabled Toilet Alarm Test Certificate
Fire Alarm Test Certificate
CCTV and Access Control Test Certificate
TV Aerial Certificate
Patient Entertainment System Certificate
Telephone Cabling Test Certificate
ICT Cabling Test Certificate
Induction Loop Test Certificate
Pipeline Pressure and flowrate Test Certificates including drainage and all steam systems
Steam boiler/generator test factory test and commissioning certificates in accordance with

Test Documentation
CIBSE Commissioning Code B
Ground Source Heating installation pressure and Test Certificates
Chiller factory test and commissioning certificates in accordance with CIBSE Commissioning Code R
Chemical clean and inhibitor dosing certification to heating/chilled water systems
Ductwork physical and bactericidal cleaning certification

Section 7.0 Architectural Requirements

7.1 Masterplan

7.1.1 The Masterplan for the New South Glasgow Hospitals has been developed in consultation with various stakeholders, including User Groups, Architecture + Design Scotland, the Carbon Trust, Strathclyde Passenger Transport, Civil Aviation Authority (CAA) and Glasgow City Council Planning Department. The aims of the Masterplan are to achieve a clarity of spaces and routes within the existing Southern General Hospital Site.

7.1.2 The proposed Masterplan design seeks to improve the entrances to the site, traffic flows around the site and enable all visitors to the new hospitals to orientate themselves quickly with the campus. A new main boulevard entrance will be created from Govan Road, which will border the new Laboratory, FM & Mortuary and Energy Centre Site. However, the traffic flows have been separated and all service access to this area will be off Hardgate Road. Public Access and drop off via private car become immediately clear on the approach to the building and the traffic flows allow drop off adjacent to the relevant entrances and then onwards to the respective car parking zones. A new transport 'hub' located centrally on the site provides direct and sheltered access to the new hospital entrance. This hub will allow 'Fastlink', taxi and private car drop off within immediate walking distance to the entrances. Public Bus routes will remain on the existing road network with additional bus stops being provided at key entrances.

7.1.3 Blue Light traffic routes into and within the site are clearly identified and provide the quickest access points from whichever direction the ambulance approach.

7.1.4 Upgrading and Replacement of car parking provision has located 4 new major car parks strategically around the site:

a) Adult Hospital x 2nr;

b) Children's Hospital; and

c) A&E Entrance

7.1.5 Pedestrians and cycle routes through the site and the interaction with the building have been developed to provide clear designated routes to the new main hospital and surround buildings, while the punctuation of the site with pockets of landscaped spaces supplement the main park area situated immediately in front of the new main hospital entrance. The 'green space' within the campus is designed to provide a functional retreat for patients, visitors and staff.

7.1.6 As the final design develops within the parameters of the Masterplan, there is a requirement to update the Development Control Plan for the entire Southern General Site to identify future uses, expansion and redevelopment.

7.1.7 The Masterplan presents the Board's vision of the New South Glasgow Hospitals on the Southern General Hospital Site and requires to be followed and implemented by the Contractor.

7.2 Exemplar Design

7.2.1 The exemplar design has been developed in consultation with the Board and User Groups. The exemplar design is intended to reflect these discussions and provide an advanced level of briefing that will enable the Contractor's response at the end of the bid period to be more advanced in terms of understanding of the Board's and User's functional, clinical and quality requirements. As well as reflecting the requirements of the Clinical Brief the design exemplar is also intended to represent a design quality benchmark against which the Contractor's proposals will be measured. The exemplar demonstrates the aspirations of the Board in terms of the graphical and technical representations of the Contractors.

7.2.2 Whilst the exemplar design has not been developed with the intention of constricting the Contractor's proposals to a particular solution nor has it been developed in order to stifle innovation or creativity, it should be noted that the functional relationships indicated in the exemplar does represent the culmination of a process of detailed consultation with the Board and Users to determine their requirements and as such it is not expected that the Contractor will require to revisit the functional relationships or design principles as set out in the following exemplar information;

a) 1:500 departmental relationship drawings for all levels of each building indicating functional relationships, entrances and main circulation routes (Appendix H);

b) 1:200 departmental drawings for 7 no. key departments in the Adult's Hospital and 4no. key departments in the Children's Hospital indicating room adjacencies, circulation layouts, corridor widths, entrances and links to other departments/facilities. (Appendix I);

c) 1:50 Room Layout Drawings indicating clinical functionality, room size and shape and compliance with ergonomic data. (Appendix J); and

d) ADB Room Data Sheets (Appendix E).

7.2.3 Described in more detail below are the key features of the exemplar design which will require particular consideration by the Contractor;

a) Adult and Children's Hospital Identity;

b) Podium;

c) Ward Tower;

d) Main Entrance; and

e) Atrium including retail space;

Adult and Children's Hospital Identity

7.2.4 The exemplar proposes a single overall building footprint subdivided into the Adult and Children's facilities, creating two distinct but adjoining hospitals. This is in acknowledgement of the benefit to be exploited through the co-location of the Adult and Children's Hospitals, a great deal of consideration has been given to identifying these in the brief and in the design of the two hospitals.

7.2.5 It is important to stress that the Children's Hospital will operate as a hospital in its own right with its own clinical staff and management, with some shared facilities. It is therefore a requirement of the brief for the Children's Hospital not only that there should be an appropriate degree of clinical and patient separation between the two hospitals but also that the distinct identity of the Children's hospital shall be maintained both externally and within the patient and public areas. This requirement is expressly reflected in the exemplar design which indicates two separate entrances for the Adult's and Children's Hospital.

Building Typologies

Podium

7.2.6 A significant proportion of the overall building footprint is dedicated to integrated acute facilities which will be housed in the 3 storey podium. The podium will house such departments as Operating Theatres, Radiology, Critical Care and Outpatients Departments. The key drivers behind the location of departments are the necessities of co-location for functionality along with appropriate public/private zoning of the facilities. For example Outpatients and Accident Emergency Departments are located on the ground floor towards the external boundary of the footprint to ensure an appropriate level of public accessibility is achieved while the core of the footprint is reserved for private treatment and diagnostic areas such as Radiology.

7.2.7 Departments located in the podium;

a) NSGH Main Entrance and Discharge Lounge;

b) NSGH Emergency Department;

c) NSGH Rehabilitation;

d) NSGH Radiology;

e) NSGH Acute Assessment;

f) NSGH Critical Care;

g) NCH Main Entrance;

h) NCH Emergency Department;

i) NCH Rehabilitation;

j) NCH Radiology;

k) NCH OPD;

l) NCH Cardiology;

m) NCH Inpatient Wards;

n) NCH DCFP;

o) Operating Theatres;

p) Endoscopy;

q) Aseptic Suite;

r) Renal Dialysis;

s) Nuclear Medicine;

t) Medical Physics;

u) Dining Area;

v) Retail and Café; and

w) Pharmacy.

Ward Tower

7.2.8 Located above part of the footprint of the podium will be the 13 storey 4-wing ward tower providing single bedroom ward accommodation across a range of departments including Renal, Vascular, Haemato-Oncolgy etc. In total the facility includes the provision of 1,109 adult and 240 children's beds. While not all bed spaces noted will be accommodated in the ward towers, the ward tower typology was developed as being the most appropriate and achievable method by which these bed numbers could be accommodated. The towers are positioned and orientated to provide best use of views across the site, provide appropriate levels of natural light and to achieve patient privacy by preventing overlooking from other ward accommodation.

7.2.9 Tower Wards include;

a) Generic wards;

b) Haemo-oncology wards;

c) Vascular wards;

d) Renal wards;

e) Dermatology; and

f) Stroke;

Main Entrance

7.2.10 There are 6 staff/patient/visitor entrances on the ground floor;

a) NSGH Main Entrance;

b) NCH Main Entrance;

c) NSGH 24 Hour/Staff Entrance;

d) NCH 24 Hour/Staff Entrance;

e) NSGH Acute Assessment Entrance; and

f) NSGH / NCH Emergency Department Entrance

7.2.11 At each of the above entrances a robust glazed canopy will require to be incorporated in order to provide shelter from the elements for staff, visitors and patients and to assist in the prevention of wet contamination of flooring within the building. Entrance canopies will require to be sized appropriately to accommodate ambulances as necessary. A methodology for the maintenance and cleaning of the canopies will also be required.

7.2.12 The ambulance entrance of the Emergency Department (ED) will be expected to have the ability to be converted into an external decontamination facility. This would include the requirement to incorporate roller screens as part of the ambulance canopy and multiple water mixer points to allow shower attachments. The area will also require the ability to isolate drained water under decontamination procedures.

7.2.13 The main entrances to the Adult's and Children's Hospitals will be expected to have a light, spacious and welcoming atmosphere and the main entrance shall be immediately apparent to all users. The main entrances for the Adult's and Children's Hospitals should reflect in form, scale, space and use of materials the aspirations and design quality promoted by the Board resulting in a meaningful expression of the Board's intent for the facility; that is to deliver first class healthcare to the local population and provide a focal point for community activities and education welfare. The entrances should demonstrate the required benchmark of architectural design quality while at the same time incorporating practical considerations, for example the provision of appropriate shelter and adequate accessibility of entrances.

7.2.14 The façade of the main entrances should be fully glazed for the full height and width of the entrance area including automatic sliding entrance doors to allow views in and out of the main entrance and reception. It is important that large glazed areas such as this should be clearly identified as such for safety purposes and must be safety glass. Solar shading devices should be incorporated as necessary to achieve the Board's stated Sustainability and Energy Targets. The size and numbers of automatic entrance doors should be sufficient for the expected number of users to pass comfortably and safely through them. A glazed canopy should be incorporated in order to provide shelter across the full width of the entrance at a height that provides appropriate shelter while also coordinating as required with the façade design. The structure and glass forming the canopy shall be robust and shall incorporate all appropriate standards of security, and where reasonably practicable, limit the potential for exposure to crime and vandalism.

7.2.15 Entrance lobbies should be provided as Section 7.5.2 including the requirement for a minimum of 6 metres of barrier matting to prevent the ingress of dirt and wet contamination to flooring. Any lobby enclosure provided requires to be fully glazed to allow users to proceed safely and confidently.

7.2.16 Once inside the building the reception areas and information points are key to orientation. The tone of a building is set by the entrance and reception to the building, therefore the Contractor's design should achieve a balance of openness with patient confidentiality and staff safety, resulting in reception areas skillfully combining a friendly welcome with low-key oversight of public areas. The expected quality of the main entrance spaces should be akin to a large hotel foyer, this expectation should be reflected in the choice of quality robust materials for flooring, walls, ceilings, balustrades etc. The quality of the space should also be enhanced by interesting shapes and forms, lighting techniques and the incorporation of art.

7.2.17 The reception area and main entrance generally will be busy places, both in terms of footfall and hours worked. Materials, finishes and furnishing therefore need to be robust, as well as attractive. The Contractor's design should cater for well selected, fit for purpose furnishings which will complement a clear approach to design. One such component of the main entrance design is the flooring, it is vitally important that the floor finish in the main entrance area should combine robustness and attractiveness with slip resistance. A material such as natural stone/ceramic tiles which have a high micro-surface roughness should be used.

7.2.18 One of the most important features of the reception area is the reception desk which should be close to the entrance and should be an open well lit counter/desk with a feature or identifying sign at high level. The reception counter requires to reflect and enhance the quality of the surroundings in terms of form, quality of materials and lighting.

7.2.19 In order to provide staff, patients and visitors with access to information especially at the key points of entry to the Building it is the Board's intention that Contractor's should incorporate electronic information points utilising touch-screen technology in addition to the manned reception points and stations and the PA system. These information points should present information (in a variety of languages) on the hospital for orientation and wayfinding purposes along with information in relation to the public transport hub which should be adjacent to the main entrance giving real time information on bus/fastlink timetables. The Contractor will be required to provide a clear strategy for the provision of these information points.

7.2.20 The main entrance requires to incorporate well planned waiting rooms which can help to relax patients, thereby reducing fear and increasing confidence. Upholstered seating set out in the style of a hotel foyer with spacious waiting should be the goal, these areas allow patients, carers and visitors to relax, chat, wander or simply enjoy the space and any views afforded. This is especially valuable where the patient may be accompanied by friends or relations.

A Changing Places facility which combines a toilet, shower and changing room for use by people with complex and multiple disabilities will require to be located at the Adult and Children's entrances. The space should be provided in accordance with the requirements of BS8300:2009 item 27 and should incorporate an adjustable changing table and fixed track hoist system.

7.2.21 A requirement throughout the hospital especially within entrance areas shall be to incorporate appropriate standards of security, and where reasonably practicable, limit the potential for exposure to crime and vandalism. Guidance is provided in HFN05 -"Design against crime-a strategic approach to hospital planning".

7.2.22 Atrium including retail space

a) The exemplar indicates a linear atrium linking the main entrances of the Adult's and Children's Hospitals. This concourse performs a number of different functions;

b) Provide a link between Adult and Children's Hospitals;

c) Provide clear horizontal and vertical links to all areas of the hospital facilities with the incorporation of stairs, lifts and escalators as necessary;

d) Provide a clear route for patients, staff and visitors to frequently attended departments such as the outpatient's department;

e) Provide access to pharmacy;

f) Provide access to retail facilities such as the cafeteria to allow users to purchase drinks, food and to consume them in a pleasant and relaxing environment;

g) Continue the quality of the main entrance spaces which will be reflected in the choice of quality robust materials for flooring, walls, ceilings, balustrades etc; and

h) Provide opportunities to incorporate art, lighting techniques and tv/video display screens to enhance the quality of the space and provide a welcome distraction.

7.2.23 The multi-level linear atrium space will be formed between the outpatient department and the remainder of the departments contained in the podium such as day surgery and radiology. The atrium will contain link bridges, escalators, lifts and stairs providing all vertical and horizontal communication links across the void space providing the necessary connections between departments. The lifts should be fully glazed to all sides providing views over the atrium space for the purposes of orientation. A high level of finish will be expected for all stairs and balustrades, any handrail, barrier or guarding to stairs or corridor links should be glazed to allow views for children and those in wheelchairs. The roof to the atrium should be fully glazed to provide a light, bright welcoming environment. Solar shading devices should be incorporated as necessary to achieve the Board's stated Sustainability and Energy Targets. The atrium will also provide fully glazed areas of façade to courtyards where available, to allow users views out to external landscaped courtyard spaces. The expected quality of the atrium concourse space should be akin to a high quality shopping mall and continue the quality of the main entrance. This should be reflected in the choice of quality robust materials for flooring, walls, ceilings, balustrades etc. The quality of the space should also be enhanced by interesting shapes and forms, lighting techniques and the incorporation of art.

7.2.24 The form of the atrium shall clearly express the individuality and special nature of parts of the Works including the retail facilities, yet the parts should harmonise with the facilities as a whole. The Contractor should give particular consideration to the architectural composition and expression of the form within the atrium which should reflect an identifiably distinct character for the Adult Acute and Children's Hospital as befits the nature of the patient groups.

7.2.25 The atrium also provides opportunities for retail facilities including pharmacy and cafeteria facilities, these areas should be clearly expressed.

Helipad

7.2.26 The Contractor will require to provide a rooftop Helipad and the associated services, access requirements and safety facilities in full compliance with the following guidance;

a) HBN 15-03 – Hospital Helipads;

b) British Helicopter Advisory Board – Helicopter Site Keepers Guidance Document; and

c) Structural Design Criteria - ICAO Heliport Manual

7.2.27 The Helipad will also require to be provided in line with all requirements of Glasgow City Council Planning Department including the following requirement;

a) A detailed noise and environmental assessment regarding the relocation of the heliport landing area shall be submitted to the Planning Authority for its written approval prior to its siting and operation. The Contractor requires to consult the Director of Land and Environmental Services, Public Health Unit concerning the methodology and approach to any assessment.

7.2.28 It is understood that this type of Helipad does not require to be licensed by the CAA (Civil Aviation Authority), however due to the congested nature of the surrounding area the Helipad operator will require a Rule 5 permission from the CAA and therefore the Contractor must consult the Operator and Board to ensure compliance.

7.2.29 The Helipad Operator(s) and Board will require to be consulted on the type of helicopters that will be expected (including size and weights). However as general guidance for the size of Helipad required a rectangle with sides at least 25 m long (or a circle at least 35.4 m in diameter) will be a minimum requirement to accommodate all helicopter types likely to make use of the facility.

7.3 Ceilings Heights & Voids

7.3.1 The floor to ceiling heights, or to services level where there are no ceilings, shall be designed to accommodate the nature and use of the accommodation, but as a minimum shall be at least 2700mm irrespective of location. The ADB room data sheets define ceiling heights on a room by room basis.

7.3.2 All circulation and communication spaces shall have a minimum ceiling height of 2700mm;

Room Type	Department	Minimum Ceiling Height
All Corridors	Wards	2700mm
Lift Lobbies	All Departments	2700mm

7.3.3 Certain special types of room should be 3000mm or above in height to suit their medical or equipment needs;

Room Type	Department	Minimum Ceiling Height
All Operating Theatres	All Departments	3000mm Where Laminar Flow curtains are present – 2100mm required to u/side of curtain from ffl.
Radiology and scanning Rooms (CT and MRI)	Radiology	3000mm
Endoscopy Rooms	Endoscopy	3000mm
Therapy Room	Rehabilitation	4500mm

7.3.4 Additionally there are a number of departments where all ceiling heights should be as a minimum 3000mm – including all main communication and interdepartmental circulation routes;

Department	Minimum Ceiling Height
Operating Theatres	3000mm
Critical Care	3000mm
Imaging	3000mm
Rehabilitation	3000mm

7.3.5 The following criteria require to be incorporated in the Contractor's Proposals:-

a) Areas such as circulation spaces, patient corridors, waiting areas, reception areas, entrance areas and atria should be given particular consideration in terms of ceiling form, material and with particular regard to maximising the height of ceilings to offer a light, spacious and welcoming character. For the avoidance of doubt a suspended ceiling tiled solution throughout will not be acceptable in these areas. Where higher ceilings are present a maintenance strategy will require to be clearly demonstrated;

b) An appropriate and safe void allowance above all ceilings shall be provided, including appropriate and safe points of access for maintenance of services. The void allowed shall be adequate for the full co-ordination and installation of engineering, cabling (including IT)

and other services. Co-ordination with the electrical, mechanical and communication services shall be an inherent part of the ceiling and building design. A full and appropriate strategy for the coordination of services requires to be clearly demonstrated to the Board through the use of 3D Modelling techniques;

c) It is imperative that the Contractor shall demonstrate their solution to the above requirement to the satisfaction of the Board by providing a clear and identifiable strategy for the installation of these services , providing satisfactorily accurate sizing and positioning for ducts , cable trays etc, including access points in plan and section to confirm compliance with this key Board requirement. As part of this requirement a clearly identifiable zoning strategy will require to be demonstrated by the Contractor regarding the location of access points to ceilings or roof voids;

d) The Contractor shall also ensure that the ceiling voids are designed to accommodate the specific requirements of the fire strategy for the Facilities -and in particular, the provision of cavity fire-barriers within compartments;

e) Services access through all Category 1 ceilings will not be acceptable (ceiling categories will be as defined in the ADB Room Data Sheets). For these areas the ceiling services should be capable of being accessed from an adjoining activity space. For the avoidance of doubt services should not be accessed from below (i.e. through the ceiling) in these areas. The following list of areas is indicative only and not exhaustive;

i) Aseptic suite;

ii) Decontamination unit;

iii) Operating theatres;

iv) Anaesthetic rooms;

v) Plaster room;

vi) Post operative recovery; and

vii) Preparation;

f) Ceiling or roof voids must not be accessible to patients or visitors. Access will be by Maintenance personnel only;

g) Modular ceilings are not acceptable in the operating theatre but may be required in associated areas for maintenance purposes. The ceiling in the operating theatre should also be able to withstand regular washing and have a completely sealed finish to maintain microbiological standards in compliance with SHTM, SHPN, HBN guidance;

h) If an acoustically absorbent ceiling is considered in any location it is essential that this does not present an infection hazard in compliance with SHTM, SHPN, HBN guidance;

i) Designated access points shall be fitted with a self-contained Ramsey-style ladder or similar where appropriate to facilitate access for maintenance purposes – this should be clearly demonstrated in the Contractor's approach to access and maintenance;

j) Demountable suspended ceilings shall be readily demountable without suffering undue damage and shall be capable of being easily cleaned;

k) Ceilings will be constructed in a proprietary suspended plaster board system in areas demanding specific hygiene criteria as defined in the ADB Room Data Sheets;

l) Ceiling mounted booms required for patient support and monitoring systems in theatres, treatment or x-ray rooms shall be co-ordinated with the ceiling layouts. E.g. Background fixings within ceiling void. Access to check and maintain fixings to all structurally mounted equipment requires to be provided by the Contractor in a clearly demonstrated strategy;

m) In line with the requirements of HAI Scribe coving will be required at the junction of wall and ceilings within all theatre suites and endoscopy rooms;

n) A minimum of 2100mm clearance is required under any suspended fixtures e.g. Signage;

o) The protrusion of light fittings, radiant panels or any other fittings will not be accepted in clinical areas;

p) Consideration may be given to making use of the ceilings to provide additional natural light by way of roof-lights. However, careful consideration should be given to the implications of incorporating these, e.g. rain noise, and to how they will be cleaned;

q) Emergency egress from roof void areas into patient areas is not acceptable (this includes any garden areas internal to the facility);

r) Suitable service maintenance walkways, incorporating handrails, shall be provided within roof voids with access hatches where walkways pass through fire barriers. Services require to be entirely clear of this walkway;

s) Floor to ceiling heights must be carefully considered in relation to the overall height restriction placed on the building by the granted Outline Planning Consent; Additionally floor levels are required to tie in with adjacent building levels where clearly required e.g. Neonatal;

t) Where Laminar flow canopies are present, a height of 2100mm will be required from finished floor level to the underside of canopy curtain for headroom; and

u) Washable ceilings are required in all clinical areas.

7.4 **Corridor Widths**

7.4.1 The table below identifies the Board's minimum requirements for corridor widths on a departmental basis with which the Contractor must comply;

Corridor Type	Department	Minimum Corridor Width (clear between handrails)
Hospital Street	Communication	Requirements for Means of Escape will dictate width – however minimum of 3000mm required
General Traffic – Staff Only	All Departments	1500mm
General Traffic – Patient Areas	All Departments	1800mm – two independent wheelchair users to pass
Patient Bed/Trolley Traffic	Wards	2150mm – straight movement with passing places width 3330
Patient Bed/Trolley Traffic	Theatres/Endoscopy	2960mm – two beds to pass regularly
FM Tunnel	Links buildings	8000mm - to be developed with robotics design and requirement.

7.4.2 Corridor widths shall be as required by the nature and use of the accommodation. Minimum widths shall apply along the whole length of the corridor. Main interdepartmental corridors in areas that patients may travel in beds shall be of sufficient width to allow two beds, with any attached equipment, to pass. Departmental corridors shall have passing places and all corridor widths shall be subject to specific agreement with the Board.

7.4.3 The following criteria require to be incorporated in Contractor's proposals:-

a) the utilisation of corridor widths and profiles is an integral element of the Clinical Brief and requires to be addressed in design solutions. This may be achieved through the use of informal seating areas and the like, whilst avoiding areas where patients may be obscured from staff view where possible;

b) corridors in patient areas shall not be less than 1800mm (clear between handrails or other protrusions), with corner protection to be provided and handrails to both sides, where appropriate as defined in Section 7.16 - Protection;

c) wherever possible reduce lengths of circulation routes and provide open areas and stopping/resting points along the length of travel;

d) avoid isolated columns in open plan areas or on circulation routes where practicable; and

e) avoid dead ends to circulation routes, particularly in patient areas;

7.5 **Doors**

7.5.1 Door widths shall be identified in the relevant ADB Room Data Sheet and Schedule of minimum door widths below (in the eventuality of a conflict between the RDS and Schedule below the wider provision will apply).

Room Type	Department	Minimum Coordinating width of Door
Ensuites	All Departments	1980 mm
Recovery	Operating Theatre	1900mm
Corridors	All Departments	1900mm in corridors greater than 1800mm wide i.e. Corridors with patient access
Operating Theatre	Operating Theatre	1900mm
Endoscopy Room	Endoscopy	1900mm
Assisted Bathrooms	All Departments	1500mm
Patient Bedrooms	All Departments	1500mm
Treatment Rooms	All Departments	1500mm
DSR	All Departments	1500mm
Disposal Hold	All Departments	1500mm
Equipment Store	All Departments	1500mm
MRI Room	Imaging	1450mm (refer to HBN 06)
Interview/Sitting Rooms	All Departments	1000mm
Consult/Exam Rooms	All Departments	1100mm
Clean/Dirty Utility	All Departments	1000mm
Offices	All Departments	1000mm
Seminar Rooms	All Departments	1000mm
General Stores	All Departments	1000mm
Staff Rest Rooms	All Departments	1000mm
Staff WC	All Departments	1000mm
Patient WC	All Departments	1100mm

7.5.2 For the avoidance of doubt, the minimum coordinating width indicated above is as defined in SHTM.

7.5.3 Notwithstanding the above, the Contractor shall be responsible for establishing, through detailed consultation with the Board, additional specific requirements for door widths in all areas of the Works. Consideration shall be given to providing sufficient door width in areas where the Board's operations rely on the use of larger items of Equipment such as waste containers and regeneration trolleys.

7.5.4 Door widths and door configuration shall be provided to allow for the delivery and removal of Equipment to each area. The Contractor shall require to demonstrate replacement planning for

major items of kit including navigation routes through corridor and other doors (e.g. replacement Imaging equipment). In this respect the Contractor shall ensure that the relevant corridor and door opening widths can accommodate the replacement of plant and materials along designated routes (identified by the Contractor). This to allow the passage of new/replacement Equipment and Specialist equipment without the need for the removal of any doors, door operating gear/equipment or handrails/protection.

7.5.5 The following criteria require to be incorporated in the Contractor's proposals:-

a) doors from the single bedrooms to en-suites in all ward accommodation should comply with the requirements of both HBN 04-01 Adult Inpatient facilities and HBN 00-02 Sanitary Spaces. The double door to the shower room should consist of a sliding/folding door and a hinged door. The sliding/folding door provides staff and unassisted patient access. Both doors need to be fully open for assisted use of the facilities. The sliding/folding door should be designed to release from the overhead track in order to provide mobile hoist access to the room and transfer to one side of the toilet. The hinged door should be able to open unhindered. To maximise the free space in the bedroom, consideration should be given to making this a folding door;

b) doors will require to accommodate overhead tracks (including supporting structures as necessary) for patient hoists in all bedrooms, with patient hoists to be installed in six bedrooms per ward generally and all bedrooms in elderly wards as well as in one room per OPD cluster in the Children's hospital;

c) all main entrance doors shall be automatically operated with break-out facility in the event of fire and have an effective draught lobby;

d) internal door leaves to all areas shall be of solid core construction, reinforced with damage protection plates; They must be resistant to all damage which would be reasonably expected for the building use. In line with BS8300 requirements the Board would expect that as a minimum all doors where there will reasonably expected to be wheelchair access – 400mm high kickplates will be provided. Refer to Section 7.16 - Protection for further details;

e) doors to some rooms shall be of a security rated construction, particularly areas where medical drugs are likely to be stored as indicated in ADB Room Data Sheets;

f) all door frames must be of solid or metal construction, and must be securely fixed in to the adjoining construction;

g) all doors to bedded areas shall be minimum width of one-and-a-half size openings to allow access for hospital beds, with double width doors required in ward area corridors. In addition to the requirements of the Disability Discrimination Act, careful consideration needs to be given as to the clear opening size of doors due to the need to transport patients and items through. Patients may be supervised, with an individual on either side of them (some patients may be evacuated in their bed to a place of safety, therefore pinch-points at rooms and corridors need to be avoided);

h) doors shall incorporate vision panels as per the ADB Room Data Sheets, to permit staff observation; of these, some will require integral blinds to obscure the vision panel for privacy reasons, this will also be indicated in ADB Room Data Sheets. Integral blinds to the vision panel are to be operable only from the inside of the room where a member of staff will

be constantly present, where a member of staff will not be constantly present (bedrooms for example) the integral blind should be operable form both inside and outside the room. Integral blinds in door vision panels require to be vistamatic type (horizontal blinds are not acceptable);

i) doors should have low-level viewing panels to ensure that a baby, toddler or young children or those in wheelchairs can see and be seen from either side of the door. Where a door has a single viewing panel, the minimum zone of visibility should be between 500 mm and 1500 mm from the floor. If a door requires an intermediate horizontal section for strength or to accommodate door furniture, the door should have two viewing panels, one accommodating a zone of visibility between 500 mm and 800 mm from the floor and the other accommodating a zone of visibility between 1150 mm and 1500 mm from the floor. Doors requiring vision panels are indicated in the ADB Room Data Sheets;

j) all doors to patient bedrooms, en-suites and bathrooms shall be fitted with a break-out (anti-barricade) facility which may be achieved by a combination of outward opening doors and ironmongery solutions. The Contractor will be expected to comply with anti-ligature/anti-barricade requirements in the Children's DCFP;

k) fire doors fitted with door closers are heavy and awkward to open and hamper easy circulation. All fire doors on circulation routes, and those not needing to be closed for security reasons, should be fitted with electromagnetic stays or swing-free door closers, which will close in the event of a fire alarm and be linked to the BMS to close at night. Door holds and door closers utilised in any location must not de-rate the fire rating of the door set to below that require for the location;

l) all bedroom doors which shall have free swing door closers (as HBN 00-04);

m) swipe card access and video plus audio door access will be required at the entrances to all departments, at links between departments to provide the necessary segregation, at all ward entrances, access points to staff only areas and access to FM/back of house areas;

n) all interview and consulting room doors to have a suitable level of acoustic performance to achieve the dB rating required by the ADB Room Data Sheets. Also refer to Section 7.8 – Acoustics. No air transfer grilles shall be permitted in these particular rooms and must comply with all requirements of the ADB Room Data Sheets;

o) the requirements for Radiofrequency shielding to doors within Radiology department shall be based on the requirements of the MRI scanner supplied and the siting of the device within the room and wider environment. Door leafs will typically incorporate copper or aluminium sheet materials and special details such as compressible brass finger strips at the head, sill and door jambs to maintain the continuity of the Rf cage electrical conductive construction. For the avoidance of doubt however it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter;

p) door closers to shielded doors require to be agreed with the Board and the Board's Radiation Protection Adviser;

q) all Radiology, Imaging and Nuclear Medicine x-ray rooms require lead lined doors as do all Theatres, dental (Children's hospital) and areas of A&E. The requirements for radiation protection shall be based on the designation and nature of the area, size of the room,

location of the door in relation to equipment and other risk factors. For the avoidance of doubt it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter;

r) doors must be fire resistant in line with fire regulations but, where connected to the fire and security alarm systems, must fail closed. Any alarm system linked to doors must not be compromised by even a short term power loss or surge;

s) doors to Theatres and Recovery areas require to open automatically upon activation of a push pad (not switch). Push pads to be sited to the left and right of both approaches to the door (i.e. 4 pads per door set). It should be possible to stand automatic doors in the opening position;

t) signs on or adjacent to all doors should be at a height of 800–1500 mm and tactile so that they can be easily read by touch;

u) external doors to non-public access areas should be metal-faced, solid timber core construction, other than louvred doors to plant areas, where ventilation is required;

v) any locked fire exit doors must have the capability of release on the activation of the fire alarm, or a local release facility of a type not likely to tempt patients to misuse it in line with Building Control requirements;

w) in the Children's Hospital doors to rooms that should not be entered by young children must be fitted with high-level latches. Where rooms require privacy, the doors should be fitted with 'free-to-escape' emergency release. In this case thumb-turn locks are not appropriate as young children can easily tamper with them, which could then cause panic in an emergency;

x) all external main entrances require to fitted with automatic sliding doors which protect both ends of a draught lobby. The entrance, doors and draft lobby must be designed to ensure that all normal hospital traffic can safely enter the building without compromising the inner environment (temperature and cleanliness, etc) or security of the building, throughout all weather conditions all in full compliance with HBN 00-04. For the avoidance of doubt all main entrances should allow for bed access/egress with a minimum clear width of 1740mm and doors should open automatically in the event of fire or power failure in line with the requirements of the Technical Standards requirements;

y) all fixings to ironmongery, fixtures and fittings in the Children's Hospital must be either securely concealed or be of a tamper-proof form (e.g. non-return screws);

z) the Contractor shall provide ironmongery which shall compliment the overall quality of the interior design concept. The Contractor shall ensure ironmongery is of robust construction suitable for its specific purpose and usage characteristics and in accordance with the Room Data Sheets. For ease of use by elderly or disabled persons the Contractor shall ensure handles are colour contrasted with the door background colour and of easy grip design. For ironmongery requirements refer to Section 7.11.1 Ironmongery;

aa) in 'back of house' areas such as catering, mortuary and all FM areas doors should be wide enough for trolleys and equipment to pass through easily and will need additional protection at heights related to equipment likely to cause damage. Any external doors to catering areas will require to be pest and insect-proof. All doors in food handling areas should have vision panels. Some doors may require security devices to allow access for designated staff only. For economy of space, chilled food stores and cold rooms may be fitted with sliding doors; flush thresholds are required to facilitate the passage of trolleys. Automatic cold air curtains should be fitted to maintain the temperature when the door of chilled food stores and cold rooms is open;

bb) Consideration should be given to providing doors within the children's hospital of different shaped vision panels, ironmongery and colours to provide a less clinical feel; and

cc) all doors within circulation and communication routes require to provide as large as practicable an effective clear opening width to allow the free movement of all forms of traffic. For the avoidance of doubt, the effective clear opening width for a swing door is the available width measured at 90degrees to the plan of the doorway clear of all obstructions (such as protruding ironmongery) when the door is opened through 90degrees or more. In all main circulation and communication routes (corridors over 1800mm) doors should comprise door leafs which are floor to ceiling heights with no overpanels. At these locations any door nib should be of a transparent nature in order to provide for maximum visibility to the corridor beyond.

7.5.6 Additionally, the Contractor requires to comply with the following:-

a) ensure that door edges do not present a hazard to visually impaired people when in hold open position. Contrasting texture flooring should be considered to guide people into the line of doors, as an integral part of the way-finding strategy;

b) light pressure delay check door closers should be provided to self-closing doors;

c) colour contrasted easy grip lever furniture and ironmongery;

d) any fully glazed doors or associated screens to have additional visual identification, for example applied manifestations;

e) level access to all doors, including escape doors;

f) generally, intermediate doors across main circulation routes should be held open on electro-magnetic devices linked to the fire and security alarm systems and designed to fail closed in an emergency or power failure.

7.5.7 Door Security

7.5.7.1 Door security requirements shall be identified in the relevant ADB Room Data Sheet, however the following criteria will require to be met by the Contractor;

a) access doors to patient areas will require to be alarmed and linked to a suitable alarm system capable of being monitored by the duty room or ward manager. This is vital within the Children's Hospital where all entrance/exit doors will require door control systems to prevent unwarranted access/accidental egress. They must be controlled externally with close proximity cards and internally by a press-to-release switch at a high-level. They will also be operated from a communications base, coupled with an audio-speech facility between the entry door and the communications base for identification purposes. Door control systems must be capable of manual or automatic release on initiation of the fire alarm system;

b) security measures are also needed to control unauthorised access to all departments through the use of swipe card and video entry systems. It is recommended that access through the main entrance to all areas be controlled by use of an entry-phone or intercom system with CCTV, linked to the reception/clerical office and communications base. Programmable close proximity card or similar systems must be fitted to changing room doors and used broadly across all departments. Ideally the programmable system should grant different patterns of access to suit the needs and privileges of authorised staff and visitors. The security measures chosen should not inhibit emergency escape from the above areas or access by the staff at any time;

c) all doors must be master-keyed / carded, with allowance for a suitable quantity of sub-master suites to facilitate the security zoning arrangements within the building such that each department, ward and service area can be locked down separately and with a master key. All doors throughout the building to have the same lock to allow a single key to be used by all staff. Spare cylinder and key sets to be maintained by the Contractor to allow ease of replacement. Secure and 'staff only' areas are to be controlled by proximity card readers linked to electrical locking devices in the doors. The proximity cards are to be contained within the staff I.D. badges. Contractor to provide facility to enable alterations to cards. Twelve thousand cards and lanyards are required to be provided by the Contractor;

d) there will be a decontamination entrance leading from the ambulance bay into A&E, which can act as a decontamination "airlock" with internal drainage and integral showering facilities with a "dirty" end onto the ambulance entrance and a "clean" end into the department. This area should have piped oxygen and suction to be able to manage the rare situation of a contaminated patient requiring resuscitative measures. This area requires to have audio/intercom communication with the adjacent hospital area to allow communication between staff;

e) the A&E will have secure entry and exit points which can be locked if required. Electric swing doors will be configured to open automatically if approached by a patient trolley. All other access will be by proximity card access by staff members; and

f) the A&E will have facilities for the management of high security patients, access to the treatment area for patient transfers of this type to have a discrete external door, security rated and access controlled as agreed with the Board and Strathclyde Police.

7.5.8 Draft Lobbies

7.5.8.1 All main entrances will require a draft lobby, the enclosure to the lobby requires to be fully glazed to enable users to proceed safely and confidently.

7.5.8.2 The lobby area should have absorbent and dirt-retaining flooring, over a sufficiently large area, to minimise damp and dirt being taken into the hospital to further minimise the risk of slip accidents. Mats must be able to be uplifted and removed from matwells for cleaning. For details of these requirements refer to floor finishes section – Section 7.9.2. Further, draft lobbies require to have air curtains and consider further energy efficient design features.

7.5.8.3 The size and shape of the lobby should also:

a) allow the smooth flow of users into and out of the building;

b) allow for the fact that users may congregate there;

c) ensure that by the time the second doors are reached, the first are closed;

d) provide a “modifying” environment between the outside and inside of the hospital; and

e) if other facilities are provided within the draught lobby, such as seats and payphones, they should not obstruct the passage of users.

7.6 **Windows**

7.6.1 Bedroom windows shall be sized and positioned so that patients can view through the window from their bed while sitting up, from a seated position and when standing. In the Children’s Hospital windows must have a low-level sill, a maximum of 600 mm high, to enable small children to see outside from their bed or cot. Blinds, controlled from within the room, are required for all internal glazed screens and windows to ensure privacy and also give protection from glare and solar gain.

7.6.2 The Contractor shall ensure that appropriate solar glazing and/or solar shading is incorporated on windows on typically East, West and South facing elevations. The Board will expect the Contractor to implement solar glazing/shading strategies as part of the overall solar heat gain and ventilation strategies. Further to this the Contractor will require to clearly demonstrate compliance with the environmental/energy targets as defined in Appendix M.

7.6.3 Natural light shall be provided in public spaces and in occupied private and staff spaces within the Facilities as far as is practical. Natural and artificial light sources should be designed to avoid or minimise glare.

7.6.4 Where possible all windows shall be designed by the Contractor to be cleaned externally and internally from the inside, unless otherwise agreed by the Board. The Contractor shall ensure no portions of windows, either fixed or opening should come below the level of worktops or desks except in in-patient areas where bedrooms and day dining rooms cills may be lowered to facilitate better external views. Locking devices to enable the windows to be released for cleaning purposes shall be by key or other device such that they cannot be released by unauthorised persons.

7.6.5 The following criteria require to be incorporated in the Contractor's Proposals:-

a) windows must combine security with good natural light and ventilation;

b) window frames to be of a robust and secure construction;

c) provision of external window cleaning system to ward tower, podium and all other windows;

d) all windows (in a naturally ventilated building solution) to have robustly controlled, limited openings to a maximum of 100mm clear opening (as per ADB Room Data Sheets and SHPN 03) with a robust, secure method of restricting the extent of opening;

e) all windows (in a naturally ventilated building solution) should be capable of opening in order to meet the desire to naturally ventilate the building as far as is practicable. This is required to address seasonal changes, where external temperatures may dictate that it is not desirable to open windows to achieve ventilation. The opening operation of all windows also needs to balance the desire to open windows against compromise of the security of the building envelope. The Contractor must submit full details of the proposed trickle vent with their bid, consideration should also be given to the effects of opening windows at height in the tower;

f) there may also be reduced air flow within the building as, for security reasons, some windows may not open extensively. With this in mind, it is essential that the ventilation and temperature control systems are of a high standard. The use of passive methods is encouraged;

g) as part of any passive, natural ventilation scheme dependant on the opening of windows, The Contractor shall demonstrate through thermal simulation (IES, TAS or equivalent) the optimum window opening arrangement has been selected to optimise thermal comfort with due consideration to any restrictions on openings;

h) the Contractor shall consider use of integral blinds to windows as part of the overall external shading strategy for the building along with meeting the specific requirements of the room as indicated in the ADB Room Data Sheets. The use of Integral blinds is considered to be advantageous in the area of Infection Control offering a practical solution to a range of cleaning issues. The Contractor must demonstrate maintenance and replacement methodologies for any proposed integral blinds (to windows or screens) and include robust gear and switching/movement controls;

i) in the critical care department windows in the single bedroom should be sealed. This is essential to maintain mechanical cooling and positive/negative airflow;

j) in the critical care department integral window blinds must be installed that can provide 'black-out' which is essential for ultrasound examinations and other imaging procedures;

k) proposals for the external solar shading of the building should be considered in the context of the overall design and, only if necessary, should consideration be given to solar glazing to south elevations. No reliance on the fitting of internal blinds can be used when evaluating reduction in solar gains;

l) where any windows require external security shutters, these shall be electrically operated and fully concealed;

m) window ironmongery in the shall be anti-ligature in the Children's DCFP;

n) windows that open onto courtyards where children play may constitute a hazard. Raised planting, for example, beneath them can prevent children sustaining injuries while running. In areas where children and young adults will be present Centre-pivot windows are to be avoided. Windows should preferably be of the sash-type with restrictors;

o) In areas where children and young adults will be present child-resistant locks should be fitted to all windows;

p) cords on window blinds or curtains should be kept short and out of reach of young children;

q) in order to promote good observation and communication between staff and patients in single bedroom ward areas large internal glazed screens between bedrooms and corridors should be incorporated. This will enable staff to observe patients and equally importantly, patients to see staff. However, patients should have the means to obscure windows where required through the use of integral blinds to provide privacy when required;

r) it should be possible for cleaners to gain easy access to the inside and outside of windows. A cleaning and access strategy for all windows and curtain walling requires to be provided by the Contractor, with all necessary equipment and access included in the Contractor's Proposals;

s) selection of the type of glass is crucial for the effective control of security, and for thermal and solar glare control and should be selected in conjunction with the overall consideration of environmental modelling of the Works. Colour rendering – for diagnosis of patients should also be considered in the choice of glass type for windows and screens. The robustness of all glazing must be appropriate to the functionality, relative to safety and resistance to damage;

t) the Contractor shall ensure that all handles or control gear shall be placed at levels which enables them to be operated by staff without the use of loose poles, and which do not conflict with the location of the adjoining construction elements, including blinds and curtains. Where windows are placed over worktops or desks, or where the operation as described above is not achievable, mechanical or electrical means of opening shall be provided by the Contractor with controls located in a suitable position within the room concerned;

u) the Contractor will be expected to use toughened glass in all locations (windows, doors, balconies, balustrades etc) except areas which are vulnerable to vandals or intruders at ground floor locations. As toughened glass is inherently strong and when damaged breaks into small pieces this is deemed to be less dangerous in terms of falling shards of glass or risk to vulnerable patients at risk of self harm. Laminated glass at ground floor level only will provide greater security. Laminated glass when broken will remain in place with numerous cracks, but the fragments are held together and do not separate therefore no hole left in the window for an intruder to get in through for example; and

v) One way screens/viewing panels should be incorporated as identified in the ADB Room Data Sheets.

7.7 **Building Envelope**

Facade

7.7.1 The Board would confirm that a variety of building envelope solutions will be considered in response to the following diverse challenges;

a) Energy usage;

b) Environmental considerations i.e. Odour from the nearby sewage works;

c) Ventilation and overheating;

d) Infection Control;

e) Acoustics;

f) Natural Light;

g) Cleaning and maintenance; and

h) Solar Control strategy

7.7.2 The envelope solutions which will be considered as acceptable to the Board include:

a) a partially sealed air conditioned building working in tandem with natural ventilation;

b) mechanically ventilated building working in tandem with natural ventilation;

c) double skin facade solution.; and

d) a sealed building where a maximum temperature solution is provided.

7.7.3 The envelope solution(s) proposed by the Contractor will require to be fully developed and modelled clearly indicating compliance with the Board's stated Sustainability and Energy Targets. It is not envisaged that a fully air conditioned solution alone will be capable of meeting the stated targets, however if this option is proposed, as above, a the Contractor will require to provide to the satisfaction of the Board a fully developed and modelled solution clearly indicating compliance with the Board's stated Sustainability and Energy Targets.

7.7.4 The Contractor shall also ensure that the external envelope shall incorporate provisions for its cleaning and maintenance. The Contractor shall ensure that the external hard and soft landscaping around the buildings shall allow access for the appropriate cleaning system, whether by ladders, mobile platforms or cleaning cradles attached to the building structure. Appropriate provisions shall be incorporated by the Contractor to allow the safe use of ladders. The external skin of the building shall be designed by the Contractor to accommodate the point load access of ladders and operatives, where the cleaning and maintenance system uses this method.

7.7.5 The following criteria require to be incorporated in the Contractor's proposals:-

a) external finishes shall be durable and easily cleaned, with finishes which may be vulnerable to abuse / vandalism (including graffiti) to be avoided;

b) anti-climbing measures shall be carefully considered, specifically in relation to any external wall-fixed rainwater goods and solar shading;

c) protection / avoidance from vehicular impact at drop-off, delivery points and the like is required; and

d) external detailing to avoid;

i) nesting or perching sites for birds and other wildlife;

ii) Unsightly weather staining of facades; and

e) Method of cleaning and maintaining façade

7.7.6 The Contractor shall design the building envelope to prevent rainwater entry into the building structure and the internal accommodation. Where water penetrates cladding elements, as part of the functional design and construction techniques, the Contractor shall ensure it is controlled and drained externally.

7.7.7 The Contractor shall ensure that all building elements and retaining structures shall incorporate appropriate means to resist the passage of dampness, both into the building structure and fabric, and into the accommodation, including the resistance to any hydrostatic pressure. The Contractor shall ensure that all such construction shall be in accordance with the requirements of the Building (Scotland) Regulations 2004, BS 8102 and Code of Practice CP 102 for Protection of Structures against Water from the Ground.

7.7.8 The Contractor shall ensure that the buildings are constructed and the design is detailed to limit air infiltration to minimum levels to reduce energy consumption and improve internal environmental conditions.

7.7.9 Performance demonstration tests for all roof and wall elements shall be carried out by the Contractor in accordance with the following:

a) BS 5368, Part 2: 1986 (EN86) Resistance to Water Penetration;

b) BS 5368, Part 3: 1986 (EN77) Wind resistance; and

c) BS 5368, Part 4: 1986 (EN86) Test Report Format.

Roof

7.7.10 The roof construction shall be fully weatherproofed, designed for minimum maintenance and suitably braced and held down to resist the influence of gusting winds appropriate to their locations. All penetrations through the roof membrane or cladding shall be suitably sealed to prevent the ingress of water. The roof shall be laid to falls appropriate to the adopted membrane or cladding and shall include sufficient provision of guttering and down pipes to adequately discharge rainwater to the underground drainage regime.

7.7.11 As part of the Board's sustainability requirements a strategy for rainwater harvesting should be considered by the Contractor. Where rainwater harvesting is incorporated, full risk analysis shall be carried out and tabled for consideration, all actions shall be taken to mitigate risks to infection control requirements. Rainwater harvesting is likely to be restricted to use in areas of the FM, Energy and Laboratory buildings.

7.7.12 The Contractor shall also ensure that all roofs shall incorporate provisions for cleaning and maintenance. Appropriate provisions shall be incorporated by the Contractor to allow the safe use of ladders, guardrails, walkways, access solutions and fall protection solutions in line with all Health and Safety Guidelines to prevent fall from height. This is a fundamental aspect of the roof design and a clear strategy detailing access provision will require to be demonstrated by the Contractor as part of the overall roof design.

7.8 Acoustics

7.8.1 The Contractor shall endeavour to minimise and mask ambient noise sufficiently to preserve patient privacy, confidentiality and maintain a calming atmosphere in public and patient areas.

7.8.2 Audiology booths require to be provided to the necessary acoustic and other standards.

7.8.3 The specific requirements of the Board with regard to Acoustics are contained in Appendix S.

7.9 Finishes

General Finishes

7.9.1 All wall finishes and backgrounds shall be selected and installed in accordance with SHTMs and appropriate British and European Harmonised Standard Specifications, Codes of Practice and ADB Room Data Sheets.

7.9.2 Areas of the Facilities that are subject to potential damage from trolleys, vehicles, beds or other similar traffic shall have adequate protection to comply with as a minimum SHTM 69 and in line with the specific requirements of Section 7.16.

7.9.3 The detail design and finished quality standards of certain specific finishes will be subject to the construction of mock-ups during the design and construction stages. These will form the benchmark for quality control of Site operations.

7.9.4 The use of colour patterning, motifs and texture should be considered by the Contractor in appropriate areas throughout the buildings as an integral part of the wayfinding strategy.

7.9.5 The following criteria require to be incorporated in the Contractor's proposals for all areas:-

a) internal finishes shall be durable and easily cleaned;

b) internal wall surfaces shall be resistant to damage appropriate to the location. Certain areas will necessitate severe duty partitions in accordance with BS 5234 Part 2:1992 (or equivalent), with wall protection. Severe duty partitions will be required in major circulation and heavy industrial areas such as FM;

c) wall finishes must be in accordance with the relevant SHTMs, HTMs HBNs, Design Guides, the Scottish Building Standards, and ADB Room Data Sheets and should also be appropriate to the activity space that they serve, in terms of: imperviousness; hygiene; joints; smoothness; moisture resistance; resistance to cracking; and resistance to abrasion;

d) internal partitions finishes shall also be as required by the nature and use of the accommodation and shall incorporate radiation protection requirements, sound reduction, fire resistance, humidity, biological attack and duty as identified by relevant HBN, SHTMs and appropriate British and European Harmonised Standard Specifications, Codes of Practice and ADB Room Data Sheets and as identified elsewhere in this document;

e) all wall finishes in clinical areas in the Children's Hospital must be durable and able to withstand wet cleaning and the accidental impact of trolleys and heavy mobile equipment. Especially vulnerable points must have additional protection. Smooth paint surfaces are the easiest for cleaning, for example eggshell or vinyl silk emulsion;

f) all wall finishes in clinical areas in the Adult's Hospital should be durable and able to withstand wet cleaning and the accidental impact of trolleys and mobile equipment. Especially vulnerable points should have additional protection. Smooth paint surfaces are the easiest for cleaning – eggshell or vinyl silk emulsion. A matte finish is not acceptable;

g) as the use of ceramic wall tiles is not acceptable in terms of Infection Control, impervious wall cladding is required in shower areas and as splash backs in kitchens, toilets, cleaner rooms etc;

h) The infection control team must be consulted and involved with material specification and detailing;

i) columns should be located, insofar as is reasonably practical, to coincide with corridor walls in order to minimise intrusion into rooms or corridors. Columns or ducts must not protrude into corridors so that they reduce the required minimum width; and

j) external walls and internal partitions shall be provided with movement control joints, appropriate to their material, method of construction and anticipated movement. Where movement joints are required these are to be identified on the layout drawings, these will not be acceptable within rooms or in clinical areas.

7.9.6 Additional specific finishes requirements that must be met by the Contractor's Proposals are identified below;

a) all Radiology, Imaging and Nuclear Medicine x-ray rooms require lead lined partitions and doors as do all Theatres, dental (Children's hospital) and areas of A&E. The requirements for radiation protection shall be based on the designation and nature of the area, size of the room, location of the door in relation to equipment and other risk factors. For the avoidance of doubt it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter;

b) the requirements for radiofrequency shielding to walls and doors in the Radiology department shall be based on the requirements of the MRI scanner supplied and the siting of the device within the room and wider environment. Walls and door leafs will typically incorporate copper or aluminium sheet materials and special details. For the avoidance of doubt however it is required that the Contractor must seek advice from and agreement with the Board and the Board's Radiation Protection Adviser in this matter, however full floor to ceiling protection should be included in all patient treatment areas (as well as full protection to all doors leading to or from treatment areas) in Radiology, Imaging and Nuclear Medicine x-ray rooms as well as all Theatres, dental (Children's hospital) and areas of A&E;

c) all Theatres throughout the facility should have no reflective surfaces or bright door handles as laser surgery may be undertaken;

d) where interventional procedures are considered, or will be undertaken in any room within the Radiology Department, the room finishes should conform to operating theatre standards. Ceilings should be continuous and impermeable. The provision of specialist paint finishes for ceilings and walls is expected and will be identified on ADB Room Data Sheets;

e) in all cases in the Radiology Department, overlapped sealed joints should be used over architraves and skirtings. Floors should be finished with non-electrostatic vinyl sheeting in order to avoid electrostatic discharges that may affect the function of the MRI and associated equipment;

f) wall and ceiling finishes in operating theatres should be impervious, durable and able to withstand wet cleaning and the accidental impact of trolleys and heavy mobile equipment. Especially vulnerable points should have additional protection. Protection measures should be considered at the initial design stage to prevent the need for regular maintenance which

would require the unit to be closed for long periods. The provision of specialist paint finishes for ceilings and walls is expected;

g) in the mortuary the floor of the body handling and post mortem area must be very hardwearing, non-slip, and impervious to water and disinfectant. The floor should be self-draining towards gullies to allow for drainage after cleansing. Walls should be capable of withstanding regular washing or hosing down, and should meet the raised junction with the floor at a waterproof joint. Ceilings should be capable of withstanding frequent washing down; and

h) IPS solutions shall be required in all toilet areas and areas where wet/sink provision is required (e.g. utility rooms). The use of flexible hose connections is prohibited.

Flooring

7.9.7 The Contractor shall ensure all level and inclined flooring shall meet the following minimum slip resistance requirements:

a) "Rz surface micro-roughness of 20 µm*;* and

b) "Slip resistance pendulum value of 36 (when either dry or contaminated)

7.9.8 The choice of flooring for areas, which may foreseeably become wet or contaminated, needs careful consideration. An anti-slip floor may be an effective control in some areas, such as kitchens, bathrooms, WCs and shower rooms. The choice of flooring will be influenced by the likelihood of the floor becoming contaminated and other factors such as the use of, and levels of, pedestrian traffic in the area. Effective cleaning will be important in maintaining the performance of anti-slip floors, however, it is important to establish with suppliers and cleaning staff that anti-slip flooring can be cleaned to appropriate hygiene standards. In certain areas such as operating theatres, where hygiene is paramount, this is especially important.

7.9.9 The flooring is just one, albeit important element, in the slip potential model and in areas where contamination occurs only occasionally, it may be more appropriate to control the risk through enhanced cleaning and management regimes. Therefore the Contractor requires to comply with the following;

a) the Contractor will require to demonstrate that a Risk assessment has been carried out in accordance with SHTM guidance. This assessment will require to be conducted in conjunction with the Board since as noted above, cleaning and management issues are factors in the assessment;

b) the Contractor shall, in order to complete a thorough risk assessment, procure test results in the "installed" condition which are independently verified by the Health and Safety Laboratory, Buxton, Derbyshire or approved equivalent. The method of testing shall be performed using a pendulum-coefficient of friction instrument with "Four-S" rubber, in accordance with approved HSE test methodology. For the avoidance of doubt, the obligation to follow the pendulum-coefficient of friction methodology is a specific obligation and is derived from the HSE, which only recognises this type of test;

c) the Contractor shall also ensure adoption of similarly robust test methodology for other areas including stair treads and nosings;

d) the Contractor shall ensure that all entrances to the Facilities incorporate appropriate floor matting designed to remove contaminants including water, dirt and leaves from footwear, trolley wheels etc. Barrier matting is most effectively deployed in conjunction with other controls including effective or enclosed canopies and heating, in particular underfloor heating and ventilation or a water evaporation system such as a hot air curtain; and

e) the Contractor shall be identify a strategy proposal at each entrance for agreement by the Board. The matting must extend a minimum distance of 6 metres along the route of travel within the building in line with NHS Scotland Safety Action Notice SAN (SC)05/08. For the avoidance of doubt the Contractor shall comply with all of the recommendations provided in SHS Safety Action Notice SAN (SC)05/08;

7.9.10 The following criteria requires to be incorporated in the Contractor's proposals:-

a) floor finishes must be in accordance with the relevant SHTMs, HTMs, HBNs, Design Guides, and the Scottish Building Standards, and should be appropriate to the activity space they serve in terms of imperviousness; hygiene; joints; smoothness; anti-static; slip resistance; absorption of liquids; radius of ignition. Areas with special requirements such as Operating Theatres and ancillary accommodation require particular consideration;

b) care must be taken in the selection of the appropriate soft floor coverings, for the avoidance of doubt carpeting or soft flooring will not be acceptable in any clinical areas;

c) in all areas the floor material should be coved to form the skirting (minimum of 100mm) to avoid angles and corners where microbial colonisation can occur. All coving must have a proprietary cap strip to the upstand. This detail will allow easy cleaning of the floor finish. In areas where frequent wet cleaning methods are employed, the flooring material should be unaffected by germicidal cleaning solutions, the skirting material used should be integral with, and have properties similar to, the floor finish;

d) vinyl, linoleum or rubber are examples of slip-resistant flooring and should have welded joints. The flooring should be at least 2.5mm thick;

e) all joints between sheet floor finishes and between cove skirtings are to be hot seam welded with care taken particularly at doorways (all welded joints and set in coves, no open joints or sit on cove);

f) loose laid barrier matting is not permitted;

g) visually contrasting texture flooring surfaces should be utilised, wherever appropriate, as an integral part of the way-finding strategy;

h) zero profiles are required at external access points, including access routes to any garden/courtyard areas;

i) smooth vinyl/linoleum coverings shall not be permitted in areas susceptible to wetting and where it is not reasonably practicable to keep them dry such as all WC's , En-suites, Clean/Dirty Utility Rooms, Cleaners Rooms, Assisted Bathrooms , kitchens etc;

j) early cognisance should be taken in the positioning of construction joints in flooring bases to avoid seams in floor finishes in the centre of rooms or circulation areas, joints in these areas will not be acceptable;

k) continuous flooring to be provided as far as is reasonably practicable, with no patching and utilising welded joints and set-in coves;

l) where movement joints are required these are to be identified on the layout drawings and will not be acceptable within rooms or in clinical areas. Movement joints must by flush with the surrounding floor finish;

m) the continuity and integrity of surfaces is important in all areas and particularly in wet and more clinically sensitive locations. Surfaces should be easily cleaned and finished to avoid potential dirt trapping points;

n) in wet areas such as shower rooms with level access floors it is important to avoid tripping hazards such as floor gulley surrounds and lippings to contain water;

o) floor gulleys, gratings and associated finishes should be integrated within the overall floor build up in accordance with relevant manufacturer's recommendations and to achieve tight and continuous sealing to minimise potential for dirt traps;

p) vinyl, linoleum or rubber flooring is tolerant of small movements in the structural floor. The floor screed therefore should be perfectly smooth, crack-free and stable. Adhesives should be powerful enough to resist the formation of "waves" in the floor finish that can result when heavy equipment is moved;

q) sufficient time should be allowed for the adhesive to set prior to use. Thresholds at doorways between adjacent rooms require particular attention because they are points of stress in the floor finish;

r) in theatres with laminar flow ventilation, the floor area enclosed by the hood should be marked with lines or a contrasting coloured area of flooring;

s) in the mortuary area it is important that the floor covering is chosen can be effectively cleaned, maintained and, where necessary, repaired. Vinyl anti-slip floor is often difficult to keep clean (due to grit type surface) and its iron-based particles produce stains, particularly visible on light-coloured flooring. A slip resistant resin flooring will require to be provided;

t) sprung flooring is required in gym and other relevant areas; and

u) waterproof finishes are required in bunding to theatre plant rooms, energy centre plant rooms and other plant areas where resilience is required to prevent water damage to areas below.

7.10 Interior Design

7.10.1 The interior environment is fundamentally important in achieving a non-institutional and therapeutic environment. The Contractor should focus on creating the highest quality spatial environments, which respond to the Boards ethos and operational needs. The interior design should be developed in conjunction with the master plan and architectural solution, producing a fully coordinated and complimentary scheme.

7.10.2 The aim should be to create progressive environments which respond sympathetically to their setting, whilst creating the opportunity to develop contemporary methods of working practices, including the development of large scale dynamic public spaces. The design should respond to client and user needs, whilst emphasising quality of materials, light and space.

7.10.3 The Contractor should seek to exploit the sensory elements of design to provide both information and stimulus. It is a physiological fact that the majority of information that we receive is visual. For sighted people, promoting the sensory aspects of design adds depth and meaning to the environment whereas for visually impaired people whose ability to access significant amounts of information is substantially limited, this design approach is fundamental to understanding the environment and operating independently within it. Because most visually impaired people have some sight, the use of colour to create contrast between critical surfaces and key design features is perhaps the most powerful way of accurately describing the immediate environment.

7.10.4 The use of tactile information should also be clearly developed in the Contractors approach, to all lift signage and door signage. Audible information, including the range of sounds created by contact with different surfaces can be extremely useful and the senses of both sound and touch affect the aesthetic experience of the environment.

7.10.5 The Contractor should demonstrate colour differentiation in surfaces. Visually impaired people are generally less confident at differentiating colours that fully sighted people, but if the colour difference is above a certain threshold value their confidence improves significantly.

7.10.6 The Contractor should indicate an understanding of the principle that the nature of the light source can significantly affect the way we perceive colour contrasts that are applied to the critical surfaces of an interior. Ceilings, walls, doors and floors are all critical surfaces that should be sufficiently differentiated from each other. Navigation through a building is much easier if these large areas re differentiated sufficiently by colour or material.

7.10.7 The Works shall contain a mixture of public, semi-public, and restricted areas which should be designed and articulated to create a hierarchy of spaces, clearly identified and linked.

7.10.8 In addition to the general and special considerations consistent with good Healthcare design, designers and planners will need to recognise:

a) the need to combine the individual specialist requirements for the care of patients with an environment that is a good for staff and welcoming to visitors;

b) The Board's requirement for the Works to meet high standards of quality, efficiency, and cleanliness;

c) the requirements of the staff for an attractive and pleasant environment to work in; and

d) The Board's requirements to ensure designs recognise environmental and ecological issues;

e) For reasons of infection control soft furnishings must be covered in an impervious material within all clinical and associated areas;

f) The interior design represents a challenging opportunity to provide an interior environment appropriate for a friendly and important public building of this type; and

g) To develop this to an agreed solution it is anticipated that extensive consultation will take place with user groups to ensure that the final outcome is projected to be responsive to the specific requirements of each element of the building;

7.10.9 It is important that the interior environment should be welcoming, comfortable, and enjoyable for patients, thereby limiting the institutional atmosphere typical of many healthcare Facilities. Users should be provided with external views and views to landscaped courtyards, corridors with break out spaces providing glimpses out of the building should also be incorporated to give users orientation.

7.10.10 The scale and diversity of patient facilities to be provided means that it will be extremely important to create individual identities to key areas within the overall building design. This will not only help patients identify and orientate themselves within the facility but will also help foster a sense of ownership among staff and a community spirit within individual elements of the building. A distinct identity should be immediately apparent in the Children's Hospital which will require through the use of colour, shape and motifs to provide interest and distraction for patients, parents and visitors alike. This will require to be reflected in all aspects of the design including flooring, wall finish, doors and ceilings. The importance of play for children, and the unique role of the hospital play specialist are described in 'Friendly healthcare environments for children and young people' (NHS Estates, 2003, pp 37–38).

7.10.11 Play specialists should be included when designing the New Children's Hospital as spaces for play are an essential requirement in all patient areas and present a unique opportunity for designers to provide creative and stimulating environments for young patients. This and the use of varied colours, murals, cartoons, varied flooring and the like are of extreme importance in the design of the children's areas and will be an important aspect for bid return and consideration.

7.10.12 The use of colour will help to differentiate the separate functions which share a common structure, and the use of symbols, graphic devices, furnishings, fabrics and accessories when thoughtfully co-ordinated will provide comfortable, yet clearly identifiable, internal environments for patients and staff alike. Any approach to this area of design must be developed carefully within the exacting requirements of procurement and to ensure an easily maintained solution.

7.10.13 It is possible that the Board shall invite external patient support groups and family groups to assist in interior design solutions and activities. The Contractor shall require being aware of such, and engaging with such groups during design development and construction. Such groups shall have an ongoing role within the Works and shall be desirous of incorporating exhibitions and artwork/contributions in the Works. The Contractor shall require supporting such an interface and allowing works to be displayed on wall finishes and the like. The Contractor's Proposals shall reflect such interfacing and engagement.

7.10.14 The Contractor shall develop an interior design strategy to cover all areas of the Works. The interior design proposals shall promote the ideals of the Identikit guidelines.

7.10.15 Proposals shall be presented by the Contractor in room-by-room schedules with samples of finishes, colours, lighting fittings, materials as appropriate, and signage, supplemented by colour sketches or coloured computer images for agreement with the Board, in time to allow for consultation with the users, and for incorporating feedback into the final scheme.

7.10.16 It is expected that the Contractor will provide Interior 3D perspectives and an Interior Colour Strategy Report detailing the following – this is not an exhaustive list;

a) Internal Views of Atriums, entrances and key high profile public areas;

b) Views of Hospital street/Mall including retail area;

c) View of receptions and waiting areas;

d) Ward areas and bedrooms; and

e) Theatres.

7.10.17 The above information should indicate the following information;

a) Architectural vision – space, height, form, composition, scale, character and use of materials;

b) Finish type, colour;

c) Overall colour strategy;

d) Incorporation of Art; and

e) Wayfinding Strategy including images

7.10.18 Where the Contractor includes internal planting displays, associated irrigation and atmospheric controls shall be provided. The Contractor shall ensure that the building design and services allows for an appropriate level of light to ensure the growth and survival or any interior planting within their design.

7.11 Architectural Hardware

Ironmongery.

7.11.1 The following criteria require to be incorporated in Contractor's proposals:-

a) the locking system shall be fully suited across the Works and shall interface with swipe card / other entry systems where provided. Particular requirements with respect to electronic door access / security requirements are contained in Section 8.3.14;

b) ironmongery, fixtures and fittings in the Children's DCPF shall be anti-ligature and anti-barricade;

c) all fixings to ironmongery, fixtures and fittings (in patient areas) must be either securely concealed or be of a tamper-proof form (e.g. non-return screws);

d) where indicated in the ADB Room Data Sheets mirrors to be shatterproof glass, with concealed fixings;

e) all joints between flush fitting components and adjoining surfaces to be as tight as practicable; and

f) all fire fighting equipment to be located within secure lockable containers housed in the wall construction, and operated by the same key throughout the development (all fire fighting equipment to be supplied by the Contractor);

g) in the interest of children's safety door handles to the kitchens should be located at a high level to prevent unauthorised access;

h) the Contractor shall provide ironmongery which shall compliment the overall quality of the interior design concept;

i) the Contractor shall ensure ironmongery is of robust construction suitable for its specific purpose and usage characteristics and in accordance with the ADB Room Data Sheets. For ease of use by elderly or disabled persons the Contractor shall ensure handles are colour contrasted with the door background colour and of easy grip design; and

j) samples of all the ironmongery products shall be prepared in accordance with section 5.9. Details of lock suiting will be submitted by the Contractor to the Board to allow adequate time for discussion and amendment if necessary before the fittings are required for installation in the buildings.

Blinds & Curtains

7.11.2 The following criteria will require to be incorporated in the Contractor's proposals;-

a) the Contractor shall provide all fixings for blinds and curtains including integral blinds;

b) all blinds, curtains and associated fixings shall be Class 0 rated;

c) the Contractor shall ensure that materials for blinds and curtains (including any cubicle curtains) shall also comply with the requirements of the Board's Control of Infection Officer for cleaning, washing and maintenance, and comply with SHFN 30 and SHTM 87, and specific Safety Action Notes. For reasons of infection control curtains must be able to withstand washing processes at disinfection temperatures;

d) the Contractor shall provide integral blinds to windows, curtain walling and internal screens;

e) The locations and fixings for both blinds and curtain tracks and cubicle curtains shall be co-ordinated by the Contractor with the window and internal window sill design from the outset of the building design development and the fixings shall be designed by the Contractor to take the proposed maximum loadings possible for the tracks concerned and shall be non-weight bearing from an anti-ligature perspective in the Children's DCFP. For the avoidance of doubt all curtains, blinds, accessories including fixings are to be provided by the Contractor;

f) Curtain tracks shall be designed by the Contractor to overlap the window openings so that they do not allow light to pass into the room when drawn. Controls for blinds and curtains shall be co-ordinated by the Contractor with the window design and its opening gear, including any operating handles, levers or stays that may be required and shall be located conveniently for staff or patients to operate as appropriate;

g) The Contractor shall fix bed and cubicle curtain tracks at the height recommended in the relevant guidance and The Contractor shall ensure bed curtain tracks are co-ordinated with other service outlets and the window positions, where applicable. An adequate ventilation gap must be provided by the Contractor at the curtain head; and

h) All Single bedrooms should have glass partitions for observation purposes, complete with integral venetian blinds for privacy.

7.12 Staircases, Ramps, Balustrades, Walkways, Escalators & Lifts

Staircases and Ramps

7.12.1 Where staircases, ramps, balustrades, walkways and lifts are provided in addition to those required to satisfy means of escape criteria, these shall be designed to relate to the anticipated capacity of use and clearly designated for public, staff or service circulation.

7.12.2 For the avoidance of doubt, the Contractor requires to ensure that for all stairs the requirements of HBN 00-04 and Technical Standards are achieved. This includes the following key criteria;

a) the maximum number of risers between landings for a flight of internal stairs should be 12-14;

b) risers and goings uniform, riser height should be 150-170mm, going minimum of 280mm, 300mm preferred;

c) for steps not adjacent to a wall, a barrier, with a minimum height of 100mm above the level of the treads should be provided for safety reasons. This requirement should be developed in conjunction with the design of the stair / balustrade to viewed as a cohesive whole;

d) open areas on the underside of stairs should be avoided to eliminate the possibility of anyone walking into the overhang created;

e) to indicate that there are descending steps ahead, a hazard-warning zone should be provided on each landing. The zone should use a floor finish that contrasts visually with the general floor finish, but has the same slip resistance. The warning zone should be at least 400 mm from the nosing and a minimum of 800 mm deep and 1200 mm wide;

f) capable of achieving mattress evacuation; and

g) where ramps are provided in addition to those required to satisfy means of escape criteria these shall be suitable for independent and / or assisted wheelchair users, trolleys and ambulant disabled people. Ramps, however will not be considered appropriate for any significant changes in level.

7.12.3 The atrium will contain link bridges, escalators, lifts and stairs providing all vertical and horizontal communication links across the void space providing the necessary connections between departments. A high level of finish will be expected for all stairs and balustrades, any handrail, barrier or guarding to stairs or corridor links should be glazed to allow views for children and those in wheelchairs.

Lifts and Escalators

7.12.4 For the avoidance of doubt, the Contractor requires to ensure that for all lifts the requirements of HBN 00-04 and HTM 2024 are achieved. This includes the following key criteria;

7.12.5 The number, type, size and speed of lifts should be determined from a traffic analysis specific to the proposed facility, and should allow adequate flexibility of the lift solution to accommodate future changes. However as a guide the following dimensional requirements will be achieved;

Lift Type	Minimum Sizes
All lifts	1100mm (wide) x 1400mm (deep)
Small General Traffic	1600mm (wide) x 1400mm (deep)
Large General Traffic	2000mm (wide) x 1400mm (deep)
Patient Trolley/Stretcher Movement	1400mm (wide) x 2400mm (deep)
Bed Movement Lifts	1800mm (wide) x 2700mm (deep)

7.12.6 Handrails should be provided on both side and rear walls of lift cars to be used for general traffic, this includes where stretcher/trolley lifts are to be used for general traffic. The minimum dimensions noted in the table above will require to be provided clear of handrails.

7.12.7 In order to segregate traffic, for operational and infection control reasons, it is not anticipated that lifts for bed movement will be used for general traffic.

7.12.8 Dedicated vertical lift facilities will be required as part of the installation of the overall Automated Material Transfer System as outlined in Appendix M. A clear strategy for the incorporation of these systems will require to be provided by the Contractor in consultation with the Board. The use of public and personnel lifts by automated systems is not acceptable.

7.12.9 Lift doors for general traffic should provide a clear opening width of 1100mm and height of 2000mm. Lift doors for movement of patient trolleys/stretchers and beds should provide a minimum clear opening width of 1370mm and a height of 2100mm.

7.12.10 Additionally the following criteria should be met:

a) the lifts within the atrium should be fully glazed to all sides providing views over the atrium space for the purposes of orientation;

b) a protected lobby should be provided where a lift does not open off a hospital street;

c) wall-wash lighting, uplighting or perimeter lighting should be utilised in the lift car rather than direct downlighting to avoid dazzling patients being transported on beds, trolleys or stretchers;

d) a visually contrasting floor surface measuring at least 1500 x 1500mm should be provided outside the lift door area;

e) lifts, where provided, are to be suitable for disabled wheelchair persons and visually impaired, with tactile controls and audible warnings; and

f) the use of escalators within the atrium space to access the upper level of Outpatients department is considered as desirable. All aspects of the Escalator design should be designed to the requirements of BS EN 115-1:2008.

7.13 Landscape Design

General Design Approach & Aspiration

7.13.1 In accordance with the principles of 'Designing Places – A Policy Statement for Scotland' (Scottish Executive 2001) the site layout and landscape design shall create external spaces that are distinctive, safe and pleasant, easy to get to and move around, welcoming, adaptable and resource efficient.

Existing Site

7.13.2 The existing hospital campus generally presents a poor quality environment for visitors, patients and staff.

7.13.3 It is dominated by large expanses of blacktop roadway and vehicles, disparate and scattered buildings, open yards, service bays and large flat areas of featureless and exposed open space. The site does include a number of mature trees which are subject to a Tree Preservation Order (TPO). The majority of these are to the eastern side of the campus, visible from the approach to the Clyde Tunnel, away from the principal area of the proposed new hospital development. The few mature trees remaining on the proposed site of the new hospital will need to be removed to facilitate the required building footprint and infrastructure.

Landscape Masterplan

7.13.4 The masterplan prepared for the development of the Southern General Hospital seeks to address many of the negative landscape issues currently affecting the campus and to provide the framework for the development of a high quality, coherent, well organised and welcoming external environment to enhance the experience of staff and patients alike. This includes the provision of a major new access from Govan Road together with a significant rationalisation of internal roads and paths to provide clear and direct approaches to the proposed new hospital and improved links throughout the campus with its hinterland. The proposed layout attempts to integrate private vehicular access, public transport and the new Fastlink route with pedestrian and cycle circulation to provide a vibrant but coherent new public realm within the heart of the Campus. In particular, the masterplan sets out the framework for the creation of high quality public realm and street frontages to the entrances associated with the proposed hospital within a strong landscape framework of formal avenue and informal tree planting. This is essential to create both a high quality setting and to provide the human scale necessary to offset any negative influence from the visual dominance of the size and physical mass of the building envisaged.

7.13.5 In particular the masterplan creates a large, central open space within the heart of the campus to be developed as a park for the use of patients, visitors and staff alike. This is intended as a multi functional space providing for social interaction and relaxation as well as opportunities for informal exercise with marked walking routes and a trim trail. The Contractor is to also to include works of art and sculptures in this area.

Hard Landscape - General

7.13.6 Areas of landscape and public realm shall demonstrate a high quality of detailed design, utilising high hard quality sustainable and durable materials to achieve design life noted in Section 5.3 The choice of materials shall reflect both the quality and importance of the proposed new building as well as the aspirations in the masterplan to create, a people friendly external environment. The contractor's attention is drawn to the need to ensure long term sustainability and the requirement to achieve the BREEAM Healthcare "excellent" rating. In this regard due reference shall be paid to the BRE "Green Guide to Specification" to maximise the use of materials and specifications achieving an A rating or better as far as is practicable with regard to other technical and specification requirements in terms of adoption and compliance with standards and legislation noted elsewhere.

7.13.7 The masterplan envisages a hierarchy of spaces and circulation and consequently surface treatments and materials shall vary accordingly.

7.13.8 The minimum standard for a pedestrian footpath within the site shall be asphalt with pre-cast concrete flat-top pin kerb edges to GCC Roads Department adoptable standards as identified in Section 9.0. At the top end of the hierarchy in the spaces associated with the frontage of the building and the main entrances, high quality modular or unit paving shall be used that shall feature clean, crisp detailing and edging together with striking and vibrant paving patterns and designs commensurate with the very best of 21st Century urban design.

7.13.9 The contractor will be expected to demonstrate a clear gradation of hierarchy within their design and choice of materials, between these two in terms of intermediate public spaces and major footpath routes around the site and within the new public park.

7.13.10 Design of all hard landscape in terms of accessibility, surfaces and gradients shall conform to or exceed BS8300 as well as to maximise long-term sustainability and BREEAM Healthcare scores.

7.13.11 Hard landscape materials, specification and laying shall conform to the following minimum standards, where relevant.

a) BS 7533 (all relevant sections pertaining to the materials chosen);

b) BS EN 1342 (Setts of Natural Stone – Requirements and Test Methods);

c) BS EN 1341 (Natural Stone – Requirements and Test Methods); and

d) BS EN 1339 (Concrete flags – Requirements and Test Methods).

7.13.12 Maintenance of hard landscape areas shall be in accordance with BS 7370 – 2. The contractor shall develop and submit a fully detailed maintenance schedule for all areas of hard landscape and associated street furniture and play equipment.

7.13.13 New access roads and vehicular circulation routes shall be designed and constructed in accordance with current highway design standards and to Glasgow City Council Roads Department, adoptable standards to the extent identified in Section 9.0. This to include all road markings to all roads, cyclepaths and car parks (incl car parking bays/spaces and drop-off points, ambulance areas and the like) and all road signage. Raised kerbs to bus drop-off/stops to be included.

7.13.14 The detailed design of vehicular roads shall incorporate appropriate traffic calming and speed control measures to reduce vehicle speeds and contribute to a pedestrian friendly environment. Consideration requires to be given to the transport of patients (particularly spinal patients) in the design of traffic calming methods. Along the hospital frontage at drop-off points and where large numbers of patients and visitors will be expected to congregate and enter the building, a change in surface material for the carriageway shall be utilised that provides the appropriate visual signals for both pedestrians and vehicle users alike and is commensurate with the high quality paving design and external environment required for the building frontages.

7.13.15 Pedestrian crossing points shall be provided at frequent intervals as indicated on the masterplan. These shall be formed at footpath rather than at road level in order to both achieve BREEAM points as well as to provide a traffic calming measure.

7.13.16 Roundabouts and important junctions shall be landscaped distinctively to provide a clear visual orientation point within the site and to reduce the apparent expanse of road and hard standing in these areas. Where possible public art or sculpture shall be incorporated in the roundabout designs to reinforce their distinctiveness.

Cycle Access

7.13.17 The design shall include improvements and modifications to the existing cycle access points, as well as creating new cycle access at appropriate locations to the site as indicated on the masterplan. New or modified cycle access shall be off-road and shared with pedestrian traffic as far as possible. In this regard, cycle paths shall be a minimum of 3 metres wide in order to comply with current guidance from Sustrans and to gain BREEAM Healthcare points. Where cycle lanes are provided either as separate routes or on roadways, the minimum dimensions and layout shall be in accordance with the above noted guidance and to the minimum required in BREEAM Healthcare.

Cycle Shelters

7.13.18 Cycle shelters shall be provided in the numbers required to achieve BREEAM Healthcare points. Cycle shelters shall provide secure and sheltered space for the parking of bicycles and shall be in a secure and visible location. Cycle storage areas shall be located adjacent to or as near as possible to building entrances to ensure direct safe and easy access/egress. Cycle shelter areas and their approach paths shall be lit to adoptable street lighting standards and shall be capable of being overseen by CCTV both day and night. Consideration of cycle stacking systems should be pursued by bidders and proposed to the Board.

Courtyards

7.13.19 The design of the new hospital building envisages the creation of a number of external courtyards for use by staff, visitors and patients. The courtyards shall be designed to provide a variety of purposes including opportunities for meeting and social interaction as well as quiet reflection and privacy. Where appropriate, courtyards and external spaces within the building shall have a practical and or therapeutic purpose, for example the incorporation of steps and ramps to assist with physiotherapy, as well as simply providing a view of plants, green space and natural light within the interior of the building.

7.13.20 In order to comply with BS8300 and the principle of free access, the finished paving level at building entrances shall be the same as the adjacent internal floor level. The building design in this location shall utilise a raised, DPC detail in order to ensure finished levels within the courtyards are visually unobtrusive. A solution which creates a series of humps or rises and falls between doorways opening out into courtyard areas will not be acceptable.

7.13.21 The internal layout design of the courtyard shall allow for any requirements for maintenance access to the building edges.

7.13.22 The courtyard paving shall be formed from high quality modular and unit paving with detailing commensurate with scale of courtyard in question. Path widths and circulation spaces shall be in accordance with minimum standards set out in BS8300 and BREEAM Healthcare, whichever is the greater. Courtyards shall include high quality planting design that incorporates the opportunity to introduce a variety of domestic/garden scale plant material including a mixture of evergreen, deciduous and herbaceous material together with bulb planting. The extent and type of plant material shall reflect the nature and function of the courtyard in question. Courtyards shall include a variety of seating opportunities to ensure that there is provision for both quiet and private contemplation and social interaction for group discussion. All courtyards shall be provided with litter bins and low level external lighting. Seating shall be in a variety of forms but as a minimum at least half the seating provided shall include backrests and arm supports. The design of the courtyards shall not restrict seating opportunities to purpose made bench or seat provision only and seating opportunities and areas of social interaction shall be incorporated into the overall courtyard design, utilising a variety of means including low walls and edgings at seat height.

7.13.23 The courtyard design shall include wherever possible the provision of tree planting in order to provide some height and to offset the potentially oppressive effect of the courtyards being surrounded by tall walls on four sides. The courtyard designs shall also incorporate some undulations and changes in level and provide visual relief from the prospect of a flat plain. In detail, courtyard designs will be expected to provide both open and intimate enclosed spaces within their overall layout.

7.13.24 The detailed design and specification of the courtyards shall provide a variety of visually distinct spaces in order that they can contribute to the wayfinding strategy and orientation round the building for patients, visitors and staff.

7.13.25 Notwithstanding the above requirements, courtyard design shall provide low maintenance external space.

Children's Play Areas and Play Equipment

7.13.26 The masterplan envisages the creation of a children's play area adjacent to the main entrance to the Children's Hospital. The purpose of this provision is both to provide a relaxed and welcoming child friendly entrance whilst at the same time actively making safe provision for children's play, whether children are outpatients or visitors to the hospital.

7.13.27 All children's play equipment shall conform to the relevant parts of BS EN 1176 and be expected to provide a design life with regular maintenance of 25 years. The contractor shall offer a range of equipment that provides the best manufacturer's warranty available and for which the supply of spare parts in guaranteed for the anticipated design life of the equipment.

7.13.28 All play equipment shall be installed with an appropriate safety impact absorbing surface suitable for the equipment in question. All safety surfacing shall be of a 'wet pour' or other continuous type surfacing system rather than tiles or loose-fill materials such as bark or sand. The final choice shall be influenced by the materials' longevity and lifecycle costs.

7.13.29 Play areas shall include a mix of equipment suitable for a broad range of ages and abilities appropriate to the context of the Children's Hospital (from toddlers through to young teenagers) and include a degree of open or free space. Seating opportunities for casual supervision by parents and carers shall be maximised and include a sufficient quantity of litter bins. Seating may be varied but must include at least 50% with back support. Provision of equipment for young children and toddlers shall include coloured boundary fencing with non-slam self closing gates.

7.13.30 The provision of an area of the play zone to be under the neo-natal link, thereby providing for an outdoor visit or play space usable in wet or inclement weather, is to be developed by the Contractor and included in the design.

Street Furniture - General

7.13.31 Street furniture shall be robust, practical and fit for purpose whilst at the same time being of a contemporary high quality design. The specification of different materials shall pay regard to both cost and long term sustainability. Any timber utilised shall be from a sustainable source and be FSC Certified Timber, where it is not of the type that is inheritantly long lasting in external or wet conditions shall be preserved, treated with a minimum 15 year lifetime guarantee or better. Street furniture items shall form a key component of the external landscape design, especially in the public realm, at entrance areas surrounding the building and within the parkland. The contractor shall provide a well considered and coherent design that presents a suite of complimentary elements that are integrated into the overall public realm and landscape design. All mild steel components and fittings shall be galvanised to and polyester powder coated or otherwise factory painted and supplied with a minimum warranty of 15 years or better prior to any retouching or painting being required.

7.13.32 All street/external furniture requires to be securely fixed to the ground.

7.13.33 Bus stops and shelters require to be installed as necessary to comply with the relevant Planning and Travel Plan requirements;

7.13.34 Covered architectural pedestrian walkways are to be provided between the Fastlink drop off area and the adjacent entrance to the new hospital as illustrated on the masterplan drawings;

Litter Bins

7.13.35 All litter bins shall be of the type which includes a front facing door or hatch that allows the internal bin or receptacle to be removed and emptied easily

Seating

7.13.36 It is anticipated that a wide variety of seating and seating opportunities shall be incorporated into the final design. The majority of this will be purpose made seating or seat items however the contractor is also expected to incorporate into the design opportunities for seating within the landscape in the form of low walls, steps and grass mounds.

7.13.37 Where formal seating is provided at least 50% of this shall include backrests and armrests. Seating shall be designed and located as a key element of the overall landscape design. Seating and benches placed seemingly at random will not be acceptable. The contractor shall ensure that adequate seating and rest points are provided at regular intervals along pathways and walking routes.

7.13.38 All seating must be securely fixed to the ground.

7.14 Soft Landscaping Requirements

General Design Approach

7.14.1 In accordance with the principles of 'Designing Places – A Policy Statement for Scotland' (Scottish Executive 2001) the planting and soft landscape design shall contribute towards the creation of external spaces that are distinctive, safe and pleasant, easy to get to and move around, welcoming, adaptable and resource efficient.

7.14.2 The landscape of the existing campus is largely flat, featureless and unwelcoming. In accordance with the masterplan the new planting design shall include substantial tree planting to:

a) provide immediate and long term landscape structure and impact within the campus grounds;

b) create a distinctive and appropriate landscape setting for the new hospital complex;

c) mitigate against the visual impact of the buildings, roads, car parking and hardstanding across the site and provide human scale; and

d) mark progression along key routes and lend identity to the different spaces that will be created.

It is required that semi mature and larger nursery stock trees are utilised along principal avenues, paths and thoroughfares to achieve this requirement.

7.14.3 The detail planting design and specification shall provide an appropriate mixture of seasonal variety, height and colour for all year round interest. It shall provide both immediate impact and medium to long term growth and be capable of delivering a high quality landscape that will develop and mature over the medium to long term. The detail design layout and choice of plant material shall be appropriate to the immediate context, such as public realm, pathways and circulation zones, private/quiet space, spaces for adults, children, visitors and patients, whilst paying due regard to environmental and climate factors. The planting design shall help to provide shelter and shade as well as assisting users to orientate and locate themselves. The planting and landscape design should be developed to reinforce wayfinding strategies through the creation of readily identifiable and distinguishable spaces.

Retention & Protection of Existing Trees

7.14.4 As far as possible, the campus layout shall maximise the retention of existing mature trees on site and incorporate them into the overall layout and landscape design. In accordance with planning conditions and best practice, all trees to be retained in the medium to long term shall be protected in accordance with BS 5837:2005, the exact method to be agreed with the Planning Authority.

Felling of Existing Trees & Vegetation Clearance

7.14.5 In accordance with the Wildlife & Countryside Act 1981, any tree felling and shrub clearance shall be carried out outside the bird breeding season (March to August). Contractors shall take due cognisance of this requirement in any work programming. Where this is not possible a qualified ecologist shall be appointed to examine all potential breeding sites before any clearance takes

place. If occupied nests are found, clearance and felling works shall cease until the nest is no longer in use. The contractor shall formally confirm to the Planning Authority in writing if clearance is in order following the ecologist's inspection. A qualified Ecologist shall be as defined in BREEAM Healthcare.

7.14.6 Where any tree work is undertaken this shall conform to BS 3998 "Recommendations of Tree Works and current HSE/AFAG safety leaflets

CAA Restrictions

7.14.7 The site lies approximately 3 km from Glasgow Airport, well within it's 13km 'safeguard circle' and therefore detailed consultation with the CAA will be required to develop proposals that minimise any increased risk of birdstrike. The landscape and planting design shall form an integral part of the 'Bird Hazard Management Plan' which is required for submission to the Planning Authority. The Contractor shall comply with the CAA publications CAP 772 – 'Birdstrike Risk Management for Aerodromes' and Advice Note 3 – 'Potential Bird Hazards from Amenity Landscaping and Building Design'. It is likely that adherence to this guidance will impact on the specification of plant material and contractors are therefore required to consult early with the CAA to establish their requirements. Approval by the CAA of the detailed landscape proposals will be required to clear the Planning Conditions relating to the detailed landscape design.

Landscape Design and SUDs integration

7.14.8 Landscape design associated with SUDS shall comply with CAA Advice Note No.6 – 'Potential Bird Hazards from SUDS'. Any surface water features associated with a SUDS design for the site shall be fully integrated with the landscape design, as opposed to simply 'landscaped'.

7.14.9 The SUDS solution of the Contractor shall actively consider underground storage tanks which shall consider the use of the water for grey purposes on the site where possible.

Biodiversity

7.14.10 The detailed landscape and planting design shall be developed in accordance with the 'Biodiversity Action Plan' submitted to the Planning Authority as part of the Masterplan.

7.14.11 It is a Planning Requirement that the new landscape framework for the campus will link areas of established green networks within and beyond the site, SUDS proposals and movement networks (roads, footpaths and cycle paths) to habitat retention and creation, minimising the impact of the development on wildlife and vegetation. Contractors will require to reconcile the requirements of the Planning Authority with the restrictions that may be required by the CAA as noted above, together with maintenance regimes on site in the detailed landscape and planting design. Contractors will be required to undertake a detailed habitat assessment using a qualified ecologist to establish the baseline situation at the start of the contract to inform the detailed landscape design development.

BREEAM

7.14.12 The Contractor shall maximise BREEAM Healthcare points available through the landscape and external works as a key element of their designs. In conjunction with 'Biodiversity' above, a qualified ecologist will be required to undertake a habitat survey to establish the baseline situation at the start of the contract to inform the detailed landscape design development with a view to achieving maximum points available and contribute towards the required "excellent" rating.

Topsoil

7.14.13 Should topsoil stripped from the site be retained on site, this requires to be in a dedicated storage area, appropriately stored, protected from contamination, maintained and re-used within the final landscape works as required. The Contractor will be required to undertake a comprehensive soil analysis (BS 3882 Annex E) to determine whether there is any contamination present that would limit or otherwise restrict the use of site stripped topsoil within the final landscape works.

7.14.14 If it is determined that the material be taken off site, either on a temporary or permanent basis, this shall be agreed in writing with the Planning Authority in accordance with condition 9.

7.14.15 The soil analysis shall also determine nutrient deficiencies and the requirements for fertilizer and soil additives required to ensure the successful growth and establishment of the planting specified for the areas to which it is finally spread.

7.14.16 Imported topsoil shall be to BS3882 "multipurpose" grade or as required to suit the final choice of plant material. The use of peat shall not be permitted. All compost shall comply with PAS 100.

Topsoil Storage

7.14.17 Where imported or existing topsoil is to be stored in a single location for no more than 6 months (maximum) the height of storage mounds shall not exceed 2M. Where a period of more than 6 months is required the height of the mounds shall not exceed 1M high. Where existing topsoil is stripped and stored the soil shall be turned every 6-12 months.

7.14.18 All topsoil stored for longer than 6 months shall be re-tested to determine the degree of nutrients, fertilizer and ameliorants required immediately prior to re-spreading in its final location.

7.14.19 Topsoil depths for planting:

a) Shrub planted areas: 400mm minimum depth; and

b) Grass areas: 150 mm minimum depth;

i) General handling and contamination prevention; and

ii) Subsoil/ground preparation for landscape areas.

Plant Material

7.14.20 The specification criteria for plant material in general shall conform to either the National Plant Specification or BS 3936 and other related British Standards. The specification criteria for Semi Mature and Root-Balled Trees shall be to BS 4043.The handling, transportation, storage and establishment of plant material shall be in accordance with the Horticultural Trades Association publication 'Handling and Establishment of Landscape Plants'. Contractors will be responsible for developing a robust and technically competent specification for all the soft landscape and planting works in accordance with the best industry standards and practice.

7.14.21 The choice of plant species and provenance of plant material shall be appropriate to achieve the purpose required by the design and for the location, scale and situation in question. There is no general limitation on the type and range of plant material envisaged with the following exceptions:

a) Thorny or spiny plant material shall be avoided, especially within the body of the site within the ornamental species mixes. This type of material traps litter and debris which is then extremely difficult to clear and consequently encourages the nesting of vermin. Possible exceptions might include the use of Hawthorn or other native hedgerow plants along the site boundaries in association with structure or woodland planting, depending upon the final design layout.

b) Poisonous plants/skin irritants on contact with foliage/stems further definition required.

7.14.22 Planting densities and size at planting shall be appropriate to ensure a careful balance between immediate and short term impact and long term growth.

7.14.23 Tree planting pit/trench size and design shall be appropriate to ensure the long term establishment and future growth of all new trees. This shall include where required the use of drainage, irrigation tubes and root protection barriers adjacent to services. All semi mature trees shall be underground guyed using an approved proprietary product such as the Platipus system (or equivalent). All tree staking shall be double short stakes with cross bar.

7.14.24 All semi mature tree planting shall be provided with a 5 year establishment guarantee from the supplier(s) The defects period and contractors' liability for replacement planting shall extend to the full period of the guarantee, subject to standard industry limitations. The defect period for tree planting in general shall extend to a minimum of two growing seasons following agreed completion of the contract.

7.14.25 Extended establishment guarantees from suppliers shall be required in relation to semi-mature tree planting.

7.14.26 Any seeded areas are to be protected by secure temporary fencing (secure to the ground and securing the seeded areas from access) until such time as the seed takes.

7.14.27 Any grass adjacent to the children's play areas and entrance to the Children's Hospital to be turfed.

Maintenance

7.14.28 The contractor shall develop and submit a fully detailed management plan and maintenance schedule of the completed landscape design for approval. Maintenance shall generally conform to the relevant sections of BS 7370 and be designed to ensure the long term establishment and development of the new landscape and planting design.

7.15 Wayfinding & Signposting

External wayfinding strategy

7.15.1 The movement of people through a hospital site is one of the key factors to the successful scheme. Wayfinding considers the different aspects regarding this and creates a system which responds to the requirements of each separate situation. The Contractor should create a unique identity for the hospital by providing an integrated solution between signage, architecture, interior design, landscape and art. The solution should provide a clear strategy for patients, visitors and staff whilst also assisting people with restricted mobility, impaired vision and language difficulties.

7.15.2 The Contractor should in their wayfinding proposals consider the prominence of architectural and interior landmarks on the site as well as colour coding, imagery, sign types and fonts etc. to create a visually stimulating family of signs as well as providing a system which conforms to current legislation. The Planting and landscape design shall assist with wayfinding and route marking around the site and provide identity to the different spaces within and around the site.

7.15.3 The solution should eliminate doubt and uncertainty in a potentially anxious environment by providing information at the right points as well as architecturally designed areas of interest and comfort. The accessibility of the site will be enhanced by a successful wayfinding system.

7.15.4 It is the Board's intention that Contractor's should incorporate electronic information points utilising touch-screen technology in addition to the manned reception points and stations internal to the building and the PA system. These information points should be located externally at appropriate locations and should present information (in a variety of languages) on the hospital for orientation and wayfinding purposes along with information in relation to the public transport hub which should be adjacent to the main entrance giving real time information on bus/fastlink timetables. The Contractor will be required to provide a clear strategy for the provision of these information points.

7.15.5 The above should be integrated into a clearly defined arts programme, which from the beginning of the project develops a strategy considering the site as a whole.

7.15.6 The following criteria require to be incorporated in the Contractor's external signage proposals;

a) all signage (internal and external) to be provided by the Contractor;

b) the signs will be exposed to the elements and therefore will require to be robust, accident proof, vandal resistant and weather proof;

c) the signs will be mounted generally on grey ppc steel posts fixed to concrete bases, the signs are to be a matt aluminium finish;

d) all light units to signs should be externally located to be easily accessed and maintained;

e) overstuck lettering is not acceptable; and

f) traffic signage to be compliant with Transport Scotland guidance;

As a minimum the Board would expect the following external signage to be incorporated, signage to be a Hospital Campus (i.e. whole existing and new hospital) wide integrated solution:

Location	Function/Type	Identity Requirements
All vehicular, pedestrian, cycle entrances to the site	Facility Identification	All external signage requires to be as NHS Identikit Guidelines and as such feature the following ; • NHS Greater Glasgow & Clyde Identity incorporated. • Generally white background with NHS Scotland dark blue text in Stone Sans type face. • Colour on external signage to be NHS Scotland Dark Blue or Light Blue only. • If required to identify for example entry only for ambulances – this can be reversed to light/dark blue background with white text. • Signage size , height and text size should be appropriate to location and function • The limited incorporation of the caring device is acceptable. • Directional signage should indicate arrows and text ranged according to the direction. • All external signage will require to be clearly illuminated. • Matt Finish to all external signs. • Built up brushed stainless steel lettering or equivalent standard finish to signage will be expected to be incorporated at key areas of public prominence – entrances, receptions, atria, main circulation.
Vehicular routes through site	Building Identification	
Vehicular routes through site	Car Park Location – directional / Availability of Spaces	
Car Park entrances	Identification of Car Park entrances	
Car Park	Identification of disabled designated spaces	
Pedestrian and vehicular routes through site	Building Location - directional	
Building Entrances	Identification of Building entrances	
Building Entrances	Identification of Building	
Building Entrances	Building Directory – indicating key departments	
Vehicular routes through site	Identification of ambulance only / service only routes/entrances and helipad	
All locations	Statutory Signage	As guidance requirements

Internal wayfinding strategy

7.15.7 Design solutions shall present an integrated and comprehensive wayfinding solution that enables patients, visitors and staff to self-navigate the Facilities with ease. The wayfinding solution must comply with the DDA, meeting the needs of people with physical and/or sensory disabilities/impairments, and those with literacy difficulties. It shall add value to the internal environment and could be a component of the comprehensive arts programme.

7.15.8 Way-finding is a critical part of the building functionality, and must guide patients and visitors to their desired destination in the most efficient manner possible. It should be borne in mind that people using health buildings may be easily disorientated due to illness and / or upset; they may be in unfamiliar surroundings; they may have difficulties with sight, hearing, mobility or learning; they may not have English as their first language; or they may need information presented at a lower level because they are in a wheelchair.

7.15.9 An audit of the signage within the Facilities shall be completed with the Board prior to Completion to ensure that the signage is complete, and that no ad hoc signs are required to complete the wayfinding scheme.

7.15.10 The following criteria require to be incorporated in the Contractor's proposals:-

a) all lift and door signage should incorporate the use of braille;

b) all signage and signage fixings must be robust and vandal resistant;

c) colour contrasted or tactile variation flooring clues should be provided to main reception area to guide visually impaired people to reception desk point at 90 degrees from circulation route. Clear orientation markers/signals are required at changes in direction at all entrance routes and main entrance;

d) There is an expectation that the signage will require to incorporate additional colour and/or images in line with the overall wayfinding strategy. The Contractor will require to provide a clear demonstration of this approach, which may for example assign colour on a departmental or level by level basis or to identify and differentiate the Children's Hospital. However any colour strategy developed for signage should be within the standard colour ranges identified (including tints) within NHS Identikit Guidelines. Any adoption of images on signage as part of this strategy will require to be developed in conjunction with the Board; and

e) In order to provide staff, patients and visitors with access to information especially at the key points of entry to the Works it is required that the Contractor shall incorporate electronic information points utilising touch-screen technology in addition to the manned reception points and stations and the PA system. These information points should present information (in a variety of languages) on the hospital for orientation and wayfinding purposes along with information in relation to the public transport hub which should be adjacent to the main entrance giving real time information on bus/fastlink timetables. The Contractor will be required to provide clear proposals for the provision of these information points.

7.15.11 The Contractor is required to comply with the relevant NHS Publications in relation to signage and must include the following provision;

Location	Function/Type	Identity Requirements
Main Entrances	Facility Identification	All internal signage requires to be developed from NHS Identikit Guidelines and as such feature the following ; • NHS Greater Glasgow & Clyde Identity incorporated. • Generally white background with NHS Scotland black text in Stone Sans type face. Other background colours can be considered – within NHS Identikit colour ranges identified. • Signage size, height and text size should be appropriate to location and function. • Directional signage should indicate arrows and text ranged according to the direction. • Matt Finish to all internal signs • Monolith, ceiling fixed or wall mounted signage types are acceptable for internal signage. • Illumination should be incorporated for signage within areas of public prominence – for example main entrances, atria, key receptions etc.
Main Entrances	Building Identification	
Main Entrances	Reception Identification	
Main Entrances	Building Directory – Identifying department locations on a floor by floor basis – featuring building plan.	
Main Entrances	Department Locations - Directional	
Main Entrances	Identification of key facilities – Toilets , Stairs, Lifts etc	
External to Stairwells	Level Directory	
Inside stairwell	Stair Identification	
Lift Car	Level Directory	
Corridors	Departmental Locations - Directional	
Corridors	Identification of Exits - Directional	
Departmental Entrances	Identification of Departmental entrances	
Departmental Entrances	Departmental Directory	
Departmental Entrances	Reception Identification	
Departmental Corridors	Key Locations - Directional	
Departmental Corridors	Room Identifiers (Every Room)	Room signs to feature the following; • Signs should be adjacent to doors at a height of 800–1500 mm and tactile (Braille) so that they can be easily read by touch. • Room name • Room number • Occupant name (should be removeable)
All locations	Statutory Signage	As guidance requirements

7.16 Protection

7.16.1 The Contractor shall be required to demonstrate that their proposal provides the most effective height / location and orientation of protection that shall prevent direct impact with the building fabric.

7.16.2 The Contractor is required to comply with the relevant NHS Publications in relation to protection and must include the following provision;

Location	Protection	Handrail
All main communication routes/main corridors between departments	Heavy Duty ; Mid-height handrail and either durable material on lower part of walls, or lower height crash rail, and with splayed skirtings in main corridors. Corner protection also required.	Handrails required. Handrails should return into recessed doorways and openings, but otherwise be continuous to aid navigation.
Hospital Street / Building Entrances	Severe duty; Mid-height handrail or crash rail, lower height crash rails and splayed skirtings. Corner protection also required.	Handrails required. Handrails should return into recessed doorways and openings, but otherwise be continuous to aid navigation.
Departmental Corridors; All wards	Heavy Duty ; Mid-height handrail and either durable material on lower part of walls, or lower height crash rail, and with splayed skirtings in main corridors. Corner protection also required. Bed locators where required.	Handrails required. Handrails should return into recessed doorways and openings, but otherwise be continuous to aid navigation.
Operating Theatres	Rails may be omitted in favour of overall durable, washable finishes. In practice the greater care shown by the theatre users appears to compensate for the lower level of protection.	None required.
Workshops, storerooms etc	May be constructed of materials which are not necessarily given a decorative finish, or applied protection. These materials include brickwork, blockwork and concrete.	None required.

7.16.3 The Contractor will also be expected to provide, as a minimum the following provision;

a) where handrails and wall protectors are provided a minimum vertical clearance of 50 mm must be maintained between the handrail and wall protector and a minimum horizontal clearance behind the handrail of 75mm;

b) where the wall protector protrudes in front of the handrail, the clear width of the corridor will be to the wall protector; and

c) handrails should be easily visible, that is, contrast visually with the surface to which they are fixed, smooth and free of any abrasive elements, neither too cold nor too hot to the touch.

7.16.4 The Contractor shall undertake a detailed review of those pieces of mobile equipment both Clinical and Non-Clinical, that is expected to be used by the Board and The Contractor within the Works. This review shall include a process of risk assessment and shall be organised to determine the type and extent of protection that is required to the building fabric. This review shall be made available to the Board as requested.

7.16.5 The Contractor shall endeavour to minimise the extent of impact damage incurred by ensuring corridors are and free awkward comers / obstructions. The Contractor shall ensure that doors and lifts are of sufficient width to accommodate all forms of hospital traffic and shall, where necessary, be designed to be normally held in the open position or to automatically open where appropriate.

7.16.6 In line with health building guidance, continuous hand-rails should be fitted to both sides of all patient accessible routes and corridors. Certain proprietary handrails have also been developed as wall protection crash rails. A combination of these hand rails or some of the following forms of protection would be deemed appropriate in patient and non patient routes and corridors:

a) crash rails;

b) defensive coves; and

c) corner treatment and reinforcement.

7.16.7 Exposed services such as ducts, radiators and pipework can be badly damaged when struck by trolleys etc. The Contractor shall incorporate measures to avoid damage to these elements.

7.17 Integration of Healing Arts Strategy

7.17.1.1 Introduction

Art and Architecture is a key strand of the Board's Arts and Health Strategy. The Board recognises that good design in healthcare buildings makes a measurable difference to the experience of patients, visitors and staff.

7.17.2 As part of it's Design Action Plan, the Board are committed to the development and integration of Art and Therapeutic Design within the new developments at Southern General Hospital and this will include;

a. New Adult Acute Hospital;

b. New Children's Hospital;

c. New Laboratory Block (part of novated design); and

d. External space and general landscaped areas within the site boundary.

7.17.3 The Art strategy will be developed in the context of;

a. current Board arts strategy work already being undertaken in Glasgow as part of ASR I and the new Maternity Unit at Southern General Hospital;

b. the range of cultural, regeneration, funding partnerships already established within Greater Glasgow and Clyde; and

c. the need to ensure a local arts perspective is developed that reflects international level of quality.

7.17.4 Competitive Dialogue Stage (May - September 2009)

Bidders are asked to clearly demonstrate within their written and drawn responses how they will develop and deliver an Arts and Therapeutic Design Strategy that reflects:

a. Integrated art, specimen art, interior design and landscaping (e.g. stained glass, bespoke art, special lighting, floor designs, therapeutic colour choices, special procurement of non clinical looking furnishings, landmark way finding, gardens and sensory planting);

b. Art enabling works (e.g. electrical infrastructure, lighting, wall niches and strengthened walls and ceilings to host future art works);

c. The provision of programmable spaces (e.g. future exhibitions, performance or sculpture); and

d. Architectural elements (e.g. entrance canopy, art doors, curved walls, specially designed stairways and car parks);

7.17.5 Bidders are asked to prepare a detailed proposal of how they will provide resources and capacity to support the Board's aspirations to develop and deliver this strategy in conjunction with a wide range of stakeholders including patients, managers, clinicians and fundraisers ensuring that the Art strategy and design proposals are fit for purpose and in line with contract management/ build timelines.

7.17.6 Broad Plan for Developing and Delivering an Arts Strategy

The Arts strategy should be developed with a tiered approach based on priority areas for art and therapeutic design to be implemented on a discretionary basis reflecting levels of finance available. The table below gives an indicative format, but bidders should bring forward proposals which they feel will develop the most rewarding strategy.

Bidders are strongly recommended to have dedicated resource for the inputs below in terms of architecture, arts and technical requirements.

STAGE	TASKS	RESOURCES
Stage 0 Competitive Dialogue	Develop Art Strategy as part of bid proposals. The strategy developed by your team will form part of the evaluation process.	Identify bidder resources that will be provided during Stage 2 design and anticipated costs over the time period for stage, along with assumptions on frequency of meetings etc. The proposals should therefore ring fence money and time for Stage 2.
Stage 2 Design Development	The successful bid team will develop their strategy along with Board managers and other associated groups as noted earlier. • As a key member of the Board's Arts Development Group you will meet monthly to develop, plans and incorporate a full arts strategy into the detailed designs for the new builds. Prepare detailed costs and budgets for these works for Board consideration. • Working to the Arts Development Group will be the artists and designers who will meet weekly through design development forum to discuss concepts, plans, detailed and help prepare detailed costs.	The successful bid team will be required to take forward the strategy subject to Board involvement and work with teams to develop a workable proposal that is both achievable, realistic and affordable in the run up to FBC and approval to proceed with construction of the adult and children's hospitals. Note: costs for the arts strategy may be included within the contractors price, or funded by external Board source, or from a combination of these.
Stage 3 Construction of Adult and Childrens Hospitals	Incorporate the agreed art strategy design into the new builds	Manage the construction and full integration of the approved strategy on site by the successful bid team. Attend periodic meetings (quarterly) to review progress.
Stage 4 Commissioning	Fully commission any loose art works requiring service connections.	This would occur during post handover Board equip[ping stage, detail and input from bidders would be developed during Stage 2.

7.18 Secure by Design

7.18.1 It is important that security is effective but not visible and we would seek to avoid through good design the need for overt signs of security systems such as perimeter fencing and extensive CCTV provision.

7.18.2 The principals of 'Secure by Design' promote good practice, and encourage the adoption of design principles that reduce crime prevention as opposed to adopting 'active' preventative measures, The Contractor shall provide a report detailing compliance as far as is practicable with Secure By Design certification requirements. The Contractor should liaise with the local police in refining a strategic approach to the security of the facilities and the overriding safety of staff, patients and visitors.

7.18.3 While connections to the community are encouraged, not to the detriment of security Frequently, 'single point of access' is a strategy that is widely encouraged.

7.18.4 The following are extracts from the 'Secured by Design Principals' Document (2004):

a) Access design and escape routes;

To satisfy the requirements of individual developments, and in the interests of good urban planning, new development must provide adequate access to meet functional and recreational needs, including for example paths and inter-connecting open spaces, and access for emergency services. However multiple footpaths and points of access can make crime easier to commit by providing a choice of alternative escape routes from the scene of a crime. Careful attention to the disposition and design of access, and in some cases limiting the means of access to developments and to buildings, can assist in reducing opportunities for a crime, be it illegal entry, vandalism, crimes against the person or vehicle theft. Uncontrolled rear access ways to buildings and footpaths that are unduly secluded provide opportunities for crime with a low risk of detection and are to be strongly discouraged. It may on occasion be necessary to restrict access to a development to one main point, and it is always advisable to carefully consider the desirability and design of secondary access routes;

b) Footpaths and cycleways;

Public footpaths and cycle ways form a vital part of the communications network in both urban and rural settings. They also provide an important local or strategic recreational amenity. Their provision is strongly encouraged by current government planning guidance, but awareness is need of the potential problems that poorly located or poorly design footpaths can have. They can, for instance provide opportunities for unobserved access to the rear of buildings, means of escape for offenders and opportunities for crimes against people. Furthermore, poorly designed or sited footpaths may cause users to feel ill at ease and give rise to fear of crime, particularly after dark. This is likely to lead to reduced levels of use, which reduces the benefit to the community and will in turn exacerbate the problem. Well designed, well used and well maintained footpaths on the other hand provide fewer opportunities for crime and are likely to feel safer;

c) Relevant Secured by Design Key points:

i) Superfluous and unduly secluded access points and routes should be avoided;

ii) Access points to the rear of buildings should be controlled, for example by means of lockable gates;

iii) In terms of security, the design of the footpath of equal importance to the design of the building. The standard combined cycleway/footway should be 3m wide as a minimum and footways 2m wide as a minimum. Any shrub planting should start at the back of the verges;

iv) The position of the planting and choice of species should be such that hiding places are not created;

v) Good visibility should be maintained from either end, and along the route of footpaths and cycleways. Sharp changes in direction should be avoided;

vi) Footpaths and cycleways should not generally be routed to the rear of the buildings, but if this is unavoidable a substantial buffer should be planted between a secure boundary fence and the footpath margins, with planting designed so as to discourage intruders;

vii) Footpaths and cycleways shall be lit in built-up areas to adoptable street lighting standards except where the route is passing through woodland or and ecologically sensitive area, in which case an alternative lit route should be made available, such as a footway alongside a road; and

viii) Alternative routes to important destinations may be beneficial, although a balance has to be struck between advantages of greater choice and perceived security against the disadvantage of providing additional means of escape or of encouraging inappropriate movement of people.

Section 8.0 Building Services Requirements

8.1.1. Introduction

8.1.1.1. The Contractor shall in carrying out the Works comply with the following non-exhaustive list of Mechanical & Electrical requirements.

8.1.1.2. The Contractor shall provide an engineering system that utilises the latest technology to create a high quality working environment that will provide an efficient hospital for all patients, their families, visitors and staff. The Contractor shall ensure the services network is efficient, effective, flexible and unobtrusive to the clinical functions. The Contractor shall ensure that the system is easy to maintain and shall maximise the opportunities for flexible adaptation and extension of The Works.

8.1.1.3. The heating and cooling mediums shall be selected to ensure the most efficient systems are utilised taking into account integration of low carbon technologies and the site wide interconnectivity requirements.

8.1.1.4. Mechanical, Electrical, Public Health and Specialist services shall be designed to be an integral and co-ordinated part of the overall scheme. Services shall be clearly identified at regular intervals and at all locations where maintenance access is required.

8.1.1.5. Plant access shall be prioritised in all aspects of the building services design to minimise the requirement for the use of portable access equipment.

8.1.1.6. Permanent access equipment shall be provided by the Contractor to allow routine maintenance of all equipment within all plant rooms and associated areas where items of plant are located.

8.1.1.7. A systematic plant replacement strategy shall be provided by the Contractor, this shall detail the works required for the replacement of all major plant items and their major components.

8.1.1.8. All access equipment including lifting beams, access platforms, equipment cradles, slings, block and tackles and access ladders to allow all plant to be replaced in accordance with the strategy shall be provided by the Contractor with each item of equipment cross referenced to the plant items within the replacement strategy.

8.1.1.9. The location of engineering and utility services shall be co-ordinated with the structure and not constrain or conflict with clinical functionality.

8.1.1.10. Access to all services shall facilitate ease of maintenance which should be safe and able to be effectively undertaken. There shall be provision for space to give flexibility for future re-planning and / or re-modelling and replacement of the services.

8.1.1.11. The Board requires the buildings to be designed to achieve a very efficient level of energy and utility utilisation in accordance with the energy targets noted in Appendix M&E4 .

8.1.1.12. The Contractor shall take cognisance of all the building services implications of the requirements described in the Employers Requirements.

8.1.1.13. The power distribution systems and final circuits where required shall incorporate, IPS and UPS systems to meet the requirements of (S)HTM06-01 together with full compliance where appropriate with the MEIGaN requirements.

8.1.1.14. UPS to be provided from resilient platforms with N+1 redundancy with ability to transfer to shunt by-pass without loss of load, these shall be distributed throughout the works to ensure that reliable interruptible supplies are provided to suit the hospital operations.

8.1.1.15. Open protocol industry standard format must be used for all elements of the Electrical, Mechanical, Public Health Medical Gases, Security and Specialist systems.

8.1.1.16. All systems shall be warranted for support for an extended period and all software shall be retro compatible.

8.1.1.17. All Mechanical, Electrical, Public Health and Specialist system plant shall be designed and installed in modular arrangements incorporating plant N+1 redundancy to minimize disruption during planned maintenance.

8.1.1.18. All Mechanical, Electrical, Public Health and Specialist systems shall be designed and installed in resilient arrangements with dual distribution paths and appropriate isolation facilities to ensure that the completed installations meet all operational, maintenance, servicing together with plant replacement requirements and that local maintenance does not disrupt adjacent areas.

8.1.1.19. Where contradictory advice is apparent, the most recent guidance shall generally take precedence; unless indicated otherwise in the main compliance section of the Employer's Requirements – Volume 2.1 Section 5.1.

8.1.2. Engineering Services Interface with Building Fabric and Service Routes

8.1.2.1. The Contractor shall ensure that co-ordination of the Electrical, Mechanical and Communication services shall form an inherent part of The Works design.

8.1.2.2. Services provision, e.g. luminaires, fire alarms, security and mechanical services, shall be co-ordinated with the ceiling layout and allow simple relocation if required.

8.1.2.3. Access to services shall be provided and the services clearly identified at regular intervals and at all locations where maintenance access is required, for example at valves and electricity connection points. Access to building services shall be in accordance with SHTM 2023 "Access for Engineering Services".

8.1.2.4. It shall not be acceptable to require other services to be removed to allow access to services.

8.1.2.5. The positioning of sockets, light switches, alarm buttons and fire “break-glass” panels etc shall be consistently located throughout the hospital buildings and to specifications set out in BS8300, unless specific clinical needs take precedence.

8.1.2.6. Structural design shall ensure that structures are co-ordinated to ensure the logical and sequential installation and maintenance of services. For example the use of columns adjacent to vertical service voids shall be avoided.

8.1.2.7. All Mechanical, Electrical, Public Health and Specialist systems shall be fully co-ordinated in 3D with prefabricated plant, escalators, lifts, the building fabric and structural frame, secondary steelwork, façade systems, fit out to ensure that the completed installations meet all operational, maintenance, servicing and plant replacement requirements.

8.1.2.8. The Contractor shall provide secure utilities services connection to those services which are;

a) to be taken directly from public and other utilities; and

b) to the point of supply (inc connection) for those utilities which are to be taken from the Board.

8.1.3. Service Routes

8.1.3.1. All service voids, risers and other spaces shall allow for installation of additional services and shall provide a defined reserve of a minimum 25% of useable area through routing cross sectional area. All isolating valves and other items requiring particular access shall be positioned at convenient locations with permanent access provision and which do not impede execution of the clinical functions of the space.

8.1.3.2. The Contractor shall provide a compliance matrix indicating the level of provision of each service together with the means of calculation of the required 25% reserve capacity.

8.1.3.3. Services shall be arranged in a clearly zoned spatial hierarchy in ceiling voids, risers and plant spaces.

8.1.3.4. Generally access to services shall not be given in clinical areas, where this is unavoidable due to the requirement for local access the Contractor shall ensure that all services are co-ordinated and grouped to minimize the number of access hatches.

8.1.3.5. Ceiling void depths in Theatres shall be minimized, and in all cases be less than that required for void protection, with all power and data wired in a loop in basis to allow rewiring without the requirement to access the ceiling void, where access is required to allow periodic inspection of fixings, this shall be accommodated by the apparatus trims and via light fitting openings.

8.1.3.6. Services shall be configured to ensure local maintenance and isolation can be carried out in each room without the requirement to take other rooms out of use.

8.1.3.7. All service voids, risers, plant rooms and other service / plant spaces shall be designed to easily facilitate the future removal and replacement of building services within each space.

8.1.3.8. In order to minimise potential disruption to the Board due to maintenance of building services, The Contractor shall route services through common spaces such as corridors and avoid through routing within department areas.

8.1.3.9. All ductwork shall be provided to allow cleaning of internal surfaces and components to be undertaken in accordance with the Health and Safety Approved Code of Practice 33, and as detailed in the HVCA Document TR17 Cleanliness of Ventilation Systems.

8.1.3.10. Plant rooms shall be configured and constructed to minimize the risk of water penetrating into Critical operational areas. This is a pre-requisite of the design and the Contractor shall provide a detailed strategy document indicating the risk assessments and mitigation measures proposed e.g. water tanks not located above Critical operational areas, plant room floors constructed to prevent water seepage, tanking to be integrated in construction detailing rather than ad hoc post installation details, appropriate location of floor gulleys and sensitive routing of water and drainage pipework.

8.1.4. Server and Nodal ICT rooms

8.1.4.1. Major leak detection shall be incorporated complete with automatic zoned shut off valves.

8.1.4.2. Water proof ceilings to be provided in all Server and Nodal ICT rooms.

8.1.4.3. Resilient redundant environmental engineering services shall be provided within the Server and Nodal ICT rooms. The rooms shall be configured and located to minimise the risk of water damage from all sources with the following minimum requirements:

a) No overhead water, condensate or drainage pipework allowed within ICT rooms; and

b) No water tanks, tea points, DSR's, Cleaners rooms, toilets or showers etc. to be located directly above ICT rooms.

All ICT rooms to be clinically cleaned prior to the installation of active equipment, this deep clean shall be carried out by the Contractor's specialist cleaners to an agreed Board specification by the relevant Board Representative and a certificate issued. Special care shall be taken in advance of the deep clean with ongoing general cleaning being carried out at regular intervals to ensure that the cable termination works are carried out in accordance with the manufacturer's recommendations.

8.1.5. Engineering Flexibility and Zoning

8.1.5.1. All Mechanical, electrical, public health and specialist systems including medical gas zoning shall be configured to promote flexibility in order to enable re-modelling, re-planning and replacement to be undertaken at a future date.

8.1.5.2. All engineering services shall be zoned with isolation and safety provision for the whole of the the Works and for individual wards and departments. The Contractor shall also ensure that zoning accounts for:

a) The requirement for “dirty” / “clean” separation;

b) Solar movement; and

c) The necessity for isolation of part of the Works without affecting the entire facilities e.g. all theatre suite services including, ventilation, water, power, medical gases, lighting and controls etc. shall be capable of being independently isolated for maintenance with the remaining theatres still in service.

8.1.5.3. The Contractor shall ensure that all sections of the services distribution can be taken out of service for maintenance without interruption of the water, gas, medical gas and electrical supplies to the adjacent areas; this shall be detailed in the systematic plant replacement strategy noted in the introduction 8.1.1.

8.1.5.4. It is a pre-requisite of the design that all services to individual Theatres and other Critical operational areas can be isolated for maintenance, repair and replacement without the need to effect the ongoing operation of the other facilities.

8.1.5.5. Specifically each Theatre shall have individual air handling units and associated controls. The air handling strategy in Critical Care areas shall be developed with the design layout to minimize disruption during maintenance and each air handling unit must not serve more than one Critical Care pod. Also Air handling units in isolation facilities in Critical Care and general areas shall be configured in accordance with SHBN04.

8.1.5.6. Air handling strategy for the large recovery areas shall be developed with the design layout to minimize disruption during maintenance with the provision of interwoven duplicated systems and sectional controls.

8.1.5.7. Air handling strategy for the large decontamination areas shall be developed with the design layout to minimize disruption during maintenance with the provision of interwoven duplicated systems and sectional controls.

8.1.5.8. Air handling strategy for all large areas shall be developed with the design layout to minimize disruption during maintenance with the provision of interwoven duplicated systems and sectional controls.

8.1.5.9. No exposed pipework shall be visible in clinical areas.

8.1.5.10. Controls at nurse bases shall be co-ordinated with all alarm panels to improve aesthetics and ensure simple operation.

8.1.5.11. Patients operated environmental controls shall be provided to allow set point variation via a graduated slider with arrow type legend (rather than temperature levels); the local set point bandwidth adjustment shall be controlled from group settings at the BMS front end.

8.1.5.12. Emergency shut offs shall be provided at appropriate locations for all services.

8.1.6. Energy Targets

8.1.6.1. The buildings and building services solutions shall provide sustainable, low carbon, low energy facilities in accordance with Appendix M&E 4.

8.1.6.2. The Contractor shall comply with the requirements relating to energy targets as specified in Appendix M&E 4.

8.1.6.3. The Contractor shall provide a breakdown of how the target energy consumption shall be achieved. In particular, the Contractor shall provide details of the anticipated electrical and gas consumption of The Works.

8.1.6.4. In order to assist in meeting this target, the Contractor shall incorporate a high level of innovative building automation and equipment monitoring. The Contractor shall ensure that a central Building Management System (BMS) for The Works is in place, providing linked control and monitoring of the estate functions. Refer to Appendix M&E 5 for details.

8.1.6.5. The Contractor shall note that the Building Volume used in the calculation of Energy Consumption Performance Indicators shall be the “Heated Volume” as defined in Encode. The Contractor shall also include services within the calculation for determining the energy consumption.

8.1.6.6. The Contractor shall calculate the energy consumption for the new buildings using weather data from CIBSE Guides, and degree-day data. The Contractor shall submit all assumptions used to the Board for comment.

8.1.6.7. In order to assist in achieving the water consumption target noted in Appendix M&E 4. The Contractor shall use water saving measures including but not limited to:

a) Low Flush Toilets;

b) Automatic Sensor Taps;

c) Flush Controls to Urinal Facilities;

d) Major Leak Detection and Automatic Shutdown; and

e) Flow restrictors (if risk assessment accepted)

8.1.6.8. Consideration shall also be given to the possible use of borehole water.

8.1.7. Thermal Comfort

8.1.7.1. It is a requirement of the Contractor's Bid Submission that a maximum temperature (28 degree C) solution be considered for the whole of the Works. This will be discussed with bidders during the bid process. Such a solution would require to be produced with the following supporting information;

a) Capital Costs;

b) Lifecycle & Maintenance Costs;

c) Additional Electrical etc loadings; and

d) Projected Energy costs.

8.1.7.2. Where maximum internal summer time temperature calculations of ventilated rooms indicate that the internal temperature will exceed those limits set out in the Appendix M&E 3 for frequent periods, the Contractor shall provide means of reducing the temperature rise.

8.1.8. Air Quality

8.1.8.1. Internal

8.1.8.2. Air quality in all areas shall take account of occupancy levels, internal pollutants, heat gains, external pollutants, atmospheric conditions and shall be controlled to provide adequate comfort and fresh air levels appropriate to the functions of each department area.

8.1.8.3. Particular attention should be given to the risk of cross infection within the hospital / healthcare environment and shall be such as to minimise the spread of infection, all systems to comply with Hai-Scribe and infection control requirements.

8.1.8.4. The Contractor shall demonstrate how their proposals facilitate the control and management of an outbreak and spread of infectious diseases, and in particular shall comply with the requirements of SHTM 2025 (Ventilation in Healthcare Premises) and Hai-Scribe. In order to reduce cross-contamination, the design of The Works shall incorporate 100% fresh air supply systems only.

8.1.8.5. The Contractor's demonstration shall cover all aspects of the building, its services, spatial relationships, PPM Regime and incorporate requirements of the Board's Infection Control Team.

8.1.8.6. Consideration shall be given to the odours from the adjacent sewage works and appropriate filtration shall be included to reduce odours entering the facility.

8.1.8.7. Special consideration shall be given to the reduction of strong smells within the Children's hospital in accordance with SHPN23.

8.1.8.8. External

8.1.8.9. The Contractor shall comply with the requirements of Glasgow City Council and other Statutory Bodies regarding airborne emissions from the Site and shall undertake all studies necessary to prove that emissions and their dispersal will not have any adverse impact on the local community or staff, patients and visitors to the Site.

8.1.8.10. All works shall comply with the Clean Air Act. 1993.

8.1.8.11. The Contractor shall ensure that all Cooking Odours/Fumes are disposed off and do not cause a nuisance to the local community or staff, patients and visitors to the Site in accordance with Planning Condition 17 (see Outline Planning Conditions documents in Appendix D).

8.1.9. Vibration

8.1.9.1. The Contractor shall ensure that Building Services Plant and Equipment are suitably isolated from the building structure in order to prevent the transmission of vibration. The Contractor shall comply with the guidance on the satisfactory magnitude of building vibration with respect to human response given in BS 6472. The Contractor shall comply with the following vibration limits detailed below:

a) Plant rooms on occupied floors 0.015 m/s^2;

b) Plant rooms above and below occupied floor levels 0.050 m/s^2; and

c) Remote plant rooms 0.100 m/s^2.

8.1.9.2. All mechanical ventilation, air conditioning and electrical plant shall be suitably isolated from the structure of the building and fan units positioned in a ducted system shall be isolated from the ducting by means of flexible connections in accordance with Planning Conditions 12 (see Outline Planning Conditions documents in Appendix D).

8.1.9.3. To minimise structure borne noise or vibration lifts and/or hoists, including doors, guide rails and ancillary plant shall be suitably isolated from the structure of the building connections in accordance with Planning Conditions 13 (see Outline Planning Conditions documents in Appendix D).

8.1.9.4. The Contractor shall establish, in consultation with the Planning Authority, whether Best Practicable Means shall be employed as an approach to control noise or whether a baseline noise survey is required. If the latter is deemed necessary the procedures to be adopted shall be agreed in writing with the Planning Authority and thereafter implemented in the agreed manner. When detailed method statements for construction are available an assessment of hospital noise and vibration sensitivity should be undertaken and adequate controls put in place prior to the commencement of any construction demolition works in accordance with Planning Conditions 15(see Outline Planning Conditions documents in Appendix D).

8.1.9.5. All plant and systems shall be installed to meet the vibration requirement of the Clinical Equipment, including theatres and micro biology microscopes etc.

8.1.10. Acoustics

8.1.10.1. The Contractor shall ensure effective control of building services noise and provide a satisfactory acoustic environment in accordance with the following levels as per (S)HTM 08-01. This shall be developed with the Contractors Acoustician to ensure that a holistic approach is taken to prevent nuisance noise, as detailed in Appendix S – Acoustic Requirements.

Table 2 Criteria for internal noise from mechanical and electrical services		
Area type	**Example**	**Noise from mechanical and electrical services**
Ward areas, sleeping areas	Single-bed ward, multi-bed ward, on-call rooms, relatives' overnight stay	NR 30
Recovery	Recovery rooms	NR 35
Small office-type spaces	Private offices, treatment rooms, interview rooms, consulting rooms	NR 35
Open clinical areas	A&E	NR40
Circulation spaces	Corridors, hospital street, atria	NR40
Public areas	Waiting areas, dining, playroom	NR40
Personal hygiene (en-suite)	Toilets, showers	NR40
Personal hygiene (general access)	Toilets, showers	NR45
Small food-preparation areas	Ward kitchens	NR40
Large food-preparation areas	Main kitchens	NR 50 (NR 55 below extract hoods)
Large meeting rooms (>35 m2 floor area)	Lecture theatres, meeting rooms, seminar rooms, board rooms, classrooms	NR30
Small meeting rooms (≤35 m2 floor area)	Meeting rooms, seminar rooms, board rooms, classrooms	NR35
Operating theatres (excluding laminar flow theatres)	Operating theatres	NR40
Laminar-flow theatres	Ultra-clean theatre	NR50
Laboratories		NR 40 where laboratory has no fume cupboards NR 60 at 1 m from fume cupboard with open sash
Table 2 Criteria for internal noise from mechanical and electrical services		
Area type	**Example**	**Noise from**

		mechanical and electrical services
Utility rooms	Clean utility, dirty utility	NR40

8.1.10.2. As well as complying with the technical requirements noted within the various hospital documents, the Contractor shall develop a managed approach with all designers and the acousticians to provide a holistic solution in areas where low level noise could create potential problems e.g. courtyards, entrance halls etc.

8.1.10.3. The Contractor shall include active solutions were these are deemed appropriate e.g. provide piped music in atria, changing rooms to assist acoustic performance.

8.1.10.4. Noise from, or associated with the completed development (the building and fixed plant) shall not give rise to noise level, assessed with windows closed, within any dwelling or noise sensitive building in excess of that equivalent to Noise Rating Curve (NRC) 35 between the hours of 0700 hours and 2200 hours and Noise Rating Curve (NRC) 25 at all other times in accordance with Planning Conditions 11 (see Outline Planning Conditions documents in Appendix D). Refer to appendix M&E3 and the general acoustic requirements noted in section 7.8 - Acoustics.

8.1.11. Plant Life Cycle Costs

8.1.11.1. The Contractor shall ensure that all plant and systems are selected and configured to provide high quality, efficient, resilient, modular flexible and maintainable Building Services solution.

8.1.11.2. The Contractor shall provide evidence of plant life cycle costings including:

a) Capital Cost;

b) Energy Running Cost;

c) Maintenance Cost;

d) Replacement Cost.

8.1.11.3. Warranty costs for each of the building systems shall be benchmarked against industry standards and backed up by detailed costings in the extended warranty schedules.

Sustainability, Renewables, Low, Zero Carbon Technologies

8.1.11.4. The Contractor shall provide evidence of compliance with the Energy Target requirements as detailed in Appendix M&E4 and section 10 and shall develop the sustainability brief in conjunction with the Local Authority to ensure compliance with:

a) Building Regulations;

b) BREEAM Healthcare Excellent requirements;

c) Building Control;

d) Glasgow City Council requirements;

e) Scottish Government Planning Policies including SPP6;

f) Advice Notes including PAN84;

g) NHS/Board objectives.

8.1.12. Design Criteria

8.1.12.1. The Building Services shall be designed in conjunction with the development of the Architectural and Structural packages to ensure a holistic approach to minimise energy use while maintaining user comfort, fabric protection and statutory compliance.

8.1.12.2. All Mechanical, Electrical, Public Health and Specialist system plant shall be designed in modular arrangements incorporating plant N+1 redundancy.

8.1.12.3. All Mechanical, Electrical, Public Health and Specialist systems shall be designed and installed in resilient arrangements with dual distribution paths and appropriate isolation facilities.

8.1.12.4. The lighting levels shall be in accordance with CIBSE guides and Building Control requirements.

8.1.12.5. Power shall be configured to meet the Target Energy demands and also the design peak load plus 25% capacity for future growth.

8.1.12.6. The growth shall be provided in a modular configuration to allow plant cycling and high efficient running.

8.1.12.7. Fire safety systems shall be provided in accordance with the Fire Strategy.

8.1.12.8. Fire alarms shall be Fire Code and BS5839 CAT L1.

8.1.12.9. Refer to Appendix M&E 3 for Room Design criteria and internal temperature frequency periods.

8.1.13. Compliance with Health Service Notes and Memorandums

8.1.13.1. The Mechanical, Public Health, Electrical, Life Safety and Lift Services shall be designed and installed in accordance with the relevant SHTM's, HTM,s, SHBN's, HBN's, SHGN's and HGN's to meet the Employers Requirements.

8.1.13.2. Refer to Volume 2.1 Section 5.0 General Design & Construction Requirements for document hierarchy and Compliance Requirements.

8.1.14. Compliance with Planning/Building Regulations

8.1.14.1. The Building Services Installations shall generally comply with the Building Regulations and Planning Requirements.

8.1.14.2. If any deviations are proposed these must be highlighted in the contractors return documentation together with the details of the proposed mitigation strategy.

8.1.15. Incoming Services - Utility Connections

8.1.15.1. General

8.1.15.2. Discussions with the supply company have been commenced by the Client and contract details are included in Appendix M&E 1.

8.1.15.3. The Contractor will be responsible for the provision of all utilities and the energy supply infrastructure to and from The Works (whether this is internal or external to the Site boundary), including:

a) Confirmation of the capacity of the proposed system;

b) Liaison with potential suppliers;

c) System development and planning;

d) Any supplies modifications to the periphery of the Site;

e) Any supplies modifications within the Site;

f) Metering and sub-metering of power supplies;

g) Metering and sub-metering of heating usage;

h) Metering and sub-metering of cooling usage;

i) Metering and sub-metering of water usage;

j) Metering required for BREEAM;

k) Strategic planning in the context of the site environment;

l) Emergency systems; and

m) Power factor correction.

8.1.16. Security of Incoming Supplies

8.1.16.1. The Contractor shall provide back up to respond to the failure of the incoming supply of Electricity, Gas and Water supplies to The Works. This shall:

a) Provide full standby generator capacity for all electrical services on an N+1 basis in accordance with the requirements and recommendations of (S)HTM 06-01;

b) Ensure that The Works are provided such that all the requirements detailed in (S)HTM 06-01 are satisfied;

c) Ensure that energy, water, power supplies, medical gases and communication supplies to and within The Works are maintained by providing standby sources of supply (eg. dual fuel boilers, standby generators etc);

d) Develop a strategy to ensure the security of the supply. The Contractor shall be required to demonstrate the feasibility of the strategy to the satisfaction of the Board; and

e) Ensure their town's water connection to the Site maintains an adequate and robust service and shall provide connection details with their proposals;

8.1.17. Water

8.1.17.1. A robust alternative town's water supply is to be provided by the Contractor to the Site from a separate sector of the Scottish Water network.

8.1.18. Site Mains Water, Fire Water, Quality & Distribution

8.1.18.1. The Contractor shall develop the Site potable and fire water networks as separate systems each arranged with adequate valving to achieve robustness in continuity of supply.

8.1.18.2. The outcome of the water survey works is awaited, it is anticipated that The Works are to be supplied from dual supplies one from Govan Road and a second from Hardgate Road.

8.1.18.3. The Contractor shall filter the Site potable water to the criteria set out in SHTN02 with 0.2 micron filtration. Pipework shall be stainless steel.

8.1.18.4. The water filtration system shall be established within the Energy Centre to provide resilient filtered water to meet the requirements for The Works.

8.1.18.5. The Contractor shall provide external isolation of water supplies to the new Facilities.

8.1.19. Incoming Power

8.1.19.1. The overall site power systems shall be integrated with the Distribution Network Operator (DNO) incoming arrangement to provide a resilient system.

8.1.19.2. Scottish Power have advised that the existing 11kV network cannot accommodate the New Hospital load; they have been requested to provide proposals to enhance their network for the development. The Contractor shall negotiate with the supplier and ensure that an integrated solution is provided to meet the new building together with the additional site requirements detailed below.

8.1.19.3. The system shall also be configured to provide power for retained estate and new build areas as indicated in Appendix M&E1.

8.1.20. Fossil Fuels

8.1.20.1. The Contractor shall be responsible, in conjunction with SGN in determining the philosophy for the provision of fossil fuels to the Site.

8.1.20.2. Options the Contractor shall consider are;

a) Un-interruptible gas supply;

b) Provision of dual fuel burners and a heating oil standby facility;

c) Installation of CHP for base load;

d) Provision of CHP to provide full campus Electrical and Heating Loads in “Island” configuration with grid as standby.

8.1.20.3. Standalone Heating Boilers are not mandatory if the bidder identifies packaged CHP plant which does not require them to provide the required resiliency and dual fuel capabilities.

8.1.20.4. Irrespective of the option proposed by the Contractor the availability criteria described elsewhere in this document must be strictly adhered to.

8.1.20.5. Natural gas is required for;

a) Space heating;

b) Limited steam generation (for humidification);

c) Combined Heat and Power systems; and

d) Catering.

8.1.20.6. The gas supply shall be provided by a new mains connection from Govan Road. The pipework shall be routed to the Energy Centre to feed the Heating Boilers, CHP plant and routed to serve localised requirements within the Works.

8.1.20.7. Twin regulators shall be provided at the gas meter, non return valves shall be fitted at fire isolation valve to avoid back pressure shutting down regulator valve on activation of the fire valve.

8.1.20.8. Automatic Isolation facility to be incorporated in all gas fire valves during fire alarm testing. Valves shall be capable of being reopened and set to work remotely via the BMS.

8.1.21. Standby Power

8.1.21.1. Electrical Supplies to the Works shall be fully backed up by on site generation as noted above and in item 8.3.31 below. The Contractor shall provide the infrastructure and plant space to allow the extension of the generation capacity to meet the additional site loads as noted above together with a 25% capacity for growth.

8.1.22. Medical Gases

8.1.22.1. A new oxygen VIE compound is to be provided by the Contractor rated to supply the combined demand of The Works and the retained estate.

8.1.22.2. The existing site systems shall be extended by the Contractor to also be capable of supplying the combined site demand, this may be achieved by the expansion of the Maternity accommodation or the establishment of a further VIE compound site, which summated with the existing Maternity storage will meet the combined demand of the the Works and retained estate.

8.1.22.3. For the purposes of the Bid, the bidder shall assume that the latter is required and shall include for a further new VIE compound to be located as per drawing G1274/U(96)01.

8.1.22.4. The Contractor shall provide all civil, builderswork and distribution pipework via a ring main distribution circuit, which should be carried through to the new building risers.

8.1.22.5. The system shall be fully compliant with current SHTM requirements.

8.1.22.6. The Contractor shall liaise closely with the Boards Supplier who will lease the VIE tanks. The contractor shall carry out all builders work, foundations, bases, blast walls together with all pipe and electrical works.

8.1.22.7. Medical gases shall be supplied and configured to suit the new Hospital requirements and retained estate requirements including:-

a) Nitrous Oxide;

b) Oxygen (as above);

c) Vacuum (Split over two systems with valved off link); and

d) Surgical and Medical Air services (Split over two systems with valved off link).

8.1.22.8. Medical air plant should be provided from 2 separate sources of supply via a ring main distribution net work, carried through to the internal risers.

8.1.22.9. Within the Children's hospital special care shall be taken in the location and covering of medical gas equipment to reduce fear while retaining full operational abilities. The proposal shall be robust, simple to use and easily cleanable.

8.1.23. IT

8.1.23.1. IT equipment/server rooms shall be established in both the new Children's Hospital and Adult Acute Hospital. The two new rooms shall be interlinked, together with associated hub rooms via a star/mesh configuration of cabling.

8.1.23.2. Distributed secondary comms rooms shall be established to allow CAT 6A cables to be run to all positions within The Works within the 90m cable length restriction.

8.1.23.3. All new incoming services shall be duplicated and presented individually at the two server rooms. Ducting and manholes to be provided to up to four providers with diverse routes for each network provider.

8.1.23.4. Distributed secondary comms rooms shall be established to allow CAT 6 Augmented (CAT6A) cables to be run to all positions within The Works within the 90m cable length restriction.

8.1.23.5. The Contractor shall ensure that his works have no impact on the security of services to the existing hospital estate during the site construction works.

8.1.24. NHS Model Engineering Specifications

8.1.24.1. The Contractor shall ensure that systems are installed in accordance with all relevant NHS Model Engineering Specifications and amendments to ensure compliance with the Technical Memorandum.

8.1.25. Service Capacity Reserve

8.1.25.1. In accordance with Good Industry Practice, all plant, plant spaces and building services systems shall be specifically designed and provided with defined reserve capacity allowances and future expansion capabilities for The Works (e.g. distribution boards with 25% spare capacity, 25% additional containment, 25% spare capacity in distribution Pipework, 25% additional plant capacity, 25% additional cooling capacity, 25% additional air handling capacity etc. for the buildings as designed). As detailed in 8.1.3.2, the Contractor to provide compliance matrix detailing how this to be delivered.

8.1.25.2. With optimum for maximum temperature variant (MV2).

8.1.25.3. This shall be demonstrated within the calculations, plant room layouts and service route drawings provided with each stage of the design build project to ensure full compliance at project completion.

8.1.25.4. In addition to the reserved capacity allowances the Contractor shall also ensure reserve capacity, service termination, zoning and general arrangement supports any future extension of the building that may be an optional feature of the Contractors Proposals.

8.1.26. Commissioning, Testing and Demonstrations

8.1.26.1. The Mechanical, Electrical, Public Health and Specialist systems shall be fully tested and commissioned in accordance with:

a) CIBSE Commissioning Code;

b) The Institute of Hospital Engineers Guidance to Engineering Commissioning;

c) Requirements of SHTN’s and SHBNs; and

d) Requirements set out in the works documents

8.1.26.2. The Contractor demonstrations are to cover all aspects of the building, its services, and spatial relationships, Soft and Hard FM and incorporate requirements of the Board’s Infection Control Team.

Refer to section 6.8 – Commissioning & Handover for details.

8.1.27. Environmental Proving

8.1.27.1. During the design stage the Contractor shall provide the Computational Fluid Dynamic requirements of SHPN57 e.g. CFD shall be used to model and prove the ventilation strategy for the works.

8.1.27.2. On completion of the commissioning of all individual systems the overall performance of the combined systems shall be demonstrated within every room within the Adult Acute and Children's Hospitals.

The following parameters shall be recorded:-

a) Space Temperature;

b) Space Humidity;

c) Space Sound Levels;

d) Controls Operation & Achieving Set Points;

e) Domestic Hot and Cold Water;

f) Air Velocities (Comfort Criteria);

g) Lighting Levels; and

h) Fire Alarm Sounders.

8.1.27.3. Trend logs from the BMS system are to be used as a record of the local conditions achieved where possible, or hand held instruments with current Calibration Certificates. All readings shall be recorded, tabulated and issued.

8.1.27.4. Measuring instrument Calibration Certificates shall be forwarded for record purposes.

8.1.27.5. Room cooling capacities shall be tested on a department by department basis by introduction of temporary heat loads to prove the system design capabilities.

8.1.27.6. This shall be carried out by the Contractor at their own cost.

8.1.27.7. The Contractor shall also carry out seasonal commissioning as detailed in Appendix U – BREAAM Guidance, to ensure full system performance i.e. Main cooling plant operation in the summer and heating plant in the winter.

8.1.28. Asset Register

8.1.28.1. The Contractor shall include for a comprehensive Asset Register to be compiled on an open protocol industry standard format for all elements of the Electrical, Mechanical, Public Health Medical Gases and Specialist systems.

8.1.28.2. The Contractor is advised that an NHS Scotland (HFS) National asset management package is currently out to tender for development, this should fully developed and implemented by the time The Works are in the construction phase, failing this the Asset Register management package should revert to industry standard current at time of construction.

8.1.28.3. The register shall be linked to the As Fitted drawings via MiCAD drawing mapping, the MiCAD should also integrate with the Labour Management Systems (LMS) to provide a fully integrated system complete with interfaces to the PPM and Board's labour resource software systems (Apollo or Eclipse).

8.1.28.4. For ease of reference, all installed Mechanical, Electrical, Public Health Medical Gases and Specialist systems components shall be asset tagged by the contractor, entered into the PPM system and linked to its full specification and maintenance schedule.

8.1.28.5. IT provision for this functionality should include for server capacity to effectively store all 3 elements, PPM, MICAD & LMS packages.

8.1.28.6. The tagging system shall be capable of simple extension to allow the Bar Coding of Hospital Equipment, and the bidders shall provide technology proposals for Board consideration.

8.1.28.7. The asset tagging system shall be interfaced with the Personal Digital Assistant (PDA) System to be utilised for Managing Building Handover and Snagging.

8.1.28.8. The Contractor shall provide and manage a computer based electronic system for the management of the handover of the building. The system shall allow a file for each room to be established, with drawings linked to the file and marked to highlight snags or defects. This system shall be configured to provide management reports on zoned and room type selection basis.

8.1.29. Planned Preventative Maintenance PPM

8.1.29.1. The Contractor should provide, as part of the contract, a full PPM manual and system (computer based software package) for all the buildings and for all building and building services elements of the project. This system will incorporate the As Fitted drawings (MiCAD format) and specifications. This schedule shall have a full planned maintenance programme of works that the FM & Estates managers can review to plan and establish their annual maintenance schedules and annual budgets. The Contractor will be responsible for the purchase and installation of the full PPM system, including pc work stations, barcode readers and tablets.

8.1.29.2. The system to be compiled on an open protocol industry standard format for all elements of the Mechanical, Electrical, Public Health and Specialist systems.

8.1.29.3. The PPM system shall be compiled at an early date with time and input included for three iterations of comments and workshops with the Estates Department to ensure that the system meets the various requirements of the Hospital Technical Publications, CIBSE,

Clinical Services and Estate's Department. The system shall be fully linked to the As Fitted drawings via MiCAD drawing mapping, to provide a fully integrated system complete with interfaces to the PPM and Board's labour resource software systems (Apollo or Eclipse).

8.1.29.4. It is understood that there may be an iterative process involved in the preparation of the information, however it is a requirement that the Contractor allows for and ensures that all PPM, Asset register, tagging, management systems and MiCAD information is fully updated to "as fitted" condition.

8.1.29.5. The Contractor shall handover a fully working system including PC's hardware, barcode readers, tablets, printers and project specific software together with system training for the Client's operators.

8.1.30. Helipad

8.1.30.1. The Contractor shall include for all services including;

a) Fire fighting systems;

b) Suppressant storage;

c) Associated drainage, lighting and vertical access; and

d) All items required to allow operation of the helipad to ensure full compliance with HBN 15-03 and CAA guides.

8.1.30.2. The Contractor shall liaise with Glasgow City Planning and the CAA to agree the proposed location and height for Energy Centre Flue and ensure that warning lights are fitted to all required parts of the development including the flue.

8.1.30.3. All warning lighting shall be installed in accordance with the CAA requirements and the lamp replacement methodology shall be included in the main Plant Replacement Strategy.

8.1.30.4. The Building Services shall be designed and installed to accommodate Compliant Helipad Operation with the inclusion of:-

a) Lighting to main energy centre flue;

b) Appropriate location and height selected for;

i. Heat rejection plant to avoid flight path;

ii. Heat rejection plant to avoid hot air generated turbulence; and

iii. Air intakes to avoid contamination from downwash; and

c) Extract ducts to avoid contamination of operators and patient's in transit.

8.1.31. Automated Material Transfer System

8.1.31.1. It is anticipated that an Automated Material Transfer System installation will be provided to reduce the requirement for manual handling and increase service efficiency, all as detailed within Appendix M&E7. The Contractor shall set out the building service and vertical transport implications to ensure that space allocation and service requirements are incorporated for docking stations and controls.

8.1.31.2. All power, controls and equipment shall be configured to ensure EMC compatibility with the robotic solution.

8.1.31.3. The building fabric and general building services installations shall be designed to accommodate the Automated Material Transfer System.

8.1.32. Radiation Protection

8.1.32.1. All required protection and amendments to the Mechanical, Electrical, Public Health and Specialist Services shall be provided by the Contractor to suit the radiation protection regime in accordance with the manufacturer's guidance HSE regulations and Technical Memorandums.

8.1.32.2. Contractor to note that all Radiation Protection measures proposed to be discussed and agreed/endorsed with/by the Boards Radiation Officer

8.1.33. Telemedicine

8.1.33.1. The mechanics of Telemedicine system shall be provided by the Contractor via the ICT network cabling infrastructure and field cabling. The PACS equipment shall be provided by the Board.

8.1.33.2. As the principal tertiary children's hospital RHSC Glasgow is actively involved in all aspects of telemedicine and the new hospital requires to be arranged and equipped to facilitate telemedicine as part of normal practice. In practice this will require:

a) The ability to plug in mobile telemedicine units throughout the clinical areas to enable clinical consultations;

b) The equipping of all teaching facilities within the hospital for the transmission and receipt of educational activities;

c) A dedicated telemedicine suite; and

d) An IT infrastructure which will enable engagement in telemedicine activities from individual offices / PCs.

8.1.33.3. Telemedicine and teleconferencing play an increasingly important role in provision of children's hospital services in Scotland through:-

a) The transmission and receipt of educational programmes;

b) Support for networked models of service delivery (regional and national); and

c) Support for direct clinical care in remote locations.

8.1.33.4. Telemedicine and teleconferencing shall also play an increasingly important role in provision of adult's hospital with similar facilities being provided.

SECTION 8.2 – MECHANICAL SYSTEMS

8.2.1. General

8.2.1.1. The Contractor shall design, supply, install, test, commission and maintain all Mechanical Building Services necessary to support the clinical activities of The Works. The following systems are indicative of those anticipated by the Board but are not exhaustive and it shall be the Contractor's sole responsibility to determine that all necessary systems (excluding Medical Equipment) are included.

8.2.1.2. Systems shall be designed, supplied, installed, tested, commissioned, and put into service all in accordance with all relevant Regulations and Standards.

8.2.2. Building Management Systems & Controls

8.2.2.1. The Contractor shall ensure that all plant can be operated in automatic mode or manual mode should a corruption in BMS software occur. Furthermore, physical bypasses shall be provided where appropriate for maintaining service, for example at control valves for critical departments.

8.2.2.2. Network communications equipment for BMS, CCTV, Access Control Systems etc. shall be housed in racks, located within environmentally controlled secure rooms. If it is proposed that these share node rooms with the main network services then suitable control measures and rack locking shall be provided.

8.2.2.3. The system shall be fully integrated with the Building Services, refer to Appendix M&E 5 for BMS requirements.

8.2.3. Metering

8.2.3.1. The Contractor shall ensure the use of meters giving high accuracy at low flow rates and that metering points give consumption in SI units including any time bands as appropriate. The Contractor shall ensure data collection and report production is by electronic systems.

8.2.3.2. The Contractor shall allow sub-metering of electricity, gas, heating and cooling usage for each individual department / ward /unit. With water consumption measured in departments and wards with high usage.

8.2.3.3. Metering shall be provided in accordance with the targeted BREEAM credits.

8.2.3.4. The BMS shall be installed to automatically read and provide trend analysis to a range of energy and water meters. All meters including those of the utility supply companies and internal sub-meters shall be automatically read by the BMS at pre-determined intervals. The Contractor shall ensure that the BMS is capable of reading utility meters on a continuous basis in order to facilitate trend analysis. The energy metering shall include (but not be limited to):-

8.2.4. Electricity

a) Main incoming HV supplies;

b) Main LV Switchboard;

c) External lighting (separate sub-meter for each car parking area);

d) All distribution boards with separate meters for power and lighting;

e) Departmental power and lighting;

f) HVAC control panels;

g) Cooling plant; and

h) Tenant areas;

For the purpose of energy estimates, hours run meters shall be provided by the Contractor for all Air Handling Unit (AHU) fans.

8.2.5. Water, Gas, Oil, Bio Fuel

Water

a) Main incoming water supply; and

b) Internal sub-meters

Gas

a) Main incoming gas supply; and

b) Internal sub-meters

Oil

a) Delivered to Site; and

b) Used on Site

Bio Fuel (if proposed)

a) Delivered to Site; and

b) Used on Site

8.2.6. Asset Management & Tracking (AM&T)

8.2.6.1. The Contractor shall also arrange for the Utility metering systems to interface with the Board's AM&T system for fiscal metering, electronic invoice & validation process.

8.2.7. Heating System

8.2.7.1. The Contractor shall provide all heating systems required to support the Board's Clinical Output Specification and to;

a) Zone and control heating circuits to provide an efficient and comfortable environment;

b) Provide valve isolation such that isolation of circuits and sub-circuits shall have minimal disruption to the remaining departments;

c) Provide 24 hour occupied (and unoccupied) wards and departments with a night set back Facilities;

d) Provide a temperature and ventilation night set-back facilities so that when departments are unoccupied they will have frost and anti-condensation protection;

e) Good quality heat emitters shall be provided to ensure satisfactory heat distribution within the area served. Heat emitters and all heating pipework shall be arranged such that in all areas, the surface temperature limits as laid down in Health Guidance Note "Safe Hot Water and Surface Temperatures" are not exceeded. Heating pipework shall not be utilised as a heat emitter within patient areas;

f) The bidder shall provide catalogue details of all proposed heat emitters; and

g) Particular attention shall be given to effective use of warm air curtains in entrance / draft lobbies.

8.2.7.2. The Heating pipework shall be thoroughly examined and tested prior to the fitting of insulation. Any site welds shall be x-rayed and a certificate issued to confirm the suitability of the completed joint for operation within the test requirements

8.2.8. Water Systems and Filtration

8.2.8.1. Cold Water Supply

8.2.8.2. The water supply system for The Works shall include two new supplies and also incorporate on-site segregated bulk water storage (24-hours). Treatment of potable cold water supplies is not acceptable and the provision of a wholesome supply from Scottish Water's mains with the minimum of storage and handling is required.

8.2.8.3. The Contractor shall design and install the domestic cold and hot water supply installations to fully comply with the requirements of;

a) (S)HTM04-01;

b) SHTM 2027;

c) SHTM 02;

d) SHTM 2040 "The control of legionella in healthcare premises - a code of practice"; and

e) Health Guidance Note "Safe Hot Water and Surface Temperatures."

8.2.8.4. Pipework shall be stainless steel with compatible accessories.

8.2.8.5. The Contractor shall include for all specialist membrane filtration treatment plant (Replaceable cartridge systems are not acceptable). The Contractor shall provide water sampling points throughout the installation in accordance with the SHTM02. Renal water treatment shall be provided by the Contractor in accordance with Appendix M&E6 with due regard for clinical requirements.

8.2.8.6. Secure local isolation via manual shut off valves shall be provided by the Contractor at all sanitary appliances and at final connection points to Equipment.

8.2.8.7. Area leak detection shall be interlinked to zoned automatic shut down valves.

8.2.8.8. Secure external isolation to the buildings shall be provided by the Contractor. Sentinal taps for testing shall be clearly identified on drawings.

8.2.8.9. Pipework and valving shall be configured to allow isolation of local services whilst maintaining adjacent facilities e.g. resilient pipework routing and valve location to ensure that only one Theatre to be off-line at a time, one CCU bed, one renal bed, one standard bed etc..

8.2.8.10. Plumbed in water dispensers shall be provided at ward level and strategic areas including main reception/café areas etc.

8.2.8.11. Plumbed water shall be provided to specialist services such as, but not limited to;

a) Washing machines in specialised units;

b) Catering requirements;

c) Dishwashers in ward areas in accordance with the exemplar layouts and Equipment List; and

d) Retail Units.

8.2.8.12. Plumbed water shall be provided to all vending machines as required throughout The Works in accordance with the Employers Requirements.

8.2.8.13. Attention is drawn in particular to SHTN 02 concerning pipework materials and standards of filtration to be used in Scottish Healthcare Facilities.

8.2.8.14. Cold water system to comply with Hai-Scribe and the Board's infection control requirements.

8.2.8.15. All hand washing facilities to be provided with automatic taps.

8.2.8.16. The Contractor shall carry out a full risk assessment of the complete water systems of the legionella risks and ensure that the system design and equipment selection and installation is carried out to minimise risks.

8.2.8.17. Water shall be provided for fire fighting including sprinklers, wet risers and fire hydrants in accordance with the local authority requirements.

8.2.9. Hot Water Supply

8.2.9.1. Appropriate operational engineering systems for hot water shall be included in the design of The Works.

8.2.9.2. Pipework shall be stainless steel with compatible accessories.

8.2.9.3. Domestic hot water systems shall be designed with plate heat exchangers and buffer vessels to provide adequate flow to satisfy maximum demand whilst minimising stored hot water and energy consumption. The provision of some storage via buffer vessels may be required to minimise the impact of hot water generation on boiler power. (If buffer vessels are required these shall be minimal rating)

8.2.9.4. The adoption of recommended design practices to control of legionella and other bacteria within the systems is critical and is considered mandatory.

8.2.9.5. Type 3 thermostatic mixing valves (TMV's) shall be installed (in accordance with NHS Model Engineering Specification D08) at all HWS outlets to SHTMs and SHGNs except where 60°C water is a particular requirement. Double check valves to be duplicated at TMV's.

8.2.9.6. The Contractor shall carry out a full risk assessment of the complete water systems of the legionella risks and ensure that the system design and equipment selection and installation is carried out to minimise risks.

8.2.9.7. Hot water system to comply with Hai-Scribe and the Board's infection control requirements.

8.2.9.8. Hot water boilers shall be provided in all Staff Rest rooms and Kitchen areas.

8.2.10. Special Water Services

8.2.10.1. The Contractor shall provide all special water services required to support the Employers Requirements, such as but not limited to:-

a) Special supplies such as de-ionised water to specialist Equipment;

b) Special supplies such as de-ionised water to Equipment washers / disinfection Equipment; and

Special supplies for Renal Dialysis (refer to appendix M&E6).

8.2.11. Ventilation & Air Conditioning

8.2.11.1. The heating, ventilation and air conditioning systems shall be logically designed to operate efficiently incorporating heat recovery and provide local control for all areas including single accommodation.

8.2.11.2. The energy and power systems shall be appropriately designed to provide fully integrated designs in terms of the incorporation of engineering services into the building fabric and external spaces.

8.2.11.3. The need to maintain the specified comfort conditions in all areas but particularly in clinical areas is of paramount importance and the Contractor shall develop strategies for achieving the specified environmental conditions with minimum energy consumption.

8.2.11.4. Air Handling Ductwork shall be constructed from galvanised mild steel sheet and not fabricated from any composite board systems. Ductwork shall be manufactured and installed in accordance with DW144.

8.2.11.5. It is essential that the Contractor designs and provides ventilation and air conditioning systems which will ensure occupants comfort. This shall be achieved by use of well tested design principals and suitable plant selection. Air flow problems must be avoided by accurate system balancing, correct selection and location of air diffusers to prevent high air velocities and stratification together with adequate air volumes and accurate temperature control.

8.2.11.6. The Contractor shall comply with the following general criteria for above systems:-

8.2.11.7. Provide natural and mechanical ventilation, comfort cooling, and air conditioning to suit The Works and clinical requirements.

8.2.11.8. Air changes shall be in accordance with CIBSE guides, SHTM's, HTM's and Building Regulations.

8.2.11.9. Provide a climate control facility in clinical and staff areas which are provided with air conditioning (if applicable).

8.2.11.10. Ensure heat gain from all Equipment and personnel is allowed for in sizing and selection of the systems.

8.2.11.11. Demonstrate how their proposals facilitate the control and management of an outbreak and spread of infectious diseases in accordance with SHTM 2025 and SHFN 30 and HAI-SCRIBE. The Contractor demonstration is to cover all aspects of the building, its services, spatial relationships, maintenance regime proposals and incorporate requirements of the Board's Infection Control Team.

8.2.11.12. Ensure that ventilation systems installed in areas classified as hazardous are designed to relevant standards.

8.2.11.13. Where grilles or diffusers are used within rooms the Contractor shall ensure they are:

a) Arranged to avoid draughts;

b) Designed to minimise noise intrusion into the space; and

c) Humidification shall be provided where control of humidity is required for clinical reasons.

8.2.11.14. The Contractor shall provide the resilience requirements of SHPN28 e.g**.** Steam Humidification shall not rely solely on interruptible gas supply.

8.2.11.15. The Contractor shall design the systems set back arrangement in accordance with the requirements of SHPN57 e.g**.** minimum set back temperature in Cardiac CC of 10^{o}C.

8.2.11.16. The Energy Centre shall be adequately ventilated throughout and in compliance with HTM's, SHTN's, CIBSE and Building Regulations current at time of construction.

8.2.11.17. Special consideration shall be given to temperature control and ventilation within transformer rooms, generator rooms, UPS rooms and battery rooms to ensure optimum equipment operation.

Local Exhaust Ventilation Systems

8.2.11.18. The Contractor shall provide all LEV systems including but not limited to that required to support the provision of;

a) Catering;

b) Workshop and maintenance facilities;

c) Plaster rooms;

d) Decontamination suites; and

e) Areas requiring exhaust as noted in SHBN's, SHTN's and SHPN's etc

8.2.12. Fume Cupboard & Micro-biological Safety Cabinets

8.2.12.1. The Contractor shall provide fume cupboard and both CAT II and CAT III microbiological safety cabinet exhaust systems if required to support the Board's Clinical Output Specification, RDS/ADB information. Systems shall comply with NHS Specifications and Guidance documentation which shall include a matched supply system into the room(s) containing fume cupboards and micro-biological safety cabinets. Fume cupboard design and installation shall be to BS 7258. Microbiological Safety Cabinet design and installation shall be to BS 5726.

8.2.13. High Specification Air Conditioning Systems

8.2.13.1. The Contractor shall provide high specification, full function and close control air conditioning systems to support the Board's Clinical Output Specification, such as but not limited to:-

a) Aseptic rooms;

b) Ultra Clean ventilation and / or operating theatres;

c) Pharmacy; and

d) Areas handling radio isotopes or other radiological contaminants.

8.2.13.2. The operating theatre suite within the Adult Acute Hospital shall be provided with five number ultra clean ventilation (UCV) theatres. All other theatres shall be the standard type.

8.2.13.3. This should be verified with the current Architects drawings and Room data Sheets.

8.2.13.4. Each individual operating theatre shall be provided with its own plant, controls and power i.e. One supply and one extract unit, there shall be no sharing of ventilation between the theatre suite.

8.2.13.5. Air conditioning systems installed in the above areas shall be higher specification air conditioning systems with standby motors belted up in accordance with;

a) SHTM 2025;

b) SHTM 2040; and

c) NHS Model Engineering Specification C04.

8.2.14. Ventilation of Isolation Rooms

8.2.14.1. Each 28 bed ward within the Adult Acute Hospital will be provided with a single isolation room.

8.2.14.2. The Children's Hospital will be provided with two isolation rooms per 28 bed ward.

8.2.14.3. This should be verified with the current Architects drawings and Room Data Sheets.

8.2.14.4. The Contractor shall provide air conditioning systems to Isolation Rooms to support;

a) Employers Requirements;

b) Clinical Output Specification; and

c) NHS infection Control standards

With strict positive / negative pressure differentials.

8.2.14.5. A simple to read digital differential pressure gauge shall be provided by the Contractor at the entrance to the isolation suite lobby.

8.2.14.6. Refer to draft SHPN 4 and drawings G1274 M(57)02 & 03.

8.2.14.7. Ventilation and air conditioning systems for these rooms shall be designed and installed in accordance with;

a) SHTM 2025;

b) SHTM 2040;

c) SHPN 4; and

d) NHS Model Engineering Specification C04

8.2.14.8. The Contractor shall demonstrate how their proposals facilitate the control and management of an outbreak and spread of infectious diseases.

8.2.15. ICT Cooling

8.2.15.1. The Contractor shall provide N+1 redundant high specification, full function close control air conditioning systems to support the Board's Technology requirements, such as but not limited to:-

a) Server Rooms;

b) Computer Rooms;

c) Telephone Rooms;

d) CCTV DVR Equipment Rooms; and

e) Entertainment Server Rooms

8.2.15.2. The Contractor shall provide close control cooling systems to support the Board's Technology requirements, such as but not limited to:-

a) ICT Node Rooms;

b) BMS Node rooms (where these are separate from ICT node rooms);

c) Security Node rooms (where these are separate from ICT node rooms); and

d) Entertainment Node rooms (where these are separate from ICT node rooms)

8.2.15.3. No water or condensate generating equipment to be located above racks.

8.2.15.4. All services to be designed to operate on local control from diverse routed automatic change over power supplies to ensure no single point of failure, BMS to monitor plant operation, set points and room environment conditions.

8.2.16. Internal Drainage

8.2.16.1. The Contractor shall provide all necessary drainage to support the Employers Requirements and their aspirations regarding reduced water consumption which shall include but not be limited to:

a) General foul water drainage;

b) General surface water drainage;

c) Kitchen drainage, inclusive of grease traps;

d) Laboratory drainage;

e) Drainage from areas handling radio isotopes, or other contaminants such as silver;

f) Bedpan disposal system; and

g) Harvested rainwater shall not be utilised in clinical areas.

8.2.16.2. The design of the system shall be in accordance with the BS EN 12056 and the Local Authority's Building Inspector's requirements; pipe routing shall be configured to minimize the risk of blockage.

8.2.16.3. Drainage pipework and accessories material shall be selected to suit the appropriate location and type of waste.

8.2.17. Bedhead Services

8.2.17.1. The Contractor shall provide bed head services in line with the ADB sheet requirements together with clinical and operational requirements. The Contractor shall ensure that bedhead services are designed and installed in accordance with SHTM 2015.

8.2.17.2. The units shall be full integrated with the Patient entertainment systems and a dedicated power outlet shall be provided for patient's equipment.

8.2.17.3. The bedhead services shall be provided via high quality proprietary units with integrated lighting and medical gas outlets.

8.2.17.4. Gas Outlets in Children's Hospital to be concealed.

8.2.17.5. The bedhead units at renal locations shall be proprietary type rather than site constructed from standard components provided all in accordance with Appendix M&E6.

8.2.18. CHP Equipment

8.2.18.1. A CHP installation is proposed as part of the low C02 / energy strategy for the new Facilities. The CHP units shall be located within the Energy Centre. The Contractor shall develop the strategy to incorporate the full benefits of tri-generation and select appropriate plant to meet the works requirements.

8.2.18.2. The installation requires to comply with the following general principles;-

a) The system shall be fully integrated with the energy strategy for the new hospital buildings to ensure economical operation;

b) The units shall operate in accordance with the Clean Air Act; and

c) Where biofuels are proposed for the CHP these shall be stored separately from the main fuel storage system and shelf life control regime integrated in the storage facility.

8.2.19. Fire Fighting Systems

8.2.19.1. The Contractor shall provide all fire fighting systems in line with a robust fire strategy for the project as outlined in Volume 2/1 Section 5.11.

8.2.19.2. All elements of the fire fighting systems, such as but not limited to

a) Wet risers;

b) Sprinklers;

c) Gaseous Extinguishants;

d) Fire Hydrants; and

e) Smoke Control Systems etc.

8.2.19.3. The above shall be fully incorporated within the building design at an early date to ensure that all service routes and plant requirements are integrated in the building envelope while maintaining safe, secure access for maintenance and regular system testing of all systems without disturbance to the Clinical operations.

8.2.19.4. Where sprinklers are used special consideration must be given to mitigate infection control issues including risk assessments, water treatment and pre-action systems.

8.2.19.5. All in accordance with (S)HTM 05-01, 05-02 & 05-03.

8.2.19.6. Specialist systems shall be provided by the Contractor for the roof mounted helipad in line with the appropriate standards.

8.2.19.7. Authorised test certificates shall be provided by the Contractor for all life protection systems.

8.2.20. Gas Systems

8.2.20.1. Medical gases

8.2.20.2. The plant shall be rated to accommodate the requirements of the new and retained hospital estate The medical gas pipeline system for the site will require a detailed design package from a specialist consultant including all required co-ordination with existing gas supplies on-site throughout the phasing periods.

8.2.20.3. Contractor to note that detailed design proposals to be discussed and agreed/endorsed with/by Board's Medical Gas Officer.

8.2.20.4. For certification of the works all new developments will require new independent external plant and complete medical gas pipeline systems. The interconnections with the existing and upgraded systems shall be valved off for certification of the main works.

8.2.20.5. The Contractor shall liaise closely with the Boards Supplier who will lease the VIE tanks. The contractor shall carry out all builders work, foundations, bases, blast walls together with all pipe and electrical works

8.2.20.6. The Contractor shall provide all medical gases required to support the Employers Requirements such as but not limited to:-

Oxygen VIE comprising 2 No. Sources (2 fixed manifold rated for the combined load of the new and existing Hospital requirements) (Board provision) Together with connection to existing hospital VIE network and extension of the existing to provide supplies to meet the fall demand requirements of the new works and retained estate;

a) Nitrogen;

b) Nitrous Oxide;

c) Oxygen / Nitrous Oxide mixture;

d) Surgical air 7 bar;

e) Medical air 4 bar;

f) Carbon Dioxide;

g) Helium/Oxygen;

h) Medical Vacuum; and

i) Anaesthetic Gas Scavenging.

8.2.20.7. All medical gas, vacuum, scavenging, and air systems shall be fully maintainable without the requirement to alter other services and a section for each system shall be included in the Contractor's plant replacement strategy detailing the system resilience, redundancy together with the replacement methodology for all vessels, distribution and equipment while maintaining service.

8.2.20.8. All power supplies to medical gas, vacuum, scavenging, and air systems shall be provided from resilient redundant distribution networks with automatic change-overs with

a holistic approach used to minimise disruption to service during electrical testing and maintenance. Isolation and distribution shall be configured to ensure that work on one power stream does not effect other equipment.

8.2.20.9. Medical gas bottles, plant areas and stores shall be accommodated within suitably designed buildings, rooms and enclosures with good access, natural ventilation and satisfactory noise emissions control.

8.2.20.10. All medical gas installations which serve clinical departments shall be connected to essential electrical supplies.

8.2.20.11. The full status of the central medical gas plant shall be monitored by an alarm system with a status signal to an alarm panel located in the FM Control Centre, and local manned office. The panel shall also report the alarm to the BMS.

8.2.20.12. The Contractor shall provide the Medical Gas installation to comply with the following general criteria;

a) Install the piped medical gases in accordance with;

i. SHTM 2022;

ii. (S)HTM 02-01; and

iii. “Model Engineering Specification C11”;

b) Install outlets as required to allow the Clinical operation of each department to be carried out;

c) In accordance with ADB sheets;

d) Within play rooms and recreation rooms all outlets shall be located in lockable area together with masks and flow meters etc;

e) Provide a medical gas distribution system sized to accommodate the demand of The Works as defined in the Room Data Sheets, with the capacity to accommodate an increase in demand (flow and consumption) of no less than 25%;

f) Ensure that the provision of medical gasses to the point of use is continuous. Where the Contractor is providing medical gases via cylinders they shall provide manifold systems with automatic change over from duty to standby to no less than two equal banks of cylinders; and

g) Ensure that adequate points of isolation exist to all medical gas systems in accordance with SHTM 2022, (S)HTM 02-01.

8.2.20.13. The Contractor shall establish duplicate VIE plant compounds within suitable locations to ensure compliance with the Technical Memorandums, Local Approved Person and suppliers requirements. The system shall be rated to accommodate the full site wide requirements and the Contractor shall include for interlinking the new plant with the retained estate systems via valved off interconectors to improve overall site resilience.

8.2.20.14. A ring main will surround the site (NSGH & RHSC) feeding all necessary areas. It will be supplied from primary, secondary and tertiary sources. Compounds shall require an 8m

boundary zone for most activities around the enclosure, going up to 15m for places of assembly and flanges in flammable gas pipes. Allowance should be made for regular large vehicle access for tank refilling.

8.2.21. Medical & Dental Vacuum

8.2.21.1. The Contractor shall provide medical and dental vacuum by duplicate quadruplex vacuum systems each with three pumps and two vessels to provide service as detailed within the relevant ADB Sheets.

8.2.21.2. Medical and dental vacuum plant areas and stores shall be accommodated within suitably designed buildings, rooms and enclosures with good access, natural ventilation and satisfactory noise emissions control.

8.2.21.3. Installations shall be connected to essential electrical supplies.

8.2.21.4. The status of the central medical and dental vacuum plant shall be monitored by an alarm system with a status signal to an alarm panel located in the FM Control Centre, and local manned office. The panel shall also report the alarm to the BMS.

8.2.22. Anaesthetic Gas Scavenging System

8.2.22.1. The Contractor shall provide active AGSS systems in all locations where Nitrous Oxides are used. These shall be duplicate vacuum systems independent of the main vacuum systems.

8.2.22.2. AGSS plant areas and stores shall be accommodated within suitably designed buildings, rooms and enclosures with good access, natural ventilation and satisfactory noise emissions control.

8.2.22.3. The installation shall be connected to essential electrical supplies.

8.2.22.4. The status of the AGSS shall be monitored by an alarm system with a status signal to an alarm panel located in the FM Control Centre, and local manned office. The panel shall also report the alarm to the BMS.

8.2.23. Medical Air

8.2.23.1. Provision of medical air for the New Hospital Buildings would be best provided by duplicate - quadruplex medical air plant, comprising of 4 compressors, 4 dryers and 2 air receivers. It will be located within the Basement plant room area with sufficient air flow for ventilation and cooling of compressors. Each compressor sized for 50% of the design flow – providing the primary and secondary supply. This ensures an N+1 operation allowing full design flow with one compressor out of service. Emergency provision should be an automatic manifold (with cylinders) located within or close to the main building.

8.2.23.2. All supplies will conform to the European Pharmacopoeia standard for controlling air purity, all necessary filters and monitoring systems will be supplied. According to (S)HTM 02, the efficiency of plant, expressed as the volume of air delivered to the pipeline distribution system, a minimum efficiency of 5 m3/kWh at 100% and 10% is required. The power consumption at zero flow should be less than 1% of that at 100% design flow.

8.2.24. Surgical Air

8.2.24.1. The size of the development warrants dedicated duplicate surgical air supply. Surgical air will be provided by a duplex plants, located in each plant room area with sufficient air flow for ventilation and cooling of compressors. An emergency supply from an automatic reserve manifold (with cylinders) will be located in separate accommodation.

8.2.25. Manifold Installations

8.2.25.1. Other gases required throughout the hospital will be supplied by an automatic manifold installation, as in the case of N2O, with an emergency reserve supply connected. Gases used less frequently may be supplied by local cylinders at point of use.

8.2.26. Pneumatic Air Tube Delivery System

8.2.26.1. The Contractor shall provide a pneumatic air tube delivery system as required to the new Facilities to support the Clinical Requirements, as detailed in Appendix M&E7 of the Employers Requirements. The Contractor shall ensure that the pneumatic air transport system shall be designed and installed in accordance with SHTM 2009.

8.2.27. Fuel Storage

8.2.27.1. The Contractor shall provide fuel storage within steel tanks located in the Basement of the Energy Centre. One of the tanks shall be provided early for beneficial use of the Board during the construction works to allow removal of the existing vertical oil tanks. The system shall include, fill points, delivery systems pumps and controls (this facility shall be integrated with the two other tanks to provide a long term fuel management facility for the boards new and retained estate.

8.2.27.2. The following fuels shall be provided by the Contractor and stored:-

a) 35sec Gas Oil - Main Boiler Plant and retained existing estate; and

b) Diesel – Generators.

8.2.27.3. Fill points for the individual fuel types shall be provided by the Contractor at a suitable location on the external wall of the Energy Centre to facilitate automated fuelling from tankers.

8.2.27.4. Supply points shall also be provided by the Contractor for the individual fuel types at a suitable location on the external wall of the Energy Centre to facilitate automated fuel distribution to the site and for tank management.

8.2.27.5. The quantity of oil storage shall be in compliance with the requirements of Appendix M&E2 Paragraph 3.0.

8.2.27.6. All plant and equipment and installations shall be in accordance with the HTM's, SHTM's and National Health Service Model Engineering Specifications with amendments to the Model Engineering Specifications to meet the requirements of the HTM's and SHTM's.

8.2.28. Testing and Commissioning of Mechanical Services

8.2.28.1. All Buildings, Services and Equipment shall be commissioned by The Contractor to ensure that they are all compliant with the quality and performance specifications,

including manufacturer's recommendations, and that all systems operate to the Board's satisfaction.

8.2.28.2. The Contractor shall appoint an independent Commissioning Engineer to manage the Testing and Commissioning as detailed in Appendix M&E3

8.2.28.3. The Contractor shall as a minimum commission the works in accordance with the 'Guidance to Engineering Commissioning' published by The Institute of Hospital Engineers (1995).

8.2.28.4. The Contractor shall be responsible for demonstrating and certifying to the Board the successful completion of all commissioning, testing and compliance with all relevant standards.

8.2.28.5. The Contractor shall provide a comprehensive hard and soft copy sets of Operations and Maintenance Manuals together with the MiCAD as fitted drawings (hard and electronic) for all installed and commissioned Equipment. 3 number off sets of each to be provided.

8.2.29. Connection to Specialist equipment

8.2.29.1. The Contractor shall include for final connection of all specialist clinical equipment including MRI's Xray, Imaging, Theatre, CCU and general equipment as indicated in the Board's Equipment Schedules.

8.2.29.2. The main services shall be terminated within 1m of each piece of equipment with the final connection being carried out in conjunction with the equipment supplier.

8.2.29.3. Energy for all Board equipment shall be supplied from the most efficient source e.g. MTHW for dishwashers etc.

8.2.29.4. All terminations shall be in accordance with the manufacturers written recommendations.

8.2.30. Water Services Leak Detection

8.2.30.1. The Contractor shall provide leak detection to all external water mains and transfer pipework serving the satellite tanks located within the basements of the other buildings by means of pressure switches and interconnecting controls to provide an audible and visual alarm in the event of major leakage and provide alarm signals at the BMS front end within the FM Control Centre.

8.2.30.2. Leak detection shall also be provided by the Contractor at:

a) Perimeter of all ICT Server rooms;

b) Perimeter of all ICT Node rooms;

c) Plant room bunds adjacent to theatres, radiology and critical care areas; and

d) Tunnel sumps.

8.2.30.3. These shall provide an audible and visual alarm in the event of local leakage and provide alarm signals at the BMS front end within the FM Control Centre.

8.2.31. Smoke Control

8.2.31.1. The Contractor shall provide all Smoke Control and Smoke Extract systems and equipment to meet the agreed fire strategy for the hospital developments. All in accordance with (S)HTM 05-01, 05-02 & 05-03.

8.2.32. Stair pressurisation

8.2.32.1. The Contractor shall provide as required Stair Pressurisation systems and equipment to meet the agreed fire strategy for the hospital developments. All in accordance with (S)HTM 05-01, 05-02 & 05-03.

SECTION 8.3 - ELECTRICAL

8.3.1. General

8.3.1.1. The Contractor shall design, supply, install, test, commission and put into service all Electrical Building Services necessary to support the clinical activities of The Works. The following systems are indicative of those anticipated by the Board but are not exhaustive and it shall be the Contractor's sole responsibility to determine that all necessary systems (excluding Medical Equipment) are included.

8.3.1.2. Systems shall be designed, supplied, installed, tested, commissioned and put into service all in accordance with the relevant Regulations and Standards.

8.3.2. Electrical Distribution Systems

8.3.2.1. MV Systems

8.3.2.1.1 A new Primary Sub- Station shall be established within the Southern General Site, discussions have taken place with Scottish Power. The Contractor shall conclude these negotiations and include for all works associated with the Construction of the Primary Sub-Station.

8.3.2.1.2 Refer to Appendix M&E1 for Utility correspondence.

8.3.2.1.3 The new Primary Sub-station shall incorporate a composite Client/Utility Company outgoing 11kV switchboard; the switchboard shall be configured to meet Scottish Power Requirements together with metered outgoing ways to allow:

a) Two ring mains to be provided for the new Hospital system being designed by the Contractor; and

b) Two further ring mains for the Board's future configuration of the retained and future estates requirements.

8.3.2.1.4 Automatic protection shall be provided to route power through the rings to minimise downtime on all unaffected sub-stations after a cable or sub-station fault.

8.3.2.1.5 Distribution in relation to the Works is to consist of separate closed unit protected auto-switching ring mains dedicated to each hospital. Unit protection shall be by pilot cables and time graded relays.

8.3.2.1.6 A full instrumentation and protection system with multi-function meters, over-current and earth fault protection to the primary ring mains shall be provided complete with remote monitoring via the BMS and FM Control Centre.

8.3.2.1.7 Refer to drawing G1274E(60)01 for indicative schematic.

8.3.2.1.8 The new Primary Sub-Station shall be delivered to allow power to be made available in line with the Laboratory Practical Completion date. Refer to Volume 2.2 documentation for details of fall back scenario if this cannot be accommodated.

8.3.2.2. LV Systems

8.3.2.2.1 All wiring systems shall be of a form defined within BS 7671:2008 (IEE Wiring Regulations 17th Edition).

8.3.2.2.2 Main LV switchgear shall comprise metal cubicle pattern switchgear enclosures containing Air Circuit Breakers (ACB) and Moulded Case Circuit Breakers (MCCB) with electronic protection selected to allow short circuit, over-current and time grading for full co-ordination and discrimination.

8.3.2.2.3 Each LV section shall be fitted with automatic power factor correction to correct the local power factor to no less than 0.95, the correction equipment shall be located closed to the corrected load, with hard wired automatic drop out facility during generator run and reset on return to mains.

8.3.2.2.4 All ACB's and main distribution ACCB's shall be fitted with monitoring units to capture and relay switchgear status, energy consumption. harmonic content, operation counter and fault indication via the Central Power Monitoring System

8.3.2.2.5 The Central Power Monitoring System work-station shall be located within the main FM control room with a second work-station located in the Estates Office.

8.3.2.2.6 The Central Power Monitoring System shall provide hierarchical maps indicating active mimic of the complete power and stand-by power distribution systems.

8.3.2.2.7 Each Main Switchboard shall be fitted with a touch screen PC to provide access to the maps and interactive mimic screens.

8.3.2.2.8 A hard copy cellular wall mounted MV Mimic Diagram shall be provided by the Contractor in the Estates Office to allow system status to be recorded manually.

8.3.2.2.9 All main LV switchboards shall be constructed to Form 4 Type 6.

8.3.2.2.10 Sub distribution and final distribution boards shall be constructed to:

a) Form 4 Type 2 for Clinical Risk Categories 1 & 2; and

b) Form 4 Type 6 for Clinical Risk Categories 3, 4 & 5

8.3.2.2.11 Risk Categories determined as (S)HTM 06-01

8.3.2.2.12 For the Works, most of the areas fall into Clinical Risk Categories 3, 4 & 5. Robust electrical supplies shall be provided to serve:

a) General lighting;

b) Standby lighting;

c) General power;

d) Medical power;

e) Medical IPS power;

f) Mechanical services plant (ventilation, medical gases, water, chilled water etc); and

g) ICT Power

8.3.2.2.13 The tower of the Adult Acute hospital contains general ward areas. For the avoidance of doubt the Board require Building Services for the Wards appropriate to Clinical Risk Category 3.

8.3.2.2.14 Due to the adjacencies, dual transformers and switch panels shall be provided to form part of the dual-unified supply philosophy employed in the distribution design. Like the MV distribution, the LV distribution shall be divided into Side A and Side B circuits. Side A and Side B Main LV switch panels adjacent to transformer substations and separate compartments will be linked together via an automatic `*bus-coupler-bus-tie'* cable way and two ACB's.

8.3.2.2.15 A robust arrangement, shall be provided to ensure that a fault or problem on the Side A switch panel does not affect the Side B panel and vice versa.

8.3.2.2.16 The Contractor shall integrate the distributed transformers, main and secondary low voltage switch rooms within the development to suit the final layout while minimising cable losses and providing simple maintenance / replacement access.

8.3.2.2.17 All plant rooms are to be in accordance with (S)HTM 2023 and (S)HTM-06-01 and the contractor shall provide a detailed Plant Replacement Strategy.

8.3.2.2.18 Distribution of LV power within the tower will be by three-phase bus-bar ducting with full size phase, neutral and earth conductors. Multiple tap off units shall be provided at each floor to serve distribution boards for lighting and power together with 25% spare capacity.

8.3.2.2.19 Each tap off unit shall contain a circuit breaker to provide full electronic time graded fault protection. The energy monitoring strategy may incorporate meters within the tap off units however where split distribution boards are proposed multiple meters shall be incorporated in the split distribution boards. All meters shall be linked back to the central system to allow remote load monitoring and energy management.

8.3.2.2.20 Each rising bus-bar pair shall serve each of the 'wings' of the tower. In accordance with the dual-unified distribution, each bus-bar pair shall comprise separate Side A and Side B bus-bars rising through the building in separate risers.

8.3.2.2.21 The final solution shall provide full system resilience and allow the distribution equipment to be maintained with the minimum of disruption to services at ward and departmental level.

8.3.2.2.22 Final circuit distribution boards shall be Type A or B with miniature circuit breaker (MCB) and (RCBO's) boards to BS EN 60439-3 located within risers or dedicated cupboards. All distribution boards are to be lockable with a suited key system with sheet metal doors to prevent unauthorised access. All boards shall be provided with ASTA certified bus-bars (rated to suit the local prospective fault current) neutral and earth terminals for each single phase way, clean earth facilities, extension spreader boxes for incoming cables separate CPC's, RCBO connections and flexible split metering facilities.

8.3.2.2.23 Distribution boards with plastic enclosures must not be used.

8.3.2.2.24 Power for all Mechanical, Public Health and Specialist systems shall be provided with resilience and redundancy to allow maintenance to be carried out on specific plant and distribution paths without the requirement to take other plant out of service.

8.3.2.2.25 All power circuits to be sized in accordance with BS7671.

8.3.2.2.26 Switchgear, Control panels etc, shall be securely located in plant areas and distribution cupboards not able to be accessed by public, patients or non FM staff.

8.3.2.3. Cables and Containment

8.3.2.3.1 Primary LV sub-main distribution is to be by bus-ducts, bus-bars and multi-core XLPE/SWA/LSF (low smoke & fume) cables to BS6724 carried on ladder rack (larger cables) and/or cable tray/basket (smaller cables). Primary LV cabling and containment is to be concealed within dedicated risers, cable trenches and risers throughout the building.

8.3.2.3.2 Side A and Side B cables and containment will be segregated and run by different routes to the final outlet as far as practicable, this requires Side A and Side B final circuit cabling to be run in separate containment up to bed head trunking units.

8.3.3. Lighting and Power

8.3.3.1. Interior Lighting

8.3.3.1.1 The lighting design must be functional for clinical use in accordance with the CIBSE and Society of Light and Lighting guides together with relevant SHTM's, SHBN's etc., the Contractor shall also ensure that the overall lighting concept is co-ordinated with the building structure and the project aesthetic requirements. Particular attention is required within entrance, circulation and non clinical areas where a mixture of LED's, conventional low energy fittings and retail lighting techniques shall be utilised to enhance the internal and external building experience in line with the architectural intent.

8.3.3.1.2 Where high efficient fluorescent lamps are not appropriate e.g. for aesthetics, signage and lighting of art works etc, the use of high output LED units and compact discharge sources shall be selected in lieu of tungsten lamps.

8.3.3.1.3 The Contractor shall provide and install high efficiency luminaires, utilising high frequency electronic control gear to provide occupiers with improved visual comfort while reducing noise levels and running costs.

8.3.3.1.4 Where VDU's are being used, the Contractor shall ensure that the lighting scheme complies with "CIBSE Lighting Guide LG3 and LG7.

8.3.3.1.5 The Contractor shall ensure that corridor lighting is multi circuited to facilitate use of 100% or 50% of the luminaires. Where the corridor is over 15 metres in length interlaced zoned lighting shall be provided. This resilient strategy must be imposed on the lighting control system design to ensure that lighting in each area is partially retained in use during maintenance of the alternate area distribution board and alternate section of the lighting control system.

8.3.3.1.6 Night lighting shall be provided within all corridors either by individual fittings or by selective switching of the general corridor wall/ceiling luminaires. The Contractor shall ensure night lighting in corridors shall not spill into patient bedrooms, or other bedded areas. Night lighting shall be provided at nurse stations, patient bed areas and locations where call systems are installed.

8.3.3.1.7 Ward night lighting override control to be fitted at nurse stations.

8.3.3.1.8 Luminaires shall be located to provide ready access for lamp changing and maintenance, whilst still providing the recommended level and quality of illumination to the area.

8.3.3.1.9 All signage is to be illuminated to ensure ease of legibility without causing glare.

8.3.3.1.10 Where sealed fittings are required e.g. in treatment rooms, isolation suites, theatres etc. the diffusers shall be composite type with easy clean flat surfaces with the optics incorporated within a stable sandwich construction.

8.3.3.1.11 Treatment Room luminaires which provide the general lighting shall be controlled by at least two circuits depending on the arrangement of fluorescent tubes in each fitting. The design of these luminaires must provide ease of access for lamp changing.

8.3.3.1.12 In ward areas the lighting shall be integrated with the bedhead services solution with combination wall mounted dimmer controlled fittings providing patient rest, watch light, reading light and examination facilities.

8.3.3.1.13 Where bed areas are used for intervention and treatment an overhead lighting scheme supplemented by bedhead units providing patient rest, watch light, reading light and examination facilities shall be provided.

8.3.3.1.14 Light fittings shall not be mounted immediately above patient positions.

8.3.3.1.15 All fluorescent lamps used in clinical areas shall have as a minimum a colour rendering capability of ≥ 85 CRI. For practical reasons consideration should be given by the Contractor to using the same luminaire in both Clinical and Non-Clinical spaces within the same ward. A reading light with an on/off switch shall be provided at each bedhead location and at the door. The Contractor shall provide an additional switch on the nurse call handset.

8.3.3.1.16 Where luminaires of the fully recessed type (modular and / or downlighter) are installed within fire rated ceilings, they should be provided with a one hour rated fire canopy. The Contractor shall also ensure that they maintain the integrity of the ceiling and that the canopies are tested to “BS 476 Parts 20 and 23, clause 5. The Contractor shall also ensure that all canopies meet the requirements of “Class O materials”.

8.3.3.1.17 Hazardous areas shall be provided by the Contractor with the appropriate classified luminaries.

8.3.3.1.18 Luminaires with prismatic diffusers installed on fire escape routes shall be fitted with flame retardant diffusers to TP (a) classification, minimum Class 3 surface spread of flame.

8.3.3.1.19 Each high dependency and recovery bed position shall have a wall or bed-head trunking mounted, examination lamp with integral switch.

8.3.3.1.20 Sealed food factory type luminaires shall be provided by the Contractor in areas in which food is prepared, cooked and stored.

8.3.3.1.21 Accessible plant areas, roof void areas, ducts, lift motor rooms, shafts and similar utility areas shall be illuminated utilising suitably IP rated luminaires.

8.3.3.1.22 Over-mirror lights shall be provided by the Contractor in all en-suites, shower rooms bathrooms and in all Male and Female changing rooms.

8.3.3.1.23 Lighting in toilets accessible to the public shall be fitted with blue light effect to minimise unsocial activities.

8.3.3.1.24 Laser and x-ray warning lights shall be provided by the Contractor outside theatres, major treatment rooms and x-ray rooms interfaced with the laser / x-ray machines.

8.3.3.1.25 Lighting levels to be in accordance with CIBSE guides and SHPN's. Theatre Pendants and lights to be selected by Board. Contractor to allow for all services.

8.3.3.2. Lighting Control & Wiring

8.3.3.2.1 The Contractor shall provide automatic control of lighting using natural light level sensing and the BMS scheduling capability for unoccupied periods (with movement sensing override for safety) primarily in circulation areas and large open workspaces.

8.3.3.2.2 In plant rooms additional controls interfaced with the access control system shall be provided at main plant room entrances to override the automatic off signals, allowing staff to carry out inspection and maintenance outwith the normal reach of the presence detection system.

8.3.3.2.3 The Contractor shall ensure that the lighting design incorporates a flexible switching arrangement to allow for varying activities within each room and for cleaning purposes. Switches for all public areas should be positioned by the Contractor so that unauthorised persons cannot switch the lighting.

8.3.3.2.4 Lighting within all WC's, Staff WC's and changing rooms shall be controlled via passive infrared sensors/movement detectors or similar, with adjustable time control facilities.

8.3.3.2.5 Lighting within clinical areas shall incorporate manual override controls

8.3.3.2.6 The Contractor shall arrange the circuiting of luminaires to control groups of fittings in order to provide flexibility of switching arrangements. Such a facility is particularly

important in large spaces where the level of daylight is not uniform and artificial lighting is likely to be needed for long period in areas remote from windows.

8.3.3.2.7 The Contractor shall provide the luminaire isolation requirements of SHPN57 e.g. all luminaires to be provided with means of safe isolation to prevent isolation of adjacent fittings for replacement.

8.3.3.2.8 The Contractor shall provide alternative circuits together with two-way or intermediate switching at all section doors and corridor direction changes for lighting in corridors and circulation areas.

8.3.3.2.9 Where multi-gang lighting control switches are required the Contractor shall provide a label fixed to the grid under the switch plate, indicating the switches are fed from different supplies.

8.3.3.2.10 The Contractor shall provide the Lighting requirements of SHPN57 e.g. all lighting in Critical Care Areas shall be dimmable with local controls. (This is in addition to the general requirement for dimmable lighting which shall be provided throughout for the purpose of energy control and commissioning setting).

8.3.3.2.11 All small power accessories and Isolation devices shall be engraved with the accessory function.

8.3.3.2.12 Circuit designation labels shall be provided at all electrical accessories.

8.3.3.2.13 All power cables shall be provided with circuit references adjacent to terminations, the references shall be co-ordinated with the MiCAD As Fitted drawings and asset register tags.

8.3.3.3. Emergency Lighting

8.3.3.3.1 The Contractor shall connect the emergency lighting to addressable self-monitoring control panels with each luminaire containing an interface unit that shall be monitored and controlled by the control panel which shall report to the BMS system. The Contractor shall demonstrate that the emergency luminaires are automatically tested in accordance with the requirements of the British Standards.

8.3.3.3.2 Local circuit monitoring shall be provided to protect all areas.

8.3.3.3.3 The emergency luminaires may be of either the maintained or non-maintained variety. The Contractor shall ensure that they are powered by a suitable battery supply connected by an auto-changeover switch or utilise self-contained battery packs within luminaires (3-hour rated). The Contractor shall ensure that the emergency luminaires will be automatically energised in the event of a failure to the local lighting circuit.

8.3.3.3.4 The Emergency Lighting shall comply with BS5266 and (S)HTM2011.

Standby Lighting

8.3.3.4.1 The Contractor shall provide 100% standby lighting via the site generation system to enable normal activities to continue during the loss of a normal mains supply.

8.3.3.4.2 The Contractor shall ensure that the quality of standby lighting is equal to that of the normal lighting at the task points.

8.3.3.5. Wiring

8.3.3.5.1 Wiring will be generally be carried out using LSF insulated single cables run in concealed steel conduit and trunking. Connections to all suspended ceiling mounted fluorescent luminaires and non modular lights shall be made via a plug & socket/ lighting control module arrangement and a reasonable length of flexible heat resisting sheathed cable. Flexible cables shall not be trailed across the top of ceiling grids.

8.3.3.5.2 Modular wiring systems may be considered for lighting in non clinical areas, however if these are put forward the components must be sturdy, proven in use with long lifespan.

8.3.3.5.3 Loop In system in metal conduit to be utilised for wiring in areas with fixed ceilings.

8.3.3.6 Small Power

8.3.3.6.1 Where required small power circuits shall be provided in accordance with the MEIGaN.

8.3.3.6.2 Where required small power circuits shall be provided from Insulated Power Supplies.

8.3.3.6.3 Where required small power circuits shall be provided from Uninterruptible Power Supplies (UPS).Final circuits shall be interlaced fed from either side of the dual power distribution systems.

8.3.3.6.4 All clinical circuits shall be wired in metal conduit and containment.

8.3.3.6.5 Power shall be provided at docking stations for recharge of robotic units.

8.3.3.6.6 The Contractor shall provide the small power requirements of SHPN57 e.g. via ceiling mounted medical supply units rather than wall mounted outlets in Critical Care Areas.

8.3.3.6.7 The Contractor shall provide the power requirements of SHPN28 e.g. All Theatres shall be provided with two articulated pendants

8.3.3.7 External Lighting

8.3.3.7.1 The perimeter, including all entrance canopies and pedestrian walkways, to all buildings shall be lit by the use of energy efficient luminaires mounted in canopies, on walls, columns and/or bollards. All on-site access roads, service yards and areas, footpaths and cycle ways shall be lit to levels compatible with the GCC Highway standards. The lighting shall satisfy the requirements of BS 5489. Lighting shall be provided by the Contractor to all direction signs around the Site where these are not adequately illuminated by external lighting.

8.3.3.7.2 The system shall also provide a welcoming atmosphere to the main entrances.

8.3.3.7.3 All access routes to plant areas shall be lit to provide safe access for maintenance.

8.3.3.7.4 All wall mounted luminaries shall be fed by back entry. Cable runs on the outside of buildings shall not be permitted.

8.3.3.7.5 All external columns, bollards etc. shall be provided with fused cut-outs and adequate termination facilities for cabling.

8.3.3.7.6 When selecting luminaires, the Contractor shall give consideration to light pollution, vandalism, security, energy efficiency and local residents. The Contractor shall ensure that the installed scheme meets the requirements of the Civil Airport Authority (CAA).

8.3.3.7.7 The Contractor shall provide warning lighting on the main building and flue in accordance with the CAA requirements.

8.3.3.7.8 The Contractor shall provide helipad lighting in accordance with the CAA requirements and the Hospital Guides.

8.3.3.7.9 The BMS shall control external lighting to minimise energy consumption, by photocell or movement sensor, the lamp type selected must be sympathetic to frequency of switching dictated by the control means.

8.3.3.7.10 The Contractor shall utilise solar powered lighting where this can be shown to be effective on the site over a reasonable time period; these shall be supplemented by conventional luminaires when the output is not available.

8.3.3.7.11 The Contractor shall wire luminaires on multiple circuits to avoid loss of light to whole areas in the event of a maintenance and mains/circuit failure.

8.3.3.7.12 External lighting installations shall be designed to provide safe lighting levels in accordance with CIBSE guides and “Secure by Design” requirements.

8.3.3.7.13 Back-up floodlighting shall be provided from FM building into yard and buildings onto entrances pathways and roads should the ‘Contractors Street Lighting’ fail.

8.3.4 Fire Alarm and Detection Systems

8.3.4.1 The Contractor shall ensure that the fully addressable automatic fire detection system integrated within the BMS for The Works is fully compliant with the performance criteria laid down under (S)HTM05 and BS 5839. Refer to Fire Strategy Volume 2.1 Paragraph 5.11.

8.3.4.2 The systems are to be designed to BS 5839 category L1 and are generally to be analogue addressable with aspirated detection provided in areas including Theatres, X-ray, MRI, and ICT rooms and all other 'specialist suites'.

8.3.4.3 All aspirating air sampling units shall be located away from public areas, either in service cupboards or accessible services risers. All circulation doors shall be installed with integrated electro magnetic door hold open devices with all security door locks interlocked for evacuation in a zoned fire condition. The locks and hold open devices must not reduce the rated fire integrity of the doors.

8.3.4.4 The aspirated systems shall be capable of providing identification of alarms or faults within individual sampling pipes.

8.3.4.5 The system design shall be integrated with the requirements of the clinical requirements.

8.3.4.6 A Fire Control Station shall be set up within the new FM Building providing command and control for the life safety systems including PC Graphics for:

a) Fire Alarm Detection and annunciation;

b) Sprinklers (monitoring);

c) Smoke dampers (monitoring and control);

d) Fire fighting systems (monitoring and control);

e) Stair pressurisation (monitoring and control);

f) Helipad systems (monitoring);

g) Cold smoke extract (monitoring and control); and

h) All systems provided in accordance with the agreed fire strategy.

8.3.4.7 The Contractor shall liaise closely with the following;

a) Board's Fire Officer;

b) Glasgow City Council; and

c) Strathclyde Fire Brigade

and ensure that an agreed fire alarm cause and effect matrix is provided by the Contractor prior to detailed design to ensure that the systems support the overall fire strategy.

8.3.4.8 Control panels are to be provided in the Control Room and at the main entrances (or at the entrances to which the fire service are to attend, if different), with additional indicator panels provided throughout the building to allow staff to respond in accordance with local evacuation procedures, and to guide the fire service to the source of the alarm.

8.3.4.9 The control panels shall be fully networked with resilient connections to the site based PC font end with map facilities and remote graphics monitoring in Hillington via a dedicated link.

8.3.4.10 The system shall be equipped with sufficient sounders to maintain sound outputs in different areas in accordance with (S)HTM 05, and incorporate visual strobe indicators for a fire condition in accordance with the requirements of the Disability Discrimination Act.

8.3.4.11 The Contractor shall ensure that The Works are divided into zones by ward / department / unit area as well as by floors with mimic or repeater panels at each nurse station (or equivalent) and at least one panel per floor located in a central circulation area. In the event of fire The Works shall be capable of individual zone evacuation with all other zones receiving awareness signalling.

8.3.4.12 The Contractor shall ensure that all fire alarm panels are capable of giving details of system status for fire, fault, and alarm conditions including full text descriptions of location at all nodes and staff base positions.

8.3.4.13 All panels shall be capable of data / event logging and report generation.

8.3.4.14 Manual call points must be provided at every exit and staircase with no point in the building being more than 30m travel from a call device.

8.3.4.15 Fire Alarm Evacuation facilities shall be provided at each main node, these shall require a double action e.g. break frangible lid and then break glass unit.

8.3.4.16 Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic fire detection systems and shall be manufacturer's latest standard design that complies with the relevant Standards and Regulations.

8.3.4.17 The Contractor shall ensure, and provide necessary documentation to confirm that this system will have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing systems to current level of technology, and extend new field panels on a previously installed network.

8.3.4.18 The Contractor shall take into account the need for maintaining patient security during alarm testing i.e. the testing regime shall not allow for ordinarily secure doors to open as a result of routine testing.

8.3.4.19 The Contractor to provide fire suppression systems in line with the proposed fire strategy, which shall include provision of gaseous systems in ICT rooms and Electrical Sub-stations together with the special requirements for the Helipad.

8.3.4.20 The Contractor shall provide fire hydrants to meet the Glasgow Council's Building Control Department and Strathclyde Fire Brigade requirements.

8.3.4.21 Progressive horizontal evacuation in patient areas is to be facilitated by each fire resisting sub-compartment being on a separate alarm zone, and by the use of two stage (evacuate/ alert) alarms. To avoid unnecessary disturbance, staff elsewhere in the building who are required to perform particular tasks in the event of a fire are to be automatically alerted by pagers or electronic communications devices to avoid the sounding of the fire alarm.

8.3.4.22 In areas where patients can escape unaided and in non-patient areas the audibility of the fire alarm should be in accordance with BS 5839. However, in other areas an audible alarm may be unacceptable and the use of visual devices is to be provided in areas such as very high dependency patient areas, these include operating theatres, ITU, audiology, plant areas, service yards, imaging and areas with high ambient noise etc.

8.3.4.23 The fire alarm signal is to be transmitted automatically to an alarm receiving centre via a monitored line to supplement the control room operation.

8.3.4.24 The fire alarm system is to contain links to all necessary ancillary services such as;

a) Automatic Door Releases;

b) Door Control Systems;

c) Access Control Systems;

d) Ventilation Systems;

e) Lifts etc; and

f) Robotics

8.3.4.25 All wiring to be MICC with red LSF sheath.

8.3.5 Telephone Distribution Systems

8.3.5.1 The Hospital requires efficient, high quality telecommunications service provided to both its internal and external customers on a 24-hour basis. The Contractor will provide a robust resilient high quality cabling infrastructure, with appropriately selected switches provided by the Hospital.

8.3.5.2 Cable links with existing Telephone equipment throughout the site will be required, with all necessary underground ducts together with copper and blown fibre provided by the Contractor.

8.3.5.3 Mobility will be covered with wireless handsets on the IP network.

8.3.5.4 Analogue line facility to be provided for faxes rather than VoIP.

8.3.5.5 10% fall back lines to be provided by the Contractor throughout the works, present technology is for PABX and analogue phones. (PABX by the Hospital, This may be simplified by technology improvement but allow analogue distribution in the meantime).

8.3.5.6 The Contractor shall supply onsite paging facilities for the works to meet the standards provided by the current service provider Multitone Electronics plc, Unit 33 Geddes House, Kirkton North, Livingston, West Lothian, EH54 6GU. Space to be allocated in node rooms for Multitone paging equipment.

8.3.5.7 New Aerial/s to be provided to ensure full coverage throughout the works.

8.3.5.8 Emergency Voice patching to be colour co-ordinated (grey).

8.3.5.9 Field cabling racks and cabling to be set up for Power over Ethernet to minimise requirement for power plugs at feature phones.

8.3.5.10 Payphones will be provided under the current managed service Premier Telesolutions, 10 Alexandra Way, Ashchurch Business Centre, Tewksbury, Gloucestershire, GL20 8NB. The contractor shall provide telephone outlets and power at required areas and the managed payphone company shall provide the hardware and service. Space to be provided for node cabinet etc.

8.3.5.11 A separate Comms room and Office shall be provided for the patient telephone lease company to accommodate their switch and billing units,

8.3.5.12 The Contractor shall include for Analogue lines to be provided for all remotely monitored systems including: Cardiac, Fire, Lifts, VIE, BMS, etc. and for all systems provided by the Contractor.

8.3.5.13 Lift cars to have two comms connections, one for remote monitoring of performance and one for interlinking to the Hillington Control Centre.

8.3.5.14 GEMS to be provided with dedicated incoming lines for their network and telephone switch equipment.

8.3.5.15 Contractor to include 6 ducts from each main server room to the main hospital boundary for Voice/Data Use to suit the agreed communications vendors.

8.3.5.16 Contractor to include 2 ducts from each main server room to the Laboratories.

8.3.5.17 Contractor to include 2 ducts from each main server room to the Estates Department.

8.3.6 Information Technology (IT) Equipment and Distribution Systems

8.3.6.1 Overall Requirements.

8.3.6.1.1 The Board recognises the importance of information and communication in all aspects of its work; improved communication enables improved efficiency.

8.3.6.1.2 The continued development of technologies provides an increased potential to simplify systems and reduce duplication allowing the Board a more complex management system of greater value to users and the Board itself.

8.3.6.1.3 This specification is intended to co-ordinate the various aspects of communication systems within the Board's operations. The specification does not describe all individual systems and their operation in great detail, but identifies the various communication systems, the Board's current strategies for their development and maintenance, the obligations placed on the Contractor.

8.3.6.2 The Contractor shall design, construct and put into service a comprehensive and robust infrastructure (e.g. containment, cabling, power, A/C, Racks, raised floors, floor grills, comms rooms and server rooms) for The Works in accordance with the requirements of the Board's Requirements.

8.3.6.3 The infrastructure shall be commissioned, labelled and documented prior to handover to the Board.

The Board will install hardware (e.g. servers, comms hardware, PCs, printers, scanners), make the final connections (at the application and in computer rooms) and commission the operational system.

8.3.6.4 The Contractor shall provide only those systems that are fully compatible with the Board's operational Information Technology systems.

8.3.6.5 The Works will be served by an N+1 server room distribution. These shall be provided internally within the new development. The server rooms should have dedicated air conditioning, fire suppression, generator back up with diverse routed power and redundant UPS systems to maintain resilience in the IT network.

8.3.6.6 The 2 main comms rooms will house servers for local distribution whilst providing diverse links with existing comms rooms throughout the Hospital estate and further a field. The Contractor shall design each room to accommodate 6 comms racks, 10 server racks and 10 equipment racks, sufficient racks for the Contractors field cabling together with sufficient racks for the Contractors BMS, CCTV, and Entertainment equipment etc. together with space provision for access round racks and work bench laptop space. All racks to be provided by the Contractor, racks are to be lockable with a suited key system for Voice, Data, combined Voice and Data, CCTV, BMS etc.

8.3.6.7 Within these principal ICT rooms, telephony servers will be provided by the hospital.

8.3.6.8 As above multiple racks shall be provided by the Contractor allowing sufficient space for network expansion. Racks shall be 42U, 800mm x 1000mm (space for 1200mm) suitable for high velocity through ventilation based on hot/cold isle philosophy.

8.3.6.9 Data risers shall be established to interlink the main server and hub rooms, the risers shall be of sufficient size to accommodate 25% network expansion and modification.

8.3.6.10 The Contractor shall provide the requisite number of hubs to suit their proposed building layout to ensure compliance with the cable length restrictions. Hubs shall be sized to accommodate all of the Contractors Equipment together with a 42U rack dedicated for the Board's use.

8.3.6.11 It is envisaged that the Board will be using voice over IP for telephony.

8.3.6.12 It is envisaged that the Board will be using wireless technology (RFID) for public, staff data, patient monitoring, equipment tracking and automated transfer system connections, access points shall be provided by the Contractor throughout the facility to meet these onerous demands. The access points shall be located to meet the various system demands throughout all areas of the works. The Contractor shall provide a robust system with area coverage overlap and resilient interconnection to the network suitable for supporting the full RFID requirements.

8.3.6.13 The Contractor shall ensure that the lighting in all ICT rooms is sufficient to allow for safe working on plant and equipment. No water, steam or waste services shall be located either in or directly above the ICT room due to risk of water damage.

8.3.6.14 Infrastructure provided by the Contractor shall be fully compliant with the requirements of the NHSIA N3 project.

8.3.6.15 The Infrastructure shall provide the Connectivity requirements of SHPN57 e.g. Wide bandwidth service etc.

8.3.6.16 The Infrastructure shall provide the Connectivity requirements of SHPN28 e.g. all theatres to be provided with cabling to theatre lights to allow for camera connection to seminar room and general telemedicine system, refer to section 8.1.34 for Telemedicine details.

8.3.7 ICT Workshop

8.3.7.1 The ICT staff workshop shall be provided adjacent to each server room; the workshop shall have suitable environment and services to allow equipment to be tested.

8.3.8 Wireless Networks

8.3.8.1 The Contractor shall provide a secure wireless network which supports the Board's requirements as set out below:

8.3.9 External Services (WAN)

8.3.9.1 As noted above multiple ducts shall be provided by the Contractor from the network vendors external access points (ducts) to each of the Server rooms. These shall be of a size suitable for external grade fibre cable(s), and copper multi-core cable(s).Further ducts will be required providing links to existing building within the estate. The Contractor shall ensure that the Board is granted free access to these ducts at all times so that it may access communications services from any third party it wishes to nominate.

8.3.10 Cabling

8.3.10.1 Cabling systems shall be installed to the highest ratified specification for IT wiring systems as defined in EN50173 and EN 50173 or equivalent standard.

8.3.10.2 All Fibres are to be single mode blown type, mesh star configuration with minimum of 20 pairs backbone.

8.3.10.3 The Contractor shall demonstrate that the proposed copper structured cable is suitable for the latest available known technology at the time of tender and be as a minimum CAT6 Augmented.

8.3.10.4 The jacket construction of the cable must be suitable for the application and details must be provided in the tender. The installation shall also cater for two outlets at every workstation being able to support a VoIP installation in line with the agreed schedules.

8.3.10.5 All voice cabling installed shall allow for an agreed spare capacity over and above the spare requirements stated in the general section.

8.3.10.6 Cables, which pass through the infrastructure of the buildings, shall be suitably protected against damage. Through walls and floors this shall involve an appropriate type of sleeve, through any form of metalwork or stiff plastic then a rubber grommet shall be used.

8.3.11 Data Patch Panels

8.3.11.1 The Contractor shall take cognisance of the ICT requirements and provide patch panels to meet the outlet requirements. 100% patch leads shall be provided with colours and lengths to be confirmed.

8.3.12 Data Outlets

8.3.12.1 The data and voice outlets will be RJ45, CAT6 augmented type with angled connector.

8.3.13 Public Address Systems

8.3.13.1 The Contractor shall provide a public address system to allow zoned emergency messaging throughout the hospitals, Lifts, Building links, tunnels, FM and Energy Centre together with external mustering areas, supplemented by local background music and zoned PA to allow entrances, receptions, atria, changing rooms and waiting areas to operate in line with the Clinical Requirements.

8.3.13.2 The emergency messaging shall be controlled from two locations and the system shall incorporate pre-recorded coded messages.

8.3.14 Staff Location System

8.3.14.1 Pagers to be integrated in the BMS and Telephone Systems to suit the Board Requirements.

8.3.15 Patients/Nurse Call Systems/Personal Attack Alarm

8.3.15.1 Nurse Call Systems

8.3.15.1.1 The Contractor shall provide a comprehensive Nurse Call System integrated within the BMS networking systems at all bed locations (and en-suites), Nurse Stations, Toilets and Showers, TV Rooms and all other areas frequented by patients. The system must be capable of emitting both audible and visual warnings for the following situations:

a) To summon a nurse (Patient to Nurse); and

b) To highlight a medical emergency (Nurse to Nurse).

8.3.15.1.2 The installation shall have the following functionality;

Ensure that both visual and audible warnings are sited in positions that enable the appropriate staff to respond to the exact location of the call both efficiently and effectively.

Ensure that the warnings, both visible and audible, should be specific to the type of emergency and must be consistent throughout all areas of The Works.

Provide systems that comply fully with the requirements of relevant S/HTMs and S/HBNs. In addition these systems shall enable on-screen alerts at locations to be agreed with the Board.

Ensure that the nurse call button / cord meet the need of the particular patient that may be required to use The Works. Patients may have cognitive problems or have difficulties with mobility.

8.3.15.1.3 A nurse call system is to be part of every bed head service. A patient hand unit with a call button is to link to an indicator panel at the Ward Nurses Station. The system is also to link to call buttons in other areas such as WC's, Bathrooms and Quiet rooms. The system shall include the following facilities:

a) Ensuite protection;

b) Over-door indicator lights;

c) Ability to link calls between adjacent wards; and

d) Cardiac arrest or 'crash' call alarms taken back to a 24 hour manned point to allow the 'crash' team to be paged

8.3.15.1.4 The Contractor shall provide a flexible system which annunciates within the nurse station with route indicators to the activated unit. Each bed system shall be transferable to adjacent and remote nurse stations via a hierarchical password control system to meet the Nursing requirements of the flexible ward configurations.

8.3.15.1.5 The system configuration shall be interlinked with the central PC based bed management system.

8.3.16 Clinical Equipment Alarms

8.3.16.1 Each clinical drug cupboard shall be alarmed as follows;

a) Light externally over door to room

b) Back to Nurses station

c) Back to local office to warn of unauthorised access.

8.3.16.2 The Contractor shall provide a system by which clinical Equipment alarms can be annunciated at a designated location during working hours but out of hours alarms can be directed to a designated member of staff, off-site. The Contractor shall determine all Equipment alarms of this nature.

8.3.17 Call Systems

8.3.17.1 The call systems or speech transfer systems shall be provided by the Contractor where normal speech is impaired by the use of glass security partitions or similar barriers. These shall generally be at public entrances and secure receptions these should contain staff control unit, speakers and microphones.

8.3.18 Induction Loops

8.3.18.1 The design of The Works shall include a comprehensive system of induction loops (fixed or portable) with suitably located dedicated sockets and signage such as to;

a) Reception areas;

b) Bedded bays;

c) Single Rooms;

d) Treatment Rooms;

e) Consulting Rooms;

f) Counselling Rooms; and

g) Interview Rooms.

8.3.18.2 Additionally, the design shall reflect these requirements in areas such as offices where staff may require this facility.

8.3.18.3 The Contractor shall provide induction loop or infrared systems in accordance with DDA requirements. The final provision and locations are to be agreed with the Board, dependent upon the final design solutions.

8.3.18.4 Portable hand held systems for use by visitors shall be made available at Reception. This shall ensure that the parts of The Works not provided with Induction Loops or infrared systems are made accessible to all users.

8.3.18.5 The “ear” symbol denoting the presence of an induction loop shall be prominently displayed. A sign shall explain clearly to people using hearing aids how they can benefit from the Induction Loop.

8.3.18.6 Alternative, proven systems that do not raise issues of patient confidentiality can be proposed by the Contractor to provide facilities wide coverage as appropriate.

8.3.18.7 The Induction Loop system shall be interlinked with the speech transfer system in order to provide a neat and unobtrusive configuration and an aesthetically discreet installation.

8.3.19 Television Installation

8.3.19.1 The contractor shall negotiate with a patient entertainment system supplier and provide the required backbone broadband cabling and wire ways and control room facilities for a leased patient entertainment system, to be installed at all bed heads in the Adult Hospital. Bed Head systems to provide:-

a) Television;

b) Radio;

c) Telephone; and

d) Game and internet services (optional at point of use)

Together with the associated infrastructure to allow these to be charged on a pre-payment basis.

8.3.19.2 Within areas were a conventional bedside screen is not suitable, the Contractor shall provide an alternative solution for location of the screen.

8.3.19.3 The Contractor shall provide a fully operational patient entertainment systems in the Children's Hospital to provide:-

a) Television;

b) Radio;

c) Interactive games;

d) Music;

e) Art; and

Protected Internet services.

8.3.19.4 In addition to facilities at each bed head, in the Children's Hospital, entertainment systems consisting of TV, DVD and games systems will be provided in the main waiting and play areas. These will require a central TV and radio reception and distribution system provided by the Contractor.

8.3.20 TV & Radio Facilities

8.3.20.1 The Contractor shall provide the infrastructure for reception and distribution of television and radio for use by patients, visitors and staff. This shall include external aerials / dishes, containment and cabling / distribution to enable radio (inc local hospital radio), and both digital satellite / terrestrial TV services to be distributed throughout The Works.

8.3.21 Lightning Protection & Earthing

8.3.21.1 The Contractor shall provide a lightning protection system for the protection of the structure, the contents and occupants. The lightning protection installation shall be in accordance with BSEN62305. The lightning protection system shall comprise of air termination network, down conductors, earth termination network, type 1 and type 2 surge arrestors and all required equi-potential bonds.

8.3.21.2 Surface fixed down conductors are not acceptable.

8.3.21.3 The Contractor shall provide a system of earthing comprising earth electrode systems, main and supplementary earth bars, main and supplementary equi-potential bonding, to ensure sufficient and fast operation of protective systems in the case of earth faults.

8.3.21.4 The earthing system shall comply with (S)HTM 06-01, BS7430, and BS7671 and with the Electricity at Work Regulations.

8.3.22 CCTV/Security Systems

8.3.22.1 General

8.3.22.1.1 The systems shall be closely integrated with the BMS to provide an integrated central monitoring and management facility. The Contractor shall provide security systems specifically designed to meet the requirements of each department / unit.

8.3.22.1.2 The systems shall present a secure and reassuring environment for staff, patients and visitors by providing appropriate security measures within the particular restraints imposed by clinical demand and personal freedom.

8.3.22.1.3 The design for all security systems shall be in line with the general principals of the approach recommended by Secured by Design refer also to section 7.

8.3.22.1.4 Local security systems alarm annunciation shall be provided within wards and at the central security facilities with remote monitoring and control off site at the Hillington Control Centre.

8.3.22.1.5 The main receptions shall also incorporate a CCTV monitor positions each with a flexible control facility to allow a combination of monitoring arrangements over two 20” Flat LCD screens.

8.3.23 Panic Alarm Systems

8.3.23.1 The Contractor shall provide panic alarm systems integrated within the BMS. Staff attack alarms will be provided by activation of a fixed discrete push button, hard wired to the underside of reception desks. All principal reception desks and staff bases will be provided with this facility.

8.3.23.2 Staff mobile panic alarms will be provided with link to receptions and security in the following areas:-

a) Accident & Emergency

b) Imaging (out of hours)

c) Pharmacy

d) Emergency Decontamination

e) Out of Hours Service Areas

8.3.23.3 All panic alarms fixed and mobile shall be monitored by the on site FM Control Centre and the remote Hillington Control Centre this shall provide a description of the alarm activation highlighting the precise location of staff members in distress.

8.3.24 Paging, Personal Attack Alarms

8.3.24.1 The Hospitals shall be installed with a radio-frequency network to facilitate the use of paging and personal attack alarms integrated within the BMS. This radio-frequency network shall include location beacons so that the exact location of pagers and attack alarm devices can be determined.

8.3.24.2 The radio-frequency network infrastructure shall be compatible with the Identicom personal security device, which is used widely across the NHS to provide lone-worker protection.

8.3.24.3 Panic buttons linked back to the FM Control Centre, and with a loud alarm at the scene, are to be installed at Reception desks and in Treatment Rooms

Decontamination room to be secured and fitted with Panic Alarm and two way intercom to adjacent area.

8.3.24.4 Treatment space in the Emergency Department to host CatA prisoners required (incl terrorist suspects transferred from 'G' Div HQ at Helen Street). This as well as decontamination room to have discrete entrance (double bank decontamination facility, have lobbies and two areas and may require armed escorts to be present. Provide lobby, seating, WC etc to support together with controlled ingress and egress and airlock type doors.

8.3.24.5 Police room in Emergency Department area to be fitted with panic alarm facilities.

8.3.24.6 The system shall be networked with the central management system and linked with other systems to allow:

The unlocking of doors along all escape routes to assist evacuation in an emergency.
Possible automatic locking of doors within an area if a panic button is pressed.
Activation of a security camera in a particular location when a door is opened to provide a picture of the person entering.

8.3.24.7 All A&E entrances shall have Video Access Control System for use at night time so that security staff can control entry from the desk positions in accordance with the Secured by Design recommendations.

8.3.24.8 General staff panic alarm system shall be integrated within the Wi-Fi network to allow staff to operate two stage affray facility within the hand held electronic PDA type equipment. This shall be configured to triangulate the location of staff members in distress and provide a department location.

8.3.25 Alarms & Intruder Detection System

8.3.25.1 The Contractor shall provide an IDS System within The Works to provide out of hours security cover. This shall be provided by PIR Detectors located within the corridors, rooms with ground floor windows, and rooms internally adjacent to any roof access points. In addition The Contractor shall ensure that restricted areas have door contacts available for monitoring unauthorised entry.

8.3.25.2 The following areas shall be fitted with local intruder alarm systems:

a) Pharmacies (to prevent the theft of controlled drugs)

b) X-ray department areas used for storing silver chemicals

c) Patient record offices

d) Stock rooms

e) Plant rooms

f) FM areas

g) All external doors

8.3.25.3 The intruder alarm systems shall link centrally back to the FM Control Centre.

8.3.25.4 The Contractor shall ensure that the proposed alarm systems for The Works include lifts, refrigeration equipment and all other critical equipment.

8.3.25.5 The Contractor shall ensure that the alarm systems can be securely monitored on Site and also remotely at the Hillington Control Room.

8.3.26 Security Access Control

8.3.26.1 The Contractor shall provide a comprehensive access control system to all external access doors and to internal doors requiring restricted access including access control doors to each ward and departments integrated within the BMS and plant area lighting controls to prevent unauthorised access. Control will be via a hierarchical proximity card system. Some departmental systems may only be activated outside normal working hours.

8.3.26.2 Ward access control doors shall also be fitted with CCTV camera and door access system. The CCTV camera shall be suitable for viewing of visitors in wheel chairs.

8.3.26.3 The Contractor shall provide the Entry requirements of SHPN57 e.g. Entrance to be controlled by use of entry-phone intercom system with CCTV linked to the reception/clerical office and communications base with access control provided across the full Critical Care Accommodation including changing room doors

8.3.26.4 Controlled access shall be provided by the Contractor to the Estates and FM vehicle hard standing and parking facilities for vehicles and pedestrians, traffic management lights and barriers shall be provided to control the yard and the associated slip road.

8.3.26.5 The Contractor shall ensure the system includes all necessary power supplies, card readers, actuators, egress buttons and emergency “break-glass” release units and fire alarm interfaces.

8.3.26.6 The system shall utilise the BMS LAN with separate field cabling and all necessary central controls / network cards provided suitable for future extension.

8.3.26.7 The system shall be interfaced with the robotics system to ensure that controlled access is provided while maintaining system integrity.

8.3.26.8 The system shall be interfaced with the theatre system to ensure that controlled access is provided while maintaining operational integrity.

8.3.26.9 The Contractor shall provide door entry video intercom systems to the designated main entrance doors and the delivery entrances with local control and facility to transfer to the main security room.

8.3.27 External CCTV

8.3.27.1 The Contractor shall provide a comprehensive colour CCTV system integrated within the BMS covering all external access points, car parking and external pedestrian/cycle circulation routes around the full Site including FM, service yards, car parks, walkways, boundary of/entrances to Site, boulevard, service tunnel etc, and the general road network.

8.3.27.2 The design shall also take cognisance of the Board's security requirements as detailed in the Boards operational requirements.

8.3.27.3 The Contractor shall ensure that the system comprises a multi-channel digital recorder with a recording frame per second for each camera which is in accordance with a detailed engineering specification to be agreed with Strathclyde Police.

8.3.27.4 The digital recorders shall also control playback of images onto a CCTV monitor.

8.3.27.5 The cameras shall be fully functional set up with stops to avoid over viewing adjacent properties, the RAID storage shall be 25 frames per second and all equipment shall be selected to provide good quality viewing and reproduction for use in prosecutions.

8.3.27.6 The external PA system shall be linked to cameras so operator can 'speak' to persons in external spaces in emergency or to reprimand/warn.

8.3.27.7 The system shall be fully integrated with the new Laboratories system and shall be configured to allow migration of the retained estate equipment without downtime.

8.3.28 Internal CCTV

8.3.28.1 The Contractor shall provide a comprehensive colour CCTV system integrated within the BMS covering all corridors, reception, lift lobbies and other areas where members of the public gather or areas where access is to be restricted i.e. wards.

8.3.28.2 CCTV cameras shall be installed at the main entrances, waiting and circulation areas of both hospitals where the security and safety of hospital staff and patients is a concern but where free access for the visiting public is allowed. The CCTV systems are also to cover:

a) All Exits and Entrances;

b) Ambulance Parking;

c) Vehicle Bays;

d) Fill points;

e) Cycle sheds;

f) All vehicle and cycle routes within the works;

g) All footpaths within the works;

h) Pharmacy Counters;

i) Ward Entrances;

j) Children's Play Areas;

k) Ambulance Entry Points;

l) A&E Departments;

m) Car Parks, Estates Yards, Public Spaces;

n) Generator Plant rooms;

o) Main Heating Plant rooms;

p) Corridors;

q) Receptions;

r) Lift lobbies; and

s) Other areas where members of the public gather or areas where access is to be restricted.

8.3.28.3 All CCTV cameras will be IP-based. They will be linked back to local hubs by fibre or Cat.6A cabling. Local data hubs will be connected back to a number of CCTV servers adjacent to electrical risers, which will in turn be linked to the main server room via a looped optical fibre network. CCTV servers will include input modules, processors and RAID storage. The system shall record at 25FPS per camera and provide 31 days storage. Each CCTV server will also be provided with an independent broadband connection to provide connectivity in the event of a network failure.

8.3.28.4 All cameras shall be linked back to the FM Control Centre and the off site facility at Hillington with local supplementary monitors in accordance with the Clinical Requirements.

8.3.28.5 The Police room in Emergency Department area to be fitted with CCTV monitors, to receive feeds from the Emergency Department cameras and any other surveillance as provided under the control of the main CCTV monitor position.

8.3.28.6 The CCTV system shall be linked to the intruder alarm and access control systems to provide specific viewing functions, such as presenting a picture on a monitor when an access card is presented to a reader, or when a movement detector activates.

8.3.29 Automatic Barriers

8.3.29.1 The Contractor shall provide all vehicle access barriers including associated power and control wiring. For Vehicle control at the A&E, FM to suit the developed traffic philosophy. Facilities shall be provided for audio visual links to the security desk to provide assistance. The Contractors shall also provide additional ducts and network cabling to strategic areas for future pay stations.

8.3.30 Uninterruptible Power Supplies (UPS)

8.3.30.1 The provision made for interruptible/ uninterruptible power supply (IPS/UPS) solutions to provide electrical safety in the patient environment shall be based on IEC 6034 for Electrical Installations in Medical Locations, (S)HTM-06-01 and the recommendations of Guidance Note 7 to BS7671 Wiring Regulations published by the Institution of Electrical Engineers.

8.3.30.2 UPS solutions shall also be provided by the Contractor to support Grade A standby lighting in Group 1 and Group 2 locations within areas of clinical risk 4 and 5.

8.3.30.3 The Contractor shall provide the UPS requirements of SHPN57 e.g. all patient supplies in Critical Care areas shall be UPS backed, dedicated plug arrangements shall be provided rather than colour coding to differentiate.

Lighting in Critical Care areas to be UPS backed, this element of the requirement may be provided from of series of resilient redundant "lighting off line" battery inverter units rather than from the main series of "on line" UPS sets.

8.3.30.4 UPS units shall be located to suit the load requirements and the Contractor shall allow for UPS resilience, redundancy, automatic by-pass and ensure that the equipment is provided with the appropriate environment to ensure full design life is achieved from all equipment and batteries.

8.3.30.5 Consideration shall be given to UPS island mode operation with measures taken to ensure that the output neutral is referenced to earth at all times e.g. bypass and isolation transformers permanently in circuit with local connection or reconstituting the UPS neutral –earth bond as required.

8.3.30.6 Batteries shall be minimum ten year design life type in accordance with British Standards, these shall be provided in cabinets and battery monitoring and battery isolation devices shall be linked to the central monitoring system.

8.3.30.7 Battery cabinets shall be located in separate plant rooms from all heat generating equipment with appropriate environmental conditions to provide a safe steady state environment for maximum battery life.

8.3.31 Generators

8.3.31.1 The site generation shall be sized to provide stand-by power for The Works and Laboratory with provision for integration of the retained estate.

8.3.31.2 The system shall comply with the distribution requirements of (S)HTM-06 as set out in the schematic drawing ref G1274/E(60)01 and the generators shall have sufficient capacity to pick up the load and meet the minimum frequency and stability requirements for the Emergency System after loss of mains power taking into consideration the site load including Medical equipment, UPS and HVAC variable speed drives.

8.3.31.3 Load management control shall be utilised to ensure that the lighting and small power are reinstated within 15 seconds of power failure. All other loads including Mechanical Services and Lift power shall be re-instated in a controlled manner within 25 seconds of power failure. The Contractor shall include for all load management software and hardware including automated motorised ACB's and MCCB's to ensure that the load management matches the generator status. The Control shall be run over twin redundant PLC's with automatic change over in the event of fault. All control circuits shall be constantly monitored for healthy operation and communication with faults indicted at the Plant rooms with remote indication via the BMS.

8.3.31.4 Active mimics shall be provided via touch screen PC's within each main switchroom to indicate the status of all main electrical plant and emergency systems.

8.3.31.5 All power for controls and monitoring equipment shall be provided from resilient supplies with UPS/ Battery backup, with back up to allow maintenance without system downtime.

8.3.31.6 A full load analysis shall be carried out to ensure that the appropriate generator sets are selected to meet the active power, reactive power and apparent power requirements and that change-overs are bump free with a maximum permissible voltage dip of 2% on load acceptance.

8.3.31.7 The alternators shall be selected to match the inrush current of the transformers which shall be brought on line (with lighting and small power loads connected) when one of the generators in each group is available on the bars. The remaining generators shall synchronise to the first unit in their group and signal to the load management controls when sufficient units are available to take the remaining loads.

8.3.31.8 Generators shall be rated as ISO8528 (2005) Continuous Operating Power COP.

8.3.31.9 Full load management shall be provided by the Contractor to allow isolated island running and parallel utility operation.

8.3.31.10 The engines shall comply with ISO 3046-1 and generators comply with ISO 8528.

8.3.31.11 To improve system resilience the generators shall be located in groups with Fire and Blast Separation.

8.3.31.12 Digital Automatic Voltage Regulations (AVR) shall be provided with optimized transient response to suit site load.

8.3.31.13 A stringent series of “Black Building Tests” shall be developed by the bidder to indicate cause and effect for all of the system fault scenarios, this shall be build up in iterations with simple single system faults escalating to major inter system failures in a matrix.

8.3.31.14 An override facility shall be provided via Castel interlocking to allow a controlled manual engine start up procedure to be available in the event of PLC failure.

8.3.31.15 Once the Matrix is agreed the tests shall be integrated in the overall commissioning strategy.

8.3.31.16 The fuel storage shall be integrated with the standby heating fuel system to provide a modular storage facility as described elsewhere.

8.3.31.17 Each generator shall be provided with a dedicated gravity feed day tank capable of tuning the set at maximum load for 10 hours.

8.3.31.18 A resilient dual piped, multiple pumped supply system shall be provided from the Modular Storage to deliver to the day tanks.

8.3.31.19 All engines should incorporate lean burn technology to minimize NOx, flues shall be run to the energy centre stack and discharged at high level.

8.3.32 Plant Rooms

8.3.32.1 The plant rooms shall be configured to ensure optimum environmental conditions to ensure efficient operation.

8.3.32.2 All walls, ceiling and floors within generator rooms, transformer rooms, MV and LV switchrooms shall be painted to minimize problems associated with dust.

8.3.32.3 All floors and roofs to be of water proof construction with all penetrations formed in bunded up-stands incorporated in the water proof design.

8.3.33 Theatre Panels

8.3.33.1 The Contractor shall provide proprietary theatre panels of touch screen design to meet the Clinical Requirements and provide a centralised control and monitoring position within the Theatre for all Electrical and Environment Systems including Mains power, Generator power, UPS power, fire alarms, temperature, humidity, theatre lights, room lights etc.

8.3.34 Lifts and Escalators

8.3.34.1 The Contractor shall provide bed passenger lifts (suitable for inclusion of at least one hospital bed (orthopaedic bed), goods lifts, service lifts, general passenger lifts, clean goods lifts, dirty goods lifts, FM robotics lifts, dumb waiters and evacuation lifts within the buildings in accordance with (S)HTM 2024 and EN 81. Evacuation lifts for emergency conditions will be considered within the fire strategy and shall be provided if required as part of that agreed strategy. All lifts provided for the movement of patients shall be supplied from the essential services supply in accordance with (S)HTM 2011.

8.3.34.2 The Contractor shall give consideration to the following in the provision of lifts:

a) The lifts shall be vandal / damage resistant but aesthetically pleasing and appropriately sized (lifts designated as passenger bed lifts shall be sized to accept as a minimum a bed and associated equipment);

b) Banks of lifts shall be appropriately controlled to maximize movement;

c) Collective controls of groups of lifts shall be used;

d) All floors including plant levels shall be served;

e) Control rooms shall be easily accessible and designed to minimise the need for artificial cooling;

f) All Lift power shall be via automatic changed over units with power fed from either side of the dual power distribution systems;

g) Emergency hands free telephones in lifts shall be accessible to the blind, partially sighted, deaf and wheelchair users. The Contactor shall link each lift car emergency phone directly to an individual emergency line at the Boards central communications centre, to facilitate emergency clinical support and communication, this shall be in addition to the lift remote fault reporting system provided by the lift suppler;

h) Remote lift operation monitoring shall be provided;

i) Lifts for people and goods shall be separated;

j) Dedicated lifts are required for theatres or swipe controlled staff access override;

k) Key operated Priority Control shall be provided for bed movement and a local controller shall be provided within the helicopter recovery area;

l) Manual Handling shall be reduced with the introduction of Automated transfer Systems which shall be integrated in the vertical transport solution. The Contractor shall clearly set out the number of lifts indicating if these are dedicated to Automated Transfer System or shared with the FM units;

m) All lift car levelling requirements shall be in accordance with the British Standards and also be in accordance with the Automated Transfer System step capabilities if this is less tolerant than the British Standard;

n) Lifts shall be conventional type rather than machine room less type to ensure operation of the Boards passenger evacuation procedures;

o) Escalators to be selected to meet the traffic flow in accordance with the Bidders scheme, units shall be designed and installed in accordance with BS5655;

p) The Bidders shall carry out vertical transport analysis for passenger, bed movement and FM movements and automated material transfer systems based on their proposed scheme and the clinical and operational requirements;

q) Lift and escalator ratings speeds shall be selected to ensure excellent service complete with inbuilt redundancy to allow for unit breakdown and planned maintenance;

8.3.35 Tagging

The Contractor shall provide a full asset tagging system in accordance with the NHS Scotland (HFS) National asset management requirements.

All installed Electrical, Mechanical, Public Health Medical Gases and Specialist systems components shall be asset tagged by the contractor, entered into the PPM system and linked to its full specification and maintenance schedule.

The tagging system shall be capable of simple extension to allow the Bar Coding of Hospital Equipment, and the bidders shall provide technology proposal for Board consideration.

The asset tagging system shall be interfaced with the PDA System to be utilised for Managing Building Handover and Snagging.

8.3.36 Service Tunnels

Full resilient building services shall be provided in the service tunnels including, ventilation, smoke control, heating, small power, lighting, emergency lighting, illuminated signage, fire alarms, leak detection, access control, public address/background music and CCTV etc. to allow the tunnels to continue to operate during sectional maintenance.

The tunnels shall be configured to meet the developed traffic flow requirements, with full consideration of the Automated Material Transfer System operation requirements including power, ventilation, unit recovery, weight, gradient and step limitations.

Special consideration shall be given the risk of single point of failure within the tunnel and the main services shall be separately routed with dedicated maintenance access provided to allow ongoing operation during maintenance.

8.3.37 Laboratory Services

All specialist services e.g. security, access control, CCTV, fire alarms BMS etc within the new hospitals shall be fully compatible with building the services to be provided in the Laboratory Building.

8.3.38 Future Proofing

The Contractor shall ensure that all systems are future proofed and shall provide a compliance matrix indicating measures taken in their supply chain to indicate the level of future proofing included in their bid.

SECTION 8.4 - DRAWINGS (these are located in Appendix M)

Schematics	Number G1274-
Main Power Schematic	E/(60)01
Power Distribution Schematic	E/(60)02
Fire Alarm Schematic	E/(67)01
CCTV/Staff attack & Intruder Schematic	E/(68)01
Nurse Call Schematic	E/(68)02
Data Schematic Diagram	E/(68)03
Typical CWS Distribution Layout	P/(53)01
Wet Riser Distribution Schematic	P/(67)02
Medical Gas Pipeline System Schematic	M/(54)01
Natural Gas Schematic	M/(54)02
Sprinkler Installation Schematic	P/(67)01
Chilled Water Distribution Schematic	M/(55)01
MTHW Distribution Schematic	M/(56)01
Typical LTHW Distribution Schematic within Building	M/(56)02
Isolation Suites, plant room adjacent Ventilation System	M/(57)01
Isolation Suite Vent System plant room above	M/(57)02
Typical Adult Ward Tower Ventilation Schematic	M/(57)03
Operating Theatre Ventilation Outline Plan and Schematic	M/(57)04
Site Layout Drg's	Number G1274-
Water, Gas and electric Site Incoming Services	U(96)01
Indicative MTHW heating distribution route	M/(56)03
Energy Centre	Number G1274-
Proposed Energy Centre Plant room layouts MTHW Solution	ME/(60)01
Indicative Primary Sub Station Layout	ME/(60)02
Detail Drawings	Number G1274-
Indicative layout of Main Services Tunnel	ME/(60)03
Board Drawing	
Existing External Services Site Plan	G1700X G(52)Combined-Site

Section 9.0 Civil & Structural Engineering Requirements

The Contractor shall in carrying out the Works comply with the following non-exhaustive list of civil & structural engineering requirements.

9.1 General Requirements

9.1.1 The Contractor shall ensure that the design and construction of the civil and structural engineering elements of the buildings and external works meets the following criteria:

a) Be designed observing due skill, care and attention to the requirements of the brief;

b) Be fully co-ordinated with the design of the building fabric, finishes, services, facades, internal walls, medical equipment and existing Site features, including buildings / structures;

c) Provide adequate space for the distribution of services, while maintaining the required finished floor levels and the floor to ceiling heights called for in the Room Data Sheets; and elsewhere in the Employers Requirements documents;

d) Maximise the clear zone above the ceilings for services to the degree consistent with overall economy for the Board;

e) Be economically adaptable to meet changing clinical needs; and

f) Require minimum maintenance and be designed to accommodate maintenance requirements for services, equipment and building fabric.

9.2 Minimum Design and Construction Standards

9.2.1 Unless otherwise agreed with the Board the Contractor shall ensure that all structural and civil engineering elements are designed in accordance with current revisions of the following standards and guidance documents:

a) BS6399 - Loading for buildings or Eurocode 1 (incl. Eurocode 0);

b) BS5950 – Structural use of steelwork in building or Eurocode 3;

c) BS8110 - Structural use of concrete or Eurocode 2;

d) BS5628 – Code of practice for the use of masonry or Eurocode 6;

e) BS5268 – Structural use of timber or Eurocode 5;

f) BS8002:1994 – Code of practice for earth retaining structures;

g) BS8004:1986 – Code of practice for foundations;

h) BS8102:1990 – Code of practice for protection of structures against water from the ground;

i) BS8007:1987 – Code of practice for design of concrete structures for retaining aqueous liquids;

j) BRE Special Digest 1:2005: Concrete in Aggressive Ground;

k) BS5606:1990 – Guide to accuracy in building;

l) BS8000 – Workmanship on building sites;

m) BS8500 – Guide to specifying concrete;

n) Glasgow City Council Roads Development Guide;

o) Design Manual for Roads and Bridges;

p) Specification of Highway Works, published by The Stationary Office as Volume 1 of the Manual of Contract Documents for Highway Works;

q) The Traffic Signs Regulations and General Directions 2002;

r) The Traffic Signs Manual;

s) Sewers for Scotland 2nd Edition;

t) BS EN 752:2008 – Drain and Sewer Systems outside buildings;

u) BS EN 12056 – Gravity drainage systems inside buildings;

v) BS EN 1825 – Grease Separators;

w) BS EN 1295 – Structural Design of Buried Pipelines Under Various Conditions of Loading;

x) CIRIA C624: Development and Flood Risk – Guidance for the Construction Industry;

y) CIRIA C635: Design for Exceedance in Urban Drainage – Good Practice: 2006;

z) CIRIA C697: The SUDS Manual: 2007;

aa) CIRIA R168: Culvert Design Guide;

bb) The Water Environment (Controlled Activities) (Scotland) Regulations 2005;

cc) SPP7 – Planning & Flooding;

dd) Glasgow City Council – ENV 3 – Flood Prevention and Land Drainage;

ee) ICE specification for piling and embedded retaining walls, 2nd Edition;

ff) CIRIA 66S: Assessing Risks posed by hazardous ground gases to buildings: 2008; and

gg) WRAS information and Guidance Note No. 9-04-03. The selection of Materials for Water Supply Pipes to be laid in Contaminated Land.

9.2.2 The Contractor shall deliver the Works set out in accordance with BS5606 – Guide to Accuracy in Building Critical dimensions and setting out points shall be clearly marked on drawings.

9.2.3 Construction tolerances, unless otherwise stated by the Board shall be no greater than those specified in Tables 1 and 2 of BS5606. Where the operational constraints of the building require special levels of construction accuracy then The Contractor shall be responsible for establishing and designing for these.

9.2.4 The performance of components shall be in accordance with the appropriate British Standards.

9.2.5 The Contractor shall ensure that building structures are designed to resist imposed, roof and wind loads not less than those required by current revisions of BS6399, Loading for Buildings.

9.2.6 The Contractor shall ensure that building structures are designed to carry the loads of heavy plant or medical equipment (including ceiling mounted tacking hoist systems) in their permanent positions and any loads that will be imposed upon the structures during the installation, removal or replacement of such heavy items. This requirement may involve the design of 'strong routes' through the buildings and/or specially strengthened areas of the roof onto which heavy items can be lifted.

9.2.7 The Contractor shall ensure that any measures considered necessary shall be taken to protect the building from ingress of naturally occurring ground gases e.g. carbon dioxide, carbon monoxide, methane and hydrogen sulphide.

9.2.8 In addition to reference to the above Performance Standards the Contractor shall take cognisance of the comprehensive list of relevant compliance documents as detailed in Section 5.1 of Employers Requirements: Minimum Design & Construction Standards.

9.3 Loadings & Structural Flexibility

9.3.1 The Works shall be designed to cater for the dead loadings associated with the chosen materials for the structure, finishes, partitions and cladding to the buildings. As a minimum, it shall also be designed for the imposed loads as specified in current British Standards. The design shall also take into account the need for specialist measures to allow for the installation, replacement and removal of Special Equipment and associated services. Structural deflections shall be limited as necessary for the proper installation and functioning of specified equipment.

9.3.2 The Contractor shall account for (but not be limited to) the following loading schedule

a) General floor loadings – Dead and Live loads;

b) Point loads for Clinical equipment and Services;

c) Impact loads;

d) Vibration loads;

e) Special plant foundation loads; and

f) Service loads

9.3.3 The Contractor shall take account of concentrated point loads from both mobile and stationary plant and Equipment. The structure should incorporate reasonable measures to accommodate updated versions of such machinery without major disruption. In addition, the Contractor shall ensure that floors and supporting structures have the capacity for retro-fitting lifting devices for all fixed items of plant and Equipment weighing 35kg or more.

9.3.4 The Contractor shall take cognisance of the requirements in designated patient areas for ceiling mounted tracking hoists etc and such measures to allow for the installation of Special Equipment and associated services.

9.3.5 The Contractor shall ensure that specific areas of the Works satisfy particular requirements of the Board's operations or Equipment in those areas. Relevant constraints may include but are not limited to maximum allowable (structural deflections) differential settlement, (vibration) and the meeting of any constraints.

9.3.6 The Contractor shall take account of dynamic loads from general movement of people through to activities such as aerobics, dance or other rhythmic activities that can give rise to harmonic effects in poor design.

9.3.7 Lateral stability bracing systems shall not obstruct or hinder Clinical or Non-Clinical operations and shall not obscure the windows or doors.

9.3.8 The vibration response of the buildings shall comply with the requirements of SHTM 2045 and be compatible with the requirements of the Equipment to be installed.

9.3.9 With respect to the Works, the Contractor shall:

a) Take due account of future flexibility of the Works (in terms of future change of use and/or relocation of equipment);

b) Specifically make allowance for future flexibility of ceiling mounted lifting equipment in designated patient areas, including the requirement for re-configuration, extension and/or retro-fitting of lifting equipment i.e. the whole of the designated area shall be capable of accommodating re-configuration or retro-fitting;

c) Make specific allowance for items of particularly heavy equipment and/or other onerous loading conditions; and

d) Make specific allowance for installation, transfer and/or removal routes for heavy equipment throughout the Facilities.

9.3.10 Parts of the structure potentially subject to damage from trolleys or vehicles shall be designed with adequate protection to prevent such damage from occurring.

9.3.11 Structural deflections shall be limited as necessary for the proper installation and functioning of special mobile, rail mounted, or fixed Equipment.

9.3.12 The Contractor shall include, within their design, provision for removal, replacement and upgrading of installed plant and Equipment. As part of this element of design, a comprehensive replacement strategy shall be prepared for implementation. This strategy shall, wherever possible, consider how these activities can be undertaken whilst minimising disruption to the function of the completed Works.

9.4 Foundations & Sub-Structure

9.4.1 The foundations shall be designed and constructed in accordance with the relevant Codes of Practice, recognising the prevailing ground conditions at the site as identified in the Ground Investigation Report (contained in Appendix N) and historical ground investigation information issued with the tender. Where the Contractor considers there is insufficient ground investigation information within the information issued for tender purposes, he shall identify this and allow for carrying out further investigation as he considers is required.

9.4.2 The Contractor shall take due cognisance of:

a) Recognition of applied loading;

b) Settlement and its effect on new buildings, links to adjacent buildings, existing adjacent foundations and existing services;

c) Dewatering and its effect on new buildings, links to adjacent buildings, existing adjacent foundations and existing services;

d) Earthworks;

e) Basement construction and waterproofing category;

f) Possibility of uncharted services and existing buried structures; and

g) Utilities Diversions.

9.5 **Basements & Tunnels**

9.5.1 The Contractor shall refer to the Masterplan, Acute Adult and Children's Hospital, Laboratory and Energy Building drawings contained in appendices for proposed locations of basements and tunnels. Basements structures in the main hospitals will generally be provided for FM/distribution and plantroom/service areas. Basements areas in the laboratory building are generally for access to the labs and mortuary as well as services distributions. It is intended that significant size tunnels will be provided between and connecting basement areas. The tunnels will provide routes for distribution of services and movement of staff.

9.5.2 Basement and Tunnel structures should be designed in accordance with the recommendations of BS 8102. The Contractor should provide designs appropriate to use of these elements i.e. he is to confirm categories of design A, B or C and identify where each is employed

a) Category A – Technical Protection;

b) Category B – Structural Integral Protection; and

c) Category C – Drained Protection.

9.6 Movement Joints

9.6.1 Structural/movement joints shall not be located through:

a) Kitchen and food preparation areas;

b) Treatment and surgery rooms;

c) Any room that HAI~Scribe prevents a floor joint from being provided in (including Theatres for example);

d) Rooms requiring a sterile environment; and

e) Any room with (now or in the future) tracking hoists or other similar lifting equipment

9.7 Superstructure

9.7.1 The Works primarily comprise the following elements:

a) Acute Adults and Children's Hospital;

b) New Laboratories Building;

c) New Energy Centre; and

d) External works and roadways/infrastructure, including utilities.
(Multi-storey car parks by others).

General

9.7.2 The Contractor shall provide designs appropriate to the type of buildings and in appliance with all SHBN's, SHTN's HBN's and Codes of Practice. The design of each building should demonstrate.

a) Ability to withstand loads and load combinations imposed on the building, vertical, horizontal, dynamic, temporary etc;

b) Compliance with robustness (tieing) requirements of current Codes of Practice and Technical Standards (Scotland) i.e. progressive collapse requirements;

c) Provision of movement must be included in designs, horizontal, vertical, shrinkage, temperature effects etc;

d) Vibration sensitive equipment will be in use throughout the new faculties. Designs should take cognisance of vibration categories;

e) Integration of building services with structure will be a highly important part of the design process. The Contractor shall demonstrate how design coordination will be achieved;

f) All material used in the design of structures shall be compatible with each other and such things as finishes (e.g. Painted); and

g) The Contractor shall prepare and supply an overall Design Philosophy Statement which should include as a minimum, General Project information, The Site, Design Team Parties, Construction Programme, The Structural Scheme, Design Standard and Sources of Reference, Modelling and Analysis and Calculations and Checking.

Acute Adults & Children's Hospital

9.7.3 The building will comprise basements, large area footprint storied structure (podium decks) and ward block multi-storey towers in 4 wings with associated cores. The Contractor shall demonstrate load paths through the building, identifying such things as transfer structures, stability cores, basements, retaining walls and foundations.

9.7.4 It is anticipated that a Helipad will be provided at roof level. The Contractor shall demonstrate a design in compliance with HBN 15-03 Hospital Helipads and identify in particular,

a) Size of helipad;

b) Size of helicopter designed for a loading applied to roof structure;

c) Load transfer of helipad structure to hospital roof structure;

d) Ramp access from/ to pad/ roof; and

e) Integration with emergency services requirements, such as fire fighting systems.

New Energy Centre

9.7.5 The Contractor is required to provide a building structure housing the new equipment that will service the overall hospital development. It is anticipated that large heavy equipment, boilers, generators, CHP plant etc. will be integrated into the design. Large spaced, double storey heights etc. will be required.

New Multi-storey Car Parks (by others)

9.7.6 The Contractor is required to provide a road and drainage and external works design that reflects and takes cognisance of the overall site, including the provision of new multi-storey car parking. Refer to Masterplan Layout for locations and sizes/ capacity of new car parking requirements.

9.8 Fire & Corrosion Protection

9.8.1 The Contractor shall provide fire protection to all elements of structure and ensure fire ratings are in compliance with space used and the more onerous of Building Regulations/the Board's requirements.

9.8.2 The Contractor shall provide a corrosion protection system appropriate to the various structural elements and their location of the buildings.

9.8.3 The corrosion protection system used shall be relevant to type of structure and its structural function and its material and location within the overall building frame. All materials used shall be compatible with each other and with surface finish materials. Reference should be made to the design life of the building structures and finishes, refer Section 5.0.

9.9 Durability & Maintainability

9.9.1 All elements of the structure shall be capable of withstanding potential deterioration due to weather, ground conditions, wear and tear, and accidental damage relevant to their location and environment.

9.9.2 Where the requirement for maintenance is less than the required life expectancy of the element(s) practical and realistic arrangements shall be designed into the construction of the Works to allow for any necessary repairs, replacements and painting etc. to be carried out safely without compromising the operational activities within and around the Works.

9.9.3 Contractor to provide a strategy statement on maintenance and replacement.

9.10 Other Performance Requirements

9.10.1 The Contractor shall ensure that all building elements and retaining structures shall incorporate appropriate means to resist the passage of dampness, both into the building structure and fabric, and into the accommodation, including the resistance to any hydrostatic pressure. The Contractor shall ensure that all such construction shall be in accordance with the requirements of the Building (Scotland) Regulations 2004, BS8102 and Code of Practice CP 102 for Protection of Structures against Water from the Ground.

9.11 Underground Drainage

9.11.1 A 'Drainage Impact Assessment and Strategy Report' has been prepared (see Appendix L) and is prescriptive in outlining the requirements which are to be assessed and met in respect of the foul and surface water drainage from the development. The report covers, *inter alia*:-

a) The proposed surface water drainage strategy and the resulting surface water drainage network design considerations and projected amendments to existing culverted watercourses;

b) The proposed foul water drainage strategy, projected foul flows and the drainage network anticipated. The Contractor is required to confirm by calculation their own assessment of flows for the development;

c) Sustainable Urban Drainage criteria which require to be met for each element of the development. Again, the Contractor is required to review the requirements and develop appropriate methods for implementation of the treatment required;

d) The management and maintenance of the designed drainage systems shall be accompanied by a summary which details the residual requirements for maintenance of each element of the drainage system, including parts of the network prospectively vestable in Scottish Water; and

e) The criteria for assessment of Flood Risk for the designed drainage networks and the development as a whole. The requirements for mitigation of the assessed flood risk and the appropriate finished floor levels for access, egress and buildings are also outlined for the Contractors to address.

9.11.2 In the development of the guidance within the 'Drainage Impact Assessment and Strategy Report', the Contractor shall be responsible for liaison with the relevant stakeholders in agreeing connection requirements to the surrounding public sewers, watercourses and drainage networks. The Contractor is responsible for the design and construction of a drainage solution that meets all the requirements of and satisfies the relevant regulatory authorities including, but not limited to, GCC, SEPA and Scottish Water.

9.11.3 All phases of the development shall treat the disposal of surface water in accordance with the principles of 'The SUDS Manual' Report no C697 published by CIRIA (March 2007)

9.11.4 The Contractor shall provide, where necessary within the on-site drainage network any isolators, retention traps, interceptor tanks and other such devices necessary to prevent the discharge of any potentially dangerous or otherwise contaminative materials to the public sewers.

9.11.5 The Contractor shall design and provide separate foul and surface water drainage systems in accordance with the requirements of the Building (Scotland) Regulations 2004.

9.11.6 All drainage shall be designed to avoid the risk of local flooding and flooding of the system into which they discharge. Flooding of electrical equipment areas and areas where stray current leakage may occur in the presence of water shall be prevented.

9.11.7 Drainage shall be sufficient to ensure that no areas of standing water occur outwith extreme storm events. The drainage systems shall be capable of coping with, as a minimum, the foul loading and the storm event specified by the relevant authority and shall be considered an integral part of

the public sewerage system. This shall include any storage required on the public network to offset the assessed impact of the development.

9.11.8 The drainage system shall be capable of taking such detritus as may normally arise during the operation of the system and during normal and winter maintenance conditions and those within the design criteria of the relevant authority.

9.11.9 The Contractor shall design the drainage system in such a way as to minimise the requirement for internal manholes.

9.12 Roads, Footpaths, Cycle paths and Car Parking

9.12.1 The extent of adoptable and non-adoptable roads is shown on the Exemplar layout drawings.

9.12.2 The Contractor shall provide a network of internal roadways providing;

a) a spine road network through the site between Govan Road and Hardgate Road to facilitate the increased levels of Hospital traffic;

b) a road network through the site between Govan Road and Hardgate Road with designated provision for blue light ambulances, related and relevant to the position of A&E services at all phases of the development;

c) a public transport hub served independently served from (a) or (b) above and in keeping with the requirements of the 'Clyde Fastlink' proposals being promoted by Glasgow City Council;

d) service access to the relevant areas as indicated on the Masterplan, which will be independent of any of the networks in (a) – (c) above;

e) sufficient Ambulance provision at A&E as outlined elsewhere in these requirements, and separate provision for temporary private vehicle layover in the same environs; and

f) a taxi / car drop-off and layover bay at an appropriate location and geometry to effect the efficient and safe pick-up and dropping off of visitors and other users of the hospital facilities.

A maximum of 3,500 car parking spaces, comprising 2400 staff and 1100 visitor / patient spaces are being created on site by others. The Contractor shall require to liaise with the Board and the consultant teams and contractor(s) carrying out this work in order to establish common routes, levels and other relevant co-ordination requirements.

9.12.3 The layout and geometry of the network of internal roads shall be generally in accordance with the Masterplan and exemplar layout provided to the Contractor.

9.12.4 The Contractor will provide details of junction upgrades including priority control measures for blue light ambulances and provision for 'Clyde Fastlink' shall be developed by the Contractor in consultation with Glasgow City Council.

9.12.5 The Contractor shall design the construction of new roads in accordance with the Glasgow City Council 'Roads Development Guide' for a Traffic Distributor Road. Pavements shall provide a residual design life at the year of completion of the works of no less than 40 years.

9.12.6 The Contractor is responsible for all approvals and consents in relation to all on-site and any off-site road, footpath, cycleway or other transport requirement.

9.12.7 The Contractor shall ensure that all roads, delivery and refuse collection areas have sufficient headroom above them to allow for the passage of appropriate emergency, servicing, delivery or refuse collection vehicles and are designed to provide sufficient space to allow efficient manoeuvring of such vehicles without undue difficulty, risk of impact or adverse effect of exhaust fumes on occupants of the buildings.

9.12.8 All structures which support roads / footpaths / cycleway shall be designed in accordance with the relevant provisions of the Design Manual for Roads and Bridges, and assume design loadings equivalent to the maximum permitted vehicle on the public highway.

9.12.9 The Contractor shall ensure that all roads, car parks and other areas that may be used by fire appliances shall have sufficient headroom for such vehicles and are designed to allow their efficient manoeuvring. The Contractor shall agree with the Board the types of delivery vehicles, which require to be considered in the design. Refer to briefing paper, facilities service yard/compound in Appendix L.

9.12.10 New car parks within the Site shall be designed by The Contractor to comply with applicable SHTM, HTM, HBN 45, HFN 20, HFN 21 and the requirements of Glasgow City Council Roads Development Guide.

9.12.11 Details showing the phased construction of all temporary and new car parking facilities constant with the masterplan shall be provided by the Contractor.

9.12.12 Where areas of surface car parks are required to be traversed by vehicles heavier than 2500kg for maintenance or access purposes, the sub-base and surfacing of these areas shall be specifically designed by The Contractor for these heavier loads.

9.12.13 Roads, delivery and refuse collection areas, and car parks, together with their supporting groundworks and structures, shall be designed by The Contractor to provide full and sufficient access for inspection, maintenance and repair of roads, car parks, delivery and refuse collection areas, structures, underground and underground drainage, including existing drainage items such as manhole covers and drains. Where access for maintenance, repair or replacement of underground services is required under the terms of an easement, the design of all elements affecting the exercise of such an easement shall also be in accordance with the requirements of the company that has the right to exercise the easement.

9.12.14 The Contractor shall also comply with the following criteria:

a) To roads, footways, footpaths and cycleways, construction is to be bituminous and in accordance with Glasgow City Council's Roads Development Guide appropriate for a Traffic Distributor Road;

b) Proposals for differential surfacing to pedestrian crossing areas are sought and shall be submitted by the Contractor for approval. Surfaces shall provide 20 years life before replacement form the date of completion of the works;

c) Cycleways shall include green surface finish utilising a recognised surfacing material which will provide 20 years life before replacement form the date of completion of the works;

d) Pedestrian crossings: types, locations, lighting and controls shall be agreed with the Board (controlled crossings to be included, exact locations to be agreed at design development stage);

e) Kerbs: to comply as a minimum standard with BS7263, Part 1: Pre-cast Concrete channels and edgings;

f) Traffic Signs and Markings to be designed to The Traffic Signs Regulations & General Directions 2002 and The Traffic Signs Manual (part of the Design Manual for Roads &

Bridges), and for the Board's approval. Markings and signage shall dimensioned apposite to a road with a design speed equivalent to 30mph;

g) Supplementary signage to support the management of traffic to preserve the provisions in (a) to (g) above shall be submitted for the Boards approval. Furthermore, the Contractor shall design and provide appropriate signage external to the car parking and other facilities to ensure ease of navigation around the Site for intermittent or infrequent users;

h) Gradients outwith carriageways shall comply with the provisions of HBN 45 and the Building (Scotland) Regulations 2004 as applicable. No gradient in excess of 1:20 shall be allowed in parking areas (other than access roadways), and 1:15 on pedestrian staff, patient and visitor access paths from parking areas to the building entrances;

i) Parking bays: comply with the reference documents, HBN 45, HBN 20, HFN 21 and the item on gradients above. The minimum parking standard parking bay shall be 2.5 x 4.8 m. Variation from the standard (to make optimum use of the space for example) may be desirable and allowed subject to agreement with the Board; and

j) Traffic parking restrictions and parking management: to be agreed with the Board.

9.12.15 Designs shall cater for the access and parking needs of pedestrians and the physically disadvantaged. This shall involve catering for visitors and staff using different modes of transport in adapted vehicles and with multiple aids / equipment.

9.12.16 This is to allow tailgate access by disabled people without the need to set ramps or lifts down within the main circulation routes of car parks. The first and last accessible parking bays in a row of 'in line' spaces shall be provided with a minimum clear area of 1.2m to both sides.

9.12.17 Parking for the transport requirements of deliveries and waste disposal, ambulances, fire appliances and other specialist and emergency vehicles shall be segregated from public and staff parking.

9.12.18 Car parking provision shall take into account the following requirements:

a) Dedicated parking for those with disabilities, the elderly and those with small children located close to the clinical areas, especially for those with limited mobility and eyesight;

b) Space for larger vehicles, which may be fitted with wheelchair ramp or carrying specialist mobile equipment from / to the Works (such spaces will be larger than the normal car parking space);

c) Appropriate zoned parking for night staff as near as practical to the controlled night entrance for staff; and

d) Electric car charging facilities in a minimum of 20nr bays.

9.13 Other External Works

9.13.1 The Contractor shall design the external works for ease of navigation and progression around the site by staff, patients and visitors.

9.13.2 The Contractor shall seek advice from the Board to seek to minimise the risk of crime and vandalism on the Works. This advice shall be pro-actively sought by the Contractor as part of the design process.

9.13.3 The Contractor shall seek advice from Strathclyde Police's crime prevention representative on the proposals for external works to minimise the risk of crime and vandalism on the Site and the Works, including compliance with Secure by Design.

9.13.4 The Masterplan and accompanying landscape drawings demonstrate the general arrangements of the external works.

9.14 Hard Landscaping Requirements

9.14.1 The Contractor shall incorporate into the Works all associated hard landscaping for the Site, including but not limited to, the following:

a) Access and hardstanding for emergency and delivery vehicles;

b) Access for building maintenance and window cleaning;

c) Access and circulation for, visitors and patients on foot, bicycles, in cars or on public transport;

d) Parking for vehicles and bicycles including disabled facilities;

e) Drop-off facilities including lay-bys and bus/transport stops;

f) Service areas, as appropriate;

g) Accommodation for building services plant, waste and materials management, as appropriate;

h) Amenity areas for staff, patients and visitors;

i) Suitable pathways and paving;

j) Protection against noise and environmental pollution;

k) Security provisions, as appropriate;

l) Appropriate Site boundary treatment;

m) Walls, fencing, gates / barriers and hedgerows as appropriate along the Site Boundary and at particular locations inside the Site;

n) CCTV surveillance to all car parks, pedestrian routes, cycle paths, therapy gardens and other specified external areas;

o) External lighting;

p) Suitable means of shelter against adverse weather conditions at entrances, bus/transport waiting, and drop-off locations and covered links provided, as appropriate;

q) Automatic vehicle access barriers; and

r) Fire hydrants.

Section 10.0 Sustainability

10.1 Sustainability

10.1.1 The consideration and implementation of sustainable facilities is a key concern and requirement of the Board in all its functions and activities.

10.1.2 The particular low carbon and sustainability considerations and requirements of the Board are provided in Section 8.0 and Appendix M.

10.1.3 The carbon management plan of the Board is contained for reference in Appendix P.

10.1.4 Guidance with regard to the consideration and assessment of BREEAM points are contained in Appendix U for reference.

Section 11.0 Community Engagement

11.1 Community Engagement

11.1.1 The consideration and implementation of Community Engagement (CE) initiatives is of great importance to the Board. The requirements of the Contractor with regard to CE in relation to the Works are contained in Appendix V.

Section 12.0 Bid Return Requirements

12.0 Bid Return Requirements

12.1 The particular bid return requirements of the Board are identified and listed, along with the evaluation process, in Volume 3 of this ITPD.

12.2 It is anticipated that the bid return information will allow the Board to assess the bids and select a private sector partner to contract with.

12.3 The Contractor will then work with the Board through the Stage 3 Design Development period to produce the FBC design requirements as identified in Appendix K.

From: Bell, Andy
To: Kane, Mary Anne
Subject: FW: Ventilation enquiry
Date: 17 March 2011 09:34:18
Attachments: v26 SHTM 03-01 Part A for consultation.pdf
V17 SHTM 03-01 Part B for consultation.pdf

For information.

Andy Bell
Facilities Management
[redacted]
Mobile [redacted]

From: Stewart Ian (NHS NATIONAL SERVICES SCOTLAND) [redacted]
Sent: 16 March 2011 15:11
To: Bell, Andy
Subject: Ventilation enquiry

Good afternoon Andy.

I have been passed your enquiry regarding maintenance of ventilation plant.

The documents that are relevant are Parts A & B of the forthcoming SHTM 03-01 Ventilation in Healthcare Premises.

This is in final draft awaiting a format check and should be published on the HFS website within the next 6-8 weeks. I can't be more precise as there are around ten new SHTMs waiting in the queue.

In the meantime, I am attaching draft copies of each and hope they will be of help.

Regards,

Ian Stewart
Project Manager
Engineering & Environment
Health Facilities Scotland
NHS National Services Scotland

Empire House
131 West Nile Street
Glasgow
G1 2RX
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NHS National Services Scotland

Scottish Health Technical Memorandum 03-01

Ventilation for healthcare premises
Part A – Design and validation

Health Facilities Scotland
Engineering and Environment

September 2010

A52859616

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Acknowledgements

Health Facilities Scotland would like to thank the principal contributors and the Steering Group led by the Department of Health for their efforts in producing the HTM 03-01 Part A document.

HTM 03-01 Part A has been updated and amended by Health Facilities Scotland for use in NHSScotland as SHTM 03-01 Part A

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Preface

About Scottish Health Technical Memoranda

Engineering Scottish Health Technical Memoranda (SHTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Scottish Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle.

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

It is not the intention within this suite of documents to repeat unnecessarily international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of eight subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.

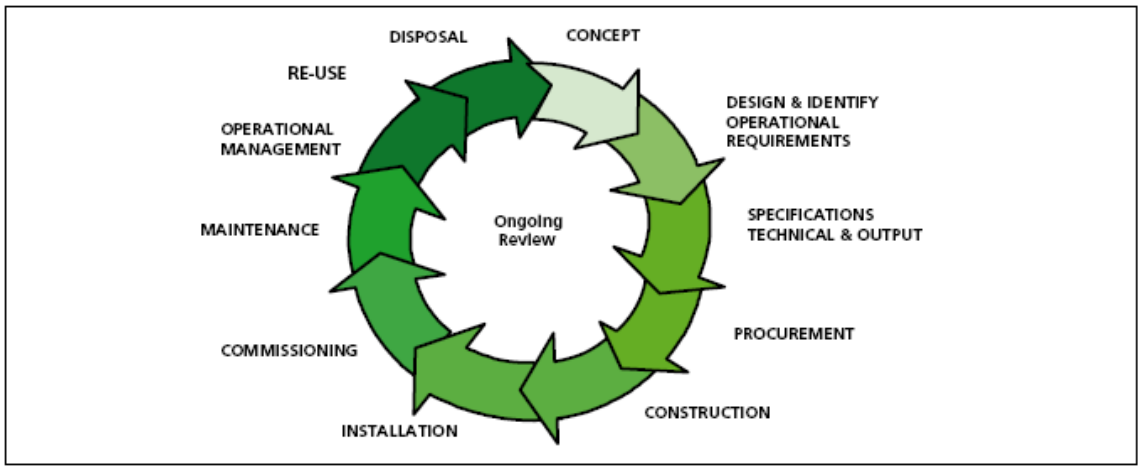

Figure 1: Healthcare building lifecycle

Structure of the Scottish Health Technical Memorandum suite

The series of engineering-specific guidance contains a suite of eight core subjects:

Scottish Health Technical Memorandum 00 - Policies and principles (applicable to all Scottish Health Technical Memoranda in this series).

Scottish Health Technical Memorandum 01 - Decontamination.

Scottish Health Technical Memorandum 02 - Medical gases.

Scottish Health Technical Memorandum 03 - Heating and ventilation systems.

Scottish Health Technical Memorandum 04 - Water systems.

Scottish Health Technical Memorandum 05 - Reserved for future use.

Scottish Health Technical Memorandum 06 - Electrical services.

Scottish Health Technical Memorandum 07 - Environment and sustainability.

Scottish Health Technical Memorandum 08 - Specialist services.

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical Services – Electrical safety guidance for low voltage systems.

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent:

Environment and Sustainability – EnCO_2de.

All Scottish Health Technical Memoranda are supported by the initial document Scottish Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

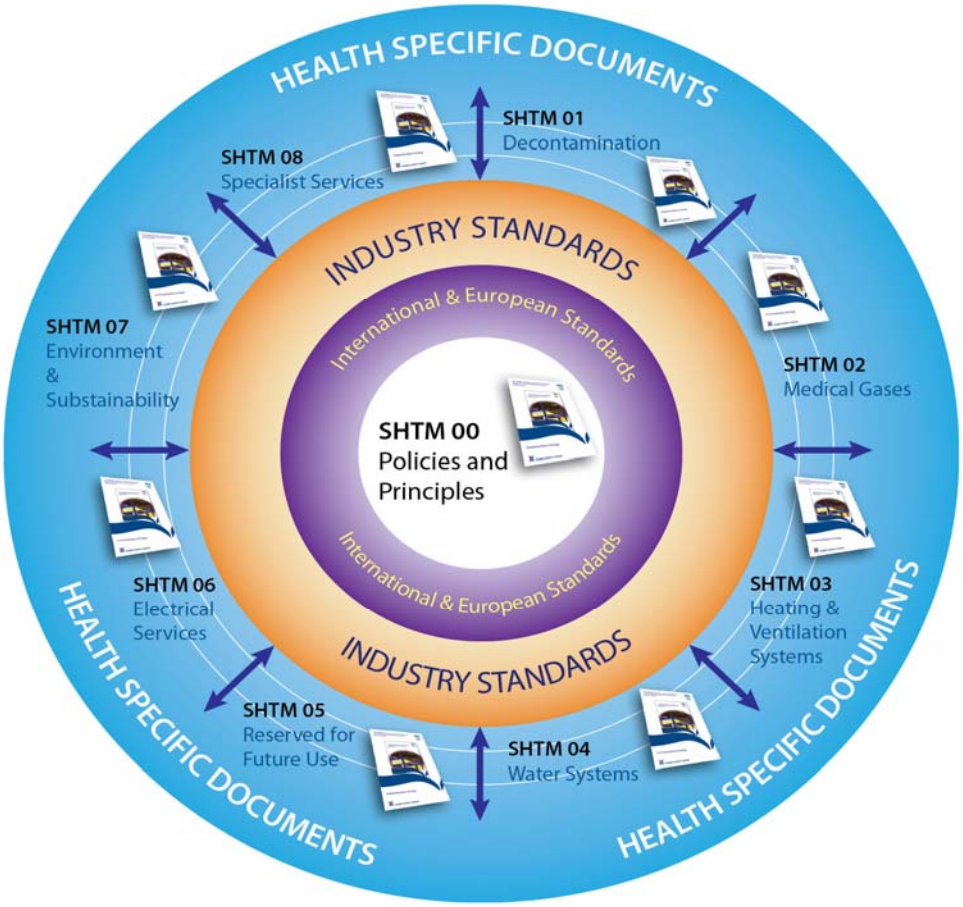

Figure 2: Engineering guidance

1. Introduction

1.1 Ventilation is used extensively in healthcare premises for primary patient treatment in operating departments, high dependency units and isolation facilities. It is also installed to ensure compliance with quality assurance of processed items in pharmacy and sterile supply departments and to protect staff from harmful organisms and toxic substances, for example, in laboratories.

1.2 This edition of Scottish Health Technical Memorandum 03 'Ventilation in healthcare premises' is published in two sections. It is equally applicable to both new and existing sites. It gives comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design implications, maintenance and operation of general and specialised ventilation in all types of healthcare premises.

1.3 Current statutory legislation requires both 'management' and 'staff' to be aware of their collective responsibility.

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

1.5 Ventilation systems in themselves present little danger to patients or staff. However, they do possess the ability to transmit hazards arising from other sources to large numbers of people. The danger may not become apparent until many patients and staff have been affected.

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

1.7 The Health and Safety at Work etc Act 1974 (HSW Act 1974) is the core legislation that applies to ventilation installations. As these installations are intended to prevent contamination, control closely the environment, dilute contaminants or contain hazards. Their very presence indicates that risks to health have been

Statutory requirements

1.8 The Control of Substances Hazardous to Health (COSHH) regulations place upon management an obligation to ensure that suitable measures are in place to protect their staff and others affected by the work activity. These methods may include both safe systems of work and the provision of a specialised

ventilation system. In laboratories the requirements are often met by the provision of fume cupboards and safety cabinets.

1.9 The existing requirements to provide ventilation, implicit under HSW Act 1974 and COSHH, have been made explicit by the Management of Health and Safety at Work Regulations 1999, the Workplace (Health, Safety and Welfare) Regulations 1992 and the Provision and Use of Work Equipment Regulations 1998, all issued as a result of European Directives.

1.10 Where specialised ventilation plant is provided as part of the protection measures there is a statutory requirement that it be correctly designed, installed, commissioned, operated and maintained. The local exhaust ventilation (LEV) section of the COSHH regulations requires that the plant be inspected and tested at least every 14 months by an independent organisation and that management maintain comprehensive records of its performance, repair and maintenance.

1.11 Certain substances have Occupational Exposure Limits (OEL) set out in Guidance Note EH 40 published annually by the Health and Safety Executive. If special ventilation systems are provided in order to achieve these standards they will be subject to the COSHH regulations as above.

1.12 All ventilation systems should conform to the principles set out in the 'Approved Code of Practice on the Prevention or Control of Legionellosis' published by the Health and Safety Commission and Scottish Health Technical Memorandum SHTM 04-01 – The control of *Legionella*, hygiene, "safe" hot water, cold water and drinking water systems.

1.13 Special ventilation plants installed in laboratories dealing with research, development or testing, whether involving drugs, animals or genetically modified organisms, may be subject to particular legislation with regard to their operation in addition to that mentioned above. Further information is given by the Health and Safety Commission Health Services Advisory Committee in:

- safe working and prevention of infection in clinical laboratories;
- safe working and prevention of infection in clinical laboratories: model rules for staff and visitors;
- safe working and prevention of infection in clinical laboratories in the mortuary and post-mortem room.

1.14 Plants installed in units manufacturing medicinal products to the standards set out in the current European Guide to Good Manufacturing Practice may also be subject to particular legislation with regard to their operation in addition to that mentioned above.

1.15 Records should be kept of equipment design and commissioning information. The Health and Safety Executive, Medicines Inspectorate and other interested bodies have a statutory right to inspect them at any time. All records should be kept for at least five years.

1.16 The fire regulations require that if ventilation ductwork penetrates the fabric of a building it should be designed and installed so as to contain the spread of fire.

1.17 Increased health risks to patients will occur if the more specialised ventilation systems installed to supply high quality air to operating departments do not achieve and maintain the required standards. The link between post-operative infection and theatre air quality has been well established. Plants serving conventional operating departments, for instance, will be required to ensure the separation of areas within the suite by maintaining a specific direction of air flow between rooms, even when doors are opened. They will also maintain the selected operating department environmental conditions regardless of changes in the outside air conditions or activities within the space. In addition ultra-clean operating ventilation systems that are designed to provide an effectively particle-free zone around the patient while the operation is in progress, have been shown to reduce significantly post-operative infection in patients undergoing deep wound surgery. Their use for other forms of surgery may well be indicated.

1.18 Ventilation systems that can be shown to be inappropriate, inadequate or ineffective and that give rise to proven failures can result in a civil suit by the patient against the operators.

1.19 If the plant has been installed to dilute, extract or contain harmful substances, its failure may expose people to unacceptable levels of hazard. Proven failures can give rise to a civil suit against the designers and operators by the individuals who have been affected. This would be in addition to the actions brought as a result of breaching the statutory requirements.

1.20 There is a statutory requirement to provide ventilation in all enclosed workspaces. It may be provided by either natural or mechanical means. The following are some of the factors that determine the ventilation requirements of a workspace:

- human habitation (minimum fresh air requirement);
- the activities of the department, that is, extraction of odours, aerosols, gases, vapours, fumes and dust – some of which may be toxic, infectious, corrosive, flammable, or otherwise hazardous (see Control of Substances Hazardous to Health (COSHH) regulations;
- dilution and control of airborne pathogenic material;
- thermal comfort;
- the removal of heat generated by equipment (e.g. catering, wash-up, sterilising areas, electrical switch rooms, Uninterruptible Power Supply (UPS) cupboards and some laboratory areas);
- the reduction of the effects of solar heat gains where other forms of reducing the solar effect is not available or practical, i.e. solar blinds;
- the reduction of excessive moisture levels to prevent condensation (for example Hydrotherapy pools);

- combustion requirements for fuel burning appliances (see BS5376, BS5410 and BS5440);
- 'make-up' supply air where local exhaust ventilation (LEV) etc., is installed.

Mechanical ventilation systems are expensive in terms of capital and running costs, and planning solutions should be sought which take advantage of natural ventilation either where the use of the area in question is not critical to airflow patterns or pressures, or where backup systems are available when natural ventilation cannot be achieved.

1.21 When new ventilation systems are accepted for use, full information as to their designed mode of operation together with recommended maintenance procedures should be provided as part of the handover procedure.

Requirement	Reason	Application
Statutory	Health and Safety at Work etc Act	Operating department Laboratories Pharmacy
	COSHH regulations	Areas containing identified biological or chemical hazards Areas containing oxygen displacing gases
	Local Exhaust Ventilation (LEV)	Enclosed work-spaces Workshops
Functional	Comfort	Situations where the quality of the environment for staff and patients is critical to their general performance and well-being
Clinical	Post-operative infection reduction	Operating suites used for general surgery, casualty, obstetrics/gynaecological and maternity procedures
	Reduction of deep wound sepsis	Ultra-clean operating suites for transplant, deep wound surgery, hip replacement, bone grafting and bone marrow transplant procedures
	Isolation from contact with bio hazards	Isolation units for patients who present a biological, chemical or radiation hazard to others. Isolation units for patients with a reduced immune system

Table 1: Reasons for providing ventilation

Functional overview – Terms in use

1.22 The terms 'ventilation' and 'air-conditioning' are often incorrectly used to describe the same equipment. A general explanation of the terms is given below.

Ventilation

1.23 Ventilation is a means of removing and replacing the air in a space. In its simplest form this may be achieved by opening windows and doors. Mechanical ventilation systems provide a more controllable method. Basic systems consist of a fan and either collection, (extraction) or distribution (supply) ductwork. More complex systems may include the ability to heat and filter the air passing through them. Ventilating equipment may be required in order to remove smells, dilute contaminants and ensure that a supply of 'fresh' air enters a space.

Air-conditioning and mechanical cooling

1.24 Air-conditioning is the ability to heat, cool, dehumidify and filter air. For full air-conditioning, humidification may also be provided. This means that the climate within a space being supplied by an air-conditioning plant can be maintained at a specific level regardless of changes in the outside air conditions or the activities within the space. Mechanical cooling may be provided where close control of 'comfort conditions' within a space is required but humidity control is not needed.

Special ventilation

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

- to remove, contain or dilute specific contaminants and fumes;
- to ensure the isolation of one space from another;
- to preserve a desired air flow path from a 'clean' to a 'less clean' area;
- to provide control of the cleanliness of a space;
- to provide 'close' control of temperature;
- to provide 'close' control of humidity.

1.26 The following departments will usually have specialised ventilation requirements, either for a single room or throughout a suite of rooms:

- operating department;
- laser surgery unit;
- intensive treatment unit;
- infectious diseases isolation unit;
- manufacturing pharmacy;
- specialised imaging, X-ray and scanning unit;

- pathology containment laboratories;
- mortuary and dissection suite;
- research laboratory;
- sterilising and disinfecting unit (SDU);
- endoscopy unit;
- renal dialysis suite;
- ultrasound facilities;
- audiology room.

1.27 Ventilation may be provided in a wide variety of ways. These will include:

- extensive purpose-built air-conditioning units housed in their own plant rooms;
- proprietary 'packaged' systems often sited outside on a roof or;
- wall-mounted electric fans located at the point of use.

1.28 A fixed volume of air may be supplied, often expressed in terms of the resulting number of air changes per hour (ac/h) within the space being ventilated. It may also be expressed in terms of litres/second/person. Alternatively the volume of air supplied may be varied in order to maintain a specific pressure relationship between the area supplied and other surrounding areas. In some situations a combination of both methods may be adopted.

1.29 Modern plants are fitted with the means to recover energy from the extract air where this can be justified without causing contamination of the incoming supply air.

1.30 Ultra-clean systems use the same basic plant and equipment as standard air-conditioning but are in addition fitted with a terminal device that supplies the air in a unidirectional manner to the working area. Their standard of filtration will be capable of delivering air with a very low particle count to the space that they serve.

Local exhaust ventilation

1.31 Local exhaust ventilation (LEV) is a term used to describe systems installed to prevent hazardous substances from entering the general atmosphere of the room in which they are being used. Their primary function is to protect staff from the effects of their work activity.

1.32 Simple LEV systems comprise a capture hood, extract ductwork and fan. These are used to contain industrial types of hazard such as fumes from welding processes, gas discharges from standby battery banks and dust from woodworking machinery. The vapour given off when large quantities of chemicals are decanted into ready-use containers and fumes from X-ray film processing units are further examples of chemical hazards often controlled by LEV systems.

1.33 In laboratories, pharmaceutical manufacturing facilities and operating suites, LEV systems usually take the form of semi-open fronted cabinets within which the hazardous substance is manipulated. These cabinets either have their own filtered air supply or are fed with air from the room. The air extracted from the cabinet is passed through a high-efficiency filter before being discharged either to the atmosphere or back into the room. Microbiological safety cabinets, laboratory fume cupboards, cytotoxic drug cabinets and fixed or mobile disinfection enclosures are all examples of this type of facility.

1.34 Mortuaries and dissection suites may have LEV systems incorporated within the dissection table, specimen bench and bone saw.

Management action

1.35 The guidance contained in this SHTM should be applied in full to new installations and major refurbishments of existing installations.

1.36 Ventilation will need to be provided:

- as a requirement for patient care;
- in order to fulfil a statutory duty.

1.37 In assessing the need for more specialised ventilation and the standards desired for patient care, managers will need to be guided by their medical colleagues and by information published by Health Facilities Scotland.

1.38 The statutory need for ventilation falls into two categories:

- in the first, the need for specialised ventilation and the standards to be adopted are clearly set out in specific pieces of legislation. An excellent example of this is the current legislation surrounding the manufacture of medicinal products in the European Community. The managers of the departments affected by this type of legislative requirement should be aware of their needs and be able to advise on the standards to be achieved;
- the second type of statutory requirement arises due to the interpretation of both the Health and Safety at Work etc Act and the Control of Substances Hazardous to Health (COSHH) regulations. The person tasked with conducting COSHH assessments will be able to advise as to the need for, and standard of, ventilation in each particular case.

Design and validation process

1.39 It is essential when undertaking the design of a specialised ventilation system that the project be considered as a whole. The process model set out below should ensure that all relevant factors are considered.

Step	Question	Design statement and information required	Comment
1	Why is the system required?	Healthcare applications Statutory elements Non-healthcare applications	
2	What is the required system performance?	Room air flow pattern Air change rate Differential pressures Air quality Room air condition Noise limits	
3	What are the constraints on the distribution system?	Location, Size, Materials Dampers, Access, Insulation Fire considerations Room terminals	
4	What are the minimum requirements for the AHU(s)?	Intake / Discharge positions *Legionella*, Health and Safety Access, Fire, Electrical safety Leaks, Insulation, Cleanliness Filtration, Drainage	
5	What control functions are required?	User control requirements Estates control functions Energy management Environmental conditions Control sequence logic Run, Set back, Off philosophy	
6	How will the system performance be validated?	Validation methodology Instruments used Design information required [*Design air flow rates* *Design air velocities* *Pressure differentials* *Noise levels* *Air quality* *Installation standard*]	
7	The system will only 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.		
8	Handover to client	Basic design information Commissioning results Validation report	

Table 2: Design and Validation process model

Use and function of typical equipment used in ventilation plant

1.40 Typical equipment used in ventilation systems is listed below together with a brief description of both function and use.

General

1.41 The equipment built into the ventilation system and its ductwork should be of a type that will neither cause nor sustain combustion. No materials that could sustain biological activity should be used in the construction or assembly of the system.

Air Intake

1.42 An uncontaminated air supply to the system is essential. In order to achieve this, the air intake will be positioned so that air discharged from extract systems or other dubious sources cannot be drawn in. Exhaust fumes from vehicles can present particular problems. The area surrounding the intake will need to be kept clean and free of vegetation and waste material in order to reduce the possibility of biohazards or fire. The intake itself will be protected by a louvre and mesh screen to prevent rainwater, vermin and insects etc from entering the system.

Damper

1.43 Several types may be fitted:

- automatic dampers fitted immediately behind the air intake and extract louvres. They will automatically close when the system is shut down in order to prevent an uncontrolled circulation of air;
- balancing dampers are fitted into each branch of the air distribution ductwork system so that the design air flow rate can be set during the commissioning process;
- where ductwork passes through a fire compartment wall, ceiling or floor a fire and/or smoke damper may be required;
- plant isolating dampers are fitted so that the main plant can be isolated from its air distribution duct system. They are manually operated and enable cleaning and maintenance of the air-conditioning equipment to be carried out.

Ducting

1.44 The means by which air is conveyed from the intake to its point of use. Ducting is usually constructed of galvanised steel and will normally be insulated to reduce noise and conserve energy. Ducts can also be formed in concrete, brickwork, stainless steel or plastic and may be rigid or flexible.

Fan

1.45 A series of rotating blades that move the air in the direction required. Fans are usually powered by electric motors either directly connected to them or driven through belts and pulleys. A fan may be arranged either to force air into or draw air from a ductwork system.

Attenuator / silencer

1.46 A device that will contain and absorb the noise emitted by a fan. They may be required to reduce disturbance caused by noise breaking out through the air intake and also noise transmitted along the ductwork to the conditioned space.

Filter

1.47 A filter consists of a labyrinth of fibrous material contained in a frame. It is designed to capture and hold particles being carried in the airstream. Because of the size range and number of particles that exist in air no filter can remove them all. The purpose of filtration is to reduce their number and size range to an acceptable level. Filters of progressively higher grades are fitted through the ventilation system:

- primary filters (coarse) are designed to collect the larger particles and are intended to keep the air-conditioning plant clean;
- secondary filters (fine) will remove the staining particles from air and keep the conditioned space visibly clean;
- high efficiency particulate air filters (HEPA/absolute) will remove virtually all particles from air. These may be required in order to reduce contamination in the working area either biologically or in terms of particle count.

Filters may be fitted to extract systems to protect energy recovery devices. They may also be fitted to remove biological, radiation or chemical hazards and if so, are often contained in a ‘safe change’ facility in order to protect those carrying out maintenance.

Activated carbon filters will reduce odours in extracted or recirculated air.

Heater battery / heater coils

1.48 A series of heater batteries or heating coils with or without fins through which steam or hot water is circulated. Heat is given up to the air passing over the battery thus increasing its temperature. Heating is usually carried out in stages, the final battery being controlled by the end user. Small batteries may be electric.

Humidifier

1.49 A device for increasing the humidity of air by adding moisture. For ventilation in healthcare premises this is normally achieved by releasing ‘clean’ steam into an

air supply duct. The steam will be completely absorbed into the air, increasing its humidity. The level of humidity may be preset or controlled by the end user.

Cooler battery / cooling coil

1.50 A series of finned coils mounted in the air supply duct. Either chilled water or refrigerant is circulated through the coils causing heat to be removed from the air. This will reduce its temperature and may also condense moisture out of the air. As free moisture in a duct can be a source of contamination the coil will be fitted with an eliminator and drainage system.

Eliminator

1.51 A device for catching and removing water droplets from an air stream. It may form part of a cooling coil or be a separate device.

Drainage system

1.52 A means of removing water from ductwork and disposing of it safely. Typically it will consist of a tray mounted in the duct to catch moisture, a glass water seal trap, continuously falling drainage pipework and an air break in the drain run to prevent waste water returning and contaminating the duct.

Access doors and observation ports

1.53 Doors and removable panels providing access for routine maintenance and cleaning. The doors should be fitted with glazed ports and suitable lighting provided so that the correct operation of devices such as cooling coils, humidifiers and filters can be easily observed without needing to switch off the plant.

Energy recovery

1.54 Many plants are fitted with the means to recover energy from the extract air without causing contamination of the incoming supply air. These devices will be fitted with a drainage system and may incorporate an eliminator. Several types of energy recovery systems are available.

1.55 Precise definitions of ventilation and air-conditioning terms are given in the CIBSE Guide B.

Typical plant

1.56 The layout of a typical plant that conforms to the requirements for healthcare applications is shown in Figure 3 below. It contains most of the equipment described above.

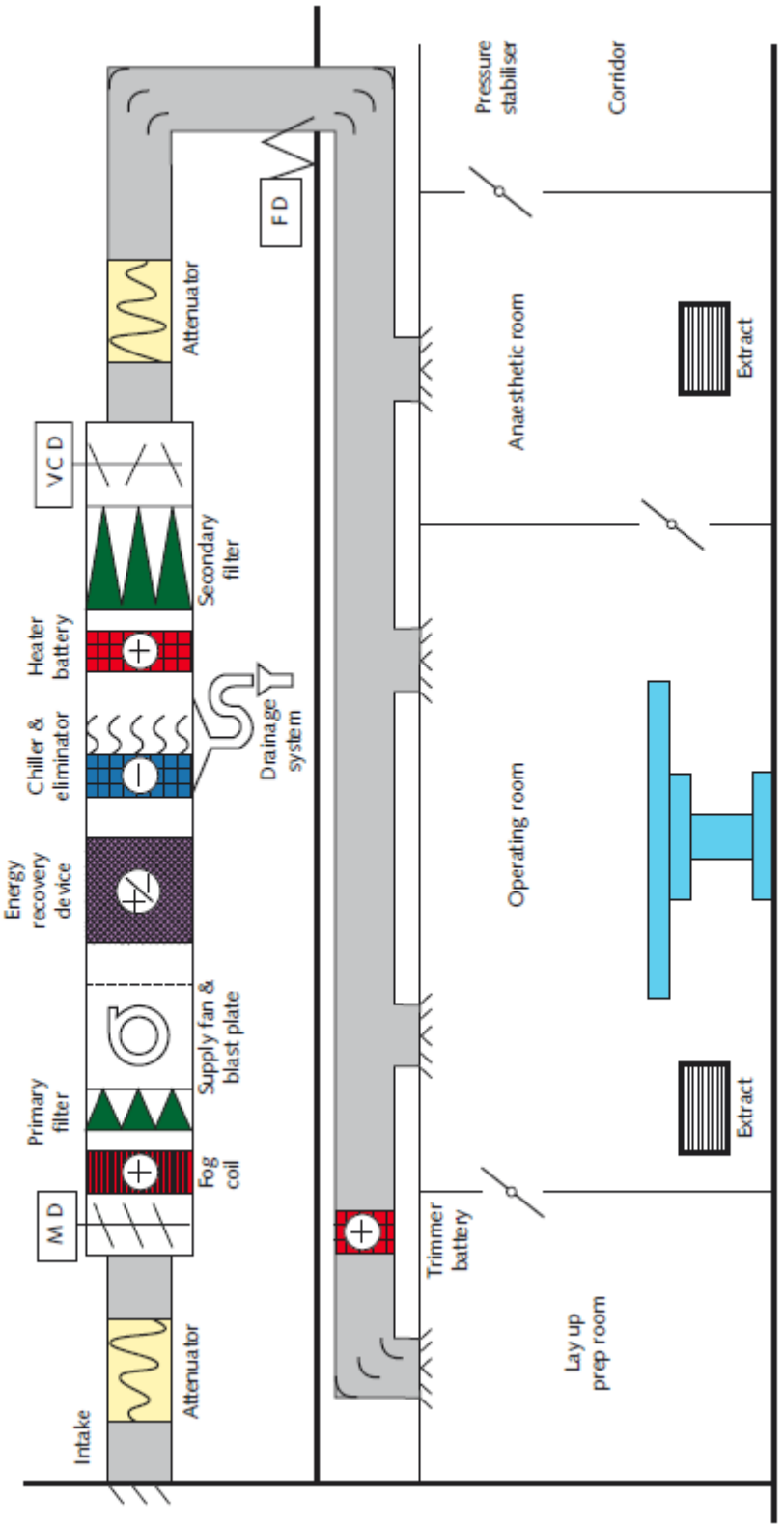

Figure 3: Design and Validation process model

2. Provision of ventilation in healthcare buildings

2.1 It is acknowledged that planning constraints imposed by the building shape and/or functional relationships of specific areas will invariably result in some measure of deep planning thus reducing the opportunity for natural ventilation. However, ventilation costs can be minimised by ensuring that where practicable, core areas are reserved for rooms that have a functional requirement for mechanical ventilation. Examples are sanitary facilities, dirty utilities and those rooms where clinical or functional requirements have specific environmental needs; and where for reasons of privacy, absence of solar gain etc., windowless accommodation is acceptable. Other spaces appropriate to core areas are those that have only transient occupation and therefore require little or no mechanical ventilation, for example circulation and storage areas.

Natural ventilation

2.2 Natural ventilation is usually created by the effects of wind pressure. It will also occur if there is a temperature difference between the inside and the outside of the building. The thermo-convective effect frequently predominates when the wind speed is low and will be enhanced if there is a difference in height between inlet and outlet openings. Ventilation induced by wind pressures can induce high air change rates through a building provided air is allowed to move freely within the space from the windward to the leeward side.

2.3 As the motivating influences of natural ventilation are variable, it is almost impossible to maintain consistent flow rates and ensure that minimum ventilation rates will be achieved at all times. This variability is normally acceptable for general areas including office accommodation, general wards, staff areas, libraries rooms, dining rooms and similar areas which should, where possible, be provided with opening windows of a design that facilitates natural ventilation.

2.4 Current guidance restricts the amount windows can be opened for safety reasons and as many designs are top-hung, their ability to permit natural ventilation is limited. It may therefore be necessary to provide dedicated ventilation openings in the fabric of the building to allow a sufficient natural flow of air into and out of the space. Paragraph 2.20 also refers.

2.5 In all cases, excessive heat gain, indoor air quality requirements or external noise may limit or preclude the use of natural ventilation.

Extract ventilation systems

2.6 Separate extract ventilation will be required for sanitary facilities, lavage areas, dirty utilities and in rooms where odorous, but non-toxic fumes are likely, in order to ensure air movement into the space. 10 air changes per hour have been found necessary, particularly in geriatric and psycho geriatric

accommodation. This will assist with control of infection procedures. A single fan/motor unit can be suitable for individual rooms, but multi-room systems should be provided with duty and standby fans or motors to meet this need.

2.7 Toilets should have an extract rate as set out in the building regulations. Where WC's are located in shower and bathroom spaces, the ventilation required for the WC will normally be adequate for the whole space.

Supply only ventilation

2.8 Mechanical supply ventilation will be required in areas where it is important to maintain a positive pressure in order to prevent the ingress of less clean air, e.g. in pharmacy aseptic suites, sterile supply packing rooms, operating theatres and their preparation rooms (air change rates are given in Table A1 within Appendix 1).

Supply and extract ventilation

2.9 Mechanical supply and extract ventilation should be provided in rooms where there is a need to control room pressure in relation to adjacent spaces. ICU, isolation suites and treatment areas are typical applications.

Mechanical or comfort cooling

2.10 Cooling is very expensive in terms of energy costs and should be provided only where necessary to maintain a comfortable environment for staff and patient, or to ensure satisfactory operation of equipment. The imaging department in particular may require cooling to offset the equipment load.

2.11 Calculations and thermal modelling should be undertaken to ensure that during the summertime, internal temperatures in patient areas do not exceed 28°C (dry bulb) for more than 50 hours per year taking into account the level of design risk for the application.

2.12 Certain non-patient areas may also require cooling and will typically include some laboratories, central wash-up and other areas that are subject to high equipment heat gains.

2.13 Where deep planning of other continuously occupied spaces, for example offices, is unavoidable, there will also be occasions when acceptable levels of comfort can only be maintained by cooling. Planning solutions of this type however will be exceptional.

2.14 Refrigeration plant should be of sufficient capacity to offset heat gains and maintain areas at a temperature that does not exceed the external design shade temperatures by more than about 3°C taking into account the level of design risk for the application.

Air-conditioning

2.15 Full air-conditioning is only required in a very small number of areas within healthcare buildings and due to the capital and running cost its inclusion should be kept to a minimum. Paragraphs 3.14, 3.15 and 4.91-4.93 also refer.

2.16 Areas whose functions may warrant the installation of air-conditioning include operating departments, intensive therapy units, manufacturing pharmacies and areas with particularly sensitive equipment.

Specialised ventilation

2.17 Due to the nature and extent of activities carried out in healthcare buildings, there will be a need for a wide range of specialised ventilation systems. The types of system which are generally required in individual departments and typical arrangements are given in Section 7.

2.18 The activities within some departments will require the provision of local exhaust ventilation (LEV). This is a statutory requirement under COSHH wherever the escape of chemicals, toxic fumes, biological material or quantities of dust into the general area would present a hazard to the occupants.

Ventilation for general areas

2.19 Table A1 in Appendix 1 provides recommended air change rates, temperatures and pressures for general areas that require mechanical ventilation in healthcare buildings.

Use of natural ventilation

2.20 The air tightness of new buildings has improved to the point that infiltration through building leakage can no longer be relied upon to provide sufficient air-flow. Attention must therefore be given to the provision of purpose made ventilation openings to achieve the necessary flow rates. The air entering the openings may need to be controlled by motorised dampers linked to temperature and / or occupancy sensors in the ventilated space.

2.21 Internal partitions, fire compartment walls and closed doorways can often impede the flow path, and when this happens, the process will be more dependent on single-sided ventilation. Nevertheless, even with this degree of compartmentation, acceptable ventilation may still be achieved without window openings that would prejudice safety, security or comfort.

2.22 Some types of window, for example, vertical sliding, can enhance single sided air change by temperature difference, and these will improve the overall rate of natural ventilation in protected or sheltered areas where the effect of wind pressure is likely to be minimal.

2.23 It is generally considered that natural cross-flow ventilation is able to give reasonable air distribution for a distance of up to 6 metres inwards from the external facade, provided that reasonably clear air paths are maintained. Beyond this distance in areas where clear air paths cannot be maintained and in areas where high minimum air change rates are specified, mechanical ventilation should be provided.

2.24 Further information can be found in SHTM 55 'Windows', BS5925 'Code of practice for ventilation principles and designing for natural ventilation' and CIBSE Applications Manual AM10: 'Natural ventilation in non-domestic buildings'.

Mixed mode ventilation

2.25 This comprises an assisted form of natural ventilation. Fans are fitted in the purpose made damper-controlled ventilation openings. Alternatively a separate ventilation unit may be installed. In both cases the dampers and fans are controlled under the dictates of temperature and occupancy sensors to ensure a minimum air flow rate while taking advantage of natural ventilation effects when present.

2.26 Where natural or mixed mode ventilation is adopted with complex air paths, the designer should produce an air flow diagram in order to ensure correct provision of air transfer devices. CIBSE Applications Manual AM13: 'Mixed mode ventilation in non-domestic buildings' gives guidance.

Mechanical extract ventilation

2.27 General extract systems can vary in complexity from a single wall-mounted fan to a ducted air system with dual extract fans.

2.28 Replacement air is generally provided by a central supply system (as described below). Unless special precautions are taken, the latter may result in an unacceptable level of draughts occurring in winter, and possible risk of unacceptable levels of noise transmission.

2.29 If individual systems are used, the ventilation can be operated intermittently, provided it continues to run for at least 15 minutes after the room is vacated, as with light switch-operated fans in individual toilets.

2.30 If general exhaust systems are used; it is recommended that filtered and tempered replacement air is provided via a central supply plant to adjoining lobbies or corridors, to prevent the risk of discomfort caused by the ingress of cold air. Fire compartmentation requirements must be maintained.

2.31 Information on specialised extract systems is given in Section 7.

Mechanical supply systems

2.32 Where mechanical supply systems are required, the fresh air should be tempered and filtered before being delivered to the space, to avoid discomfort.

2.33 The air should be heated using a constant or variable temperature source, but generally only to the space air temperature. In most instances, the low-pressure hot water heating (LPHW) should offset any fabric loss, so that setback room temperatures can be maintained during unoccupied periods without the need for the ventilation system to operate.

Balanced ventilation

2.34 Balanced ventilation systems are merely a combination of a supply and extract systems of equal volume; and either a single space or a whole building may be considered to be balanced. A balanced system is necessary in instances where it is essential to maintain consistent air movement within an area, for example, treatment rooms.

Cascade ventilation

2.35 In operating departments it is normal practice to supply air to the operating room, and allow it to pass through less clean areas – corridors, utility rooms etc. (from where it is eventually extracted).

Recirculation systems

2.36 Due to the nature of the use of mechanical ventilation systems within healthcare buildings, there are few opportunities for the application of recirculation air systems. They are however normally used for HEPA filtered clean room applications where the extract air is significantly cleaner than the outside supply. Recirculation is also routinely used in the canopy section of Ultra Clean Operating theatre ventilation systems.

2.37 Where the designer is considering the installation of a recirculation air system, due account must be taken of:

- minimum fresh air supply volume required by the Building Regulations (currently 20%);
- prevention of contamination of supply air from vitiated air in extract systems;
- prevention of stratification occurring within plenum chambers and mixing boxes which may result in freezing of downstream coils;
- ensuring sufficient velocities through control dampers (ideally 5-6 m/s) to provide suitable authority; and good shut-off;
- modulating control of mixing to provide optimum on-plant conditions;

- use of 'free cooling' by cycling the dampers to minimum fresh air when the enthalpy of the outside air is above that of the extract air under conditions when cooling is required.

Chilled beams

2.38 The use of chilled beams for the provision of heating, cooling and ventilation is increasingly common in healthcare premises. The use of Active Chilled Beams providing tempered filtered air to a heating / cooling device within the room can provide effective local control of environmental conditions.

2.39 Care should be taken in positioning chilled beams to ensure the avoidance of cold draughts particularly when used in the cooling mode. The control settings should ensure that the external elements of the beam are always above dewpoint.

2.40 Consideration should be given to the ease with which specific types of chilled beam units can be accessed for cleaning having regard to the need to control the infection risk. The impact of maintenance requirements on room availability should also be considered.

Split comfort air-conditioners

2.41 Split comfort air-conditioners, room conditioners or cassette units are used increasingly where there is a small local requirement for cooling for operational purposes. They can provide an effective economic solution to cooling needs, where a central refrigeration system is not practicable.

2.42 The units re-circulate room air so provision for a fresh air make up, either by natural or mechanical means, to the standard required by the Building Regulations must be provided.

2.43 The recirculation of room air presents problems with indoor air quality (IAQ) and may increase the risk of healthcare associated infection (HAI). Split units should not therefore be used in critical patient areas.

2.44 Split units may be used for single room applications or as multiple linked units that can independently provide either heating or cooling, all served by a single outdoor unit. These systems enable good temperature control of a number of rooms with maximum energy efficiency.

2.45 Whether single or multiple systems are used, it is essential that the designer gives due consideration to the source of electrical supply, location of the heat rejection unit, environmental effects to the refrigerant used and drainage provision for the cooling coil condensate.

2.46 The units will require routine maintenance for filter change and cleaning; they should therefore be installed in an accessible position.

Dilution ventilation and clean air flow paths

2.47 Dilution ventilation has in the past been used to control levels of hazardous substances in a space. This approach is no longer considered acceptable. The COSHH Regulations require that known hazardous substances should be substituted by safe alternatives. If this is not possible then they should be controlled at source by the use of closed systems such as anaesthetic gas scavenging units or exhaust protective enclosures such as fume cupboards.

2.48 The exposure of staff to casual spillages of substances such as medical gases in anaesthetic rooms should in the first instance be dealt with by establishing a clean airflow path. Air should be supplied at high level and extracted at low level directly behind the anaesthetic equipment position. The philosophy of establishing a clean air-flow path from the supply point; to the staff; on to the patient and out via a low level extract would also apply in recovery rooms and maternity delivery rooms including labour, delivery, recovery & post partum (LDRP) Rooms. A suitable air change rate will provide dilution ventilation as an additional safeguard; see Table A1 in Appendix 1 and Table A2 in Appendix 2, Note c.

2.49 In operating theatres the patient will be on a closed breathing circuit in a room with a high air change rate. Under these circumstances the dilution effect would be considered sufficient to control any casual exposure to anaesthetic gases.

Mechanical ventilation systems

System selection

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

Choice of central/local plant

2.51 Mechanical ventilation is expensive to operate, and as such, should be controlled to operate when the space being served requires to be ventilated. In addition, loads on refrigeration plant are rarely constant owing to changes in solar gain, occupancy and use of heat-generating equipment and lights, therefore control of temperature is critical.

2.53 If the ventilation loads throughout a department or building are in phase, or are not significant, a central plant with single zone control can be adopted. However, this is rarely the case, and elsewhere, the condition or quantity of supply air to different areas or zones of the building must be varied accordingly. This can be done by providing either individual plants to each zone, or separate zone terminal control. Where there is a high density of rooms with similar ventilation requirements in an area of a building or department, it is usually economical to combine them into a central system.

2.54 In large buildings, a choice between a single distribution system and multiple smaller systems may arise. Large distribution systems and their plant can have the advantage of lower operating costs, but require more space for vertical shafts. In general, very long runs of ducting should be avoided to prevent undue heat losses or gains, excessive leakage, and difficulties in balancing during commissioning. As the pressure losses in the long runs will be greater and a higher initial static pressure will be required, this will lead to a more expensive class of ductwork. Multiple smaller distribution systems may be more expensive in capital and operating costs but they avoid long runs, large ducts and vertical shafts, and this may reduce overall building costs. They also provide a more robust service as the failure of an individual system does not prevent the use of the rest of the building.

Zoning of the building

2.55 The efficiency and effectiveness of any ventilation or air-conditioning installation depends largely on the zoning and control of the installation. The factors to consider when determining the zoning of a ventilation system for a building or department are:

- periods of occupancy;
- fresh air/ventilation requirements;
- smoke control.

2.56 Where the ventilation system is not merely tempering the air, but also providing the heating and/or cooling requirements, the following additional factors will need to be considered:

- internal or peripheral location;
- orientation of windows;
- variation in internal loads;
- level of control required.

2.57 For single zone plant in staff areas, local control (with a run-on timer if required) is recommended, as this can be turned off when the space is not in use, thus saving both thermal and electrical energy. Most supply and extract systems, conversely, are required to operate continuously while the department is occupied, thus some form of time or use control is necessary.

2.58 The control of individual plant items is covered in Section 4, with examples of typical control strategies in Section 6. For control of particular specialised ventilation and air-conditioning systems refer to Section 7 of this document.

2.59 On very rare occasions a duplicate standby air handling plant may be justified. If installed it must be provided with a gas-tight damper at its junction with the supply distribution duct, so that no back-flow can occur. Standby plants can become sources of contamination if warm moist air is allowed to dwell within them. Their design and control system must ensure that this cannot happen.

Specific requirements for hospital departments

2.60 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).

3. Assessment of service requirement

Selection of design criteria

External design conditions

3.1 The most accurate data that is available for the summer and winter conditions at the site should be used. The Metrological office can supply data for the United Kingdom.

3.2 Healthcare mechanical ventilation systems will normally be 'full fresh air'.

3.3 Local adjustments such as for height above sea level, exposure factor, or other climate peculiarities, should be made as appropriate.

Internal design conditions

3.4 The design conditions selected within patient areas must strike a balance between the comfort requirements of staff and patients, who often have very different levels of clothing and activity.

3.5 Recommendations for the dry resultant temperature and humidity of individual spaces are shown on Activity Database (ADB) A-Sheets. Appendix 1 Table A1 gives a summary.

Minimum fresh air requirements

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

3.7 Where odour dilution is the overriding factor, it is recommended that 10 litres/second/person should be taken as the minimum ventilation rate.

3.8 Smoking is not permitted in healthcare premises. If permitted for example in residential care, it will be confined to designated areas. It therefore follows that these areas will contain a high percentage of smokers so the ventilation rate would be at least 36 litres/second/person for these applications (CIBSE Guide A; Table 1.10 refers).

3.9 In non-standard applications such as laboratories, aseptic suites, operating departments, etc., the particular requirements for each area should be considered independently in order to determine the overriding minimum requirement for ventilation.

Limiting supply air conditions

3.10 For most applications in healthcare buildings, it is the temperature differential between the supply and room air, rather than the actual temperature of the supply air which is the critical factor. The maximum recommended supply-to-room air temperature differential is:

summer cooling: - 7K

winter heating: + 10K

3.11 It is also necessary to keep supply air humidity below 70% during winter in order to minimise risks associated with condensation.

Air purity

3.12 In healthcare premises, the standard of filtration will depend on the activities within the occupied spaces. With the exception of special areas, (for example manufacturing pharmacies), the requirement for aerobiological needs is not stringent and filtration is only required to:

- maintain hygienic conditions for the health and welfare of occupants, or for processes such as food preparation;
- protect finishes, fabrics and furnishings; to reduce redecoration costs;
- protect equipment either within the supply air system, that is, to prevent blocking of coils, or in the space itself to prevent dust collection.

3.13 Given that almost all viable particles will originate from the occupants of a space and not from the incoming air, dilution is the more important factor aerobiologically. Therefore, for general areas a G4 filter will be suitable. More critical areas will require a F7 filter. HEPA filters will only be required in Ultra Clean systems.

Humidity control requirements

3.14 Providing humidification is expensive in terms of plant, running costs and maintenance, and therefore its use should be restricted to where it is necessary for physiological or operational reasons.

3.15 Humidification was originally required for some healthcare applications e.g. operating theatres, in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased. Humidification is therefore no longer required unless there is a very specific application requirement.

Maximum noise levels

3.16 Noise will be generated in an air distribution system by the fan, ductwork fittings, dampers and grilles. The specified maximum noise level will depend on the activities within the occupied spaces.

3.17 The overall noise levels should not exceed the values given in Scottish Health Technical Memorandum 08-01 – 'Acoustics', although general requirements are given in Table 3.

3.18 Attenuation should be incorporated into the ductwork system or plant arrangement as necessary to reduce noise from fans and plant items in order to achieve the acceptable limits within the rooms at the design air flows.

3.19 Plant noise should not be greater than 80dB(A) within the plant room from the fans, coolers, heaters, humidifiers etc. when starting up or running, and should be reduced to lower noise levels where the plant is near to departments sensitive to noise.

3.20 Attention must be given to the reduction of tonal components. High tonal components from air diffusers etc. can seriously disturb concentration over longer periods even when the overall noise level is low. Broadband noise causes less annoyance. Reference should be made to SHTM 08-01 - 'Acoustics'.

3.21 The designer requires knowledge of the total hospital layout and operational policies, to assign acceptance magnitudes to all the possible noise sources, in order to arrive at the correct rating.

Room	Overall noise level - NR	Ventilation plant commissioning - NR	Ventilation plant design - NR
Operating department	50 (55)	45	40
Ward areas	33	30	30
Sanitary facilities	45	40	35
Industrial areas	50	45	40
Circulation areas	50	45	40

Table 3: Interior noise level

3.22 In Table 3 the overall noise level takes account of all internal and external noise sources. The commissioning noise level is the level measured with a sound level meter in the unoccupied room, taking account of the external noise together with the noise generated by the ventilation system. When occupied and in use, this commissioning level will constitute a continuous background noise which will allow the overall noise level to be achieved. The ventilation plant design noise level is that generated by the plant alone with no other noise source being considered. The levels suggested make recognised allowance for the ingress of environmental noise that must be considered in the overall design, that is, in specifying the attenuation of walls, partitions, ceilings, etc.

3.23 The recommended criterion is measured as the "A" weighted sound pressure level expressed in decibels, which should not be exceeded for more than 10% of the time.

3.24 The designer must also consider noise escaping to the external environment and this must not be unacceptable to occupants of adjacent buildings.

Calculation of building loads

Air infiltration

3.25 Air infiltration occurs due to a complex combination of wind pressure, thermal effects, location relative to other features and the construction standard of the building. The infiltration rate is governed by the size and number of openings in the building envelope and the complexity of internal air paths.

3.26 CIBSE Guide A (2006) Section 4 provides information and formulae for the calculation of air infiltration and natural ventilation of buildings. In all cases the requirements of the appropriate section of the Scottish Building Regulations must be met.

Summertime temperatures

3.27 The calculation method for determining the summertime temperature is described CIBSE Guide A (2006) Section 5. However, it is very important to select the time of day and time of year of peak loadings for the calculations. These will be dependent on the orientation and proportion of solar to total heat gain. In establishing outside design values, the design risk having regard to the function and occupancy of the building should be considered.

3.28 Where calculations indicate that internal temperatures will frequently exceed the selected design external shade temperature by more than 3K for a period that exceeds the building design risk, methods of reducing temperature rise should be implemented. Options include: - reducing solar and casual gains, the use of chilled beams or ceilings, increasing ventilation rates or providing mechanical cooling. In some situations it may be possible to alter the thermal mass of the structure to 'move' the peak temperature event time so that it occurs outside of the occupancy period. Calculations and thermal modelling should be undertaken to ensure that during the summertime internal temperatures in patient areas do not exceed 28^{o}C dry bulb for more than 50 hours per year. It has been found that there is a relationship between preferred indoor temperatures and mean outside temperature. Fig A2 in CIBSE Guide A indicates this relationship.

Peak heating load

3.29 Peak heating local calculations are necessary on all mechanical supply systems to establish the size of heater batteries and subsequently the central plant.

3.30 Where ventilation systems provide tempered air to spaces that have supplementary LPHW to offset the building fabric losses, the plant heating load should be calculated based on the external winter design temperature, the design internal air temperature, and the calculated total air volume (including a suitable allowance for leakage).

3.31 Where the ventilation system is the only means of heating a space, an increase in load equivalent to the calculated fabric heat losses from the space should be added to the ventilation load. A check of supply temperature difference should be made. If it exceeds 10K the ventilation supply volume should be increased to suit.

Condensation risk

3.32 A check should be made to ensure that the selected air condition will not lead to surface condensation on low-temperature elements of the ventilated space.

3.33 Where there are local sources of moisture that would require excessive levels of ventilation to avoid condensation, the designer should consider the capture and removal of moisture at the source of the evaporation via an exhaust hood or similar device.

3.34 In intermittently heated buildings, it is necessary to consider the condensation risk at night setback conditions as well as during normal operation. Calculation methods for this assessment are given in CIBSE Guide A.

Peak cooling load

3.35 In addition to the base data of airflow rates and temperatures, when calculating cooling loads, the designer must take into account:

- solar cooling loads;
- surface conduction cooling loads;
- internal gain cooling loads;
- cooling loads due to high-level humidity control;
- method of control of internal conditions;
- fluctuations in internal temperatures.

3.36 When the peak internal loads have been assessed and a suitable allowance made for non-coincidence, the supply temperature can be calculated.

3.37 Once the lowest required supply temperature of the air handling unit has been established, and an allowance made for temperature rise through the fan and ductwork (usually 1K for low pressure systems), the off-plant enthalpy can be established from a psychrometric chart or table.

3.38 The cooling loads for all plants on the chilled water system should be calculated at each of the individual peak times in order to establish accurately the required (diversified) capacity of the chiller.

Annual energy consumption

3.39 Annual energy consumptions of heating-only ventilation systems are simple to calculate based on supply-to-external air temperature rise, and frequency of occurrence of external temperatures as given in CIBSE Guide A.

3.40 Minimum air volumes are usually fixed by the room loads or fresh air requirements. However, the designer may increase airflow to some rooms or zones in order to balance loads, as detailed in the following paragraphs on "Calculation of plant requirements."

3.41 The method of zoning and control can significantly influence energy consumption.

3.42 The nature of air-conditioning operation, comprising cooling and reheating for humidity or zonal temperature control, makes prediction of energy consumption very complex. It is imperative that these calculations are performed to ensure optimum energy efficiency.

3.43 The concept of load and plant operation charts is outlined in the CIBSE Guide A. The method requires the designer to establish the minimum and maximum loads on all zones across the range of external temperatures between winter and summer design conditions. Once the load chart is complete, the plant chart converts the loads to supply temperatures, which are then superimposed on external air temperatures.

3.44 When all temperatures for all zones are plotted on the plant operation chart, set points and resetting schedules can be established. From this information, the outputs of individual heaters, coolers and humidifiers can be established at any given external temperature. When those loads are computed against annual frequency of occurrence of external temperatures as given in CIBSE Guide A, the annual energy consumption of individual elements, and thus the air-conditioning system, can be established.

3.45 In order to prevent surface condensation occurring, it is necessary to provide sufficient ventilation to maintain the maximum and ambient dew-point temperature below the lowest surface temperature, the coldest usually being the glazing. Paragraphs 3.33 and 3.34 also refer.

Calculation of plant requirements

Air supply volumes

3.46 The minimum air supply volume for a room is determined by the greatest of these three criteria:

- the minimum fresh-air requirement;
- the minimum supply volume for the room load as determined by the maximum heating or cooling supply temperature differential;
- the desired/required air change rate.

Plant sizing

3.47 Once the design airflow has been established the cross-sectional area of the air-handling unit can be calculated based on a maximum coil face velocity of 2.0 m/s.

3.48 In order to establish the length of the air-handling unit, it will be necessary to refer to manufacturers' literature, ensuring all necessary access panels and components are included as detailed in Chapter 4.

3.49 The fan duty should be calculated by adding the resistances of all elements that contribute to the pressure drop of the index circuit.

3.50 The main elements that must be considered are:

- inlet or discharge louvres;
- plant entry and discharge;
- attenuators;
- components within the air-handling unit;
- duct-mounted heaters and filters (including a dust allowance);
- ductwork distribution;
- ductwork fittings, including: fire dampers, volume control dampers, bends and sets, tees, changes of section;
- air terminal device;
- discharge velocity.

3.51 Where packaged air-handling units are installed, the fan pressure drop is usually quoted as external plant resistance, and thus the designer does not need to calculate the resistances of individual plant items. The designer should, however, ensure that an allowance has been made for filter clogging; and confirm whether the fan pressure quoted is fan total or static pressure.

3.52 Resistances of ductwork and fittings may be obtained from the CIBSE Guide A. However, the designer should exercise some care when using tabulated pressure loss information for fittings that are relatively close together.

3.53 Upon completion of the resistance calculation exercise, the designer should make allowances for calculation and construction tolerances as indicated in Table 4.

Criteria	Low pressure systems	Medium/high pressure systems
Volume flow rate margin for leaking and balancing requirements	+5%	+5%
Total pressure loss margin A. for increase in volume flow rate (above)	+5%	+5%
B. for uncertainties in calculation	+5%	+10%
Combined total pressure loss margin	+10%	+15%

Table 4: Typical fan volume and pressure margins

Plantroom size and location

3.54 The ventilation plant and associated equipment should be positioned to give maximum reduction of noise and vibration transmitted to sensitive departments; while at the same time, achieve an economic solution for the distribution of services.

3.55 It is not recommended that noise and vibration generating plant be housed either directly above or below sensitive areas (for example, operating or anaesthetic rooms) unless there is no alternative, in which case, additional care and attention must be given to the control measures.

3.56 The plant must also be located so that it is remote from possible sources of contamination, heat gains and adverse weather conditions. The design should ensure that wind speed and direction have a minimal effect on plant throughput.

3.57 Safe access to and around plant is essential to facilitate inspection, routine maintenance, repair and plant replacement.

Provision of primary services

3.58 Where more than one air-handling plant requires cooling, remote central cooling plants with piped chilled water are preferred. In the case of a single plant, a multi-stage direct-expansion cooling coil with refrigerant piped from an adjacent compressor/condensing plant could be considered. If this option is selected, a refrigerant gas detector mounted in the base of the duct and an alarm system audible to the end-user will also need to be provided (as dictated by COSHH Regulations).

3.59 Clean dry steam is preferred for humidification, provided that the boiler water treatment does not render the steam unusable for direct humidification.

3.60 If a suitable supply of steam cannot be obtained from the steam main, a steam generator should be provided locally, or a self-generating humidifier installed. Electric humidifiers require considerable electrical loads and if a gas supply can

be derived, this would be preferable. The location of a local steam generator is critical if condensate is to drain back into it.

Inlet and discharge sizing and location

3.61 Air intakes and discharge points should preferably be located at high level, to minimise the risks of noise nuisance to surrounding buildings, contamination and vandalism.

3.62 Intakes and discharges should be designed and located so that wind speed and direction have a minimal effect on the plant throughput.

3.63 Helicopter landing pads in the vicinity of ventilation intakes and discharges can result in large short-term pressure changes. This can cause pressure surges in supply systems and reverse airflows in extracts. Exhaust fumes from the helicopter may also be drawn into intakes.

3.64 Intake points should be situated away from cooling towers, boiler flues, vents from oil storage tanks, fume cupboards and other discharges of contaminated air, vapours and gases, and places where vehicle exhaust gases may be drawn in.

3.65 Where intakes have necessarily to be sited at or near ground level, the area around them should be paved or concreted to prevent soil or vegetation being drawn in. They should also be caged or located within a compound to prevent rubbish being left in the vicinity. The likely proximity of vehicle exhausts should also be taken into account when determining the protected area around the intake.

3.66 The discharge from an extract system must be located so that vitiated air cannot be drawn back into the supply air intake or any other fresh-air inlet. Ideally, the extract discharge will be located on a different face of the building from the supply intake(s). In any event, there must be a minimum separation of 4 metres between them, with the discharge mounted at a higher level than the intake.

3.67 Discharges from LEV systems should preferably be vertical and usually not less than 3m above roof level. They should not be fitted with a cowl that could cause the discharge to be deflected downwards.

3.68 Each intake and discharge point should be fitted with corrosion-resistant weatherproof louvres or cowls to protect the system from driving rain. Louvres should be sized based on a maximum face velocity of 2 m/s in order to prevent excessive noise generation and pressure loss.

3.69 The inside of the louvres should be fitted with a mesh of not less than 6 mm and not more than 12 mm to prevent leaves being drawn in and infestation by vermin.

3.70 The duct behind louvres should be self-draining. If this is not practicable, it should be tanked and provided with a drainage system.

3.71 Cleaning access must be provided either from the outside via hinged louvres or by access doors in the plenum behind the louvre. Where a common plenum is provided, cleaning access should be via a walk-in door.

Heat rejection devices

3.72 The design conditions given in Chapter 2 make no allowance for the elevated temperatures that can occur on the roof of buildings. Refrigeration condensers and cooling towers should, if practicable, be shaded from direct solar radiation, or the design adjusted to take account of the gain.

3.73 Air-cooled condensers must always be the first choice for heat rejection from any refrigeration plant. Evaporative cooling systems must not be used in healthcare premises unless limitations of space mean that they are the only way that the cooling load can be met. If they are used, national guidance on preventing and controlling *legionella* must be closely followed.

3.74 Reference should be made to Scottish Health Technical Memorandum 04-01: 'The Control of *Legionella*, hygiene, 'Safe' hot water, cold water and drinking water systems, Part A: Design, Installation and Testing, and Part B: Operational Management, published by Health Facilities Scotland, 2010.

4. Air handling unit design and specification guidance

General requirements

Location and access

4.1 Air-handling units should be located in an accessible area secured from unauthorised entry. Siting units in ceiling voids above occupied spaces is not appropriate.

4.2 Units located on roofs must have a safe means of access together with suitable precautions to prevent personnel or equipment falling or being blown off during maintenance activities.

4.3 Units located at ground level should be secured within a locked compound to prevent unauthorised access. Measures should be taken to exclude vehicles from the vicinity to ensure that exhaust fumes will not be drawn into intakes.

4.4 Units may have a working life of approximately 20 years. It can be anticipated that over this period there will be a need to access every element within the unit for deep cleaning. It is also quite possible that the main fan and individual heater and chiller batteries will need replacement. Suitably positioned service connection joints and adequate spacing should permit these items to be withdrawn without the need to dismantle other installed plant or equipment. Batteries that are significantly wider than 1metre should be split to permit withdrawal from both sides.

4.5 It is essential that air-handling units are positioned so that all parts are easily and safely accessible for routine inspection and service. If a unit is located against a wall or backs onto another unit then access to all parts must be available from the front. Units greater than 1 metre wide should preferably have access from both sides or access doors large enough to permit the full and safe entry of maintenance personnel.

4.6 Water may be used during routine cleaning or spilt when maintenance is being undertaken. The area around the unit should be tanked to prevent water penetration to adjacent areas and adequately drained.

4.7 Fire precautions should be incorporated in accordance with Firecode. Guidance is available in BS5588: Part 9 and Sections 5 & 6 of this document.

4.8 Combustion equipment must not be located in a fire compartment that houses air-handling equipment.

Technical requirements

4.9 The basic technical requirements of the whole of the ventilation system should meet the relevant clauses of the Health Technical Specification. It should be noted that the Specification contains a menu of clauses that cover a wide range of applications, so it is important to select only those that are relevant to the specific application.

Note 1: At the time of writing, Health Technical Specification C04 was due for revision in order to bring it into line with the revised standards as set out in this Scottish Health Technical Memorandum. Where conflicts in specification arise, the Scottish Health Technical Memorandum takes precedence.

4.10 It is essential that the main plant/ductwork is located far enough above the floor to permit the correct installation of drainage systems for cooling coils, humidifiers and heat recovery systems. Easy access for maintenance of drainage systems and their associated pipework must be provided.

4.11 Organic materials or substances that can support the growth of microorganisms must not be used in the construction of the plant or its distribution system. The water fittings and materials directory lists suitable materials for sealants and gaskets.

4.12 The plant and its distribution system must not contain any material or substance that could cause or support combustion.

4.13 Plants should have a high standard of air-tightness. The double-skin method of construction with insulation sandwiched between two metal faces is recommended. The panels may be available in a variety of colours at no additional cost. This can aid identification by colour coding of units in a plant room (for example green for general ventilation; blue for theatres; red for laboratories and isolation facilities; grey for extract etc).

4.14 The inside of the plant should be as smooth as possible. Channels, rolled angles or formed sections that could trap or hold moisture should be kept to a minimum. If stiffeners are required, they should be fitted externally. If internal bracing has to be fitted it must be of a design that will not trap or hold moisture.

4.15 Airflow across air treatment components such as filters, heat exchangers and humidifiers will be influenced by the pattern of the approaching airstream. If unsatisfactory conditions are created, the performance of the component will be reduced.

4.16 Access to items that require routine service such as filters, frost batteries and chiller batteries should be via hinged doors. The doors should be large enough (for example 500 mm minimum) to allow easy access. Items requiring infrequent access such as attenuators may be via bolted-on, lift-off panels. All doors and panels should be close-fitting and without leaks.

4.17 Care should be taken during installation to ensure that electrical and mechanical services are not installed in positions that will reduce or impede access.

4.18 It can be difficult to turn off AHUs in order to inspect filters and drainage trays. Viewing ports and internal illumination will therefore facilitate routine inspection of such items. Viewing ports should be at a convenient height so that temporary ladders are not required. Internal illumination should be provided by fittings to at least IP55 rating. Fittings should be positioned so that they provide both illumination for inspection and task lighting. All of the lights in a unit should be operated by a single switch.

4.19 Access to AHUs and items in the distribution system such as filters or heater / chiller batteries should be via fixed ladders and platforms or pulpit-style moveable steps. The installation of distribution ductwork and other electrical or mechanical services should provide sufficient clearance to allow the pulpit steps to be easily wheeled into position.

AHU drainage system

4.20 All items of plant that could produce moisture must be provided with a drainage system. The system will comprise a drip tray, glass trap, air break and associated drainage pipework.

4.21 The drip-tray should be constructed of a corrosion-resistant material (stainless steel is preferred) and be so arranged that it will completely drain. To prevent 'pooling', it is essential that the drain connection should not have an upstand; and that a slope of approximately 1 in 20 in all directions should be incorporated to the drain outlet position. The tray must be completely accessible or, for smaller units, easily removable for inspection and cleaning.

4.22 Each drip tray should be provided with its own drain trap. The drain trap should be of the clear (borosilicate) glass type. This permits the colour of the water seal to be observed thus giving an early indication of corrosion, biological activity or contamination within the duct. The trap should have a means for filling and incorporate couplings to facilitate removal for cleaning. It should be located in an easily visible position where it will not be subject to casual knocks. The pipework connecting it to the drainage tray should have a continuous fall of not less that 1 in 20.

4.23 Traps fitted to plant located outside or in unheated plant rooms may need to be trace-heated in winter. The trace-heating must not raise the temperature of water in the trap above 5°C.

4.24 Water from each trap must discharge via a clear air gap of at least 15mm above the unrestricted spill-over level of either an open tundish connected to a foul drainage stack via a second trap, or a floor gully (or channel). A support should be provided to ensure that the air gap cannot be reduced. More than one drain trap may discharge into the tundish providing each has its own air break.

4.25 Drainage pipework may be thermoplastic, copper or stainless steel. Glass should not be used. The pipework should be a minimum diameter of 22 mm and a fall of at least 1 in 60 in the direction of flow. It should be well supported and located so as not to inhibit access to the AHU.

Layout of air handling unit

4.26 The AHU should be arranged so that the majority of items are under positive pressure. Any item of plant requiring a drain should be on the positive pressure side of the fan. A recommended layout is given in schematic from in Figure 3.

4.27 A separate extract unit will generally be required for the area served by each supply unit.

4.28 An energy recovery system will normally be fitted between the supply and extract units.

Provision of dampers

4.29 Fire- or smoke-actuated dampers shall be provided at the locations required by Firecode. (See paragraphs 5.17 to 5.21).

4.30 Motorised low-leakage shut-off dampers should be located immediately behind the intake and discharge of each supply and extract system respectively. They should be of the opposed-blade type, opening through a full 90^{o} and must close automatically in the event of power failure or plant shutdown to prevent any reversal of the system airflow.

4.31 The quality of motorised dampers is critical. They should be rigid, with square connections fitted with end and edge seals of a flexible material and with minimal play in linkages. The leakage on shut-off should be less than 2%.

4.32 A manually operated isolating damper should be installed between the main AHU and its distribution system to enable the unit to be isolated when cleaning is in progress.

4.33 Good practice will require the fitting of a main volume control damper so that the design airflow rate can be set at commissioning. The damper should be lockable in any position. If it will also be used for plant isolation, it should be capable of being reset to give the design airflow without the need for re-measurement.

4.34 Internal plant isolating dampers or provision for the fitting of shut-off plates between items within a unit are not required.

Vibration

4.35 Vibration from a remote plantroom can be transmitted by the structure of the building, may be regenerated and may sometimes be magnified many times. Units should be selected to have the minimum vibration generation and installed on suitable anti-vibration mounts. Pipe and ductwork should incorporate anti-

vibration couplings, preferably in two planes at right angles, as close to the vibration source as possible. Consideration should be given to the use of anti-vibration pipe hangers and supports.

Sequence of components

4.36 The following arrangement of plant components is typical although in many instances not all elements will be required:

- fresh air intake;
- motorised isolation damper;
- frost / fog coil;
- pre-filter;
- energy-recovery device;
- attenuator;
- fan;
- blast plate;
- attenuator;
- chiller battery;
- eliminator;
- heater battery;
- humidifier;
- final filter;
- isolation / volume control damper.

Note 2: Attenuators may be located in the intake and discharge duct if they are of a suitable type (See clause paragraphs 4.159 to 4.162)

There may be instances where the above arrangement is not appropriate and the plant arrangement should be planned accordingly.

Fans

General requirements

4.37 The fan should be selected for good efficiency and minimum noise level, but the overriding factor should be the selection of a fan characteristic such that the air quantity is not greatly affected by system pressure changes due to filters becoming dirty or external wind effects.

Acceptable types

4.38 Fans can be of the axial, centrifugal, cross-flow, mixed-flow or propeller type, depending upon the requirements of the system.

4.39 Where used, centrifugal fans should preferably be of the backward-blade type. Alternatively, where noise levels are more critical and pressure requirements are lower, forward-curved blade fans are acceptable. For high-power applications, aerofoil-blade fans may be appropriate.

Selection

4.40 Generally, large ventilation systems will use centrifugal fans due to their efficiency, non-overloading characteristics, and developed pressures.

4.41 Forward curved centrifugal fans can overload if allowed to handle more air than they are designed for.

4.42 Alternatively, it may be appropriate to use mixed flow fans in high-pressure systems.

4.43 Axial flow or propeller fans are generally only used in local through-the-wall systems, or systems with very low pressure requirements.

4.44 Cross-flow fans have very low operating efficiencies, and thus their use is restricted to applications such as fan coil units.

Location and connection

4.45 Fans are normally positioned to 'blow through' the central plant so that the cooling coil and humidifier drains will be under positive pressure.

4.46 The fan performance figures given by manufacturers in their catalogue data are based on tests carried out under ideal conditions, which include long uniform ducts on the fan inlet/outlet. These standard test connections are unlikely to occur in practice, the designer should therefore ensure as far as is practical that the fan performance will not be significantly de-rated by the system. This objective can be approached by ensuring that the fan inlet flow conditions comprise uniform axial flow velocities with low levels of turbulence.

4.47 Where the outlet duct is larger than the fan discharge connections, there should be a gradual transition, with a following section of straight duct, having a length equivalent to three duct diameters.

4.48 The design of the fan intake connection must be carefully considered to avoid swirl in the airstream. When the air spins in the same direction as the impeller, the performance and power consumption of the fan are reduced. When the air spins in the opposite direction to the impeller the power consumption and noise will increase with hardly any pressure increase. Airstream swirl is usually induced by large variations across the fan intake caused by the air passing round a tight bend immediately before the intake.

4.49 Where a centrifugal fan is located with an open intake, the clear distance between the suction opening and the nearest wall should be not less than half the diameter of the inlet. If two fans with free inlets are positioned within the same chamber, their adjacent suction openings should be at least 1 diameter apart.

4.50 Airtight flexible joints should be provided at fan inlet and outlet connections. They should be equal in cross-section to the points of connection and be neither longer than 200 mm nor shorter than 100 mm.

4.51 For centrifugal fans, a diffuser screen / blast plate should be fitted immediately downstream of their discharge.

Supply fan drive arrangements

4.52 Where the fan drive is via a motor-driven belt and pulley, it should be external to the air stream. This arrangement has the following advantages:

- the fire risk is reduced;
- the drive is visible so it is simple to check that the belt is still there;
- particles shed from the drive belt are outside of the air stream;
- if the belt slips, the “burning rubber smell” is not transmitted down into occupied areas of the premises;
- noise generated by the motor and drive will not be transmitted along the ductwork;
- waste heat is excluded from the system;
- the drive may be through a vee or toothed belt and pulley. The latter have the advantage of eliminating belt squeal on start up and have a longer service life. They are particularly suitable where the fan drive motor is fitted with a soft start and should be located external to the air stream.

4.53 The drive train should be easily visible without the need to remove access covers. Protecting the drive train with a mesh guard is the preferred option. For weatherproof units designed to be located outside, the fan drive will be external to the duct but enclosed. It should be easily visible through a viewing port with internal illumination and access via a lockable hinged door.

4.54 For direct-coupled fan and motor units, the motor should be out of the air stream.

4.55 For induction drive ‘plug’ motor arrangements (where the motor is fitted within the fan and is integral to it) and in line axial fans with a pod motor; the fan / motor combination may be within the air stream provided the motor windings are protected from over temperature by a thermister and lockout relay.

Extract fan drive arrangements

4.56 The preferred method where the fan drive is via a motor driven belt and pulley arrangement will be to locate it external to the air stream.

4.57 The fan drive and motor may be located inside the duct within the air stream provided the motor windings are protected from over-temperature by a thermister and lockout. The drive train should be easily visible through a viewing port, have internal illumination and access via a lockable hinged door.

4.58 Where the system air is explosive, aggressive or has high moisture content, the extract fan motor must be located outside the air stream. This is generally achieved with axial fans by using a bifurcated unit.

Control

4.59 Fans in healthcare applications are normally either single or two-speed. Where there is a requirement for two-speed operation, this is generally via a local user control (for example, in a hood extract system to provide a boost facility) or via a time schedule for energy saving during unoccupied periods.

4.60 Normally only a single motor is required with a standby motor available for fitting as necessary or fitted but not belted. Twin, run and standby motors - with the standby being jockeyed around - are not required.

4.61 Where there is a specified requirement for standby fans, the system should incorporate an automatic changeover facility activated via an airflow sensor. Fault indication should be provided.

4.62 The control of fans in terms of start-up and run is increasingly being vested in computer software. Inverter-drive, variable-speed, soft-start systems are becoming a standard approach. It should be remembered that most healthcare applications require known amounts of air to be delivered while the system is in use. Constant volume systems that deliver specified air-change rates are therefore the norm. Duct- or room-pressure-controlled, variable-speed systems have a very limited application in healthcare.

4.63 It is necessary to ensure that - should the computer control system or its software develop a fault - then the fan can be switched to a direct-start, fixed-speed, manual operation. This is particularly important for critical care systems serving operating suites, high-dependency care units of any type, patient isolation facilities, laboratories and pharmaceutical production suites. Off-site software support is no substitute for the ability of on site staff to override the automatic control and keep the system operating in an emergency. Under these circumstances actions that may shorten the life of the plant are considered of secondary importance to that of preserving the health and safety of patients and staff.

Heater batteries / heater coils

General requirements

4.64 Frost batteries are installed to protect the downstream filters from low-temperature, high-humidity intake air conditions. As they handle unfiltered air they should be constructed of plain tubing without fins and be as near to the outside as possible to minimise condensation during cold weather. Access for cleaning will need to be provided to both sides of the coil.

4.65 Where steam coils are used for a frost battery, they may be constructed using spiral-finned copper tube. As they will be prone to fouling the tube layout and spacing should permit easy access for regular cleaning.

4.66 Main and branch heater-batteries should be constructed of solid-drawn copper-tube coils with copper fins, generally connected in parallel.

4.67 Where there is a wet heating system in the areas served, the main heater-battery should be sized for the ventilation requirements only, and not for the fabric loss.

4.68 Access for cleaning must be provided to both sides of all frost batteries and heater-batteries.

Acceptable types

4.69 Electric, water or steam heater-batteries may be considered. However, electric heater-batteries are expensive to operate and where there are alternatives, their use should be restricted to low-power use (for example trimming control).

4.70 Where steam-supplied heater-batteries are used, their control, venting and trapping systems should be designed so that a vacuum cannot occur within the coil. The condensate drainage arrangements should not allow pressure to build in the main resulting in a back-up of condensate in the coil.

Location

4.71 Where possible, wet-trimmer heater-batteries should be located in plant areas.

4.72 Where it is necessary to locate heater-batteries in false ceilings etc, consideration should be given to the use of electric heaters. If this is not practicable, drip-trays should be installed under both the battery and the control valve assembly to protect the ceiling. A moisture sensor and alarm should be fitted in the tray. In any event, to facilitate maintenance access, they should be located above corridors or other non-critical areas and never above patient occupied spaces.

4.73 Auxiliary fan coil units should not be installed in the ceiling above an occupied space. They should be accessible for routine maintenance and cleaning without the need to cause significant disruption to the operation of the department that they serve.

Control

4.74 LPHW frost coils should be controlled by an off-coil temperature sensor operating a motorised valve to provide a minimum plant "on temperature" of between 2°C and 5°C. The off-coil temperature of the frost coil is generally sensed by a serpentine thermostat downstream of the coil or upstream of the next plant item. This thermostat will shut the fan down if any part of the air stream is below the minimum set-point.

4.75 Steam-supplied frost coils should be fitted with an on/off control operated by a temperature sensor mounted upstream of the battery. These are normally set to open the control valve fully when the outside temperature drops to +1°C. This will ensure that there is no standing condensate in the base of the coil.

4.76 The main heater-battery should be controlled in the same manner under the dictates of either an off-coil temperature sensor, or a room temperature sensor, depending on the plant configuration and method of control. Trimmer heater-batteries are generally controlled by one or more averaging temperature sensors within the room or rooms in the zone.

4.77 Heater-battery control valves should drive closed on system shutdown or fan failure. The control system should then automatically set to provide frost protection.

Cooling coils

General requirements

4.78 Cooling coils will need to be decontaminated periodically. They must have good access both up and downstream. Hinged access doors with viewing ports and illumination inside the duct should be provided both sides of the coil.

4.79 An eliminator will be required downstream of all cooling coils. The eliminator may take the form of an extension of the coil fins or be a separate device. If a separate device it should be removable as a unit to permit cleaning of the coil face.

4.80 All cooling coils must be fitted with their own independent drainage system as specified above. A baffle or similar device must be provided in the drip tray to prevent air bypassing the coil. The tray should be large enough to capture the moisture from the eliminator, bends and headers.

4.81 Where coils are greater than 1m high, intermediate drip-trays will be required.

Selection

4.82 Cooling coils supplied with chilled water are the preferred option. For small loads or where chilled water is not available, direct expansion coils may be used.

4.83 Care must be taken in selection to minimise electrolytic action resulting from condensation on the airside. Coils constructed from copper tubes with copper fins extended on the downstream side in the form of an eliminator, and electro-tinned after manufacture are preferred. Aluminium fins should only be used if vinyl-coated.

4.84 All parts of the coil and its associated ductwork in contact with moisture must be manufactured from corrosion-resistant materials. Pressed steel coil headers, even if treated, have been shown to be prone to corrosion over time and should not be used. Steel mounting frames and casings present similar problems so stainless steel is preferred.

Location

4.85 Micro-organisms that multiply in moisture cannot be avoided when the coil is dehumidifying. However, locating the final filter downstream of the coils will reduce the risk of infection.

4.86 Cooling coils in AHUs should be located upstream of the final filter.

4.87 Where any cooling coil has to be located above a ceiling, drip-trays should be installed under both the coil and the control valve assembly to protect the ceiling. A moisture sensor and alarm should be fitted in the tray. To facilitate maintenance access, they should be located above corridors or other non-critical areas and never above patient occupied spaces.

Control

4.88 There are two basic methods of control for cooling coils:

- off-coil control – used in multi-zone systems or single-zone systems where close humidity control is required, to provide a constant maximum off-plant condition which satisfies the temperature and high humidity requirements of the zone with the highest load;
- sequential control – used in single-zone systems, or multi-zone systems with averaging sensors where close control is not required. A room or duct temperature sensor controls the cooling coil and heater battery in sequence to maintain constant room conditions.

4.89 The advantage of off-coil control is that accurate humidity control can be provided without relying on humidity sensors, which are prone to inaccuracy and drift. Off-coil control is however, expensive to operate in terms of energy consumption, due to the fact that there is no feedback of room loads, and thus at low loads and in systems where there are large zonal variations, significant over-cooling and reheating will occur.

4.90 On systems with two-speed operating, it is usual to isolate the cooling coil upon selection of low speed. In addition, on system shutdown, low airflow or fan failure, the cooling coil must be isolated.

Humidifiers

Design need

4.91 Humidification was originally required for some healthcare applications in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased. Humidification is therefore no longer required unless there is a very specific application requirement.

4.92 Operating-theatre AHUs do not generally require humidifiers but provision for their retrofitting in terms of space provision and a capped drainage system should be provided.

4.93 Where humidification is required, it will be subject to the specific requirements set out below. These are intended to ensure that the unit will operate safely and not become a source of contamination.

General requirements

4.94 The most important requirement for a humidifier is to create complete mixing of the steam with the air. The manufacturers' instructions should be followed regarding minimum distances which should be allowed before bends or other components. This is particularly important with respect to a filter mounted downstream. If it becomes saturated by the humidifier, organisms can grow through the filter and be released into the duct. These may then be carried on the airstream into an occupied space.

4.95 The section of ductwork containing the humidifier may need to be periodically decontaminated. Hinged access doors with viewing ports and internal illumination should be provided. A label warning that the device emits live steam and should be isolated prior to opening should be affixed to the access door.

4.96 All parts of the humidifier and its associated ductwork in contact with moisture must be manufactured from corrosion-resistant materials. Stainless steel is preferred.

4.97 The electrodes of self-generating electrode-boiler type humidifiers should be stainless steel.

4.98 All humidifiers must be fitted with their own independent drainage systems as detailed in paragraphs 4.72 and 4.87 or 4.20 to 4.25.

4.99 For self- and locally-generated steam humidifiers, the cleanliness of the water supply is essential for their safe operation. Provision should be made for draining down supply pipework and break tanks for periodic disinfection and cleaning during periods when they are not required in service.

4.100 The addition of treatment chemicals for continuous control of water quality for humidifier/air handling units should be avoided. Consideration could be given to installing a UV system to control microbiological growth. Given the limitations of

UV systems, however, this will require filtration to high quality to ensure the effectiveness of exposure of organisms to the UV irradiation. As with all water treatment systems the unit should be of proven efficacy and incorporate UV monitors so that any loss of transmission can be detected.

Acceptable types

4.101 Only steam-injection manifold-type humidifiers are considered suitable for use in health building air-conditioning systems. Water humidifiers of any type should not be used.

4.102 Steam may be derived from the central steam supply provided that it does not contain any treatment carry-over, or generated locally either within or adjacent to the humidifier.

4.103 The introduction of steam should be by an appliance specially designed to discharge dry steam into the air-conditioning system without objectionable noise or carry-over of moisture.

4.104 During the design stage, consideration should be given to the proposed methods for the regular cleansing of the humidifier(s) and their components.

Selection

4.105 The number and length of steam-injection manifolds to be used is dependent on various factors such as duct cross-sectional area, air velocity, dry-bulb temperature and manifold design. Guidance from the manufacturer should be followed closely.

4.106 A mains steam humidifier can be noisy and will be difficult to control if it is operated at an excessive steam pressure. It should be sized for an operating pressure of approximately 1 bar. The pipework supplying it should be provided with a dirt pocket, pressure reducing valve and steam trap installed as close as practicable to the humidifier, so that the steam condition at entry is as dry as possible. A temperature switch on the condensate line (or equivalent design provision by the humidifier manufacturer) should be incorporated to prevent 'spitting' on start-up.

4.107 Most operational problems with mains steam humidifiers arise because of back-pressure in the condensate discharge line which will result in flooding into the duct. Unless the condensate from the device can be discharged and collected at atmospheric pressure, it should be discharged directly to drain.

4.108 A local steam generator, where used, must be fed with potable quality water. Additional water treatment to the standard set out above may be required. If the humidifier is unused for a period exceeding 48 hours, it must automatically drain its water content, including that contained in the supply pipework, right back to the running main and leave itself empty.

4.109 Some steam generators are of a type that requires regular cleaning and descaling. The design must allow for them to be installed such that they can be

physically isolated from the air duct in order to prevent contamination of the supply by cleaning agents while this is taking place.

Location

4.110 Careful sitting of the humidifier injection manifold is required to prevent the steam impinging onto the side(s) of the duct, condensing and generating excess moisture.

Control

4.111 Accurate humidity control can only be provided on single-zone systems, or multi-zone systems with zonal humidifiers. In the above systems, humidity sensors control the humidifier for low-level humidity control, and override the temperature controls to open the cooling coil valve for high-limit humidity control.

4.112 Multi-zone systems are more usually controlled by a minimum humidity sensor located in the supply duct(s) following the last heater-battery.

4.113 Overriding controls separate from the normal plant humidistat should be installed. Their purpose is to prevent excessive condensation in the conditioned space when starting up. A time delay should be incorporated into the humidifier control system such that the humidifier does not start until 30 minutes after the ventilation/plant start-up. In addition, a high-limit humidistat should be installed to limit the output of the humidifier so that the saturation in the duct does not exceed 70%. This humidistat is to control the added moisture. It is not necessary to install a de-humidifier to reduce the humidity of the incoming air if it already exceeds 70%. The humidifier control system should ensure that the humidifier is switched off when the fan is not running.

4.114 On systems with two-speed operating, it is usual to isolate the humidifier upon selection of low speed. In addition, on system shutdown, low airflow or fan failure, the humidifier should be isolated.

Filtration

General requirements

4.115 The purpose of filtration is to reduce the level of airborne contamination in an air stream. It is generally carried out in stages.

4.116 Filters must be securely housed and sealed in well-fitting frames that minimise air by pass. Air by pass significantly reduces filter efficiency, the higher the filter grade the greater the effect. Mounting frames should be designed so that the air flow pushes the filter into its housing to help minimise air bypass. Mounting frames that withdraw so that the filter can be changed without having to reach into the unit are preferred.

4.117 Neither the filter media, nor any material used in the construction of the filters, should be capable of sustaining combustion. The filter media should be such that particles of it do not detach and become carried away by the airflow.

4.118 Filters need to be readily accessible for replacement so a hinged access door should be provided. The upstream side of the filter should be visible for inspection through a viewing port with internal illumination.

4.119 All filters should be provided with a means of visually checking the differential pressure across them. Direct-reading dial-type gauges marked with clean and dirty sectors are preferred.

4.120 A complete spare set of filters must be provided at handover.

Definition of filter terms

4.121 Particulate air filters are divided into four categories:

- general ventilation filters grades G1 to G4;
- fine filters grades F5 to F9;
- high efficiency particulate filters (HEPA) graded H10 to H14;
- ultra-low particulate air filters (ULPA) graded U15 to U17.

4.122 General filters are graded in terms of their 'Synthetic dust weight 'Arrestance'. This represents the percentage of a test dust captured by a filter. 'Arrestance' provides a good indication of a filter's ability to remove the larger, heavier particles found in outdoor air. These are of a size to block finned batteries and large enough to settle out in the air distribution system.

BSEN 779 grade (Eurovent grade)	% Arrestance	Notes and typical healthcare application
G1 - (EU1)	< 65	Metal mesh grease filter
G2 - (EU2)	65 to < 80	Coarse primary filter
G3 - (EU3)	80 to < 90	Primary air intake; return air; energy recovery device protection
G4 - (EU4)	> 90	General purpose tempered air supply

Table 4a: General Filters

4.123 Fine filters are graded in terms of their 'Atmospheric dust spot Efficiency'. This is a measure of the filter's ability to remove the very fine staining particles found in outdoor air. It will indicate how 'visibly' clean a filter will keep a ventilated space. The staining particles are approximately the same size as most common bacteria so it is also a rough measure of the filter's ability to remove microorganisms.

BSEN 779 grade (Eurovent grade)	% Efficiency	Notes and typical healthcare applications
F5 - (EU5)	40 to 60	General purpose panel / bag filter
F6 - (EU6)	60 to < 80	Basic grade bag filter
F7 - (EU7)	80 to < 90	Medium grade bag or pleated paper Conventional operating theatre supply air
F8 - (EU8)	90 to < 95	High grade bag or pleated paper
F9 - (EU9)	> 95	Basic HEPA filter – Level 8 clean rooms

Table 5: Fine Filters

4.124 High efficiency filters (HEPA and ULPA) are graded in terms of their ability to capture their 'Most Penetrating Particle Size' (MPPS). High-efficiency filters self-select the particle that they are least able to trap, hence the MPPS. They are then tested against that size of particle. These filters are designed to provide very high-efficiency filtration of particles in the sub-micron size range.

BSEN 1822 grade (Eurovent grade)	% Efficiency @ MPPS	Notes and typical healthcare application
H10 - (EU10)	85	Ultra-clean theatre terminal
H11 - (EU11)	95	
H12 - (EU12)	99.5	
H13 - (EU13)	99.95	
H14 - (EU14)	99.995	Pharmacy aseptic suite Category 3 room extract
U15 – U17	-	Not generally used in healthcare

Table 6: High Efficiency (HEPA) Particulate Filters

Selection primary filters

4.125 All filters should be of the dry type. Panel filters are cheap and disposable with relatively low dust-holding capacity. They are generally used as pre-filters to eliminate large particles that would otherwise clog or cause damage to the fan and finned heating and cooling batteries. Stainless steel frames that hold disposable pre-cut filter pads are preferred.

4.126 General ventilation supply plant should incorporate primary air filters of grade G3, sized for a maximum face velocity of 2.0 m/s. Additional coarse pre-filters may be justified where the intake air is exceptionally polluted. They are sometimes fitted as a temporary measure when building work is being carried out in the vicinity of the air intake.

Secondary filters

4.127 Where a higher standard of filtration is required, secondary bag or pleated paper panel filters would be used. Rigid frame filters incorporating pleated paper elements are preferred over bag filters for critical care applications such as operating theatres.

4.128 In urban or other areas of high atmospheric pollution, a higher standard of filtration may be justified to reduce the level of staining to internal finishes.

Extract air filters

4.129 Extract filtration will generally only be required where heat-recovery devices are installed. There are a very limited number of specialised applications (microbiological safety cabinets and similar LEV systems) where contaminated air is required to be filtered prior to discharge to atmosphere. If it is safe for staff to work in a room without wearing respiratory protective equipment, it is safe to discharge the room air to atmosphere without filtration.

Return-air filters

4.130 They are used to reduce the load on HEPA filters in recirculating applications such as Ultra Clean operating suite ventilation canopies and pharmacy aseptic suites.

High-efficiency filters – HEPA and ULPA

4.131 HEPA filters are expensive so their use should be kept to a minimum. Applications requiring HEPA filters include the air supply to aseptic suites in manufacturing pharmacies, the discharges from microbiological safety cabinets and isolation facilities.

4.132 If used, HEPA filters should be of the replaceable panel type with leak-proof seals. They should be installed in a manner that permits on-site validation of the filter and its housing. This may involve the release of a Dispersed Oil Particle (DOP) challenge smoke through an injection point upstream of the filter and a measurement of the DOP penetration across the downstream face. Alternatively a particle-counting method may be used.

4.133 HEPA filters are sometimes fitted in extract systems to capture hazardous substances or organisms. Design provision must be made for the subsequent safe handling of contaminated filters by maintenance staff. This may be achieved by:

- sealing the hazardous substance into the filter before it is removed;
- providing a system to fumigate the filter to kill any organisms;
- housing it in a ”safe change” unit that permits the filter to be ejected into a bag and sealed without staff having to come into direct contact with it.

4.134 In view of the costs and problems associated with placing HEPA filters in extracts, it is recommended that a full risk assessment be carried out at the design stage. This should include defining the true need for HEPA filters in an extract; validation of its performance at installation; the method of safely changing a contaminated filter; and its subsequent disposal.

4.135 ULPA filters are very expensive and are designed to remove particles below a size that are either surgically or aerobiologically significant. There would have to be exceptional circumstances in order to justify their use in healthcare ventilation systems.

Activated carbon filters

4.136 Activated carbon filters are able to remove gases and vapours from an air stream and are graded according to the range of substances they can remove. They are not normally fitted in air-conditioning supply systems.

4.137 They are occasionally fitted retrospectively because the main air intake has been poorly sited and is drawing in traffic fumes. Where used they must be protected by a particulate air filter.

4.138 Activated carbon filters are more commonly used in specialised fume extraction systems when the location of the discharge means that dilution cannot be relied upon to disperse noxious fumes.

Location

4.139 The primary filter should be positioned on the inlet side of the supply fan, downstream of the frost coil. The secondary filter, when fitted, should be on the positive-pressure side of the fan. This will prevent air being drawn into the system after the filter and capture any particles shed by items of equipment within the AHU.

4.140 The filter installation must be arranged to provide easy access to filter media for cleaning, removal or replacement, with side or front withdrawal as required.

Control

4.141 Differential-pressure transducers should be provided to monitor and alarm remotely on excessive filter pressure drop. In critical areas dirty-filter indication lights should be provided at the point of use.

Energy-recovery

General requirements

4.142 Energy recovery will normally be fitted to all healthcare ventilation systems. It may be omitted only where it would clearly be uneconomic. Where the economic case is marginal, space should be allowed for the retrofitting of an energy recovery system.

4.143 For systems in healthcare premises, a plate heat exchanger or ‘run-around coil’ system is suitable. Thermal wheels may be used providing they are fitted with a purge sector. The small amounts of air leakage across those devices are not considered significant. Other systems such as heat pumps or heat pipes are also suitable. Selection should be based on relative locations of the supply and

extract units, ease of maintenance and practicality. Cleaning access will be required to both sides of any energy-recovery device.

4.144 The following are the minimum energy transfer efficiencies required for devices handling equal air volumes:

- run-around coil – 45%;
- plate heat exchanger – 50%;
- thermal wheel – 65%;
- any other energy-recovery device – 50%.

4.145 If a plate heat exchanger is chosen, the plates should be constructed of metal. Plastic should not be used for internal bypass dampers and drive gears.

4.146 Whichever energy-recovery device is chosen the extract side will need to be protected by a G3 filter and provided with a drainage system as described in Section 4; Paragraphs 4.20 to 4.25, to remove condensate.

Location

4.147 Energy-recovery devices should be located downstream of the frost battery and pre-filter, prior to the cooling coil or main heater battery on the supply side.

Control

4.148 It is essential to consider the control of both the energy recovery device and the frost battery when assessing the economics of recovery, as all energy provided by the frost battery will directly reduce the heat exchange of the recovery device. To this end, the off-coil setting of the frost coil should be the minimum possible to protect the primary filter (for example +2^{o}C).

4.149 The energy-recovery device should be controlled in sequence with the main heater battery, and should incorporate a control to prevent the transfer of unwanted heat when the air-on condition rises above the required plant set point.

4.150 In instances where the plant is cooling the air, it may be possible to remove heat from the supply air at high ambient conditions, under the dictates of enthalpy sensors in the intake and extract ducts.

Attenuation

General requirements

4.151 Noise will be generated in an air distribution system by the fan, plant items and airflow. The ductwork is a very effective transmitter of this noise hence there is generally a need to limit the noise transmission to meet the requirements of the

building. This normally involves the provision of sound attenuation treatment as part of the overall ductwork system design.

4.152 A thorough assessment of the design should be made to assess the noise impact. This should take into account the following primary factors:

- fan- and plant-noise generation;
- air-flow generated noise in ductwork fittings and dampers;
- noise generated at grilles, diffusers and other terminals;
- noise break-in and break-out of ductwork;
- cross-talk and similar interference;
- the noise limitations for the building and surrounding areas;
- external noise generation.

4.153 A method of assessment of these factors and the sound attenuation requirements of ductwork systems is given in CIBSE Guide B.

4.154 The fan is usually the main source of system noise. The sound power that it generates varies as the square of the fan pressure, and thus to limit the fan noise level the system resistance should be kept as low as economically possible. As a general rule the selected fan should operate close to its point of maximum efficiency to minimise its noise generation. Where there is disturbance to the airflow at the fan inlet, the manufacturer's stated fan noise levels should be increased by up to 5 dB(A). More precise guidance on this aspect may be available from the manufacturers.

4.155 Fans radiate noise through both the inlet and outlet connections and it may be necessary to provide attenuation to limit the noise from both of these connections. It is always preferable and more economic to control noise and vibration at source, or as close to source as possible. It should be noted that attenuators offer a resistance to airflow. The resistance must be included in the fan and ductwork calculations.

4.156 Provided care is taken in the design and construction of low-pressure systems to avoid significant noise generation in the ductwork, attenuation should only be needed to absorb fan noise.

4.157 Noise breakout from all equipment housed in the plantroom must be taken into consideration if control is to be satisfactory. Any ductwork within the plantroom after the silencer should be acoustically insulated to prevent noise break-in or the silencer relocated at the point of entry or exit of ductwork to and from the plant room.

4.158 There is no complete means of control over external noise generation from such as road traffic, aircraft, factory and community noise. Consideration must be given to this at the design and planning stage.

Acceptable types and location

4.159 The noise levels produced by ventilation and other plant should be reduced by either lining the inside of the duct with sound-absorbing material or fitting bespoke attenuator units.

4.160 In supply systems, sound-absorbing material should not be applied to the inside surface of a duct system downstream of the final filter, owing to the risk of mechanical damage and the subsequent dispersal of the media into the ventilation system.

4.161 In supply and extract systems, sound-absorbing material must not be applied to the inside of a duct within 1 metre of a fire damper. The material should be non-particle-shedding and fire-resistant (further guidance can be found in SHTM Firecode suite of documents). Where sound-absorbing material is applied in a section of duct that will be routinely exposed during maintenance activities it should be protected from mechanical damage.

4.162 Bespoke attenuator units with a sound-absorbing infill suitable for the quality of air being handled and protected by a perforated sheet metal casing are the preferred option for critical systems. Absorption of moisture, dirt and corrosive substances into the 'in-fill' and the release of fibrous particles into the airstream should be prevented by the use of a membrane. The membrane material should have a declared service life of at least 25 years. If these conditions can be met then the attenuator may be located in the supply ductwork downstream of the final filter. When so located cleaning access should be provided at both ends of the attenuator unit.

5. Air distribution system

Air distribution arrangements

Ductwork distribution systems

5.1 Ductwork systems for ventilating and air-conditioning applications are referred to by their velocity or pressure category, that is, as low, medium or high velocity (or pressure) systems. Heating & Ventilating Contractors Association (HVCA) limits are up to 10 m/s or 1,000 Pa; 20 m/s or 1,750 Pa: and 40 m/s or 3,250 Pa in the case of conventional low, medium and high pressure systems respectively. High-pressure systems are disappearing because of the constraints of the Building Regulations but existing systems may sometimes need to be altered or extended.

5.2 For normal applications in healthcare buildings, low velocity systems are recommended; and the use of higher velocities than those recommended is not likely to be economical. Future trends are likely to be towards even lower optimum duct velocities; however, velocities below 2 m/s are unlikely to be justified.

5.3 The site will often dictate the main routing of ductwork systems, but in general, the design should seek to make the layout as symmetrical as possible; that is, the pressure loss in each branch should be as nearly equal as possible. This will aid regulation and may reduce the number and variety of duct fittings that are needed.

5.4 Main distribution ductwork should not be routed above sleeping areas. Where there is no alternative route, additional acoustic insulation will be required.

5.5 Where auxiliary cooling units, fans, filters or trimming devices are installed in the distribution system, they must be independently supported and fitted with a suitable drainage system where appropriate. If they are a source of vibration they should be linked to the distribution ductwork via flexible connections.

5.6 The fan of a Local Exhaust Ventilation (LEV) system provided under the COSHH Regulations should be located outside of the building so that all of the ductwork within the building is under negative pressure. Where the fan has to be within the building it should be located as close as practicable to the outside with an absolute minimum run of discharge ductwork within the building. The discharge ductwork within the building will be under positive pressure so it must not be penetrated by test holes or inspection hatches.

Ductwork materials and construction

5.7 The choice of duct material should take account of the nature of the air or gas being conveyed and the environment in which the duct will be placed.

5.8 Galvanised-sheet-steel is generally suitable and most economical for normal ventilating and air-conditioning applications. Its inherent mechanical strength renders it resistant to casual damage both during the construction phase and throughout its service life when mechanical and electrical services around it are altered. It also readily withstands the impacts sustained when rotary equipment is used to clean it internally.

5.9 In instances where moisture levels and/or corrosive elements in the air being conveyed are very high, aluminium, stainless steel, PVC or GRP (glass-reinforced plastic) ducts should be used. Stainless or black steel are the only suitable materials for high-temperature ductwork.

5.10 In inherently wet areas, such as the base of fresh air inlet ducts and some extract systems, the ductwork may require draining to prevent a build-up of standing water. The layout of the drains should be as specified in Section 4 Clauses 4.20 to 4.25.

5.11 Where builderwork plenum chambers or ducts are used, these may be constructed of various materials. However all such ducts must be rendered and sealed to prevent dust shedding. A greater allowance may need to be made for leakage.

5.12 Galvanised, black and stainless steel ductwork should be manufactured and installed to the current HVCA specification for sheet metal ductwork DW144, but excluding the use of bolt-through supports.

5.13 GRP and PVC ductwork should be manufactured and installed to the current HVCA specification for plastic ductwork DW154.

5.14 Where phenolic-board ductwork is considered, care should be taken to ensure that it is fabricated to a quality standard and installed strictly in accordance with the manufacturers' instructions. Its pressure rating and degree of support should be suitable for the application and ducts should be fitted with mechanical protection where required. Installers should be experienced having received training in the techniques required and certified to this effect by the manufacturers. Due consideration should be given to the impact on ductwork pressures created by the closing of dampers. Phenolic-board ducting should not be installed in plant rooms where it could be vulnerable to impact damage.

5.15 Flexible ductwork is unsuitable for air distribution in healthcare applications. It should only be used to make the final connection to a terminal (See clauses 5.54 and 5.55).

5.16 The inside of the ductwork should be free from structural projections and as smooth as possible. Flanged, gasketed joints are preferred.

Fire aspects, damper types and locations

5.17 It is essential that all relevant fire aspects of ducting systems are agreed with the fire officer before the design is finalised.

5.18 Ductwork must be fire-stopped where it penetrates fire compartment walls, floors and enclosures, cavity barriers and sub-compartment walls or enclosures, and provided with weatherproof collars where roofs or external walls are penetrated.

5.19 Fire/smoke dampers shall be provided at the locations required by Firecode. The fire-damper mounting frame must be securely attached to the building fabric. Where a fire-damper is not mounted directly in a fire compartment wall, it must be correctly supported and the ductwork between it and the firewall must posses the same fire rating as the firewall that it penetrates. The fire-rated portion of ductwork must not be penetrated by test holes or inspection hatches. All fire/smoke dampers shall be capable of remote re-setting via the Building and Energy Management System or equivalent, after periodic testing procedures.

5.20 An access hatch shall be provided adjacent to each fire damper so that its correct operation can be directly observed.

5.21 Smoke-diverting dampers must be provided on recirculation air systems to divert automatically any smoke-contaminated return air to the outside of the building in the event of a fire; and arranged so that the normal open smoke-diverting damper on the return-air branch to the input unit closes and all the return air is exhausted through the extract fan. Guidance is available in SHTM 81 and BS5588: Part 9.

Duct sections

5.22 Ducting is generally available in rectangular, circular and flat oval sections, although other sections may be made for special situations.

5.23 Rectangular ducting is most common on low-pressure systems, for the following reasons:

- it can readily be adapted to fit into the space available;
- fittings are cheaper than those for circular or flat oval ductwork;
- it can readily be joined to such component items as heating and cooling coils, and filters.

5.24 When sizing ductwork, the designer should take into account:

- both installation and operating costs;
- space limitations imposed by the structure and other services;
- operating noise levels;
- requirements of regulation at the commissioning stage.

5.25 For overall economy and performance, the aspect ratio should be close to 1:1, since high aspect ratios increase the pressure loss, heat gains or losses and overall cost (for example, changing the aspect ratio from 1:1 to 1:4 can typically

increase the installed cost of the ductwork by 40% and add 25% to the heat gains or losses).

5.26 Rectangular ducting should not be the first choice for high pressure systems, and should be avoided in systems operating at high negative pressures, because the strengthening of the flat sides and the sealing requirements necessary to make rectangular ducts suitable for these high pressures are costly.

5.27 Circular ducting is preferable for high-pressure systems, and for systems operating at high negative pressures. In the case of the latter, additional stiffening rings may be necessary. Machine-formed spirally-wound ducting and a standard range of pressed and fabricated fittings can sometimes make circular ducting more economical, particularly in low pressure systems having a relatively low proportion of fittings.

5.28 Flat oval ducting provides an alternative to circular ducting, principally where there is a limitation on one of the dimensions in the space available for the duct run.

5.29 Other sections may be used, such as triangular sections to pass through roof trusses. Such sections present difficulties in the provision of fittings, and connections to standard plant items, and are likely to be more expensive than traditional sections.

Standard ductwork fittings

5.30 All fittings should conform to current HVCA specification DW144. Wherever possible, long radius bends, large radius main branches, not more than 45^{o} angle sub-branches and long-taper transformations should be used.

5.31 Fittings should be arranged with vanes in sub-branches connected directly to grilles and diffusers, and turning vanes in square bends (when used). When vanes are used, additional cleaning access will be required.

5.32 The number of duct fittings should be kept to a minimum and there should be a conscious attempt to achieve some standardisation of types and sizes. Increasing the number and variety of fittings in a system can markedly raise its overall cost.

5.33 Bad design in relation to air flow can lead to vibration of flat duct surfaces, increases duct-generated noise and pressure loss, unpredictable behaviour in branch fittings and terminals, and adverse effects on the performance of installed plant items (such as trimmer batteries).

Branches

5.34 There are many designs of branches and junctions in use. The important features are that the flow should be divided (or combined) with the minimum interference and disturbance. Changes in duct sizes should not be made at the branch but a short distance downstream (or upstream). A good dividing branch

design cannot be effective if the flow entering the branch is not uniform across the section.

Changes of section

5.35 The expansion of a duct section should be formed with sides having a total included angle of no more than 30°, and preferably less than 20°. If the angle of expansion is greater, the flow is not likely to remain attached to the walls of the duct and large eddies will be formed with flow reversal at the walls. This leads not only to a high-pressure loss, but also to non-uniform velocity pattern at the outlet. Where there is insufficient space for a gentle expansion and a greater angle is necessary, internal splitters should be used.

5.36 A contraction in a duct section is less critical, but the total included angle of the taper should not exceed 40° (or 20° where the contraction is made on one side of the duct only)

5.37 The most economical way to change the section of a rectangular duct is to restrict the change of duct size to one side only. If the calculated reduction or increase to the side dimension is 50 mm or less, it is usually not economical to change the size at the position. The minimum size of a rectangular duct should usually be 150 mm x 100 mm.

Other fittings

5.38 As a general rule, fittings should avoid abrupt changes in direction and also sharp edges that cause the flow to separate and form eddies, thus limiting pressure loss and causing noise generation. If the fitting leads to the flow preferentially attaching to one side of the outlet, then a significant length of straight downstream duct is necessary before the next branch or fitting; this length should be greater than five equivalent diameters.

Thermal insulation

5.39 Thermal insulation is applied to ductwork to reduce heat exchange, and to prevent condensation.

5.40 In a duct system, the air temperature changes can be significant, especially when passing through untreated space, and these have the effect of reducing the heating or cooling capacity of the air and of increasing the energy input to the system. The heat transmission to and from the surrounding space can be reduced by effective insulation of the ducts.

5.41 Condensation can arise in ductwork systems conveying cooled air and, apart from creating conditions conducive to corrosion of ductwork, condensation affects the heat and vapour-resisting properties of insulating materials themselves which may induce further condensation.

5.42 In normal circumstances, the insulation thickness for heat resistance is sufficient to prevent surface condensation, but in extreme conditions the

insulation thickness for vapour resistance may be greater than that for heat resistance. When cold ducts pass through areas of high dew-point, carefully selected vapour barriers should be applied externally to the insulation.

Noise generation within the ductwork

5.43 Noise is generated in ductwork at sharp edges, by tie rods, damper blades, duct obstructions and sharp bends etc. This air-flow-generated noise becomes an important factor if it is about the same or greater level than the upstream noise level. (Air-flow-generated noise is often referred to as “regenerated noise”).

5.44 The noise level generated by airflow in ductwork is very sensitive to the velocity. The sound power of this noise is approximately proportional to the sixth power of the velocity; that is, a doubling of the duct velocity will increase the sound power by a factor of 64. The duct velocities should therefore be kept as low as possible. In general, duct fittings that have lower pressure loss factors in similar flow conditions will generate less noise.

5.45 Ductwork serving quiet areas should not be routed through noisy areas where noise break-in can occur and increase the noise level in the ductwork.

5.46 Grille, register and louvre noise should be kept to the minimum by selecting types having low noise-producing characteristics, without high tonal noise, and should be fitted with acoustically treated external inlet and outlet louvres.

5.47 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required. They will normally be of the ‘through-the-ceiling, ‘up-and-over’ type and may include a fire damper if required.

Volume control damper locations

5.48 Manually operated balancing dampers are needed generally:

- in the main duct downstream of the fan;
- in branches of zone ducts;
- in sub-branch ducts serving four or more terminals;
- at terminals not covered by the previous item.

5.49 Dampers integral with terminals should only be used for final trimming of air volumes, otherwise noise and air distribution problems may ensue.

5.50 Dampers in rectangular ducts should be single-bladed when the longer side is up to 450 mm but be of the opposed-blade multi-leaf type above this size. In circular ducts, iris-type dampers are recommended. Dampers must be accessible, incorporate a position indicator and means of locking in the commissioned position. Dampers should be located as far away as possible from adjacent branches or plant items.

Cleaning and access door locations

5.51 Cleaning and access doors are required to facilitate access to plant items and ductwork components for inspection, maintenance, cleaning and replacement, and must be of sufficient size to permit safe access for the required functions. Consideration should also be given to the number of doors to be provided.

5.52 Recommended locations for access doors are given in the current HVCA specification DW144 and are generally provided to give access to:

- every regulating damper;
- every fire and motorised damper;
- filter (to facilitate filter withdrawal);
- both sides of cooling/heating coils;
- humidifiers;
- fans and
- motors and impellers.

5.53 Care should be taken when siting access doors to ensure that no other services to be installed will prevent reasonable access.

Flexible ducting

5.54 Flexible ductwork may be used for final connections to grilles and diffusers provided it is constructed to meet the fire precautions recommended in BS8313. It must not pass through fire compartment walls, floors or enclosures of sub-compartment walls or enclosures, or through cavity barriers.

5.55 Flexible ducting will cause a significant frictional loss and may be difficult to clean and should never be used in lieu of a bend. Where installed it should take the most direct route and be as short as possible, never exceeding 1 metre in length.

Diffuser and grille selection and sizing

5.56 The effectiveness of all ventilation and air-conditioning systems depends on the methods by which air is introduced to, and vitiated air is removed from, the space. The usual results of poor air-terminal selection and/or positioning are: - draughts, stagnation, poor air quality, large temperature gradients and excessive noise.

5.57 Air can be supplied to a space in a number of ways, although any device can be broadly placed into one of two categories: that producing a diffused supply, or that producing a perpendicular jet. Diffusers may be radial or linear, and normally utilise the Coanda effect (that is, adhesion of the air stream to an adjacent surface), to reduce the risk of excessive room-air movement. A

perpendicular jet is formed by discharging air through grilles, louvres or nozzles, which are generally adjustable.

5.58 Air-flow patterns produced by both types of terminal are dependent to a large extent on the presence of the Coanda effect.

5.59 Supply air terminals can be incorporated into any room surface, for example, floors, walls (high or low level), desktop etc.

5.60 As they operate on the jet principle, the use of sidewall and linear grilles is restricted to areas where air change rates are low, that is, less than 10 per hour. Perforated rectangular diffusers can provide acceptable conditions within the occupied zone at up to 15 air changes per hour. In areas where a higher air change rate is required, square or circular ceiling mounted diffusers should be used.

5.61 The performance of supply air terminal devices is provided, based on three criteria: throw, spread and drop. **Throw** is defined as perpendicular or parallel distance from the terminal to the point at which the air velocity is 0.5 m/s isovel. **Spread** is defined as the width of the 0.5 m/s isovel; and **drop** is defined as the vertical distance from the centre line of the terminal to the bottom edge of the 0.25 m/s isovel.

5.62 It is necessary to consider each of these parameters in both summer and winter conditions to ensure satisfactory operation of the air-terminal device, as warm jets behave very differently from cold jets.

5.63 A warm jet tends to rise until it attaches itself to a horizontal surface, while a cold jet falls. Care must be taken to ensure that this does not lead to unacceptable temperature gradients in winter or excessive air velocities in the occupied zone in summer.

5.64 In order to ensure satisfactory air movement within a space, it is necessary to consider interaction between air movement from adjacent terminals, and ceiling mounted fixtures (light fittings etc), as well as interaction between air movement and room surfaces.

5.65 If the supply and extract terminals are too close, short-circuiting may occur, while if they are too far apart, stagnant zones may be formed. Where two opposing air streams meet, the individual velocities must not be greater than 0.25 m/s.

5.66 Supply and extract grilles and diffusers should be fitted with opposed-blade dampers for fine balancing purposes.

5.67 Further guidance on the selection of grilles and diffusers is given in the CIBSE Guide B.

5.68 In operating theatres, the supply terminals must be able to produce a down-flow movement of air in the operating zone 1 metre above floor level. Ceiling mounted diffusers with fixed directional vanes that provide a downward turbulent airflow are the preferred option. Plenum boxes fitted with perforated

screens to produce a parallel downward flow are also acceptable. Nozzles or jets of any type are not acceptable. Sidewall-mounted linear diffusers that utilise the Coanda effect to send air across the ceiling and 'drop' it into the operating zone are also not suitable. However linear ceiling mounted diffusers that provide a direct downward airflow around the operating zone may be used.

Transfer grille - size and location

5.69 Air-transfer grilles in walls, partitions or doors form an integral part of the building's air distribution system. Modern doorsets have very low leakage rates so cannot be relied upon to permit even quite small airflows. Failure to make adequate provision for air to move from room to room will result in excessive pressure differentials and 'door whistle'.

5.70 Transfer grilles are required in locations where there is a significant imbalance between the supply and extract rates in a room. They will relieve any pressure differentials that may affect the operation of the spaces and/or the ventilation system and permit airflow in a known direction. However, transfer grilles are vulnerable to damage and, in many instances, as long as the equivalent free area is provided, they can be substituted with undercut door.

5.71 Care needs to be taken to ensure that the positioning of transfer grilles does not interfere with the fire or smoke integrity of the building. In general, the air-transfer grilles should not be installed within fire-resisting boundaries, although if this is unavoidable, they should be fitted with fire- or smoke-dampers.

5.72 Where installed, transfer grilles should be of the non-vision type, sized for a maximum face velocity of 1.5 m/s.

5.73 In photographic dark rooms, lightproof transfer grilles will be required.

5.74 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required. (See also paragraphs 5.43 to 5.47).

Pressure stabilisers - size and location

5.75 Pressure stabilisers are required in lieu of air-transfer grilles in areas where it is necessary to maintain pressure differentials between adjacent rooms to prevent reversal of airflows for example, in operating suites, isolation facilities and clean rooms. (See also Section 7 paragraphs 7.24–7.28).

5.76 Fire precautions for pressure stabilisers are the same as for transfer grilles. For sizing criteria, refer to Section 7 paragraph 7.23

5.77 Pressure stabilisers should be of the balanced-blade type, with the facility to make fine adjustment of the pressure setting. They should be silent in operation and give a seal as tight as practicable when closed. The materials of construction and method of assembly should allow for cleaning and disinfection.

5.78 Pressure stabilisers should be installed in a visible location so that their operation can be readily observed.

5.79 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where confidentiality is required. In these cases, the pressure stabiliser and cross-talk attenuator should be mounted in a short length of ductwork within the ceiling void.

5.80 Pressure stabilisers may need to be fitted with a stand-off baffle on their discharge side to prevent a sight line in situations where a laser will be used. Baffles may also be required to preserve privacy or prevent discharge air causing draughts or disturbing the air distribution pattern in the adjoining room. They are also useful in low-level locations to prevent the airflow path being obstructed by portable equipment.

6. Automatic controls

6.1 Various options for control of single and multi-zone air-conditioning systems are given in CIBSE Guide B.

General requirements

6.2 The basic requirements for an automatic control system are as follows:

- facilities to start, set-back and stop the plant;
- facilities to control the volumetric air-flow;
- facilities to control the system or room pressure;
- temperature control and indication;
- humidity control and indication;
- devices to monitor and indicate the plant's operating state;
- alarms to indicate plant failure, low air-flow, and filter state.

The control functions actually provided will depend on the purpose of the ventilation system.

6.3 There will also be a need to determine the control strategy in the event of a fire either within the zone being served or within an adjoining zone.

6.4 The designer should consider whether it is necessary for the supply and extract fans to be interlocked, either so that the supply fan will not operate unless air-flow is established within the extract system, or vice-versa depending on the required pressures within the rooms being served.

6.5 The sequence switching of units in order to prevent transient reverse airflows will be particularly important in laboratory and pharmacy areas that also contain fume cupboards, safety cabinets and other LEV systems.

6.6 Alarms should be provided to show 'filter fault' and 'low air-flow'. The "filter fault" alarm should be initiated by a predetermined increase of pressure differentials across the filter. The 'low air-flow' alarm should be initiated when the supply air quantity falls to 80% of the design value.

Objectives of control system

6.7 The primary objective of ventilation plant control system is to maintain the space served within the required environmental control limits, at the appropriate times, regardless of external conditions or internal loads and with the minimum energy consumption.

6.8 Often, it is not possible to predict accurately building load variation at the design stage, and thus optimum set points cannot be assessed. Information provided by monitoring the operation of the plant via a Building and Energy Management System (BEMS) will enable optimum set points to be established and energy consumption reduced. Control of most systems will be via a BEMS. This will enable the operating conditions and control tolerances to be set and monitored. The BEMS may also be set to log the actual energy consumed by the system together with that recovered by the energy-recovery device. This will provide a useful check on overall operating efficiency and provide evidence that energy targets are being achieved.

6.9 BEMS incorporating self-adaptive control algorithms that automatically adjust the set-point to the suit the usage and load are preferred. The provision of movement sensors within the controlled space in order to determine the actual occupancy will facilitate this process.

6.10 The failure of specialised ventilation systems can have grave consequences for the delivery of healthcare. Control systems should therefore be simple, robust and reliable.

6.11 Computer-software-driven control systems are becoming the norm in building services. However, it should be remembered that healthcare ventilation systems need to be available to operate outside of normal working periods when software support is not available. Should the software fail, it will be left to site staff, who may have little knowledge of the control algorithms to restart the ventilation system. It is therefore essential to ensure that a simple means of re-starting critical systems in the event of a software failure is provided (see also paragraphs 4.62 - 4.63)

Location of controls

6.12 Whether within the plant, duct or room, sensors should be located to provide accurate measurement of the condition of the air being monitored.

6.13 Sensors and control items such as control valves should be located close to the element being sensed or plant item being controlled, in order to minimise time lags within the system which may create over-shoot of conditions beyond the design envelope and result in additional energy consumption.

6.14 There are practical advantages in locating all control valves for an air-handling unit in a bank (at a convenient height) at one end of the unit. (This will not normally result in an undue additional control lag.)

6.15 Some applications require intermittent mechanical ventilation, frequently at a high air-change rate, (for example, in bathrooms and treatment rooms.) Local controls to facilitate this mode of operation should be placed in a prominent position to encourage economical use.

6.16 Local controls that enable the user to select more than one mode of operation should be clearly labelled to identify the particular mode selected. Where the system allows different room pressures to be selected then a direct-reading

pressure gauge should be fitted within the eye line of the users to provide an independent confirmation of the resultant mode of operation. A clear description of the selectable modes of operation should be mounted adjacent to the control switch.

Fire aspects

6.17 A fire control panel should be mounted at the entrance of the area that the ventilation serves. The panel should have restricted access for the fire officer and include independent on/off controls and indication of the supply and extract systems.

6.18 In certain critical care departments it is preferable to maintain the supply ventilation in case of a fire within the area. For example, in an operating department, while undergoing surgery the patient cannot always be easily moved without significant risk. In the event of a fire in a staff or support area of the department, or adjoining zone, the continued supply of air to a theatre will maintain it at a positive pressure and protect the patient and staff from the effects of smoke. This will allow time for the patient to be stabilised so that he/she can be safely evacuated if necessary. A similar situation occurs for patients in ITU and other critical care units. In all of these cases the ventilation to the critical area should continue to operate unless the AHU starts to draw in smoke. For these departments, a notice should be affixed to the fire control panel drawing attention for the need to liaise with departmental staff before switching off fan units.

6.19 All supply AHUs should have a smoke sensor mounted in the main supply duct immediately downstream of the AHU. In the event of a fire in the AHU or smoke being drawn into the system from an outside source, it should cause the supply air fire damper to close and shut down the AHU.

Time switching

6.20 Facilities to start, set-back and stop the plant should be provided in the plantroom. Remote start and set-back control and indication, if required, should be provided at a manned staff location, for example, at the reception or staff base or, in theatres, within the Surgeon's Panel.

6.21 Many ventilation systems may be completely shut down when the area served is not in active use. Alternatively, where there is a need to maintain a background condition, the ventilation output can be reduced by "setting back" the system. This will significantly reduce energy consumption and extend the life of filters and other system components.

Start-up control

6.22 The plant's start control should contain a control logic that will start the plant in the sequence set out in the following algorithms, Figures 4-7.

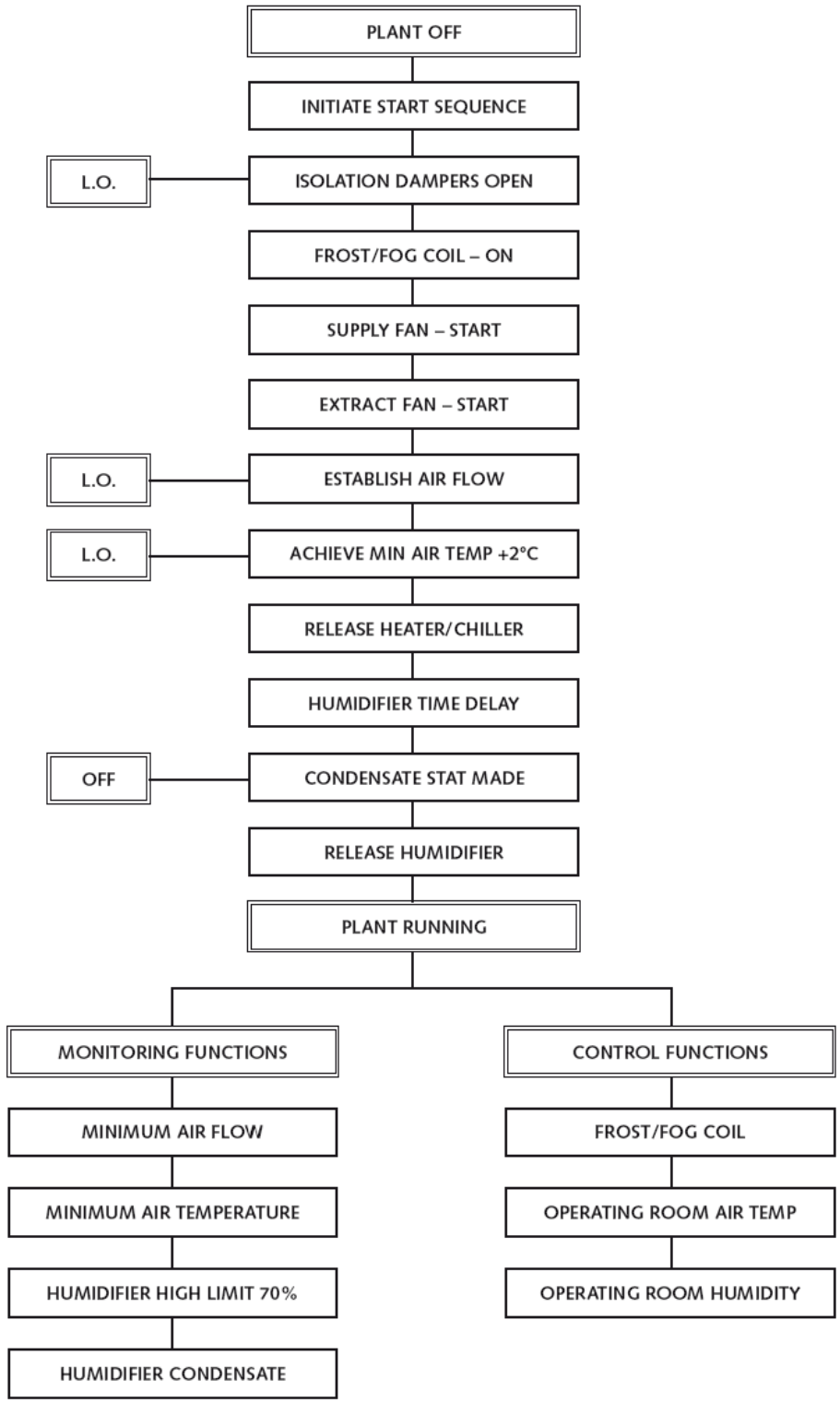

Figure 4: Typical plant control algorithm – normal start-up sequence

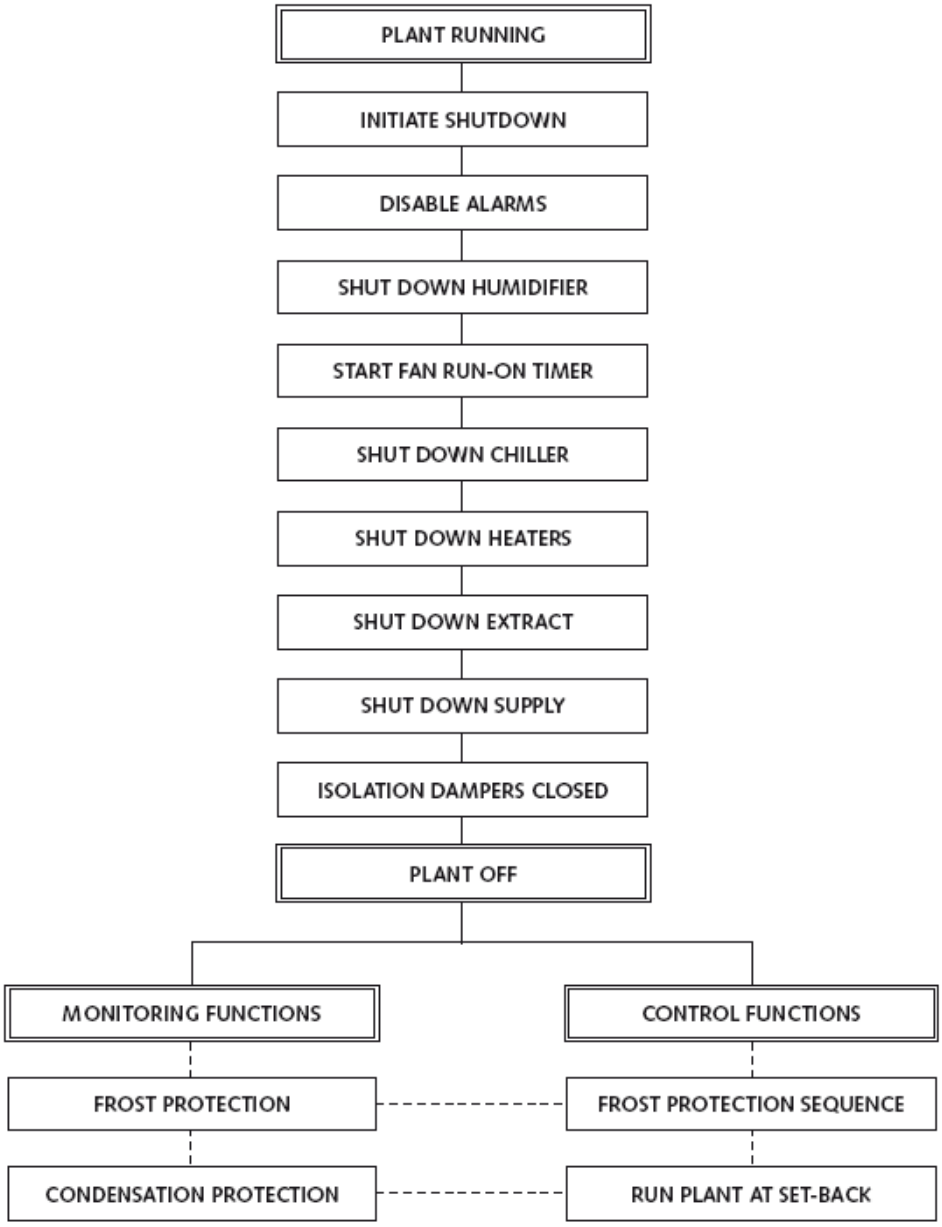

Figure 5: Plant control algorithm – normal shutdown sequence

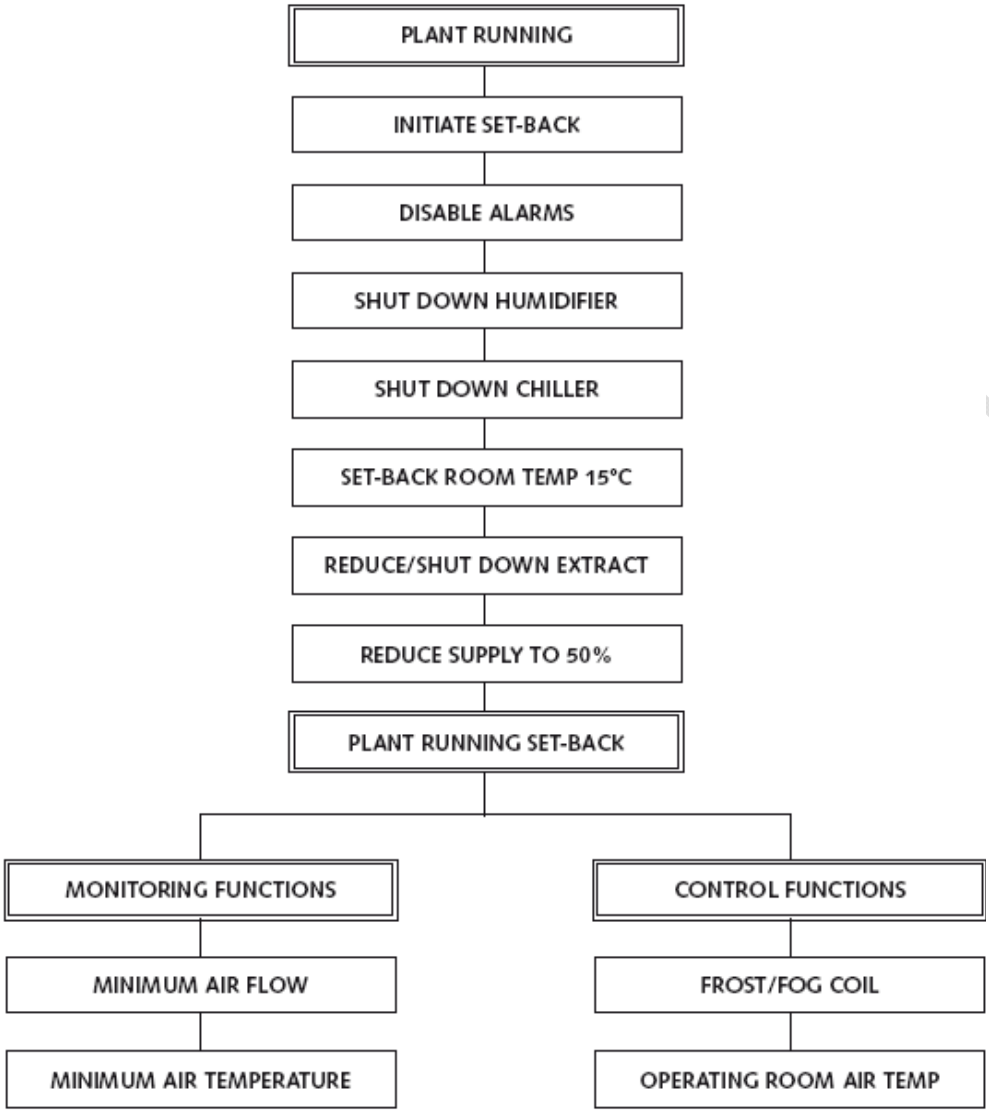

Figure 6: Plant control algorithm – set back sequence

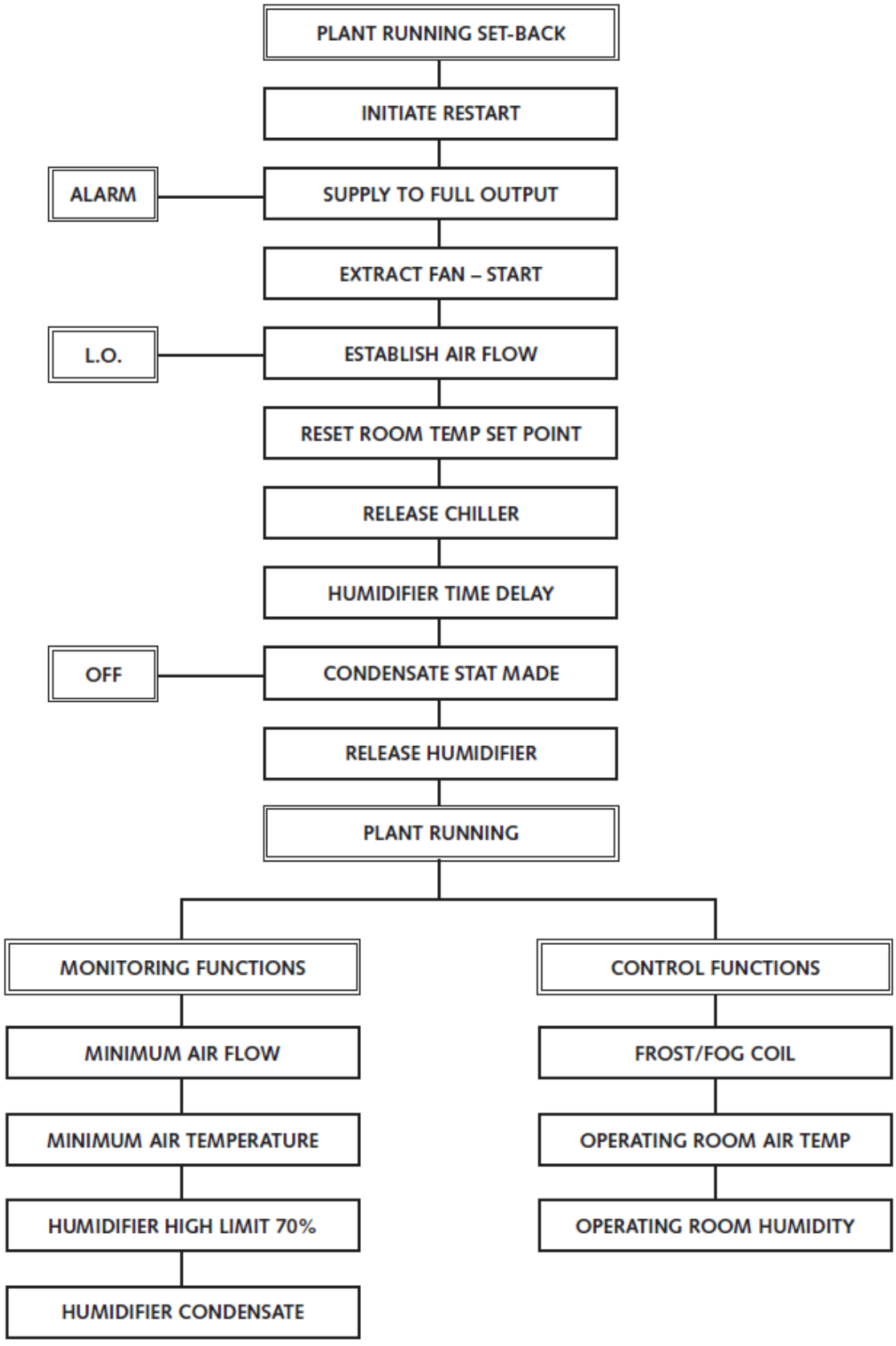

Figure 7: Plant control algorithm – restart from set-back

Set-back control

6.23 Where variable speed controls are installed, the setback facility for each plant should depress the control temperature to around 15°C; exclude any humidification and cooling from the system; and reduce the supply and extract air volumes to around 50%. The extract fan can also be turned off as long as the desired direction of air movement from clean to less clean will be maintained (See also figures 4-7).

Use control

6.24 The installation of movement detectors allows for “use control” of ventilation systems. A simple control logic that reduces the system to a “set-back” condition if there has been no movement detected in the space for, say, 30 minutes and that switches the system “off” if no movement is detected for one hour is recommended for many applications, including operating suites.

6.25 A variation on this can be provided by linking ventilation controls to lighting. For example, in an operating theatre, the system may be off outside of working hours, could run at set-back when the general lighting was switched on and increase to full speed when the operating lamp is switched on. As with movement detection, a 30-minute run-on should be provided at each stage when the lights are turned off.

6.26 Either of the above control strategies may be refined by linking to the BEMS to provide a control logic related to normal working hours and associated ‘real-time’ movement within the zone being controlled. This should result in significant energy savings.

Environmental control

Temperature control methods and application

General

6.27 All control valves must fail safe, that is, close in the event of power or air-flow failure, with the exception of the fog/frost battery control valve, which should open upon power or airflow failure.

6.28 Control valves should be located in an accessible position. Isolation valves should be provided to enable the control valve to be removed for service without the need to drain-down the system.

6.29 Care should be taken to ensure that the installation of control valves and their associated pipework do not obstruct access to the AHU inspection doors and hatches.

Room temperature control

6.30 The limits for room temperature set point are generally between 16°C and 25°C depending on the particular application, and in some specialised instances (for example, operating departments) are adjustable within a predetermined range by the user.

6.31 The selection of temperature set point for each room or zone, may be by a control facility in the room / zone, or remotely at the control panel or BEMS. Where the control device is mounted within the room / zone and adjustable by the user, it should be marked either 'raise' and 'lower' or '+'and' -'. It should control within a specified temperature range to suit the user requirement with a control tolerance of ±1K. All other control set-points should be selectable either on the control panel or at the BEMS interface.

6.32 Where local control is provided, an indication of temperature will be required locally, or at a staff base (if appropriate), using an analogue or digital indicator. The indicator should be large enough to be read from the normal working position (for example, at the operating table in a theatre). This may be mounted in a supervisory or, "surgeon's" control panel, with the signal repeated on the main system control panel or BEMS. It is important that this indicator displays the actual measured temperature and not the selected temperature.

6.33 Where the supply and extraction systems are designed for ventilation only and there is a wet heating system to provide background heating, care must be taken to avoid one system trying to heat the space while the other system is trying to cool the area.

Frost battery control

6.34 Steam-supplied frost batteries must be operated as on/off devices with their sensor mounted upstream of the battery. This will give 'open loop' control. A set point of +1°C is recommended.

6.35 Low pressure hot water (LPHW)-supplied frost batteries should be controlled using the proportional mode. Their sensor should be located downstream of the battery to give 'closed loop' control. A set point of between 2°C and 5°C is recommended.

6.36 If the temperature downstream of the frost battery, as sensed by a serpentine thermostat, falls below the required set point over any part of the coil, the plant must automatically shut down in order to prevent damage to the other batteries. The serpentine thermostat must not be in direct contact with the coil.

Off-plant control

6.37 The control logic must prevent the chiller and pre-heater being on at the same time.

Humidity control methods and application

6.38 In order to prevent excessive condensation when starting up from a total plant shut-down, a time delay should be incorporated into the control system such that the humidifier does not start until 30 minutes after the ventilation plant starts up.

6.39 Irrespective of the method of control, a high-limit humidistat should be installed to ensure that when the humidifier operates, the condition of the air in the duct does not exceed 70% saturated, particularly during plant start-up.

6.40 With certain types of steam humidifiers, it may be necessary to install a thermostat in the condensate line from the humidifier's steam supply, to ensure that the steam at the control valve is as dry as possible before it is injected into the air supply.

6.41 The humidifier and cooling-coil control must be interlocked so that they cannot be on at the same time.

6.42 The humidifier control system should ensure that it is switched off with the fan. It is preferable to design the control system so that the humidifier is isolated for an adequate time before the fan is turned off so as to purge humid air from the system.

6.43 All control valves must fail safe (that is, close in the event of power failure) and the humidifier must be interlocked with the low airflow switch.

Multi-zone control methods and application.

6.44 Close control of all air-conditioning parameters may be difficult to achieve with multi-zone systems, since each zone will in theory require a re-heater and humidifier to give total control of humidity if that is what is required. In reality such close control is rarely required in practice. It is therefore usual with multi-zone systems to provide control of zonal temperature only, with humidity control where fitted being based on average conditions within all zones, or minimum conditions within one zone.

6.45 Where there is a requirement for close control of air-conditioning parameters in a number of zones (e.g. an operating department) separate plants should be provided for each zone in order to avoid the need for expensive over-cooling and reheating of individual zones.

6.46 Most multi-zone systems within healthcare premises are controlled based on off-coil control within the central plant, with trimmer heater batteries on individual zones.

Alarms and indication

6.47 Supply and extract systems should include indicator lamps on the control panels to confirm the operational status of each system. Where the usage is on

a regular daily pattern, time control with a user-operated timed manual over-ride should be provided.

6.48 Where a system is provided for a particular space, the indicator should be in, or immediately adjacent to, that space and local controls should be provided with labels clearly defining their function (eg. isolation suites.)

6.49 The 'plant failure' and 'low air-flow' alarms should be initiated by a paddle switch or other device located in the main air supply duct. This should operate when the air quantity fails to reach or falls to around 80% of the design value and will give indication of fan failure, damper closed, access door left open, or any other eventuality that could cause a reduction of air quantity. Monitoring the current drawn by the fan motor is not a substitute for a sensing device that is directly affected by the air-flow.

6.50 The 'filter fault alarm' should be initiated by a predetermined increase of pressure differential across the filters, thereby indicating a dirty filter.

6.51 Direct-reading gauges or manometers should be installed across filters to give maintenance staff an indication of their condition.

6.52 Visual indication should be provided at a manned staff location (for example, the reception or staff base) and on the main control panel and BEMS to show 'plant failure' and 'low air flow'.

BEMS

6.53 Control of most systems will be via a Building Energy Management System. This will enable the operating conditions and control tolerances to be set and monitored. The BEMS may also be set to log the actual energy consumed by the system and recovered by the energy recovery system. This will provide a useful check on the overall operating efficiency and provide evidence that energy targets are being achieved.

7. Specialised ventilation systems

7.1 This section contains design information for a range of healthcare ventilation applications.

7.2 The following departments will require a degree of specialised ventilation.

- the Operating department;
  - treatment rooms;
  - endoscopy, day case and minimum invasive suites;
  - cardiology and operative imaging suites;
  - conventional operating theatres;
  - Ultra Clean Ventilation (UCV) operating theatres;
  - barn theatres;
  - recovery and ancillary areas.
- Obstetrics;
  - maternity theatres;
  - birthing rooms;
  - LDRP Rooms;
  - SCBU.
- critical areas and high-dependency units of any type;
- Isolation facilities;
  - infectious diseases units;
  - bone marrow and other transplant units;
  - chemotherapy and oncology units.
- Sterile Supply and Decontamination Units;
  - wash rooms;
  - inspection and packing rooms;
  - sterile pack stores.
- the Pharmacy departments;
  - aseptic suites;
  - extemporaneous preparation areas;
  - radio pharmacies.
- the Pathology department;
  - laboratories;

  - cat 3 and 4 rooms.
- the Mortuary and Post mortem suite;
  - mortuaries;
  - post-mortem rooms;
  - specimen stores.
- Hydrotherapy units;
- Burns units;
  - burns theatres;
  - treatment rooms;
  - isolation rooms;
  - tissue banks.
- Emerging specialties;
  - gene therapy units;
  - stem-cell laboratories.
- Infrastructure;
  - plant rooms housing combustion equipment;
  - welding facilities;
  - wood working workshops;
  - electric vehicle charging areas.

7.3 Design information for many of these applications is given in Appendix 1 Table A1, Appendix 2 and in the following Chapters within this section.

7.4 It is not possible within this existing document to give definitive guidance for every healthcare specific ventilation application. Additional detailed guidance may be issued in due course in the form of supplements.

General information

7.5 The section on operating theatres is the most extensive and contains much information that is common to other applications. Where no specific guidance is given then the principles set out below should be followed:

- the foregoing sections of the document contain general information on healthcare-specific aspects of ventilation system design and specification;
- a set of standard solutions for the design of general operating theatre suites to conform to past and new standards is given in new standard layouts Nos 1, 3, 5 and 7 and those for UCV theatres in new standard layouts Nos 2, 4, 6 and 8 within Appendix 3;
- the CIBSE Guides A & B contain basic information on ventilation design that can be applied to most applications;

- where a British or European standard exists that is specific to the application (for example, a clean room) it should be used as the basis of the design requirement;
- air should always move from clean to less clean areas. A hierarchy of room cleanliness is given in Appendix 2 Table A2;
- differential pressure will prevent contamination between areas when doors are closed. Information on air leakage through closed doors and hatches for a range of differential pressures is given in Appendix 2 Table A3;
- the flow of air will prevent contamination between areas when doors are open. Information on air leakage through open doors and hatches for a range of differential pressures is given in Appendix 2 Table A4;
- if anaesthetic gases are used, 15 air changes per hour will be required;
- a methodology for calculating a design solution for a non-standard suite of operating rooms is given in Appendix 4. This may be adapted as necessary to suit other less complex applications where air is required to cascade from clean to less clean areas.

7.6 The supply of air to a room has four main functions:

- to dilute airborne contamination;
- to control air movement within such that the transfer of airborne contaminants from less clean to cleaner areas is minimized;
- to control the temperature and if necessary the humidity of the space;
- to assist the removal of and dilute waste gases where used.

7.7 Because of the complexities of controlling air-movement patterns, much design effort will be required for this aspect. It is important that the design makes the best possible use of the air available, as excessive supply airflows for the control of air movement should not be used. The amount of air supplied will be determined by the number of doors and desired air-change rate.

7.8 There are four routes whereby airborne contaminants may appear in a room:-

- through the supply air;
- shed directly by the room occupants;
- arising as a result of the work activities;
- transferred from adjacent spaces.

7.9 Particles entering with the supply air can be controlled by the selection of suitable filter grades.

7.10 Particles shed directly by the room occupants can be controlled by:

- restricting access to essential persons only;
- the choice of the occupants' clothing;

- the room's air-change rate.

7.11 Particles arising as a result of the work activity can be controlled by:

- enclosing, semi-enclosing or otherwise controlling the work-based source;
- the room air-change rate.

7.12 The transfer of particles from adjacent spaces can be controlled by:

- differential pressure;
- air-flow paths.

7.13 Air change rates are given in Appendix 1 Table A1. These figures have been found to give sufficient dilution of airborne contaminants, provided the mixing of room air is reasonably uniform.

7.14 A downward-displacement turbulent air distribution is generally preferred. The supply and extract diffusers should be positioned to ensure that all parts of the room are actively ventilated and that where necessary the staff will be in a clean air-flow path. (See Section 5 for additional guidance on supply terminals).

7.15 Horizontal-flow room-air distribution with or without a Coanda effect can be a source of draughts and difficult to set up correctly. Its use should be confined to non-critical areas.

Air movement control

7.16 The design of the system should seek to minimise the movement of contaminated air from less clean to cleaner areas. Transfer grilles enable air to pass in either direction between rooms of equal class and pressure. Pressure stabilisers operate in one direction only; they allow excess air to be directed to the area desired and assist in maintaining room pressure differentials. When closed they prevent significant reverse air-flow.

7.17 The relative locations of supply and extract terminals and their design air-volume rates will determine the basic airflow between adjacent spaces. Transfer grilles and pressure stabilisers will permit and control the flow of air between spaces ensuring a flow from the clean to less clean areas. Failure to provide such devices will lead to uncontrolled air flows when personnel move between rooms. They may also result in doors being held partially open by air pressure

Temperature and humidity control

7.18 To achieve the required room conditions, supply flow rates are calculated conventionally, taking account of all heat and moisture gains and losses, and of maximum permissible temperature differences between the room and supply air. In most applications the base heating load will be provided by a heating system. In critical systems the room or suite being considered will be within the

heated building envelope so the ventilation will be sized to suit the casual gains or losses.

7.19 Temperature differences of up to 10 K for winter heating and 7 K for summer cooling must not be exceeded.

7.20 It is acceptable for the humidity to swing uncontrolled between 35% and 70% saturation.

Removal and dilution of waste anaesthetic gases

7.21 Anaesthetic gases are subject to occupational exposure limits. Waste anaesthetic gas must be contained and removed by a suitable gas-scavenging system. Some leakage from the anaesthetic equipment and the patient's breathing circuit will occur with all systems, particularly during connection and disconnection; and from the interface with the patient. The air movement scheme should ensure that this leakage is diluted and removed from the room. Anaesthetic agents are heavier than air so placing the supply terminal at high level with an extract at low level, adjacent to the anaesthetic gas terminal units will ensure that staff are in a clean air-flow path.

7.22 In LDRP and delivery rooms the use of anaesthetic gas is controlled on demand by the patient. This may result in significant leakage which, in order to reduce staff exposure, will need to be controlled by establishing a clean airflow path. A supply at high level at the foot-end of the bed with extract at low level at the head-end will provide such a path.

Fire aspects

7.23 When considering the overall airflow movement, careful thought needs to be given to the operation of the ventilation system, to limit smoke spread in the event of a fire.

Door protection

7.24 Air should flow from the cleaner to the less clean areas as shown in Appendix 2 Table A2. There are several factors that affect the likelihood of a reverse air-flow through doorways:

- when a person passes through a doorway, both the passage of the person and the movement of the door flap cause a transfer of air between the areas separated by the door;
- when a door is left open there is a transfer of air between the two areas separated by the doorway. This is caused by air turbulence, but is greatly increased by any temperature differential between the areas (a 1.4 m wide doorway may allow the transfer of 0.19 m^3/s of air in each direction when there is no temperature difference, but when the temperature differential increases to say 2 K, the volume transferred may increase to 0.24 m^3/s).

7.25 Two methods of door protection are used in order to reduce the likelihood of contamination of clean area by a reverse air-flow from a less clean area:

- closed door protection – a pressure differential is created across a closed door so that any air leakage is from the clean to the less clean area. Appendix 2 Table A3 gives details of closed door leakage rates for a range of differential pressures;
- open door protection – the pressure differential drops (See Appendix 2 Table A5) and is effectively replaced by a flow of air through the doorway from the clean to the less clean area. The flow of air needs to be sufficiently large to ensure that significant reverse airflow cannot occur and will be related to the relative cleanliness of the areas being considered. Appendix 2 Table A4 gives air-flow rates for open door protection related to door / opening size and classification of the adjoining areas.

7.26 Pressure stabilisers enable the room differential pressure to be set when the doors are shut, thus providing closed-door protection. When a door is opened the stabilisers will close, forcing air to be directed through the doorway thus providing open-door protection.

7.27 The recommended air-flow rates to achieve this are given in Appendix 2 Table A3. Provided that the dilution criteria in Appendix 1 Table A1 are met, the occasional small back-flows created (when two doors are opened simultaneously; or when there is a high temperature difference across an open door) will have little effect on the overall air cleanliness of the affected room.

7.28 In applications where it is critical to maintain a specific airflow and /or pressure regime (for example isolation rooms) all windows in the zone should be locked shut or sealed. Trickle vents, if fitted, will also need to be sealed.

Systems design

7.29 The design of the ventilation system for an area depends on the overall configuration of the department. Where the department is served by more than one AHU, the control of the units may need to be interlocked so that reverse air-flow patterns do not occur.

7.30 Dual-duct high velocity systems have advantages, but are noisy, costly and may give rise to unacceptable values of humidity. Single-duct, low velocity/pressure systems are preferred.

7.31 Extract grilles should be sited and balanced to promote air movement in the desired direction.

7.0 (a) Operating department ventilation systems

7.32 The information given in this section relates to general operating suites. It will be applicable to other types of theatre suite such as maternity, burns, cardiac, etc. The standard values given may need to be adjusted to reflect non-standard room sizes, pressure regimes and air change rates.

7.33 A method of obtaining a design solution for non-standard theatres is given in Appendix 4.

7.34 Additional information for UCV theatres is given in Section 7.0 (b).

General

7.35 The supply of air to an operating room has four main functions:

- to dilute airborne contamination;
- to control air movement within the suite such that the transfer of airborne contaminants from less clean to cleaner areas is minimized;
- to control the temperature and if necessary the humidity of the space;
- to assist the removal of, and dilute, waste anaesthetic gases.

7.36 Because of the complexities of controlling air-movement patterns, much design effort will be required for this aspect. It is important that the design makes the best possible use of the air available, as excessive supply airflows for the control of air movement should not be used. The amount of air supplied to the operating room will be determined by the number of doors and desired air-change rate.

7.37 The detailed considerations upon which the supply air-flow rate is based are as follows.

Dilution of airborne bacterial contaminants

7.38 There are four routes that airborne contaminants may appear in an operating room:

- through the supply air;
- shed by operating staff;
- produced by the surgical activities;
- transferred from adjacent spaces.

7.39 Supply flow rates for the main rooms of the operating suite are given in Appendix 3. For the other areas where room sizes and activities vary from site to site, air-change rates are given in Appendix 1; Table A1. These figures have been found to give sufficient dilution of airborne bacterial contaminants, provided the mixing of room air is reasonably uniform.

7.40 A downward-displacement air distribution is preferred; it may be either turbulent or laminar flow. For turbulent flow the supply-air diffusers should be positioned either in the centre of each quadrant of the ceiling or along a line between the centres of each quadrant. This should ensure that all parts of the room are actively ventilated and that there will be adequate air movement at the operating table. Laminar flow would be provided by a perforated plenum terminal centred

above the operating table. (See Section 5 for additional guidance on supply terminals).

7.41 Suspended articulated equipment is usually fitted in theatres. These require significant structural steelwork in the ceiling void to cater for the loads imposed by the resulting bending moments. It is important to ensure that the void is deep enough to accommodate both the steelwork and the ventilation ducts. The location of the steelwork must not prevent a suitable layout of the ventilation ductwork and correct positioning of the supply air terminals. It needs to be recognised that the correct ventilation of an operating theatre plays a significant part in controlling healthcare acquired infections and is not subordinate to the desire to make equipment easy to move.

7.42 Horizontal flow distribution with or without a Coanda effect can be difficult to set up correctly and are unlikely to be as effective in Theatre applications. It should not be used in new installations. However space constraints may force its retention or replacement when refurbishing existing installations. Where fitted, the supply grilles will require a means of directional adjustment.

7.43 For general operating theatres, the air supply would be filtered in the AHU. Terminal HEPA filters are not generally required.

Control of air movement within the suite

7.44 The design of the system should seek to minimise the movement of contaminated air from less clean to cleaner areas. Transfer grilles enable air to pass in either direction between rooms of equal class and pressure. In older designs suitably dimensioned door undercuts were often used in lieu of transfer grilles. Pressure stabilisers operate in one direction only; they allow excess air to be directed to the area desired and assist in maintaining room-pressure differentials.

7.45 The relative locations of supply and extract terminals and their design air-volume rates will determine the basic air-flow between adjacent spaces. Transfer grilles and pressure stabilisers will permit and control the flow of air between spaces ensuring a flow from the clean to less clean areas of the suite. Failure to provide such devices will lead to uncontrolled airflows when personnel move between rooms and doors being held partially open by air pressure.

Temperature and humidity control

7.46 Supply flow rates to achieve the required room conditions, are calculated conventionally, taking account of all heat and moisture gains and losses, and of maximum permissible temperature differences between the room and supply air. In most applications the room being considered will be within the heated building envelope.

7.47 Temperature differences of up to 10 K for winter heating and 7 K for summer cooling must not be exceeded.

7.48 It is acceptable for the humidity to swing uncontrolled between 35% and 60% saturation.

Removal and dilution of waste anaesthetic gases

7.49 Anaesthetic gases are subject to occupational exposure limits. The air-movement scheme should ensure that staff are in a clean air-flow path. (See Section 7 paragraph 7.21).

7.50 Air extracted from operating suites should not be re-circulated, as it may contain malodorous contaminants. However an energy recovery system should be fitted in the extract in order to reduce the plant energy consumption. (See Section 4 paragraphs 4.142 - 4.147).

Fire aspects

7.51 When considering the overall air-flow movement, careful thought needs to be given to the operation of the ventilation system, to limit smoke spread in the event of a fire. However, this is a highly staffed department with a low fire risk/load status and these factors need to be recognised when developing the fire strategy. It is considered satisfactory to treat the complete operating department as a single fire compartment providing there are at least two exits from it. Over-compartmentalisation can lead to difficulties in establishing clean air-flow paths and room-air dilution rates. This will lead to an increased risk of healthcare-associated infections. Staff areas within the department should be treated as a sub-compartment. (See Section 6 paragraph 6.18).

Door protection

7.52 Air should flow from the cleaner to the less clean areas as shown in Appendix 2 Table A2. The factors that affect the likelihood of a reverse airflow through doorways are discussed in Section 7 paragraphs 7.24 - 7.26.

7.53 It is not possible to design an air-movement scheme, within the restraints of the amount of air available that will protect the operating room when two doors are simultaneously opened. The design process that has been used considers that each door is opened in turn and ensures that the direction and rate of air-flow through any open doorway is sufficient to prevent any serious back-flow of air to a cleaner area.

7.54 Provided that the air-change rates in Appendix 1 Table A1 are met, dilution will be sufficient to ensure that the occasional small back-flows created (when two doors are opened simultaneously; or when there is a high temperature difference across an open door) will have little effect on the overall air cleanliness of the affected room.

7.55 The following general points should be taken into consideration during the design of operating suites:

- Number of exits – the fewer the number of rooms (and therefore doorways) leading from the operating room the better, as traffic is reduced and less complicated air-movement control schemes are required.
- Scrub and hand-wash facilities – these may be a part of the operating room, often in a bay. The bay would count as part of the operating room volume and should have a low-level active or passive extract to remove the moisture-laden air. Should a separate room be required for the scrub area, a door between the scrub-up room and the operating room is an inconvenience to scrubbed staff, and could be replaced by an opening. This opening should be larger than a normal single doorway, but the scrub would not, in these circumstances, be considered part of the operating room volume.
- If an alcohol scrub regime is employed, individual theatre scrubs may not be required and would be replaced by a common departmental pre-/post-operation scrub position in the corridor. This would require local extract to prevent a build-up of moisture.
- Preparation 'Sterile Pack Store' (SPS) – if it is intended to 'lay-up' instruments in the operating room, the preparation room is then used simply as a sterile pack store. The nominal room pressure can therefore be the same as that of the operating room and the airflow between the two rooms in either direction. Air supplied to the preparation room may be directed into the operating room either through a door mounted transfer grille or if no door is fitted, through the opening. Alternatively, stock ready-use sterile items can be located in a bay within the theatre. In this case, a portion of the total theatre supply air should be provided in the bay to ensure it is actively ventilated.
- Preparation room 'lay-up' – when the preparation room is used as an instrument 'lay-up' room, it should be regarded as being of greater cleanliness than the operating room, and the design should minimise the transfer of air from the operating room to the preparation room. Air supplied to the room may be directed to the operating room through a pressure stabiliser taking care not to compromise the airflow pattern in the operating room. The air may also be directed into a corridor;
- Service corridor – if materials to be disposed of are placed in impervious material for transportation, it is not necessary to have a separate corridor for this purpose. However, a service corridor has many operational advantages it terms of the flow of materials through the theatre suite. It also permits routine service and maintenance access without compromising the use of adjacent theatre suites.

Standard air-movement control schemes

7.56 In the previous versions of this guidance standard air movement control schemes were given that provided a range of design solutions to typical operating suite layouts. These were satisfactory design solutions for 'standard' sized rooms within the suite but were never intended to be universal for any sized room or suite. Guidance on operating suites contained in HBN 26 (2004) has increased the recommended size of operating room from approximately

35m^2 to 55m^2. Associated room sizes and air change rates have also increased. This means that the original standard solutions are no longer appropriate for new-build installations.

7.57 Because of the resulting increase in the volume of air supplied to the theatre, provision needs to be made either to actively remove it or allow it to escape passively through pressure stabilisers. The increase in room size has also made the number and position of air-supply terminals critical to the effective ventilation of the room.

7.58 Four new standard solutions have been developed to reflect the current guidance on theatre suite layout and room sizes given in HBN 26 (2004) as well as the general increase in air-change rates.

7.59 The most commonly used original standard solutions have been revised and updated. They have been retained in this guidance, as they will remain applicable to older theatre suites that are being refurbished to their original performance standards. They will also be applicable in existing departments where space constrains do not permit the upgrading of suites to the latest standard of performance or where a pre-built "shell" is being fitted out.

7.60 It is important to recognise that in any situation where a "non-standard" room size or theatre suite layout is being considered, the designer must return to first principles when developing a solution. Examples of non-standard configurations would be:

- cardiac theatres that typically have an operating room half as big again as normal, a perfusion laboratory and no anaesthetic room;
- operating departments served by a central instrument lay-up preparation area rather than individual prep rooms;
- balanced-flow theatres for infectious cases.

Appendix 4 contains a methodology for assisting the designer to arrive at a suitable solution.

7.61 The new and revised standard design solutions are as follows:

No 1 – Typical Conventional theatre – room sizes as HBN 26;

No 2 – Typical UCV theatre – room sizes as HBN 26;

No 3 – HBN 26 illustrated Conventional theatre;

No 4 – HBN 26 illustrated theatre with UCV terminal fitted;

No 5 – Pre-2006 Conventional theatre, single corridor (SHTM 2025; 1b);

No 6 – Pre-2006 UCV theatre, single corridor (SHTM 2025; 1a);

No 7 – Pre-2006 Conventional theatre, two corridor (SHTM 2025; 5b);

No 8 – Pre-2006 UCV theatre, two corridor (SHTM 2025; 5a).

7.62 Details of these standard solutions are given in Appendix 3. They contain diagrams that show the relationship of rooms and the various doors and transfer devices between them, **but should not be regarded as architectural layouts.** The schemes have been developed using the calculation procedure described in Appendix 4. Important features of the solutions are:

- Zone trimmer heaters – a trimmer heater battery is advocated when calculations indicate that the temperature differential between rooms may be greater than 2 K. Generally this will only be the case in the preparation room when designated as a lay-up.
- The preparation room (sterile pack store)/operating room interface – these rooms are deemed to be of equal cleanliness, and thus a transfer grille is required between these rooms or the door can be replaced with an opening wider than a standard door.
- Preparation (lay-up)/disposal room interface – pressure relief dampers are recommended here to provide an air path when doors are closed, while preventing back-flow when a door is opened elsewhere.
- Operating room/anaesthetic room interface – pressure stabilisers, or in some cases, carefully sized transfer grilles are recommended here, and between the anaesthetic room and corridor, and between the operating room and corridor.
- Operating room/scrub room interface – an opening is provided between these rooms. The flow of air through the opening provides protection, and gives bacterial dilution within the scrub room; the air is then exhausted to the corridor via a pressure stabiliser.

7.63 No mechanical supply or extract ventilation is provided in the scrub room, and thus when a door is opened elsewhere in the suite, the stabiliser will close, allowing the air to be re-directed to help protect the doorway. If the scrub is a bay within the theatre then a suitably positioned pressure stabiliser and / or active extract should be provided to ensure air movement and prevent a local build-up of moisture.

7.64 Any other scheme may be used and the standard solutions applied, if the following conditions are met:

- room relationships in air network terms are as shown in the plans;
- door-gap measurements approximate to those given in Scottish Health Technical Memorandum 58 – 'Internal doorsets', (but see also Appendix 2 Table A3 and the comment below);
- casual heat gains are accounted for;
- a trimmer battery is installed in the air supply system to the preparation room;
- leakage through the structure is kept to a minimum.

Note 3: It should be noted that many doors are now fitted with cold smoke seals as standard. These will significantly reduce the door leakage rate when new and undamaged. It is therefore recommended that provision for the design door leakage is factored into the sizing of the appropriate transfer grille or pressure stabiliser. Failure to do this will result in air gap whistles and doors being held partially open by air pressure.

7.65 It is recommended that every effort should be made to adopt one of the schemes described above.

Air terminals and air distribution within rooms

7.66 The selection and sighting of air diffusers will be critical in establishing an efficient pattern of mixing. To this end the diffusers selected must be fit for purpose. Ceiling mounted circular 'air master' style, square 'four-way blow' or similar diffuser designs that provide a downward displacement, turbulent airflow are the preferred option. (See Section 5 paragraph 5.68).

7.67 Plenum-type 'laminar'-flow-style diffusers with a footprint that encompasses the operating site are acceptable but may be prone to buoyancy effects as a result of temperature difference. Manufacturers' type-test data should be consulted to ensure that the terminal will achieve the required performance envelope. Note that these are not true laminar-flow systems in the strict sense of the word but produce a downward-displacement parallel-flow style of air distribution.

7.68 The diffuser equipment chosen should not cause 'dumping' and it should provide a velocity 1 metre above floor level at the operating position of between 0.2 m/s and 0.3 m/s.

7.69 In the operating room, the supply air terminals must be at high level, and should all be adjustable for rate of flow as well as being easily cleaned and silent in operation.

7.70 In order to ensure that all parts of the operating room are actively ventilated, there should be an air-out path on each face or in each corner of the theatre. This may be provided by a pressure stabiliser, transfer grille, active or passive extract terminal. A minimum of three, but preferably four, air-out paths - approximately equally spaced - should be provided.

Automatic control

7.71 The automatic control of ventilation in operating suites needs to be simple and robust. Over-reliance on complex room pressure and flow relationships linked to automatic fan speed control are unnecessary and in the long term have been shown to be unreliable. Complex software algorithms that can only be accessed and interpreted by off-site specialists should not be used. Whichever control strategy is chosen it is important that on-site staff have the facility to override the control system and keep the ventilation operating at least until the surgical procedure is complete. (See also Section 6; paragraph 6.11)

7.72 Theatre air-conditioning control sensors should be actively ventilated. They would typically be located in a sampling extract duct mounted in the surgeon's panel, positioned at normal working height (1.8 m above finished floor level) and be accessible for cleaning and the removal of fluff and lint.

7.73 Wall-mounted passive-temperature and humidity sensors are not recommended.

7.74 Controls should be provided to enable operating department ventilation plants to be closed down when the operating suites are unoccupied. (See also Section 6 paragraphs 6.24 - 6.26)

7.75 When in the 'off' mode, the control system should ensure that the ventilation plant is automatically reinstated if the space temperature falls below 15°C.

7.76 The theatre control panel should include plant status indication; clearly-readable temperature and humidity indicating gauges; and means of adjusting the set point for temperature. Theatre ventilation plant status indication should be located at the staff control base.

7.77 Where it is considered necessary to fit a humidifier, it should be selected to humidify to 40% saturation at 20°C during the design winter outside conditions. The cooling coil should be able to remove sufficient moisture so that 60% saturation at 20°C is not exceeded during the design summer outside conditions.

7.78 Each operating suite should be served by an independent supply and extract plant.

Ventilation of operating department ancillary areas

General

7.79 There are advantages in providing mechanical ventilation to all areas of the department. Maintaining operating suite airflow patterns is simpler and grilles and diffusers can be sited to eliminate condensation on windows. Where radiators or embedded wall or ceiling panels are installed they should be confined to the corridors and staff-only areas of the department.

Ventilation requirements

7.80 Appendix 2 Table A2 gives guidance on the operating department areas in descending order of cleanliness, and this should be considered in the overall design of the department ventilation systems. The specified flow rates of air through doors given in Appendix 2 Table A4 for the operating suite are not necessary for other areas of the department. However, the air-flow directions must be maintained from the clean to the less clean areas.

7.81 All windows in the department should be double-glazed and hermetically-sealed in order to ensure that the desired airflow pattern is maintained under all

external environmental conditions and to avoid infestation. Trickle vents if fitted will need to be sealed.

Systems design

7.82 The design of the ventilation system for the ancillary rooms depends on the overall configuration of the department. The plant for the ancillary rooms may need to be interlocked to the theatre suite plants so that reverse air-flow patterns do not occur.

7.83 Extract grilles should be sited and balanced to promote air movement along the clean and access corridors towards the reception/transfer areas. This should not affect the air distribution in the operating suite(s).

Reception

7.84 The aim in these areas is to provide comfortable conditions having regard to the movement control requirements of the department as a whole. The number of air changes will depend on the particular design.

Sterile pack bulk store

7.85 The store needs to be maintained at a positive pressure in order to preserve the cleanliness of the outside of the packs; 6 air changes are recommended.

Recovery

7.86 The air-change rate in the recovery room will be rather higher than that needed merely to provide clean, comfortable conditions, as it is necessary to control the level of anaesthetic gas pollution; 15 air changes are recommended, with a balanced air flow.

7.87 The supply air terminals should be ceiling mounted above the foot-end of the recovery bed positions. Extract should be at low (bed height or below) level behind the bed head positions or in the corners. This will establish a clean airflow path so that staff do not inhale anaesthetic gases exhaled by recovering patients.

7.0 (b) Ultra-clean ventilation systems

General requirements

7.88 The design philosophy of a conventionally ventilated operating suite is based on the need to dilute contaminants and control both the condition and movement of air in an operating suite. Ultra-clean ventilation (UCV) is a means of significantly increasing the dilution effect by providing a large volume of clean filtered air to the zone in which an operation is performed and sterile items are exposed. Air is discharged above the operating zone and while not truly laminar, its downward displacement purges the clean zone of contaminants and

particles generated by the activities within it. The airflow in and around the clean zone also serves to prevent particles originating outside the zone from entering it. The resulting reduction in contaminants has been shown to reduce significantly post-operative sepsis following certain orthopaedic procedures.

7.89 The number of bacteria that are present in the air at the wound site and exposed surgical items is dependent on the operating team, their procedural discipline, choice of clothing and the type of UCV system. Ultra-Clean air is defined as that containing not more than 10 CFU/m^3.

7.90 UCV systems are very successful in reducing contaminants at the wound site so it is often considered that there is no need for complex air movement control schemes in the rest of the suite. However when designing the ventilation scheme it should be noted that the users may switch the UCV terminal to "set-back" when non-orthopaedic surgery is taking place. This is because the high airflow rates can cause increased moisture evaporation of exposed tissue that may be detrimental to the surgical outcome. In recognition of this, the ventilation scheme should be capable of providing operating conditions to at least a "conventional" theatre standard throughout the suite with the UCV in set-back mode. It should also be remembered that suitable levels of ventilation will always be required in the peripheral rooms.

7.91 UCV systems can be designed and built from first principles or a range of bespoke modular units of varying shapes and sizes are available with each manufacturer having a slightly different approach to UCV design. Some systems are fitted with partial or full walls to delineate the clean zone and direct a laminar or exponential downflow of air within it. Other designs utilise slotted linear supply terminals to produce an air curtain around the clean zone together with laminar-flow diffusers to provide a downward-displacement supply within it. **Notwithstanding any variation in the design philosophy, all UCV systems will be required to achieve completely the performance standard set out in the "Validation" section of this document**. (Section 8)

7.92 As with conventional theatres, each UCV operating suite should have its own dedicated air handling unit (AHU) to the standard set out in Section 4 of this document. To ensure operational flexibility and permit routine maintenance, air handling units should not be shared between suites.

7.93 In retrofit installations, site conditions may preclude individual AHUs for each suite. In these circumstances an AHU may be shared between not more than two operating suites providing each suite has its own control of temperature. An accessible airflow measurement test point should be provided in the supply branch duct to each theatre so that the primary air volume to each UCV canopy can be determined. In addition the branch supply and extract should be capable of being physically isolated and the main air-flow rate reduced so that either suite can be taken out of use without detriment to operating conditions in the other.

7.94 An inherent feature of a UCV system is its large airflow so it is essential to re-circulate the air supplied to the operating theatre and/or to recover its energy in order to optimise operating costs.

7.95 The primary fresh-air volume supplied to a UCV suite will be the same as in a conventional suite and it should be dispersed to the rooms in the suite in the same manner. This is an important aspect of the design and requests by UCV suppliers for increased primary air-supply volumes should be resisted.

7.96 Laying-up in the clean zone is preferable for infection control reasons. Where a Sterile Pack Store (SPS) Preparation room is provided a transfer grille will be required in the preparation room / theatre door.

7.97 If the Preparation room is intended to be used for laying-up instruments, a pressure stabiliser will be required between the prep room and theatre. It should be fitted with a stand-off baffle to prevent air transfer interfering with the ultra-clean airflow distribution.

7.98 Separate scrub-up or disposal facilities are not necessary for air cleanliness although operational policy may prefer such a provision. A separate anaesthetic room should, however, be provided.

7.99 There is no aerobiological reason why two or more UCV systems should not be installed in a common area as long as adequate spacing is provided. These are known as “barn theatres” and require special design considerations and operational discipline. The relative positions of the UCV units, temperature control range and location of doors and openings to other areas will all significantly affect the airflow at the operating positions.

Types of UCV system

Remote plant systems

7.100 In a remote plant system, all the air-conditioning equipment is located outside of the operating room, except for the unidirectional air-flow terminal, terminal filter, air diffuser and the return-air grilles (see Figure 8).

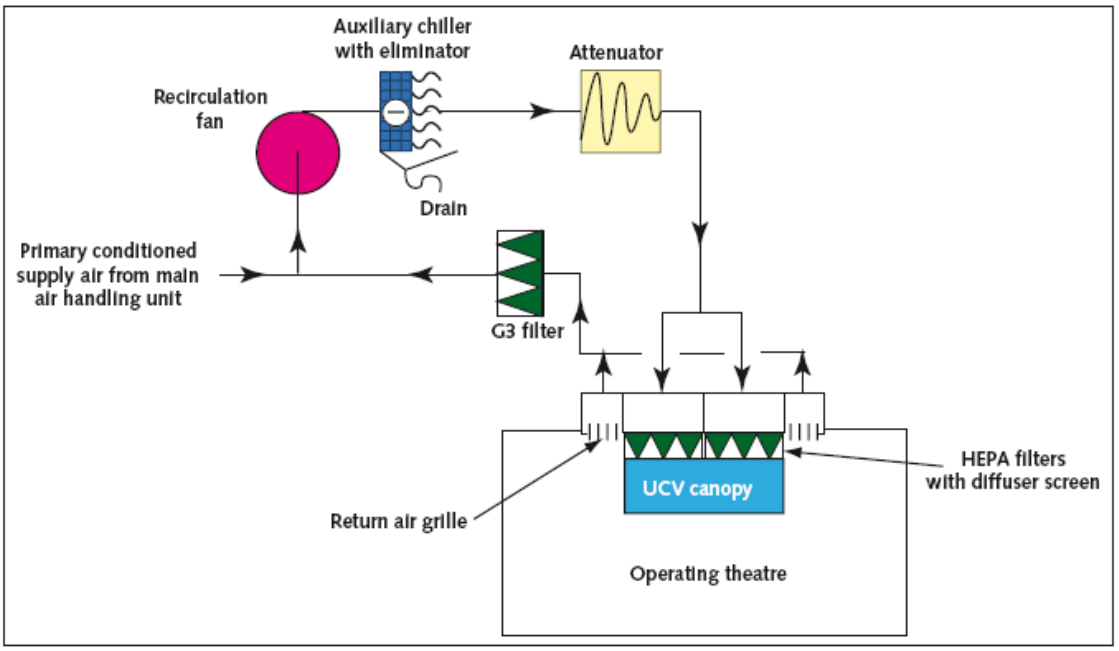

Figure 8: UCV theatre with remote air recirculation

7.101 This arrangement is the preferred option for new installations as it has the following advantages:

- the recirculation fans are out of the theatre thus reducing noise. Multiple recirculation fans can be replaced by a single fan unit with its drive out of the air stream;
- casual heat gains from recirculation fan(s), canopy lights, equipment and people within the theatre can be removed by a chiller battery in the return air stream. This will prevent heat build-up in the theatre;
- the return-air filters can be changed without needing access to the theatre making routine maintenance more feasible;
- the opportunity exists to locate the HEPA filter in the primary supply duct rather than the theatre terminal. This will reduce the number of filters required and allow them to be changed without entering the theatre.

Modular systems

7.102 Modular systems are frequently used in retrofit applications. Vertical or horizontal units are available.

7.103 Vertical-flow modular units comprise a ceiling-mounted air-terminal module containing return-air filters, return-air fans, final filter and air diffuser. Primary air is supplied by a remote air-conditioning unit at the volume and to the standard required for a conventional operating suite. (see Figure 9)

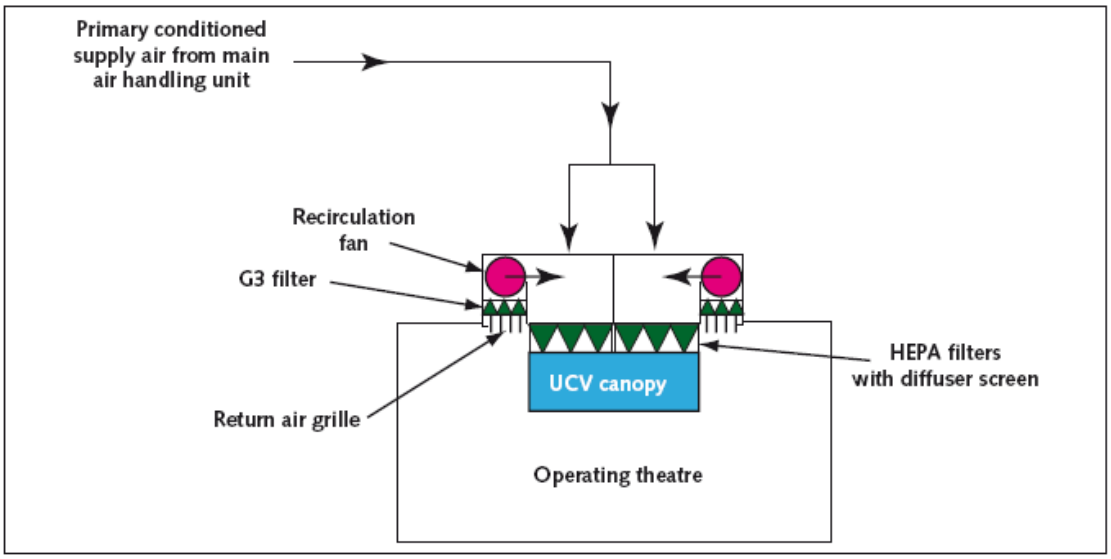

Figure 9: UCV theatre with modular system

7.104 Horizontal or cross-flow modular units comprise a wall-mounted air-terminal module standing vertically to produce a horizontal flow of air and containing final filter/diffuser, return-air filters and fans. The module may incorporate a cooling unit or be supplied with 'fresh air' from a separate primary cooling system.

Vertical flow UCV systems

7.105 Vertical-flow systems have a superior performance and are more effective at reducing infection risks. Air-curtain or partial-wall systems are acceptable, but are known to be more susceptible to problems arising from performance deterioration, poor operating-team discipline and high occupancy rates than is the case with full-wall systems. A full-wall is considered to be any wall terminating not more than one metre above the finished floor level.

7.106 Because of the large volume of air being moved in a relatively small space, the siting of the return-air grilles can cause short-circuiting of the air discharged through the UCV terminal. If the return-air grilles are positioned at high level, partial walls should be provided to control short-circuiting. The partial-walls shall be not less than 1m from the operating room walls and terminate at least 2m above floor level. The clearance should be increased proportionally for larger terminals (that is, 1.15m for 3.2m x 3.2m units and 1.25m for 3.5m x 3.5m units). In all cases, the sidewalls should terminate at 2m above floor level.

7.107 Siting the return-air grilles around the periphery of the theatre at low level will eliminate short-circuiting, remove the need for partial walls and give an improved airflow path. In any event there should be an air-out path on each face or in each corner of the theatre. These may be provided by combination of pressure stabilisers and passive or active low level extract grilles. Failure to provide air-out paths on all faces of the theatre may result in the surplus air causing entrainment into the clean zone.

7.108 Vertical systems should have a clean zone large enough to encompass the operating site and all of the instrument trays likely to be needed for the surgical

procedures to be undertaken. Ophthalmic and minor hand surgery would typically require a 1·4m circular or rectangular terminal. For major orthopaedic procedures a minimum size of 2·8m x 2·8m will be required. This is the area projected on the floor under the supply air terminal within the partial walls, full walls or air curtain. Any air outside this zone cannot be guaranteed to be ultra-clean although given the dilution factor the level of microbiological contamination will be much lower than the general level in a conventional operating room. The use of lines or a coloured area on the floor delineating the extent of the clean zone will assist staff and is therefore essential.

7.109 When upgrading an existing conventional theatre to an ultra-clean standard the only solution may be the installation of a modular system. In these units, the heat gains from the return-air fans and terminal lights may warrant the inclusion of supplementary cooling within the module although modern luminaries contribute substantially less unwanted heat. However issues of cooling coil drainage, condensate removal and maintenance access within the space constraints of the module may make this option impracticable. The additional cooling load should then be catered for by conditioning the primary air to compensate.

7.110 If an existing AHU is to be retained, it may require modification to ensure that it achieves the minimum standards set out in Section 4 of this document. The fan may need re-rating to accommodate the change in system resistance. The cooling coil may also need to be upgraded to cater for the increased load resulting from the return air fans and terminal lights. Failure to make adequate provision for this may make the theatre unusable during prolonged warm spells.

7.111 A factor affecting the air-flow pattern is the supply or room air temperature difference. When the supply-air temperature is significantly above room temperature, buoyancy effects will reduce the volume of air reaching the operating zone. If it is anticipated at design stage that this will be a regular occurrence, then a system incorporating full-walls should be used. Demountable extensions that convert a partial-wall to a full-wall unit are available.

7.112 Convection up-currents from the surgical team and operating lamp tend to counter the movement of clean air towards the operating site, hence the air velocity reaching the operating level is critical. The minimum velocity given below has been selected to take account of these factors and is greater than the theoretical minimum value.

7.113 For all vertical UCV systems the design discharge velocities will be as follows:

Air velocity 2 metres above floor level:

- partial-wall system = 0.38 m/s average;
- full-wall system = 0.30 m/s average.

Air velocity 1 metre above floor level:

- all systems = 0·2m/s minimum within the operating zone.

The validation Section 8 paragraphs 8.75 – 8.86 gives details of the method of measurement.

7.114 Variable-speed recirculation fans with differential pressure control may be the most suitable solution for maintaining consistent performance and energy saving.

Horizontal UCV systems

7.115 Horizontal UCV air-flow systems have been shown to be less effective than vertical systems and are not the preferred solution. There may be occasions, however, where architectural, engineering, economic or workload considerations prevent the installation of a vertical-flow system and only a horizontal-flow system can be installed.

7.116 Horizontal- or cross-flow modular units comprise a wall-mounted air terminal standing vertically to produce a horizontal flow of air across the operating field. The terminal module contains the final filters, air diffuser, return-air grilles, filters and fans. The module may incorporate a full air-conditioning unit or be supplied with 'fresh-air' from a separate primary air-conditioning system. In the latter case the return-air fan power may warrant the inclusion of a supplementary cooling coil within the module.

7.117 The system should have sidewall panels at least 2·4m apart. The panels may fold to facilitate cleaning of the theatre. The minimum height of the terminal should be 2·1m and a deflector at the top of the filter/diffuser will be acceptable as an alternative to a full roof. These dimensions reflect currently available equipment and may impose operational constraints in addition to a lower level of performance common to these systems.

7.118 In the horizontal flow systems, personnel working between the filter and surgical wound will disperse bacteria that are more likely to contaminate exposed surgical instruments and enter the wound. This may be minimised by the use of improved clothing and operating procedure to reduce dispersion of bacteria. The use of lines on the floor delineating the extent of the clean zone and hatching or colour coding the 'no-entry' zone between the air diffuser and patient will serve to prompt staff and are therefore essential.

7.119 The air discharge velocity as measured 1m from the diffuser face should have a mean value of 0·4 m/s. The validation Section 8 gives details of the method of measurement.

Filters

7.120 The main plant primary and secondary filters should be to the standards and in the location set out in Section 4.

7.121 Terminal filters should be provided within the airflow terminal or in the air supply to it. High efficiency particulate air (HEPA) filters grade H10 as specified in BS EN 1822 will be required as a minimum. There is no aerobiological benefit in

fitting filters of a higher grade than this, although for practical reasons most UCV manufacturer recommend the fitting of H12-grade filters.

7.122 In some modular UCV units, the terminal filter is used as a pressure equaliser to balance airflow and filters of a higher grade with a greater pressure drop may be recommended by their manufacturer. The increased resistance may affect the velocity of air reaching the operating level and there will be penalties in terms of installed fan power and higher noise levels.

7.123 The final filters should be installed in a leak-proof housing in a manner that allows the terminal unit, filters and their seals to be validated. A challenge test will be carried out during commissioning to prove the effectiveness of the complete installation.

7.124 Where UCV units are constructed in sections, a means of measuring the pressure drop across the terminal filters in each section should be provided. The pressure test-points should be located outside of the partial wall, capped to prevent air leakage and accessible within the theatre without the need to open the unit inspection panels. Alternatively direct-reading pressure gauges should be fitted.

7.125 The UCV system will require a return-air filter to capture the relatively coarse particles that would otherwise significantly reduce the life of the final filter. This should be at least a G3 grade to BS EN 779. In remote recirculation systems there may be advantages in fitting a higher grade return air filter, as it will reduce the load on the terminal HEPA filters and extend their life.

Noise level

7.126 If sound-attenuating material is used to line any portion of the inside of the UCV unit it should be non-particle-shedding and fire-resistant. (Further guidance can be found in SHTM Firecode suite of documents).

7.127 The maximum noise level in an operating room fitted with a UCV terminal of any type shall not exceed 50 NR. The validation section gives details of the method of measurement.

Lighting and operating lights

7.128 CIBSE lighting guide LG2 and BS EN 12464-1 give detailed information of lighting requirements. Operating luminaires should comply with the photometric requirements detailed in relevant sections of BS EN 60601.

7.129 The position of the UCV light fittings and style of partial walls, where fitted, should neither adversely disturb the airflow nor result in significant spatial variations in illuminance levels.

7.130 In vertical units, specialised task lighting should be provided by toroidal, cruciform or small multiple dome-shaped luminaires as they have good aerodynamic properties. The ideal luminaire will have a minimal effect on the airflow regardless of where it is positioned. Large-diameter saucer-shaped

luminaires should not be used in vertical-flow systems as they will occlude the airflow in the critical central zone. It is important to consider the suitability of existing luminaires when retrofitting UCV systems.

7.131 In vertical UCV installations a minimum of 2·75 m from floor to underside of the diffuser is required to allow for supporting mechanisms and lamp articulation. When upgrading existing systems this dimension may not be achievable. However, when parked, the lowest point of the central light stem, luminaire and articulation arms should never be less than 2 m above floor level.

7.132 The traditional means of light support is a central column that passes through the UCV terminal and is rigidly fixed to the building structure. The position of the support therefore prevents air being supplied at the centre of the terminal. Separate supports displaced from the centre of the clean zone would lead to improved airflow. This approach was advocated in the 1994 version of HTM 2025 but at the time of writing no UK manufacturer has chosen to adopt this solution.

7.133 In horizontal units the size or shape of the specialised task luminaire has little effect on the air-flow pattern.

Controls and instrumentation

7.134 The functions of the supply AHU and extract ventilation should be continuously monitored by a BEMS control unit. The controls and instrumentation for the main plant are set out in Section 6.

7.135 UCV systems will additionally require:

- a set-back facility that can reduce the air supplied through the UCV terminal to a volume that equates to not less than 25 air changes per hour of the operating room gross volume whilst still leaving the supply AHU operating at full speed;
- a facility to turn the entire system, supply AHU and UCV terminal, off. (an emergency stop is not required);
- a read-out sufficiently large to be clearly visible from the operating table that shows the temperature of the air being supplied by the UCV terminal;
- a read-out sufficiently large to be clearly visible from the operating table that shows the relative humidity of the air being supplied by the UCV terminal;
- a red indicator light that will illuminate when either the supply AHU or the UCV terminal fails, either or both are switched off or are at set-back;
- an amber indicator light that will illuminate when the UCV terminal is at set-back and the supply AHU is running;
- a green indicator light that will illuminate when both the supply AHU and UCV terminal are operating at full speed;
- a blue indicator light that will illuminate when the UCV terminal air flow, as detected by a differential pressure sensor, falls below 80% of the design flow rate.

AHU	UVC terminal	Indicator light	Comment
Off or Fault	Off or Fault	Red	Ventilation not operating at a suitable level to commence surgical procedures
Off or Fault	On (set-back)		
Off or Fault	On (full speed)		
On (set-back)	Off or Fault		
On (full speed)	Off or Fault		
On (set-back)	On (set-back)		
On (full speed)	On (set-back)	Amber	Ventilation provided to at least conventional theatre standard
On (full speed)	On (full speed)	Green	Full UCV standard conditions
–	–	Blue	HEPA-filter resistance causing low air flow

Table 7: Indicator light logic table

7.136 The switching devices and indicators should be incorporated in the surgeon's panel and their functions clearly labelled. In retrofit installations an auxiliary panel for the UCV may be the most practical option. If fitted it should be mounted adjacent to the surgeon's panel and their control functions interlocked as necessary.

7.137 When a system is designed to have partial walls with full-wall extensions, a volume control facility may be incorporated to allow the system to be run with reduced velocity when the demountable full-walls are in place. It would be the responsibility of the user to ensure correct operation of the system. To assist the user an explanatory notice should be included on the theatre control panel.

7.138 A direct-reading gauge should be fitted in the theatre to show a representative pressure drop across the final filters. If the UCV control box is located out of the theatre and has a means of manually adjusting the return air-fan speed then it should also be fitted with a direct-reading differential pressure gauge. The means of adjusting the return-air fan speed should be lockable to prevent casual adjustment. The direct-reading gauges should be fitted with a means of indicating the correct operating pressure range.

7.139 The UCV-unit manufacturer's control box should be located in an accessible position preferably in the operating department adjacent to the operating theatre that it serves. A service corridor, if provided, is an ideal location. The control box should be clearly labelled with the identity of the operating theatre that it serves.

7.0 (c) Extract systems

7.140 Extracts may be provided for a variety of reasons including:

- simple odour control (for example in a WC or mortuary);
- to receive and remove moisture-laden air (for example, in a kitchen);
- as part of a combined supply/extract balanced system (for example, in an operating suite);
- to capture a hazardous substance at source (for example a safety cabinet).

7.141 Devices that use an inflow of air to control exposure of staff to hazardous substances are classified as Local Exhaust Ventilation (LEV) systems under the COSHH Regulations.

7.142 An LEV system may comprise a self-contained unit incorporating its own carbon filter such as a simple bench-top fume cupboard. Alternatively it may be a complete "ventilation system" comprising a make-up air supply, multiple-exhaust-protected work stations, branch and central extract ductwork, duplex extract fans and a high-level discharge terminal. It may also incorporate a special filtration system appropriate to the hazardous substance being controlled. Such systems could be required for workshops containing woodworking machinery or large centralised pathology laboratories housing multiple safety cabinets, dissection benches, fume cupboards and specimen stores.

7.143 It is important to recognise at the design stage whether an extract is being provided for comfort or as an LEV system. Typical systems in healthcare include:

- microbiological safety cabinets and Category 3 containment rooms;
- fume cupboards;
- welding-fume extracts;
- woodworking machinery duct collectors;
- battery-charging bay extracts;
- powered plaster and bone saws;
- pharmaceutical preparation cabinets and tablet machines;
- dissection benches, cut-up tables and some specimen stores;
- medium- and high-risk infectious disease isolation facilities;
- decontamination facilities;
- dental furnaces, grinders and polishers.

7.144 General design information and guidance for LEV systems is produced by the Health and Safety Executive (HSE) as HS(G)37. Information on the design and installation of microbiological safety cabinets is given in BS5726 and that for fume cupboards is given in BS EN 14175. Their recommendations should be closely followed.

7.145 LEV systems are statutory items that will be subject to an independent inspection every 14 months.

Hood extract systems

Special requirements

7.146 Extract canopies will be required over steam-and-heat-emitting appliances, for example sterilisers, catering and washing equipment; and for the extraction of toxic fumes over benches used for mixing, sifting and blending procedures.

7.147 Perimeter-drain gulleys and corrosion-proof grease eliminators should be provided on kitchen hoods.

Typical arrangements

7.148 The air-flow rate must be sufficient to ensure an adequate capture velocity in the vicinity of the process; typical values are as follows:

- evaporation of steam and like vapours 0.25 m/s to 0.5 m/s;
- chemical and solvent releases 1.0 m/s;
- vapour of gases 5 m/s to 6 m/s;
- light dusts 7 m/s to 10.0 m/s.

Excessive velocities will be wasteful of power and generate noise.

7.149 The lowest edge of the canopy should be 2m above finished floor level, with a minimum of 300mm overhang beyond the edge of the equipment on all sides.

7.150 A compact arrangement of equipment (but with access for maintenance) will minimise the canopy area, and hence reduce the air volume necessary to achieve the optimum capture velocity.

7.151 Hoods required for the control of heat gain and vapours may be connected to the general extract system when it is convenient to do so, but where non-corrosive ductwork materials are necessary, a separate discharge is preferred.

7.152 Lighting and internal divider plates are often required to be built into the perimeter of large canopies. However, built-in shelving systems are not recommended, as they interfere with the air-flow, and constitute a maintenance problem.

Control of hood extracts

7.153 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the hood extract and any associated supply can be shut down. To this end, local control should be provided.

Bench extract systems

Special requirements

7.154 Bench extract ventilation is required in departments such as pathology and mortuary, where activities involve the release of malodorous or toxic fumes that should not be inhaled. Where hazardous substances are being controlled, the system should be designated an LEV.

Typical arrangements

7.155 Each ventilated position will usually be accommodated in a continuous run of benching, which should not be more than 650 mm from front to rear and which should be provided with a continuous upstand at the rear. Each position should have a 1200mm x 150mm linear extract grille mounted on a purpose-designed plenum box (incorporating guide vanes as necessary), with its face flush with the upstand. The bottom of the grille should be as close as practicable to the level of the working surface (usually 75mm above, to allow for cleaning). The minimum velocity across any part of the grille should be 1 m/s. The grille should be readily demountable to allow for cleaning.

Control of bench extract systems

7.156 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the bench extract and any associated make-up supply can be shut down. However, a run-on timer with a minimum setting of 30 minutes must be provided. To this end, local or automatic-use control should be provided.

7.157 Processes that produce hazardous vapours, fumes, dusts or noxious vapours should be enclosed or semi-enclosed in a suitable cabinet or exhaust protected workstation.

Safety cabinet and fume-cupboard extract systems

7.158 Safety cabinets and fume cupboards are devices that use an inflow of air to control exposure of staff to hazardous substances. The units, their exhaust systems, filters, fans and discharge terminals are all classified as Local Exhaust Ventilation (LEV) systems under the COSHH Regulations. The make-up air system to a room that contains an LEV system should also be considered as an essential part of the system and be included in the LEV classification. Information on the design and installation of microbiological safety cabinets is given in BS 5726 and that for fume cupboards is given in BS EN 14175. Their recommendations should be closely followed.

7.159 The Advisory Committee on Dangerous Pathogens (ACDP) publishes 'The Management, Design and Operation of Microbiological Containment Laboratories' covering the general environment in which they are used and operational considerations.

Special requirements

7.160 The supply-air system should not distort the unidirectional and stable air pattern required for fume cupboards and microbiological safety cabinets. In general, supply-air ceiling diffusers should not discharge directly towards fume cupboards or safety cabinets, unless the terminal velocity is such that the air-flow pattern of the cabinet is unaffected. The design should ensure that high air- change rates, and/or the opening and closing of doors do not have any adverse effect on the performance of safety cabinets or fume cupboards. A damped door-closure mechanism may help.

7.161 In order to safeguard the user, all safety cabinets and fume cupboards must be fitted with a clear indication that they are operating correctly. Direct-reading gauges or falling-ball indicators are preferred (in addition to electronic pressure indicators). The system should be set to alarm audibly if the face velocity falls below the minimum safe operating level.

Arrangements for safety cabinet installations

7.162 The manufacture and installation of microbiological safety cabinets must be in accordance with the relevant national standards and guidance issued by the Advisory Committee on Dangerous Pathogens (ACDP).

7.163 A Class 1 microbiological safety cabinet must be specified for routine work involving Group 3 pathogens. It should be housed in a Category 3 containment room. Specific design information on containment rooms is issued by ACDP in conjunction with the Health and Safety Commission.

7.164 Siting and installation of microbiological safety cabinets are of particular importance because:

- the protection afforded to the operator by the cabinet depends on a specific and stable unidirectional air flow through the open front;
- the protection to the environment by the cabinet depends on the high efficiency particulate air (HEPA) filters. The exhaust air should never be considered as totally free from microbiological hazard.

7.165 Microbiological safety cabinet is HEPA filtered prior to being discharged to outside. The extract ductwork should as far as practicable be kept under negative pressure while inside the building.

7.166 Current standards permit the installation of microbiological safety cabinets with integral fans, provided that the extract ductwork can be kept short (that is, less than 2m); such an installation however, is likely to be noisy and is not recommended for use in new buildings.

7.167 The discharge from the cabinet should be fitted with a back-draft damper. In multiple installations where several cabinets discharge into a common extract and discharge duct, it must be possible to isolate each cabinet from the system when not in use.

7.168 Roof-level discharge, wherever practicable, is preferred since it removes much of the uncertainty over air re-entering the building through ventilation inlets and/or windows. In such an installation, the extract fan should be situated separately from the cabinet and close to the discharge outlet, to maintain the duct within the building under negative pressure. The discharge point on a flat roof should be through a 3 metre high terminal. This is required to safeguard staff who may need to access the roof periodically for maintenance. This requirement will also be applicable to fume-cupboard discharges.

7.169 Where this is impracticable, discharge into the room via a double HEPA filter has been accepted. The preferred method, however, is to discharge 3 meters above the roofline in line with the similar standard for fume cupboard designs.

Arrangements for fume cupboard installations

7.170 The manufacture and installation of fume cupboards must be in accordance with the relevant national standards and associated guidance.

7.171 The primary factors that contribute to the effective performance of fume cupboards include:

- an adequate volume of supply air;
- an effective exhaust system to promote the safe dispersal of waste products to atmosphere.

7.172 The air velocities through sash openings must be sufficient to prevent hazardous materials from entering the laboratory while avoiding excess flow rates that interfere with the investigation process. Average face velocities should be between 0.5 and 1.0 m/s, with a minimum at any point within 20% of the average, the upper end of the range being applicable to the containment of materials of high toxicity. The design velocity must be maintained irrespective of whether the sash opening is varied, or whether doors or windows are open or closed. Variable Air Volume (VAV) cupboards are available which offer a reduction in energy use.

7.173 The possibility of a fire or explosion that may not be contained by a fume cupboard must always be considered. A fume cupboard should not, therefore, be sited in a position where exit to an escape route will necessitate passing directly in front of it.

7.174 Fume-cupboard fans should be installed as near as possible to the termination of the duct, thus maintaining the maximum amount of ductwork at negative pressure.

7.175 Where there are adjacent buildings with opening windows, or where downdraughts occur, it may be necessary to increase the height of discharge ducts in order to achieve adequate dispersal. In complex locations, airflow modelling or wind tunnel tests may be required to determine the optimum height of the stack (see also paragraph 7.167).

7.176 Fume-cupboards for certain processes must have separate extract systems. However, where appropriate, individual fume-cupboard exhaust systems may discharge via non-returning dampers into a single collection duct rather than having a large number of separate stacks. The collection duct should have a large cross-sectional area to minimise its effect on the individual exhaust systems; be open to atmosphere upstream of the first connection; and be designed to discharge a total air volume at least equal to the combined individual extract systems.

7.177 Individual fume-cupboard extract systems, discharging either directly to atmosphere or into a collection duct, do not require duplex fans. However, a collection duct designed to provide dispersal of effluent from a number of individual extracts, should have duplex fans with automatic changeover.

7.178 Some fumes are particularly corrosive, so the choice of material for the ductwork, and type of extract fan fitted should reflect the nature of the fume being conveyed.

Control of extract systems

7.179 It is desirable to provide local control of safety cabinets in order to maximise the life of the HEPA filter, and to permit the sealing of the cabinet and room for fumigation if spillage occurs.

7.180 To cope with the risk of an accident or spillage outside safety cabinets, a 'panic button' should be provided to switch off the supply to that area; and discharge all extracted air to atmosphere.

7.181 In pathology departments, it will be necessary to have one or more microbiological safety cabinets and one or more fume cupboards available for use at all times, including weekends, therefore, local overriding controls for all these items and any associated ventilation plant will be necessary.

7.0(d) Plantroom ventilation

General requirements

7.182 Plant rooms are required to be ventilated in order to maintain acceptable temperatures for satisfactory operation of the plant and controls, and for maintenance activities. In the case of plant rooms housing combustion equipment, a secondary function of the ventilation is to provide make-up air for the combustion process.

7.183 The air required for these purposes should be introduced into the space through inlets positioned to minimise the discomfort to occupants; they should be unlikely to be blocked, closed deliberately (except in the case of fire shutters if required), or rendered inoperative by prevailing winds.

7.184 Plantroom ventilation air should not be used for any other purposes, such as make-up air for extract; and where the plantroom contains combustion equipment, the appliance pressure must not fall below the outside air pressure.

7.185 Specialised healthcare air handling equipment must not be located in a fire compartment that houses combustion equipment.

7.186 Statutory regulations for plantroom ventilation are contained in the Scottish Building Regulations, and further guidance is given in CIBSE Guides A & B.

Assessment of ventilation levels

7.187 Ventilation requirements must take into account all heat sources within a plantroom, and where there are large glazing areas, solar gains. The ventilation rate should limit the maximum temperature within the plantroom to 32°C.

7.188 As the level of equipment operating during mid-season and summer is often lower than the winter condition, and the cooling effect of the outside air is reduced, it is necessary to calculate the minimum volume for each season of operation, and the inlet and outlet grilles or fan sizes should be chosen to cater for the largest seasonal air volume.

7.189 Replacement air should not be drawn through pipe trenches or fuel service ducts. Where metal ducts penetrate walls and floors, effective sealing should be provided to confine the ventilation to the boiler room and to meet fire protection requirements. Penetration of fire barrier walls by ventilation ducts should be avoided if possible.

7.190 Fire dampers in plant room ventilation ducts should be electrically interlocked with the boiler plant.

7.191 Care must be taken to prevent any noise generated in the boiler room emerging from natural or mechanical ventilation openings to the detriment of the surrounding environment. Particular care is necessary with mechanical flue draughts and fan-diluted flue systems.

7.192 Information on required air volumes in contained in the CIBSE Guide A & B.

7.193 Where combustion plant is installed, the high-level (outlet) openings should be sized to cater for the total ventilating air quantity; and the low-level (supply) openings sized to cater for the total combined ventilating and combustion air quantity.

Choice of ventilation system

7.194 Ventilation air may be introduced and exhausted by either natural or mechanical means or a combination of both. However, where possible, natural systems are preferred.

7.195 Generally, small installations at or above ground level should have their combustion and ventilation air provided by natural means, employing both high- and low-level openings.

7.196 Basement, internal and large installations at or above ground level will usually require a combination of natural and mechanical ventilation. If the airflow rate is difficult, both supply and extract may require mechanical means.

7.197 Whether natural or mechanical, the system should be designed to avoid both horizontal and vertical temperature gradients. Both inlet and outlet openings should be placed on opposite or adjacent sites of the building to reduce the effect of wind forces.

7.198 Where mechanical air supply is employed, electrical interlocks with the boiler plant should be provided to prevent damage in the event of failure of the supply fan(s) once the air volume is established.

7.199 The necessary free opening areas for a naturally ventilated plantroom may be calculated using either the method in A4 of the CIBSE Guide A or the table in section B13 of CIBSE Guide B.

7.200 A combined natural and mechanical ventilation system should allow for natural extract at high level, to take advantage of convective forces in the room, with mechanical supply at low level. The high level natural ventilators should be sized to cope with the total quantity of ventilation air, as above.

7.201 To prevent leakage of flue gases and to ensure that the flue draught is not impeded at any time, the air pressure in the boiler room must not exceed the prevailing outside pressure. Therefore, the fan duty should exceed the calculated total combined combustion and ventilation air quantity by at least 25%. Fan-powered inlets should be arranged to flow outside air into the space at a point where cross-ventilation will ensure pick-up of heat without causing discomfort to occupiers.

7.202 Where it is impractical to provide sufficient natural ventilation to remove the heat emitted by the plant, both mechanical supply and extract will be required.

7.203 The high-level extract should be sized to cater for the total ventilating air quantity and the low-level supply should exceed the total combined combustion and ventilating air quantity by at least 25%, as above.

7.0(e) Ventilation of hydrotherapy suites

General requirements

7.204 In a hydrotherapy suite heat recovery should be via heat pump.

7.205 The quantity of supply air should be calculated as 25 litres/sec/m^2 wetted surface, with the wetted surface taken as 110% of the pool water surface area.

7.206 A re-circulation plant is recommended, with a minimum of 20% fresh air.

7.207 As far as practicable, re-circulated pool air should be provided to the ancillary changing and recover accommodation, with the only extract from the toilets, laundry/utility room and pool hall.

7.208 Supply air to the pool hall should be introduced at high level and directed towards the perimeter to mitigate condensation, with extract air taken from directly over the pool. Dampers should not be located over the pool water.

Control of hydrotherapy pool installations

7.209 The supply and extract fans should be interlocked so that the supply fan does not operate until flow is established within the extract system.

7.210 Time-clock control should be provided, with a local override switch to extend the normal operating period as required.

7.211 Night setback temperature (in the range of 21-25^{o}C) and high humidity control (in the range of 60-75% sat) should be provided to override the time clock in order to prevent condensation. The exact set points should be ascertained post-installation.

7.212 A remote indication panel should be provided in the pool hall, giving a visual display of the pool water and pool air temperature.

8. Validation of specialised ventilation systems

Definitions

Commissioning - Commissioning is the process of advancing a system from physical completion to an operating condition. It will normally be carried out by specialist commissioning contractors working in conjunction with equipment suppliers. Commissioning will normally be the responsibility of the main or mechanical contractor.

Validation - 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 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.*"

Commissioning is often sub divided into sections e.g. air handling unit, automatic controls, airside balance, building fabric and fittings. Each section may be commissioned by its specialist installer and they are often accepted in isolation. Validation differs from commissioning in that its purpose is to look at the complete installation from air intake to extract discharge and assess its fitness for purpose as a whole. This involves examining the fabric of the building being served by the system and inspecting the ventilation equipment fitted as well as measuring the actual ventilation performance.

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 independent Authorised Person appointed by the Health Board.

It is anticipated that training in the validation of specialised healthcare ventilation systems for independent Authorised Persons will become available during the life of this SHTM.

Commissioning general

8.1 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.

8.2 The duct-sizing procedure should take into account the requirements of system balancing, and the position and number of regulating dampers included in the design should be sufficient for this purpose.

Location of dampers and test holes

8.3 Balancing/commissioning dampers will be required in each branch of the distribution ductwork.

8.4 Test holes for the measurement of air-flow will be required at carefully selected points in main and all branch ducts. The number and spacing of holes are given in the BSRIA Application Guide Set COMPAK 1. Their positions must be identified at the design stage.

8.5 The test positions need to be accessible for commissioning to take place. They may also be required for subsequent annual verification of the system performance, so they should not be covered by permanent lagging.

8.6 The measurement point should be in a straight length of duct as far away as possible from any upstream bends, dampers or other elements that could cause disturbance to the airflow. The actual location should be:

- at least 1.5 duct diameters upstream of sources of turbulence such as dampers and bends;
- if this is not possible, 10 diameters downstream of dampers, bends or tees, and 5 diameters downstream of eccentric reducers;
- where there is enough space round the duct to insert the pitot tube and take readings;
- where the duct has a constant cross-sectional area.

8.7 Test holes for measuring total airflow from a fan should be located either 4 diameters upstream or 10 diameters downstream of the fan. Provision should also be made for measuring the speed of rotation.

Information to be provided

8.8 It is essential that the designer should pass on his intentions fully to the commissioning engineer by indicating which parts of the system are high, medium and low pressure, and by providing:

- relevant parts of the specification;
- schematic drawings indicating performance data as indicated in Table 8;
- equipment schedules;
- controller and regulator schedule;
- fan performance curves;
- wiring diagrams for electrical equipment, including interlock details.

Items in system	Information to be provided
Fans	Fan total pressure Volume flow rate at high and low speed Maximum motor current
Plant items	Type and identification numbers from equipment schedules Fluid and air volume flow rates Fluid and air side pressure losses Dry bulb temperatures Wet bulb temperatures Humidity
Dampers, including motorised and fire dampers	Identification numbers from equipment schedules Location Identification number Volume flow rate
Main and branch ducts	Dimensions Volume flow rates and velocities Identification numbers from equipment schedules
Terminal	Location Identification number Grille or diffuser factor Volume flow rate and neck velocity Operating static pressure
Test holes and access panels	Location Identification number
Controllers	Set points

Table 8: Information to be provided on schematic drawings

Notes: For Table 8

1. Fan total pressure is the difference between the total pressure (static pressure + velocity pressure) at the fan outlet and the total pressure at the fan inlet.

2. Where volume flow rates are variable, maximum and minimum values should be provided.

Commissioning personnel

8.9 As one individual is unlikely to possess all of the required commissioning skills, a commissioning team is therefore usually needed. The objective of commissioning is to ensure that the necessary performance and safety requirements are met.

8.10 During the commissioning process a great deal of information will be generated which will form an invaluable future source of reference about the plant. It is essential to ensure that it is collected together in the form of a commissioning manual and handed over to the client on completion of the contract together with the 'as fitted' drawings. This information should be both in hard copy and electronic format.

8.11 In order to be successful the commissioning process must start before achieving practical completion as many parts of the system will become progressively less accessible. The correct installation of those parts will need to be witnessed and leak -rate tests carried out as construction proceeds. Failure to establish responsibility for commissioning early enough will delay the completion of the project or lead to unsatisfactory plant performance.

Commissioning brief

8.12 The commissioning team will require a detailed brief from the system designer. This should include:

- a 'user' brief comprising a description of the installation and its intended mode of operation;
- the precise design requirements with regard to the scheme of air movement, room static pressures, supply and extract air-flow rates and acceptable tolerances;
- full details of the design conditions both inside and out, for winter and summer together with the control strategy;
- equipment manufacturer's type test data, commissioning, operation and maintenance recommendations;
- drawings showing the layout of the system, positions of air-flow measurement test points, dampers, regulating devices and filters within the duct runs, together with sizes of ducts and terminal fittings. It will save time if these drawings are annotated with the design volumes and static pressures required at each branch and outlet point;
- wiring diagrams for all electrical equipment associated with the air handling systems including motor control circuit details and any interlocking and safety devices such as emergency-stop buttons adjacent to the item of plant.

8.13 The CIBSE Commissioning Code, Series 'A' – "Air Distribution", provides full guidance on the information that will be required by the commissioning team.

8.14 The designer should include in the contract document instructions on verifying the accuracy of test instruments that should be supported by reference to relevant calibration certificates.

8.15 The system, on completion, should be operated by the contractor as a whole and subject to performance tests in accordance with the contract requirements.

For critical systems, these may include independent validation of the system performance on behalf of the client.

8.16 Prior to dynamic commissioning, it is essential that builders' work in the area served by the system is complete, all rubbish and dust is removed, concealed plumbing (IPS-type) panels are in position and ceiling tiles are in place and clipped. Floors should be mopped and visible dust removed from all other surfaces.

8.17 Once the system is shown to meet the design intent the handover documentation should be completed. In the event of performance not being acceptable, the matter should be dealt with in accordance with the contract arrangements.

Pre-commissioning checks

8.18 The pre-commissioning checks consist of visual inspection, manual operation of equipment, static measurements and functional tests of individual components. They should be carried out prior to setting the system to work and undertaking the dynamic commissioning process set out in paragraph 8.29 onwards of this guidance.

Standard of installation

8.19 During the installation of the system the following must be witnessed:

- that the plant and installations have been provided and installed in accordance with the design specification and drawings;
- that only approved sealants have been used in the installation;
- that all components function correctly;
- that the satisfactory sealing of access doors and viewing ports have been carried out;
- that air pressure tests and air-leakage tests on ventilation ducting have been carried out in accordance with the methods set out in the HVCA's DW/143: Ductwork Leakage Testing. It is usual to carry out these tests, a section at a time, as the ductwork is installed and before its insulation is applied. The results must be recorded in the commissioning manual;
- that gaps around doors and hatches are as specified in the design;
- that the correct operation of pressure stabilisers, control dampers, isolating and non-return dampers have been checked and installed in the correct orientation for air-flow;
- that test holes have been provided in their specified locations and are sealed with suitable grommets;
- that control dampers are secured and their quadrants fitted correctly;
- that any interlocks are operative and in accordance with specification;

- that the electric circuits are completed, tested and energised;
- that electric motors have been checked for correct direction of rotation both at full speed and set-back;
- that cooling and heating media are available at correct temperatures and pressures and in specified quantities;
- that the air-conditioning plant components and controls function correctly;
- that the air-conditioning plant interlocks and safety controls function correctly;
- that the plant is physically complete, insulation is applied and all ducts and pipework are identified as specified;
- that the building housing the ventilation plant is generally in a fit condition for commissioning and performance tests to commence, that is, windows, doors, partitions etc are completed, surfaces sealed and their final finish applied;
- that the areas containing the ventilation plant and those being served by it are clean;
- that access to all parts of the system is safe and satisfactory.

Cleanliness of installation

8.20 During installation it must be established that ductwork is being installed to the 'advanced level' as defined in the HVCA (2005) 'TR/19 – Guide to good practice: internal cleanliness of ventilation systems'. This specifically includes ensuring that ductwork sections arrive on site and are stored with their open ends sealed and that open ends remain sealed during installation to prevent the ingress of builders' dust.

8.21 Should any doubt exist whether the guidance has been observed, the ducts must be cleaned internally to restore them to this standard before being taken into use.

8.22 "Builders work" ducts of brick or concrete must be surface sealed to prevent the release of dust before being taken into use.

8.23 The area around the supply air intake must be free of vegetation, waste, rubbish, builders' debris or any other possible source of contamination.

Certification of equipment

8.24 The following test certificates should be assembled by the commissioning team and be available for inspection at any time during the contract period. They will form part of the handover information and should be placed in the commissioning manual:

- type-test performance certificates for fans;
- pressure-test certificates for:

  - heater-batteries;
  - cooling coils;
  - humidifiers (if appropriate);
- type-test certificates for attenuators;
- type-test certificates for primary and secondary filters;
- individual test certificates for high efficiency particulate air (HEPA) filters.

Equipment tests

8.25 Prior to setting the system to work, the checks in paragraphs 8.26-8.28 should be witnessed, and proving tests should be carried out as detailed.

Filters

8.26 The quality of filter housing and in particular, the seals is a critical factor in maintaining the efficacy of the filtration system by ensuring that air does not bypass the filter panels. Therefore, the following checks should be made:

- filter seals should be fitted and in good condition;
- filters should be installed correctly with respect to air flow;
- bag filters should be installed so that the bags are vertical and their pockets free;
- HEPA filters should be installed in a sealed housing and their seals tested to DIN 1946 if specified;
- all filters should be checked to ensure they are free of visible damage;
- the differential pressure indicators should be checked for accuracy and that they are marked with the initial and final filter resistance.

Drainage arrangements

8.27 The drain should conform in all respects to the “Design considerations” of this SHTM. In addition the following must be proved:

- that the drain tray is easily removable;
- that a clear trap is fitted and is easily removable;
- that the drain has a clear air gap of at least 15mm;
- that the pipework is supported so that the air break cannot be reduced;
- that the drain system from each drain tray is independent up to the air break;
- that the operation of the drainage system is proved by introducing water into the duct at the drain tray and observing that it completely drains out. This check is to be repeated both at normal speed and set back once the fans

have been commissioned. At this time the clear trap can be marked to indicate the normal water level with the fan running.

Fire dampers

8.28 The following must be witnessed and proving tests should be carried out as detailed:

- the operation of all fire dampers;
- the access provided to enable the dampers' to be visually inspected and / or re-set should be sufficient for the purpose;
- indication should be provided of the dampers' position (open/tripped);
- indication of the fire dampers' location should be provided both on the ductwork and at a visible point on the building fabric if the ductwork is concealed.

Dynamic commissioning

Air-handling and distribution system

8.29 The fan drive, direction of rotation, speed and current drawn should be set in accordance with their manufacturer's instructions.

8.30 After the installation has been checked to ensure that it is in a satisfactory and safe condition for start-up, it should be set to work and regulated to enable the plant to meet its design specification. The proportional balancing method described in the CIBSE Commissioning Code "A" must be followed. The air-flow rates must be set within the tolerances laid down in the design brief. This will normally be the design airflow rate +10% -0%.

8.31 When combined supply and extract systems are to be balanced and the area that they serve is to be at or above atmospheric pressure then the supply should be balanced first with the extract fan switched off, and then the extract balanced with the supply fan(s) on.

8.32 For combined systems where the area that they serve is to be below atmospheric pressure then the extract should be balanced first with the supply fan switched off and then the supply balanced with the extract fan on.

8.33 On completion of the balance all volume air-flows in supply and extract ducts and from grilles and diffusers must be measured and recorded. The true air change rate can them be calculated from the data obtained.

8.34 The main supply and extract duct volume control dampers must be locked and their position marked.

8.35 All grille and diffuser volume control registers must be locked to prevent alteration and their final position marked.

Room air distribution

8.36 The pressure-relief dampers and pressure stabilisers must be set to achieve the specified room static pressures and locked. The grille direction control vanes and diffuser cones must be set to give the specified air-movement pattern. Visualisation techniques may need to be employed in order to prove that the required air-flow pattern is being achieved. This may be a potential requirement when commissioning LEV systems or rooms that contain them.

Air-conditioning plant

8.37 The specified flow rate and/or pressure drops must be set for all heater batteries, cooling coils and humidifiers. The methods described in the CIBSE Commissioning Codes "W" and "R" should be followed. On completion their regulating devices must be locked to prevent alteration.

Control system

8.38 The control system should not be commissioned until both the air distribution system and air-conditioning equipment have been commissioned.

8.39 Because of the specialised nature of control systems and the fact that each manufacturer's system will contain its own specialist components and settings, the commissioning should be completed by the supplier and witnessed by a representative of the user.

8.40 The location of all control and monitoring sensors should be checked and their accuracy proved.

8.41 The control system's ability to carry out its specified functions must be proved.

8.42 If the plant is provided with a "user's" control panel in addition to the one located in the plantroom then the operation of both must be proved. This will typically apply to operating departments and laboratory systems.

Specific performance standards

Air movement

8.43 The performance of the system should be measured and compared with information provided by the designer.

Plant capacity and control

8.44 When setting to work and proving the design, both the manufacturer of the air-handling plant and the control specialist should attend site together and jointly commission the system.

8.45 If any doubt exists as to the capacity of the installed system, then its ability to achieve the specified inside design conditions with the plant operating at winter

and summer outside design conditions must be proved. Artificial loads will be required in order to simulate the internal gains/losses and the outside design conditions.

8.46 On completion of the plant performance test, recording thermo-hygrographs should be placed in each room/area served by the plant and also the supply air duct upstream of the frost battery. The plant should be run for 24 hours with all doors closed. During this period the inside conditions must stay within the tolerances specified. The BEMS should be used to obtain the information required wherever possible. Periodic tests will be required during the defects liability period.

Noise levels - general

8.47 The commissioning noise level is the level measured with a sound-level meter in the unoccupied room and taking account of the external noise together with the noise generated by the ventilation system. When occupied and in use this commissioning level will constitute a continuous background noise that will allow the overall noise level to be achieved. The ventilation plant design noise level is that generated by the plant alone with no other noise source being considered. The levels suggested make recognised allowance for the ingress of environmental noise.

8.48 The noise levels apply at the maximum velocity for which the system is designed to operate. Acoustic commissioning tests should be carried out with all plant and machinery running normally and achieving the design conditions of airflow, temperature and humidity.

8.49 An industrial-grade sound-level meter to BS3489 or IEC 651 Type 2 will normally be sufficient to check the noise level.

8.50 The noise level readings are to be taken at typical normal listening position 1.5m above floor level and at least 1m from any surface and not on any line of symmetry. In critical rooms the noise should be measured at the centre of the room and at the centre of each quarter. The mean of the 5 readings should then be calculated.

8.51 In the event of a contractual deficiency, a Type 1 precision-grade sound-level meter should be used and the noise level determined by the procedure given in Scottish Health Technical Memorandum 08-01 (forthcoming).

Filter challenge

General ventilation filters

8.52 In-situ performance tests will not normally be required for primary and secondary filters and their housings. However the filters should be visually inspected for grade, tears, orientation and fit within their housing. Filters should be clean and a replacement set available. Bag filters should be installed so that

their bags are vertical and spaced so that air can move through them freely. Any filter found to be wet should be replaced and the cause investigated.

HEPA filters (for exhaust protective enclosures and laboratories)

8.53 Pathogenic material may be discharged through damaged or badly installed HEPA terminal filters. The complete installation must be tested using the method set out in BSEN: 14644 'Method of Testing for the Determination of Filter Installation Leaks'.

8.54 The challenge tests may be carried out using either of the following techniques:

- use DOP (Dispersed Oil Generator) to provide the challenge and a photometer to detect leaks;
- use a Discrete Particle Counter (DPC) to detect leaks. (In order to obtain a sufficient challenge it may be necessary to remove temporarily the supply AHU secondary filters).

8.55 In both cases the upstream challenge should be measured. A measurement of particle penetration through a representative section of the HEPA filter media is then taken and used as the reference background level. These two readings enable the range of the detecting instrument to be set.

8.56 A challenge aerosol of inert particles of the type produced by a DOP generator should be introduced into the air, upstream of the HEPA filter. The downstream face of the filter, its mounting seal and housing would then be scanned for leakage using a photometer. A leak should be deemed to have occurred if a steady and repeatable reading on the photometer at any point exceeds 0.01% of the upstream reading.

8.57 Alternatively a Discrete Particle Counter (DPC) may be used. For the Discrete Particle Counter method the filter face is sampled at several points to establish the smallest non-penetrating particle size. If particles at or above this size are detected when subsequent scans of the filter face, its seal and housing are made, then there is deemed to be a significant leak at, or near, the test position.

8.58 Should the HEPA filter fail this test it must be replaced. Should the filter mounting seal or housing fail this test it may be repaired and the test repeated.

Bacteriological sampling

General ventilation systems

8.59 Bacteriological sampling will not normally be required for either general or local exhaust ventilation (LEV) systems unless otherwise specified.

Conventional operating rooms

8.60 The level of airborne bacteria introduced by the supply air can be checked by closing all doors and leaving the operating room empty with the ventilation system running for 15 minutes. An active air sampler set to 1 cubic metre and mounted on the operating table should then be activated remotely. Aerobic cultures on non-selective media should not exceed 10 bacterial and/or fungal colony forming units per cubic metre (CFU/m^3).

8.61 The results should be examined to establish the broad category of organisms present. A high preponderance of fungal organisms may be an indication of inadequate filtration for the particular installation. Precise guidance is inappropriate and will depend on local circumstances.

8.62 It may be appropriate to carry out a check of airborne bacteria during a surgical operation. If required this should be carried out as soon as possible after handover. Unless there are unusually high numbers of personnel or extensive activity in the room, the number of airborne bacterial and/or fungal CFU averaged over any five-minute period, would be unlikely to exceed 180 per cubic metre.

8.63 Information on the additional validation testing of UCV Operating suites is given in Section 8.0(a).

Ventilation system commissioning/validation report

8.64 Following commissioning and/or validation a full report detailing the findings should be produced. The system will only 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.

8.65 The report shall 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);
- estates and facilities.

8.0(a) Validation of UCV operating suites

General

8.66 Commissioning of a UCV terminal will normally be carried out by its supplier. Commissioning of the air-handling unit, fire dampers, distribution ductwork and control systems may be undertaken by different teams. It is therefore important to recognise that the UCV terminal is only one element of the specialised ventilation system serving the operating suite and it cannot be accepted in isolation.

8.67 In order to ensure that the complete system operates correctly it will be necessary to validate the system as a whole from the air intake through to the extract discharge. It is unlikely that "in house" staff will possess the knowledge or equipment necessary to undertake this process. Validation of Ultra-Clean operating theatre ventilation systems should therefore be carried out by a suitably qualified independent Authorised Person appointed by the client.

8.68 It is anticipated that training in the validation of specialised healthcare ventilation systems for independent Authorised Persons will become available during the life of this SHTM.

8.69 The following regime of inspection and testing should be applied to the validation of new installations designed to provide Ultra-Clean conditions in an Operating suite. The test regime has been devised to ensure that the system as installed fully achieves the design requirement for these systems as set out in Section 7.0 (b) of this document.

Basic requirement

8.70 The operating suite to be validated should be physically complete with final finishes applied. All ventilation systems serving it should be operating correctly and delivering the design air-flow rates.

8.71 In order to avoid pre-loading the UCV terminal's recirculation ducts and HEPA filters, the Operating suite should be free of any obvious dust and at least "builders clean" before the recirculation fans are set to work.

8.72 The validation procedure for a conventional theatre suite should have been satisfactorily completed to the standard set out in Section 8 prior to attempting to validate the UCV unit. In particular:

- the supply AHU will have achieved the minimum standard;
- the operation of all fire dampers will have been proved;
- the supply and extract air-flow rates as measured in ducts and at room terminals will achieve their design values +10%; -0%;
- room differential pressures will be correct.

Evidence of the satisfactory achievement of the foregoing standard should be available for inspection and independently measured as necessary prior to validating the UCV unit.

UCV unit validation procedure

8.73 Tests to validate the suitability and performance of an ultra-clean operating suite should be undertaken in the order that they appear below. Should an item fail to meet the required standard it should be rectified and successfully retested before passing on to the next test.

Summary of test regime

- Challenge tests to ensure that:
  - the UCV terminal unit is correctly assembled and sealed so that no air will bypass the filters;
  - the terminal filters are correctly sealed in their housings;
  - the terminal filters are of the same grade, of uniform quality and undamaged.
- Air velocity measurements to ensure that
  - a sufficient quantity of air is being delivered by the terminal;
  - the terminal quadrants are in balance;
  - the air flow has sufficient velocity to reach the working plane.
- An entrainment test to ensure that contaminants arising outside of the UCV terminal footprint are not drawn into it.
- Visualisation techniques to gain an understanding of the overall system performance.
- Noise measurement to ensure that working conditions are satisfactory.
- Control system checks to ensure that the system operates as specified.
- Biological monitoring to determine how effective the system is in use.

Test and measuring conditions

8.74 While validating the UCV terminal, the conditions in the Operating room shall be stable and within the given ranges.

temperature: – 19 - 23°C dry bulb.

humidity: – 30 – 65% relative humidity.

Test and measuring equipment

8.75 Any test or measuring equipment used should have a certificate to prove that it has been validated within the previous 12 months at a calibration facility using traceable national standards.

8.76 In the case of a noise meter, its “matched sound source” should have a certificate to prove that it has been validated within the previous 12 months at a calibration facility using traceable national standards. The noise meter should be calibrated to the sound source on each occasion that it is used.

Test grid – vertical units

8.77 A test grid should be constructed on the floor within the ultra-clean terminal footprint as projected by the inside dimensions of the sidewalls or boundary air

curtain. A suitably marked test sheet will provide a consistent standard of test grid.

8.78 The test grid should comprise test squares of 280mm each side.

8.79 The test grid should be aligned along the centre lines of the terminal footprint with its centre under the centre point of the terminal.

8.80 Any test square with 80% of its area within the UCV footprint should be used as a test position.

8.81 An inner zone should be designated that is not less than 36% of the total footprint. It should be made up of a number of test squares distributed symmetrically about the terminal footprint centre line. Regardless of the shape of the terminal footprint, the inner zone should comprise a minimum grid of 6 x 6 test squares.

8.82 Unless specified otherwise, a test position should be in the geometric centre of a test square.

8.83 Test position 1 should be the leftmost test square in the row nearest to the operating room wall that houses the surgeon's panel.

(For an example of a grid for a 2.8 x 2.8 metre terminal see Figure 10)

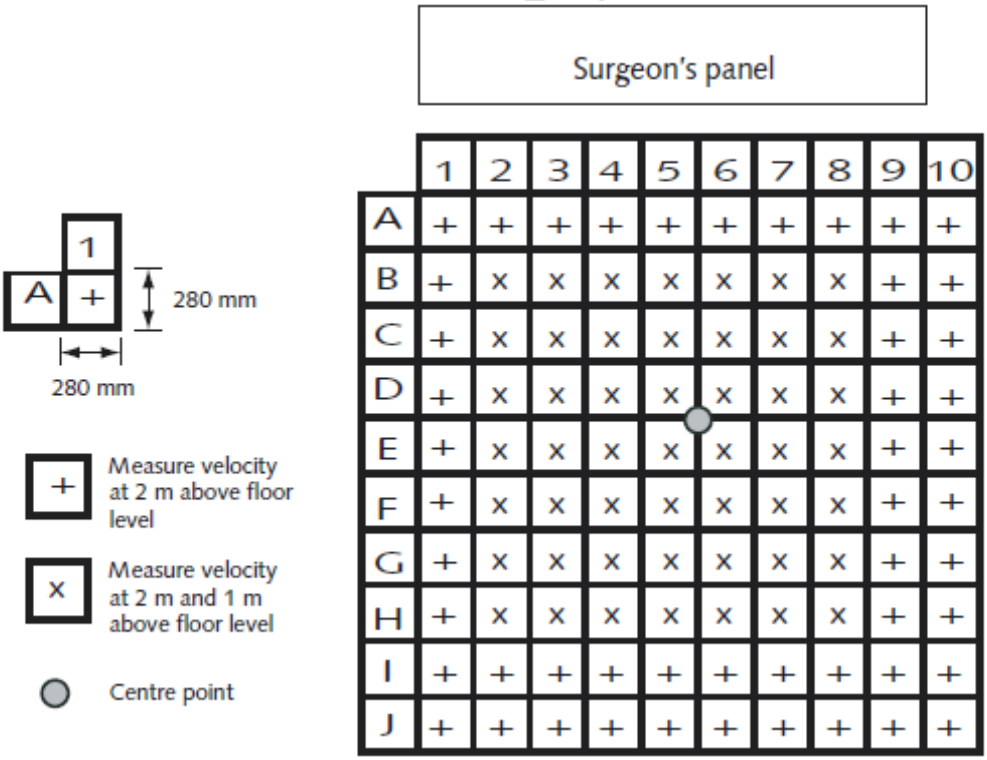

Figure 10: EXAMPLE of a TEST GRID for a 2.8m x 2.8m UCV TERMINAL

Test grid – horizontal units

8.84 A line of test positions should be marked on the floor 1 m in front of the face of the UCV terminal.

8.85 A test position should be marked in the centre of the line. Additional test positions should be marked at 280mm spacing along the line either side of the centre position, up to the full-face width of the unit.

UCV terminal challenge tests (Vertical and horizontal systems)

8.86 The diffuser screen fitted below the face of the terminal HEPA filters should be lowered or removed while the challenge tests are being carried out.

8.87 The installed HEPA filters should be checked to ensure that their grade accords with the design specification and that their performance has been certified by the manufacturer.

8.88 The challenge tests may be carried out using either of the following techniques:

- use DOP to provide the challenge and a photometer to detect leaks;
- use a Discrete Particle Counter (DPC) to detect leaks. In order to obtain a sufficient challenge it may be necessary to remove temporarily the supply AHU secondary filters.

8.89 In both cases the upstream challenge should be measured. A measurement of particle penetration through a representative section of the HEPA filter media is then taken and used as the reference background level. These two readings enable the range of the detecting instrument to be set.

8.90 For the DOP test this should be set as the reference level and a leak will be declared significant if penetration greater than 0.01% of the range is detected. (See paragraph 8.56 for details).

8.91 For the Discrete Particle Counter (DPC) method the filter face is scanned to establish the smallest non-penetrating particle size. If significant particles at or above this size are detected when subsequent scans are made then there is deemed to be a significant leak at, or near, the test position. (see paragraph 8.57 for details)

UCV terminal unit clean zone leak test

8.92 This test will confirm that there is no unfiltered air bypassing the HEPA filter.

8.93 The joints and service penetration points under the UCV terminal within its side walls or boundary air curtain should be scanned to prove that there are no leaks.

8.94 A leak is defined as a significant rise above the background level.

Terminal HEPA filter seal leak test

8.95 The test will confirm that there is no unfiltered air bypassing the HEPA filter's seal.

8.96 Each HEPA filter's seal should be scanned to prove that there are no leaks.

8.97 A leak is defined as a significant rise above the background level.

Terminal HEPA filter media leak test

8.98 The test will confirm that the HEPA filters have not sustained damage while being installed.

8.99 The face of each HEPA filter should be scanned to prove that there are no leaks.

8.100 A leak is defined as a significant rise above the background level.

Vertical UCV terminal air velocity tests

Test set up

8.101 The terminal face diffuser screen should be in place for these tests.

8.102 Take spot readings to establish that the room is within the specified temperature and humidity test conditions.

8.103 Set out the test grid as described previously.

8.104 Swing the operating lamp arms and any other stem arms so that they align to present the least resistance to air flow, are perpendicular to the front edge of the test sheet and face the back edge. Any lamp and equipment heads should as far as practicable be outside of the UCV terminal footprint.

Test instrument

8.105 The measuring instrument should be a hot-wire anemometer with a digital read-out. The instrument resolution should be at least 0·01m/s, have a tolerance of ±0·015m/s or 3% of that reading and be calibrated down to 0·15m/s or lower. An alternative instrument may be used providing it is of no lesser specification.

Test method

8.106 The instrument should be mounted on a test stand and set to take a mean reading over a ten-second sample interval.

8.107 It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. Alternatively they could be downloaded to a computer or data logger at the end of the test.

8.108 The test stand to be positioned on each test point in turn and the reading taken when the instrument has stabilised.

8.109 When taking a reading the test person should not stand within the same quadrant as the test instrument.

8.110 Readings are to be taken at the test positions with the instrument probe facing the wall housing the surgeon's panel, commencing at the first test position. Readings are taken working along the row from left to right and back, or for all text positions in one quadrant at a time.

8.111 When all test positions under one half of the terminal have been covered, readings of temperature and humidity are then taken at the specified height in the centre of the terminal. The read-outs on the surgeon's panel should be recorded at the same time.

8.112 Having completed one half of the test grid, the operating lamp arms and any other stem arms should be swung round through 180° and the test stand reversed so that the wall housing the surgeon's panel is behind the test person. Readings are recommenced starting at the right of the test row and working from right to left a quadrant at a time, as above.

UCV high-level discharge velocity test

8.113 Measurements of air velocity are to be taken at every test position 2 m above floor level and the results averaged.

8.114 The average of the total readings taken is to be not less than:

0.38 m/s for a partial-wall system;

0.30 m/s for a full-wall system.

The average air velocity for each quadrant should not exceed ±6% of the measured average velocity for the terminal

UCV low-level air velocity test

8.115 Measurements of air velocity are to be taken at each of the inner zone test position 1m above floor level.

8.116 The measured velocity at every test position in the inner (operating) zone shall be not less than 0·2 m/s.

Horizontal UCV terminal air velocity test

Test set up

8.117 Set out the line of test positions as described previously.

8.118 Swing the operating lamp arms and any other stem arms so that they align to present the least resistance to air flow and are perpendicular to the line of test positions.

Test instrument

8.119 See that specified for vertical systems (paragraph 8.105 refers).

Test method

8.120 The instrument should be mounted on a test stand and set to take a mean reading over a ten-second sample interval.

8.121 It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. Alternatively, they could be downloaded to a computer or data-logger at the end of the test.

8.122 The test stand should be positioned on each test point in turn and the reading taken when the instrument has stabilised.

8.123 When taking readings the test person should stand well downstream of the instrument.

8.124 Readings are to be taken at the test positions with the instrument probe facing the UCV terminal, commencing at the first test position on the left and working along the row from left to right at the specified height.

8.125 The instrument should be reset to the next specified height and the test repeated and so on.

8.126 Readings of temperature and humidity should be taken at the specified height in the centre of the terminal. The read-outs on the surgeon's panel should be recorded at the same time.

UCV discharge velocity test

8.127 Measurements of air velocity are to be taken at all test positions at 1 m, 1·5 m and 2 m above floor level.

8.128 The average of the total readings taken should be no less than 0·4 m/s.

UCV entrainment test (Vertical systems only)

Rationale for the entrainment test

8.129 The performance of UCV systems may be compromised by room air being drawn into the ultra-clean airflow, a phenomenon known as "entrainment." Significant levels of entrainment could lead to microbial contamination of items left exposed on instrument trolleys laid out beneath the canopy.

8.130 UCV systems having permanently fitted full sidewalls do not need to be tested, as the sidewalls physically prevent entrainment.

Principle of the test

8.131 A source of particles is produced outside of the UCV terminal and is used to challenge the system. A detector is placed within the ultra-clean airflow and used to determine the percentage penetration of the test particles at predefined locations under the UCV terminal footprint. The source and detector are moved in tandem around the UCV canopy and pairs of readings taken, from which the percentage penetration at specified locations is calculated. The degree of penetration should be below specified maximum limits if entrainment is to be declared not significant.

8.132 The entrainment test may be carried out using either of the following techniques:

- use DOPs to provide the challenge source at the specified release position and a photometer to measure the entrainment; or
- duct non-HEPA-filtered air to the specified release position and use a DPC to measure the entrainment.

Test set-up

8.133 The terminal face diffuser screen should be in place for these tests.

8.134 The test should be performed without any equipment in place beneath or closely adjacent to the UCV terminal.

8.135 The theatre lights should be moved to a central position beneath the terminal and raised to 2m above floor level, so as not to interfere with the peripheral airflows.

8.136 Take spot readings at the centre of the canopy, one metre from floor level, to establish that the room is within the specified temperature and humidity test conditions.

8.137 Set out the test grid as described previously.

8.138 For either of the following entrainment tests, a measurement of particle penetration through a representative section of the HEPA filter media is to be taken and used as the reference background level.

Test equipment, challenge source, measuring instrument and detector head

8.139 The challenge and detector equipment should be chosen so that:

- the tracer particles are mainly within the size range 0.3 to 5 microns and thus capable of remaining airborne for a substantial time;

- the particles used should not be able to penetrate the terminal filters in sufficient numbers to cause a background count that is more than 0.1% of the challenge count;
- the choice of particle and detector will enable a minimum of a three-logarithm (1,000-fold) range of counts to be recorded between the highest (that is, source) and lowest (that is, background) readings expected. (A concentration of approximately 10^5 particles per cubic metre of source air has been shown to be adequate.)

Source – Dispersed Oil Particles (D.O.P.)

8.140 The DOP generator should be able to produce a cloud of test particles in the form of a visible smoke. The test smoke should be delivered via an aperture so that it flows vertically downward from the lowermost edge of the partial wall, on the outside of the UCV canopy.

8.141 The test smoke is to be delivered via an aperture.

Note 4: To prevent undue contamination of the theatre and filters with deposits of oil, DOP should only be released for the minimum amount of time necessary to complete the test.

Challenge source – natural particles

8.142 The source unit should be a fan/blower or other method that takes non-HEPA-filtered air and expels it via a delivery head at the specified release position to provide the particle challenge. The challenge air should be delivered vertically downwards from the lowermost edge of the partial wall, on the outside of the UCV canopy, parallel to the airflow coming from the diffusers. The challenge air velocity should be the same as the measured average velocity at 2 m from the terminal under test.

Note 5: The use of DOP for testing is gradually being phased out and replaced by a natural challenge measured with a DPC. At the time of writing research is under way to define more precisely a challenge source unit for natural particles. It is anticipated that such a unit, together with a matching test methodology, will become available during the life of this Scottish Health Technical Memorandum.

The detector (defined in terms of range and resolution)

8.143 This may be a photometer or a DPC. It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. The instrument should be capable of sampling a minimum a 28.3 litres of air per minute and in the case of the DPC, provide readings for particle size ranges from 0.3 microns to 5.0 microns and greater. The instrument should be compliant with the requirements of BS EN ISO 14644-1. An alternative instrument may be used providing it is of no lesser specification.

Test positions and orientation of source and detector

8.144 The test positions should be at the centre of each test square, as defined for the velocity test.

8.145 For rectangular UCV terminals, measurements of penetration are to be taken at the four corner test squares of the test grid and at intermediate positions along the line of test squares between the corners. The number of intermediate test positions will be as equally spaced as possible around the periphery with no fewer than 3 and no more than 5 complete test squares between test positions.

8.146 A further series of measurements are to be obtained around the periphery of the inner zone. Measurements of penetration are to be taken at the four corner test squares of the inner zone of the test grid and if necessary at intermediate positions along the line of test squares between the corners as equally spaced as possible, with no fewer than 3 and no more than 5 complete test squares between test positions.

8.147 A single measurement should be taken at the geometrical centre of the UCV terminal footprint. The centre measurement will be taken with the detector head mounted vertically upwards 1 metre above floor level.

8.148 The centre of the challenge particle source should be aligned with the centre of the designated test square, with its longer edge against the outer edge of the partial wall and delivering the challenge from the lower edge of the partial wall. The air containing challenge particles is directed vertically downwards from the lower edge of the partial wall, in a plane parallel to the adjacent partial wall. Where there is physical interference due to obstructions such as gas pendants, the source will be moved to the next available non-obstructed test-square location nearest to the stipulated sampling position. The detector should then also be moved to remain opposite the source.

8.149 In the case of non-rectangular terminals, an interpretation of the above strategy should be adopted that will yield a no less searching examination of the unit's ability to control entrainment.

Test method

8.150 The sampling head of the detector instrument is mounted on a test stand with its sampling orifice facing outwards horizontally from the centre of the UCV canopy, 1m above floor level. The sampling head should be orientated at right angles to the partial wall when sampling along the sides of the test grid but will be set to bisect the angle when measuring at the corner test positions (Figure 8 in section 8, at paragraph 8.84 illustrates the challenge and detector orientations when evaluating a 2.8m x 2.8 m UCV terminal).

8.151 The test will commence at the first test position, this being designated the leftmost corner of the test grid when facing the wall housing the surgeon's panel. The penetration will also be measured at the corresponding test point on the inner zone commencing at the corner nearest to the first test position. When these tests have been completed, the source and detector equipment should be

moved to the next test positions, working around the test grid in a clockwise direction.

8.152 The test stand should be positioned on each test point in turn and a pair of readings (challenge, then penetration) taken when the instrument has stabilised. The detector should be set to take a reading over a 15 second sample interval.

8.153 When taking a reading the test person should stand within the UCV terminal footprint but not in the same quadrant as the detector head.

Analysis and interpretation

8.154 The following standard is to be achieved:

- penetration to be not greater than 10% of the challenge at each test position in the outer zone;
- penetration to be no greater than 1% of the challenge at each test position in the inner zone;
- penetration to be no greater than 0·1% of the challenge at the centre of the test grid.

If a result is close to, or above the given limits, then a further reading must be obtained using a longer time base (1 minute) and the penetration must not exceed the given limit.

Basis of the test

8.155 Whyte W, Shaw BH, Freeman MAR. An evaluation of a partial-walled laminar-flow operating room. *J Hyg Camb* 1974; 73: 61 – 75.

Whyte W, Lidwell OM, Lowbury EJL, Blowers R. Suggested bacteriological standards for air in ultraclean operating rooms. *J Hosp Infect* 1983; 4: 133 – 139.

UCV visualisation

8.156 The use of smoke to gain an understanding of the overall performance of the system may prove useful at this stage in the validation process but cannot be relied on to produce a contractually definitive measure of performance.

UCV noise level

8.157 An industrial-grade sound-level meter to BS EN 61672 Type 2 fitted with a muff should be used to check the noise level. The instrument should be calibrated using a matched sound source prior to each set of readings.

Vertical systems

8.158 The noise level readings should be taken at typical normal listening positions 1·5 m above floor level and at least 1m from any surface and not on any line of symmetry. Measurements should be taken under the centre of each quadrant of the UCV terminal and the four readings averaged.

Horizontal systems

8.159 The noise level readings are to be taken at typical normal listening positions 1·5m above floor level on the test line. The width of the unit should be divided in two and a measurement taken in the centre of each half but avoiding any line of symmetry. The two readings should be averaged.

8.160 Measurements should also be taken in each room of the suite.

8.161 In the event of a contractual deficiency a Type 1 precision-grade sound-level meter complying with BS EN 61672 should be used. Readings should be taken at the positions specified above and in each case the logarithmic mean of the results should be calculated in order to determine the noise level. (Further information can be found in SHTM08-01, forthcoming).

8.162 For vertical or horizontal systems, the noise level shall not exceed:

- 50NR [55dB(A)] – for UCV operating rooms and spaces without doors that open directly on to it (for example the scrub);
- 40NR [45dB(A)] – for all other peripheral rooms of the suite.

UCV control system checks

Temperature

8.163 The readings of temperature taken under or in front of the UCV unit should be within ±1 K of each other and the read-out on the surgeon's panel.

Humidity

8.164 The readings of humidity taken under or in front of the UCV unit should be within ±5% of each other and the read-out on the surgeon's panel.

Direct-reading differential pressure gauges

8.165 The differential pressure across the terminal filter(s) should be measured to confirm the accuracy of the indicated reading of any gauge.

Control functions

8.166 The operation of all control functions provided on the surgeon's panel should be proved for conformity with the design specification.

8.167 If an auxiliary panel has been fitted then its interlocking with the main surgeon's panel control functions must be proved to conform to the design specification.

Panel indicator lights

8.168 The panel indicator lights should illuminate as appropriate when the control functions are selected or warning levels are reached

BEMS interface

8.169 The operation, monitoring and alarm functions must be proved to conform to those set out in the design specification.

UCV theatre microbiological tests

8.170 There is little value in performing microbiological sampling in a new theatre supplied with ultra-clean ventilation. The foregoing filter challenge tests, air velocity measurements and entrainment test should have proved that the system operates satisfactorily and achieves the contracted level of performance. The HEPA filters will remove bacteria-sized particles from the air supplied through the UCV terminal. Therefore there will be an insignificant number of bacterial and/or fungal CFUs present until the Theatre is actually used.

8.171 Once the theatre has been taken into use, microbial sampling during a surgical procedure should help to confirm the satisfactory performance of the system and discipline of the users. Before commencing bacteriological testing, the room and its ventilation system should have achieved a steady state condition: (see also paragraph 8.74)

8.172 The installation should be tested during surgical procedure at intervals between the time of the first incision and final closure of the wound. On average, the air sampled within 300 mm of the wound should not contain more than 10 CFU/m^3.

UCV validation report

8.173 Following validation a full report detailing the findings should be produced. The report shall conclude with a clear statement as to whether the UCV theatre suite achieved or did not achieve the standard set out above.

8.174 A copy of the report should be lodged with the following groups:

- operating department;
- infection control;
- estates and facilities.

Appendix 1 - Table A1: Recommended air-change rates

Application	Ventilation	ac/Hour	Pressure (Pascals)	Supply Filter	Noise (NR)	Temp (°C)	Comments For further information see Section 6
General ward	S / N	6	-	G4	30	18-28	
Communal ward toilet	E	10	-ve	-	40	-	
Single room	S / E / N	6	0 or –ve	G4	30	18-28	
Single room WC	E	3	-ve	-	40	-	
Clean utility	S	6	+ve	G4	40	18-28	
Dirty utility	E	6	-ve	-	40	-	
Ward Isolation room	-	-	-	-	-	-	See SHPN 4; Supplement 1
Infectious disease Iso room	E	10	-5	G4	30	18-28	Extract filtration may be required
Neutropenic patient ward	S	10	+10	H12	30	18-28	
Critical Care Areas	S	10	+10	F7	30	*18-25*	Isolation room may be –ve press
Birthing Room	S & E	15	-ve	G4	40	*18-25*	Provide clean air-flow path
SCBU	S	6	+ve	F7	30	*18-25*	Isolation room may be –ve press
Preparation room (Lay-up)	S	>25	35	F7*	40	*18-25*	*H12 if a lay-up for a UCV Theatre
Preparation room / bay sterile pack store	S	10	25	F7	40	*18-25*	*50NR if a bay in a UCV Theatre
Operating theatre	S	25	25	F7	40	*18-25*	
UCV Operating theatre	S	25*	25	H12	40	*18-25*	Fresh air rate; excludes re-circulation
Anaesthetic room	S & E	15	>10	F7	40	*18-25*	Provide clean air-flow path
Theatre Sluice/dirty utility	E	>20	-5	-	40	-	
Recovery room	S & E	15	0	F7	35	*18-25*	Provide clean air-flow path

Table A1

Application	Ventilation	ac/Hour	Pressure (Pascals)	Supply Filter	Noise (NR)	Temp (°C)	Comments For further information see Section 6
Recovery room	S & E	15	0	F7	35	*18-25*	Provide clean air-flow path
Cardiac catheterisation lab	S	15	+ve	F7	40	*18-22*	
Endoscopy room	S	15	+ve	F7	40	*18-25*	
Endoscopy cleaning	E	>10	-ve	-	40	-	
Day case theatre	S	15	+ve	F7	40	*18-25*	
Treatment room	S	10	+ve	F7	35	*18-25*	
Pharmacy aseptic suite	S	20	#	H14	-	*18-22*	# See EGGMP (Orange guide) a
Cat 3 or 4 containment room	#	>20	#	H14*	-	*18-22*	# See ACDP guide; *Filter in extract
Post mortem room	S & E	S = 10 E = 12	-ve	G4	35	*18–22*	Provide clean air-flow path
Specimen store	E	-	-ve	-	-	-	Fan accessible from outside of store

Table A1: continued

Notes: 18-22°C indicates the range over which the temperature may float

18-22°C indicates the range over which the temperature should be capable of being controlled

S = supply N = natural ventilation

E = extract a – European guidelines on good manufacturing practice published by the Medicines and Healthcare products Regulatory Authority (MHRA)

Appendix 2 - Hierarchy of cleanliness

			Air-flow rate for bacterial contaminant dilution	
Class	**Room**	**Nominal pressure (Pa) a**	**Flow in or supply m^3/s**	**Flow out or extract m^3/s**
Sterile	Preparation room (a) lay-up (b) sterile pack store Operating room Scrub bay b	 35 25 25 25	See standard schemes in Appendix 3 for recommended design values	
Clean	Sterile pack bulk store Anaesthetic room c Scrub room	 +ve 14 c 14	6 ac/h The greater of 15 ac/hr or 0.15 -	- The greater of 15 ac/hr or 0.15 0.10
Transitional	Recovery room Clean corridor General access corridor Changing rooms Plaster room	3 0 0 3 3	15 ac/hr d e e 7 ac/hr 7 ac/hr	15 ac/hr d 7 ac/hr 7 ac/hr 7 ac/hr 7 ac/hr
Dirty	Service corridor Disposal room	0 -5 or 0	- -	f 0.41 or 0.10

Table A2

Notes: (applicable to Table A2)

a. Nominal room pressures are given to facilitate setting up of pressure relief dampers, the calculation process, and the sizing of transfer devices. In practice, the resultant pressures are not critical, provided the desired airflow rates and movement are achieved.

b. An open or semi-open bay is considered to be part of the operating room; provided air movement is satisfactory, no specific extract is required. However if the layout means that air movement is poor, a local extract may be required to control local condensation on the building surfaces, which can result in mould growth.

c. For design purposes, anaesthetic should be assumed to be at 14 Pa. When commissioning 10 Pa is considered suitable.

d. 15 ac/hr are considered necessary for the control of anaesthetic gas pollution.

e. Supply airflow rate necessary to make up 7 ac/hr after taking into account secondary air from cleaner areas.

f. No dilution requirement. Temperature control requirements only.

Type	Pressure difference - Pa						
	5	10	15	20	25	30	40
Single door (CDB Size 2.4.3.2.6.)	.03	.05	.06	.06	.07	.07	.08
Double door (CDB)	.04	.08	.10	.11	.12	.13	.14
High permanent length of 3mm gap	.004	.008	.010	.011	.012	.012	.013

Table A3: Leakage flows in m^3/s through closed door gaps

Note: CDB = Component Data Base

It should be noted that many doors are now fitted with cold smoke seals as standard. These will significantly reduce the door leakage rate when new and undamaged. It is therefore recommended that provision for the design leakage is factored into the sizing of the appropriate transfer grille or pressure stabiliser. Failure to do this will result in air gap whistles and doors being held partially open by air pressure.

Factory-assembled door-sets with a steel frame and pre-hung leaves have become common. There is effectively no leakage across these doors when closed. Therefore, when this type of door assembly is fitted, the door leakage can be ignored and the design airflow into the room reduced accordingly. The design airflow would then become that required either (i) for open door

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protection, or (ii) to achieve the specified air-change rate - whichever is the greater.

Room class		Dirty	Transitional	Clean	Sterile
Sterile	Hatch	0.3	0.24	0.18	
	Single door	0.47	0.39	0.28	0 or 0.28 a
	Double door	0.95	0.75	0.57	0 or 0.57 a
Clean	Single door	0.39	0.28	0 or 0.28 a	
	Double door	0.75	0.57	0 or 0.57 a	
Transitional	Single door	0.28	0 or 0.28 a		
	Double door	0.57	0 or 0.57 a		
Dirty	Single door	0	Open single door = 0.80m x 2.01m high		
	Double door	0	Open double door = 1.80m x 2.01m high		

Table A4: Recommended air flow rates in m^3/s through a doorway between rooms of different cleanliness to control cross-contamination

Designer's Notes:

a The degree of protection required at an open doorway between rooms is dependent upon the degree of difference in cleanliness between them.

b Flow rate required between rooms within the same class tends to zero as class reduces.

c If two rooms are of equal cleanliness, no flow is required (in practice there will be an interchange in either direction) and the design of the air movement will assume zero air-flow. In certain cases, however, interchange is not permitted and a protection airflow of 0.28 is assumed in the design, for example, in the case of a preparation room used as a "lay up".

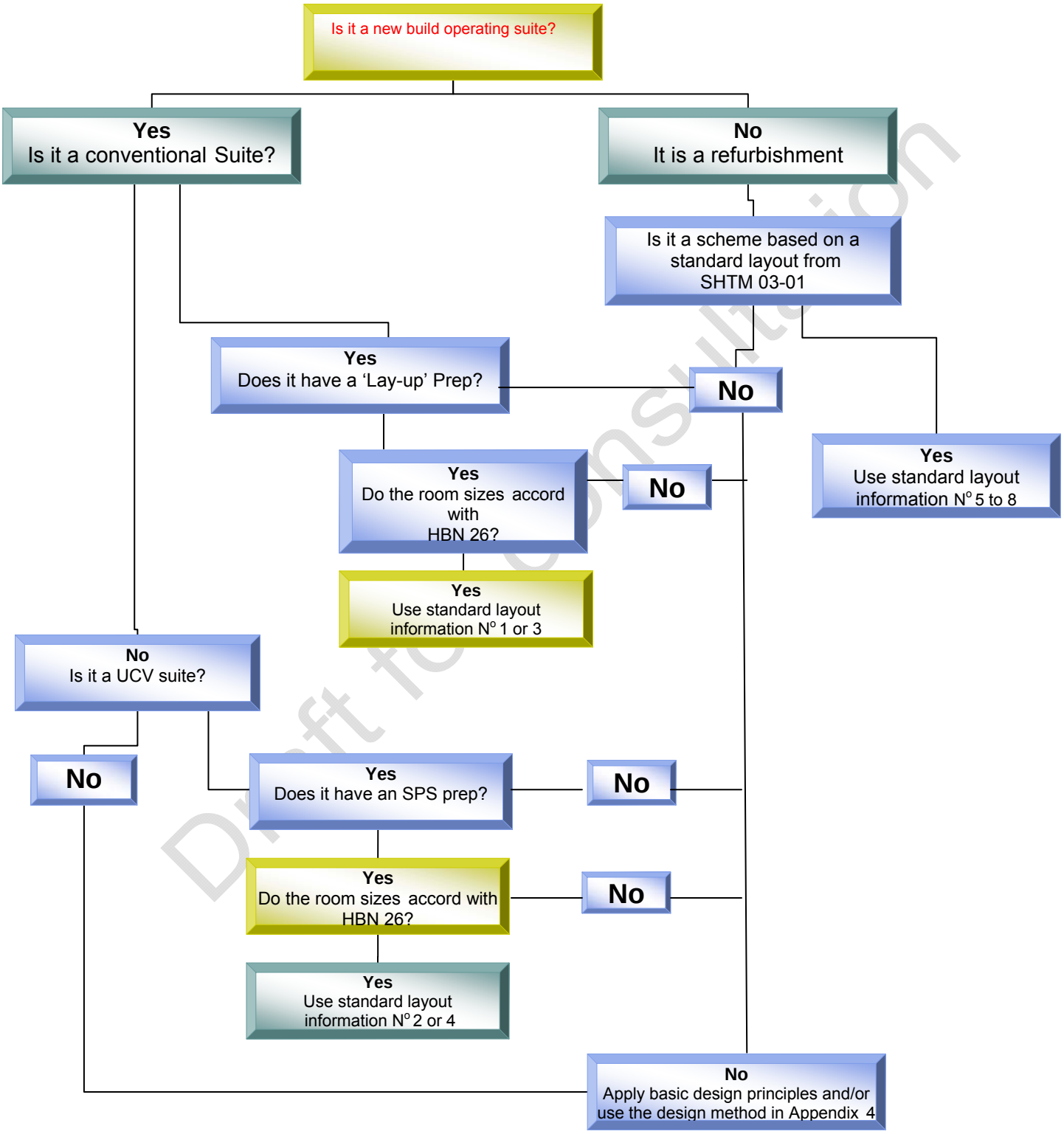
		Effect on other rooms	
Door open between	Resultant pressure in these rooms (Pa)	Room	Pressure (Pa)
Operating room and corridor or Scrub bay and corridor	0	Anaesthetic Preparation – lay up Disposal Preparation – sterile pack store	0 12 -6 5
Operating room and anaesthetic room (or other series room with double doors)	17	Preparation – lay up Disposal Preparation – sterile pack store	26 -9 22
Operating room and disposal room or Operating room and preparation room	25	No change	
Anaesthetic room and corridor (or other series room with double doors)	0	Preparation – lay-up Disposal Operating room Preparation – sterile pack store	30 -6 20 25
Preparation room – corridor Disposal room & corridor	0	No change	
Disposal room & outer corridor	0	No change	

Table A5: Typical pressures in an operating suite when a given door is open

Notes:-

1. The room differential pressure protects against reverse flows when the door is closed.
2. The flow of air through a doorway protects against reverse airflow when the door is open.
3. Pressure stabilisers control flow and ensure a known air-flow path between rooms when doors are closed and reduce back-flow between rooms when doors to other rooms are open.

Appendix 3 - Operating suite design logic



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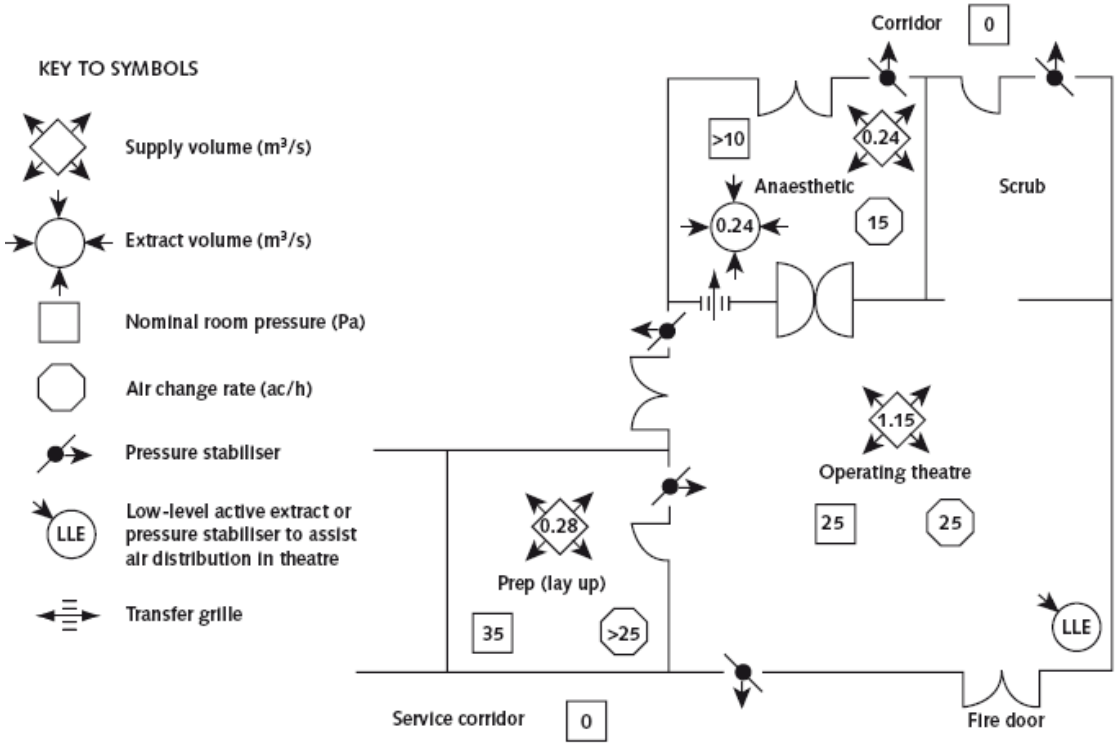
New Standard Layout N^{o} 1 - Suitable for a typical conventional theatre suite (Room sizes as specified in HBN 26)



Room	Size m^3 Derived from HBN26	Air-Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	165	25	25	1.15
Anaesthetic	57	15	>10	0.24
Lay-Up-Prep	36	>25	35	0.28**
Scrub	*	-	25	-

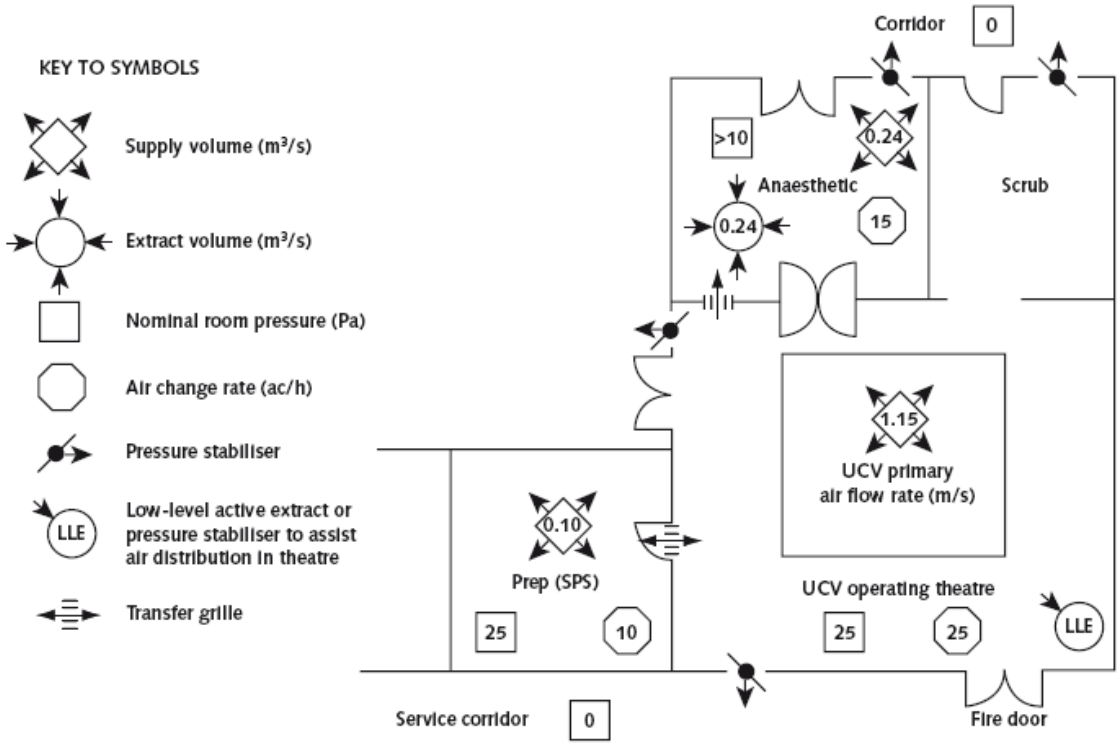
*This is a separate scrub and is not considered as being part of the theatre volume.

**Interchange is not permitted between the theatre and lay-up prep; therefore an airflow protection of 0.28 + 0.06 closed-door airflow is required as a minimum.

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New standard layout N° 2 - Suitable for a typical UCV theatre suite (Room sizes as specified in HBN 26)



Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15**
Anaesthetic	57	15	>10	0.24
Sterile Prep	36	25	25	0.10
Scrub	*	-	25	-

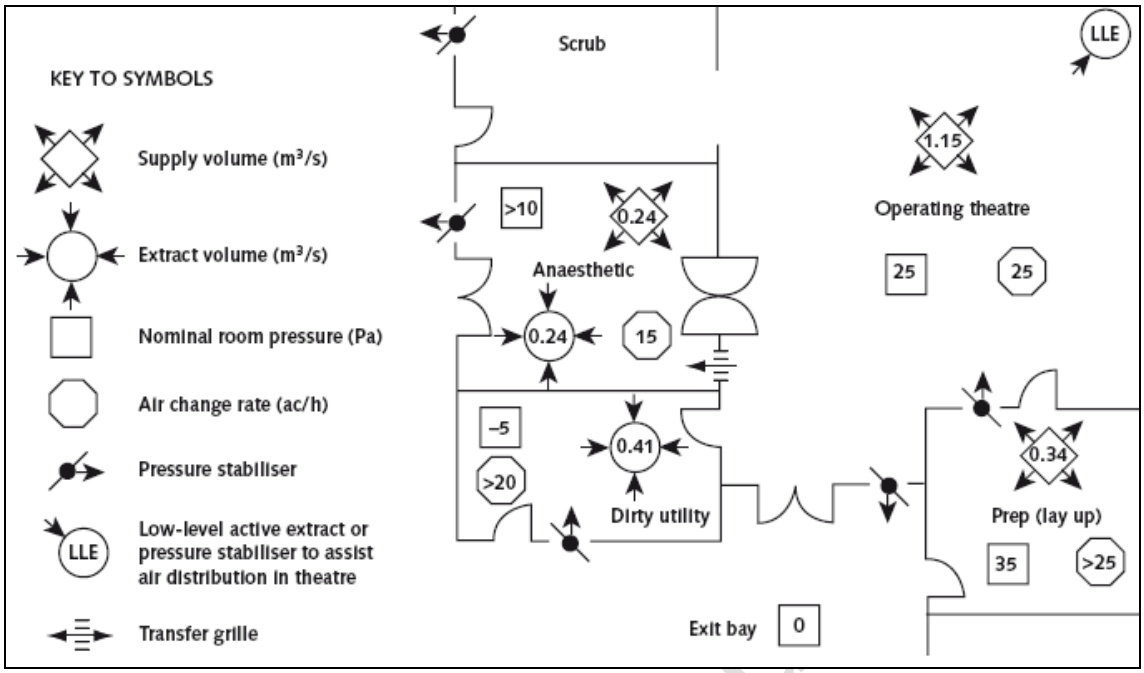
*Separate scrub and not considered as part of theatre volume

**Primary Fresh air Volume Only

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New standard layout N^{o} 3 - Suitable for a typical Conventional theatre suite (Layout and room sizes are as illustrated in HBN 26)



Room	Size m^3 Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	165	25	25	1.15
Anaesthetic	57	15	14	0.24
Lay-Up Prep	36	>25	35	0.34**
Scrub	*	-	25	-
Dirty Utility	36	-	-5	0.41

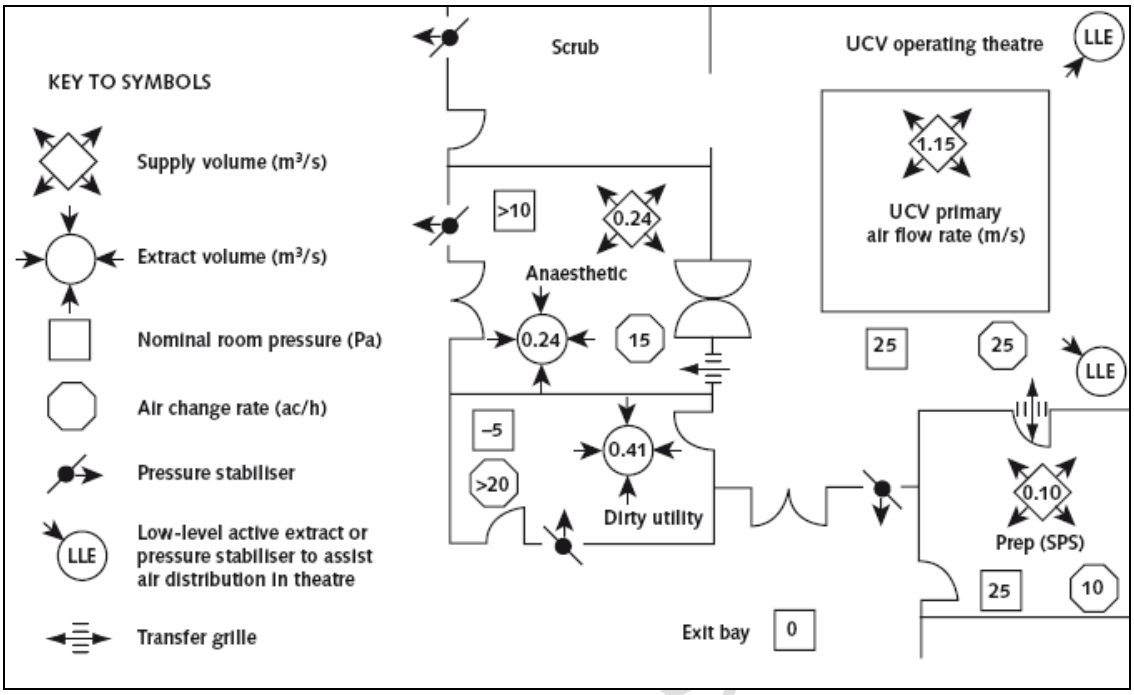
*Separate scrub not considered part of theatre volume.

**Interchange is not permitted between the theatre and lay up prep therefore as table 4 an airflow protection of 0.28 + 0.06 closed door air flow is required as a minimum.

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New standard layout N^{o} 4 - Suitable for a typical UCV theatre suite (Layout and room sizes are as illustrated in HBN 26)



Room	Size m^3 Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	165	25	25	1.15**
Anaesthetic	57	15	>10	0.24
Sterile Pack Prep	36	10	25	0.10
Scrub	*	-	25	-
Dirty Utility	36	-	-5	0.41

* Separate scrub not considered part of theatre volume

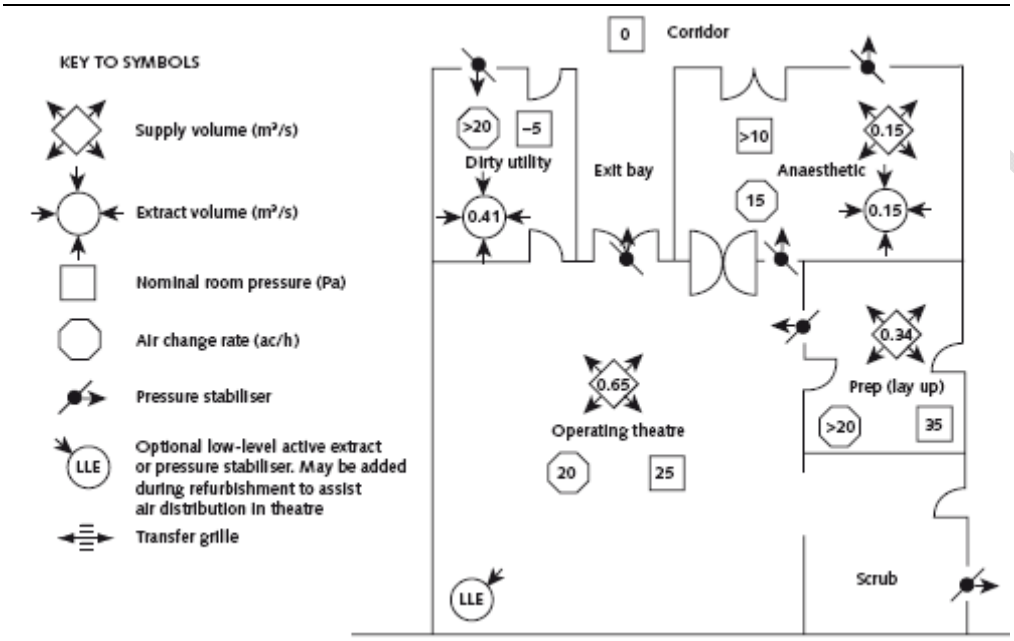
**Primary Fresh air Volume Only

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New standard layout N° 5 - SHTM 2025 Existing standard plan '1b' typical layout for a conventional theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



Room	Size m³	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.65
Anaesthetic		15	14	0.15
Lay-Up Prep		-	35	0.34
Scrub		-	25	Included within theatre
Disposal		-	-5	0.41

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor.

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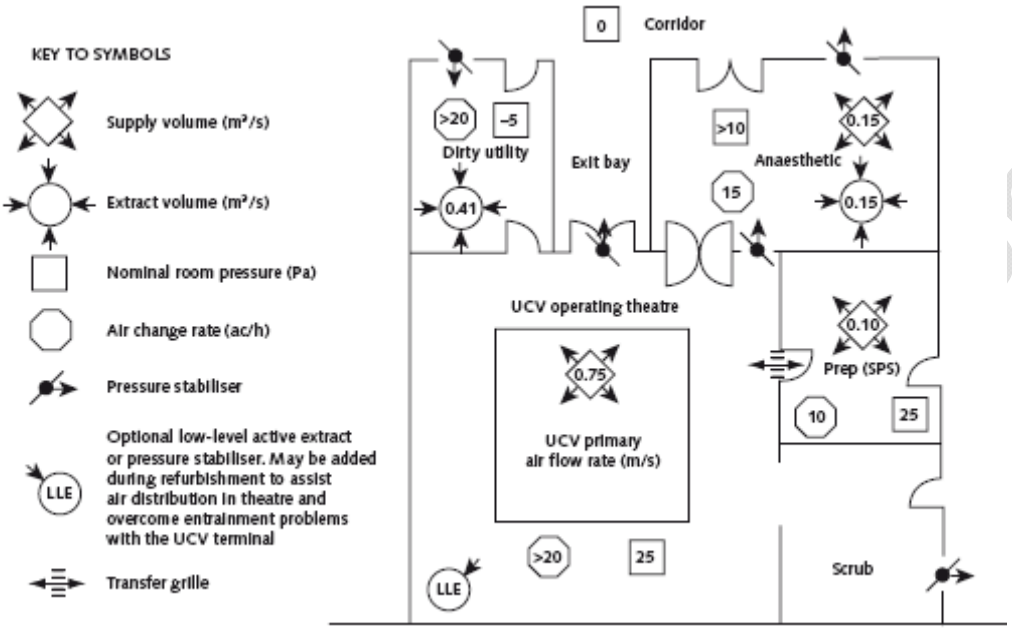
Standard layout N^{o} 6 - SHTM 2025 Existing standard Plan '1a' Typical layout for a UCV theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



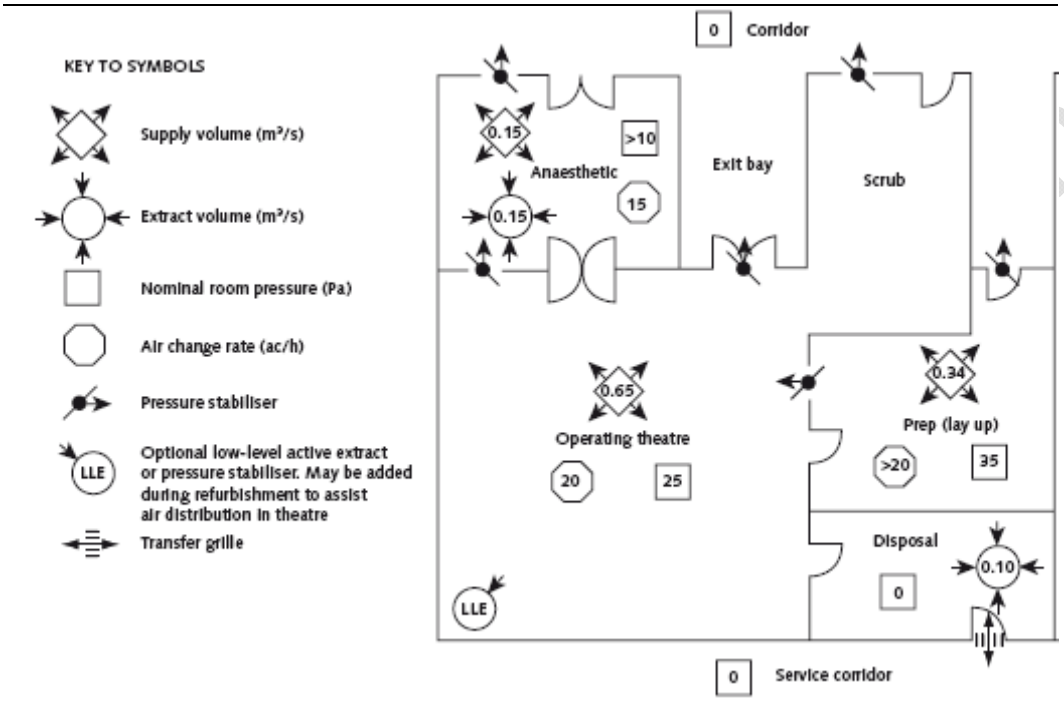
Room	Size m^3	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.75*
Anaesthetic		15	>10	0.15
Sterile Pack Prep		10	25	0.1
Scrub		-	25	Included within theatre
Disposal		-	-5	0.41

*Primary fresh airflow volume

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor.

Standard layout N^{o} 7 - SHTM 2025 Existing standard Plan '5b' Typical layout for a conventional theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.

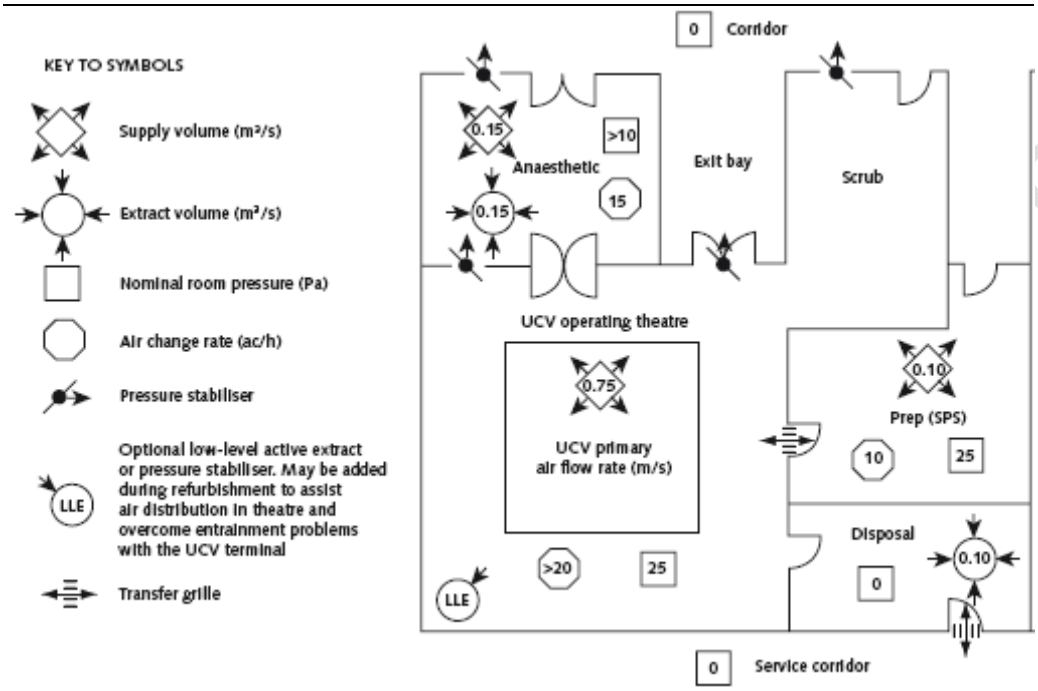


Room	Size m^3	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	Existing Theatre Suite to be Measured on site	20	25	0.65
Anaesthetic		15	>10	0.15
Lay-Up Prep		>20	35	0.34
Scrub		-	25	Included within theatre
Disposal		-	0	0.1

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor. Alternatively the disposal room could be omitted and replaced with a disposal hatch between the theatre and corridor.

Standard layout N^{o} 8 - SHTM 2025 Existing standard Plan '5a' Typical layout for a UCV theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



Room	Size m^3	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.75*
Anaesthetic		15	>10	0.15
Sterile Prep		10	25	0.1
Scrub		-	25	Included within theatre
Disposal		-	0	0.1

*Primary fresh air-flow volume only

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor. Alternatively the disposal room could be omitted and replaced with a disposal hatch between the theatre and corridor.

Appendix 4 - Design of air-movement control schemes for operating theatres.

General

A4.1 Standard operating suite design solutions are given in Appendix 3. If these standard solutions cannot be used, the following procedure should be adopted, which will result in an acceptable design. Note that the method employed can equally be used to provide a design solution to a ventilated suite of rooms for any application.

A4.2 The method is concerned with the calculation of airflow rates to ensure that correct air movement occurs between rooms when any one door is open. Under most circumstances, the air quantities required for air-movement control will approximate to those for either temperature control or bacterial contaminant dilution. This flow rate is sufficient to control the effects of any slight reverse flows occurring when a door is opened.

A4.3 The progression through the design procedure is shown in the airflow design procedure chart (Figure A4/3) and is supported by worksheets WS1 to WS7 described in paragraph A4.4. It is recommended that a plan of the suite and an airflow network be made (Figure A4/2) to collate all information. Flow rates, air-transfer devices etc should be entered as required. The remainder of this Appendix may be treated as reference data to assist in the various steps. The following symbols are used:

S_S – supply airflow rate for summer temperature control;

S_W – supply airflow rate for winter temperature control;

S_D – supply airflow rate for dilution of bacterial contaminants;

S_L – supply airflow rate for heat loss;

S_G – supply airflow rate for heat gain;

E_D – extract airflow rate for dilution of bacterial contaminants;

S_F – final supply airflow rates;

E_F – final extract flow rates;

S_{AMC} – air-supply flow rate for air-movement control;

E_{AMC} – air-extract flow for air-movement control;

L_{OUT} – leakage airflow rate outward;

L_{IN} – leakage airflow rate inward;

$\sum_{OUT}$ – total airflow rate outward;

$\sum_{IN}$ – total airflow rate inward.

A4.4 To simplify the procedure, standard worksheets (WS1 to WS7) have been devised. For each operating suite, a set is required comprising one each of WS1, WS3, WS5, WS6a, WS6b and WS7, one WS4 for each corridor and one WS2 to cover each peripheral room. WS2 has five versions:

- WS2a single flow;
- WS2b parallel/series multi-flow;
- WS2c parallel multi-flow or series multi-flow (unbalanced);
- WS2d series multi-flow (balanced); and
- WS2e bay (semi-open).

Peripheral room type

A4.5 The rooms in the operating suite other than the operating room and corridor are referred to as peripheral rooms. Peripheral rooms have been classified according to the flows in and out. These room classifications are defined below in paragraphs A4.6 – A4.11.

Single flow

A4.6 This is a room with only one door and a net surplus of supply or extract air.

Parallel multi-flow

A4.7 This is a room with two or more doors through each of which the air-flows either outwards (high-pressure) or inwards (low-pressure) (for example the Prep (lay-up) in standard layout 5 in Appendix 3).

Parallel/series multi-flow

A4.8 This is a room having a net surplus of supply or extract and with two or more doors. One or more doors will be to an area of equal cleanliness and need not be protected; hence, the flow may vary between inwards and outwards, the remaining door being to an area of greater or lesser cleanliness (for example the Prep (SPS) in standard layout 6 in Appendix 3).

Series multi-flow (unbalanced)

A4.9 This is a room having a net surplus of supply or extract and with two or more doors. Air flows inwards through one or more doors and outwards through one or more doors.

Series multi-flow (balanced)

A4.10 This is a room as in paragraph A4.9 above, but having either no mechanical ventilation or no net surplus of supply or extract. (for example an anaesthetic room).

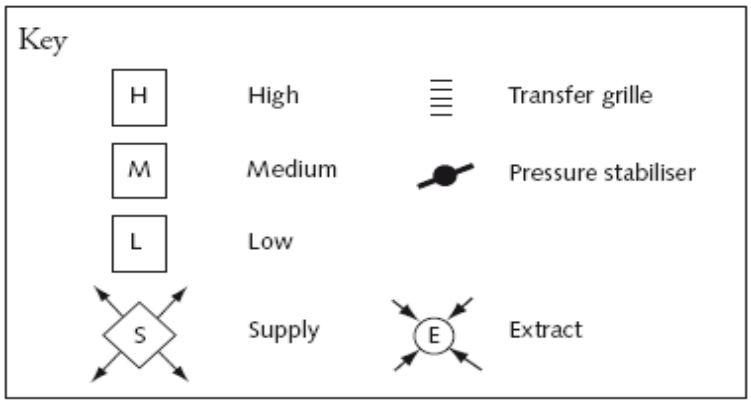
Bay

A4.11 A room that has a permanent opening to the operating room may be considered as a bay off the latter (for example a scrub). Two categories exist:

- open bay – the opening is larger than a normal single door opening. The bay may be considered as part of the main room;
- semi-open bay – the opening is no larger than a normal single door opening. In this case it is possible to protect the bay from the main room by provision of air supply or extract in the bay, or by passing air to or from another area.

Air-movement control in peripheral rooms

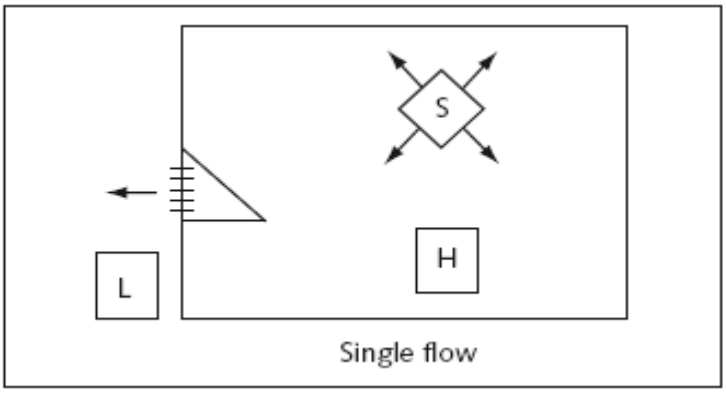
A4.12 For the design of air-movement control, two types of air-transfer device are considered. These are transfer grilles and pressure stabilisers. Each has a particular field of application within the design, as described in paragraphs A4.34 – A4.43. Air movement is controlled in each of the different room types described in paragraphs A4.13 – A4.31.



Note: This key applies to each diagram in 4.13 - 4.27.

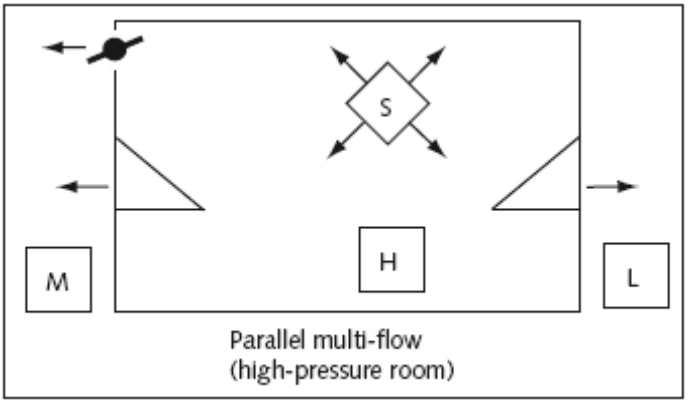
Single flow rooms

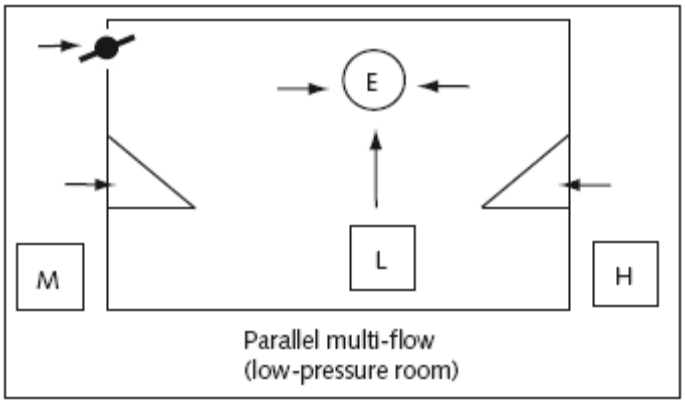
A4.13 An appropriately sized transfer grille should be located in or adjacent to the door of each single flow room to relieve the pressure differences across the door when closed.



Parallel multi-flow rooms

A4.14 The pressure difference across the closed doors must be relieved, but transfer grilles are not appropriate where two doors lead to areas of different pressures, because reverse flow could occur when the other door is open. For this reason, pressure stabilisers are used.



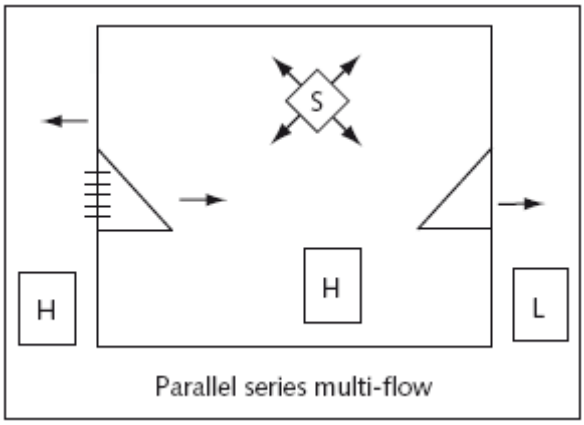


A4.15 These rooms will be either high-pressure or low-pressure with respect to the adjacent areas (see preparation lay-up room and disposal room, respectively, in standard layout 5 of Appendix 3). The pressure-relief damper is always situated between the room and area, which results in the smaller differential pressure to ensure best use of air.

A4.16 Just as reverse flow can occur if transfer grilles are used, it can similarly occur via door gaps when the other door is opened. It is not possible to avoid this, except by using air locks, but due to the low flow rates and short durations involved, this is not considered to be of importance.

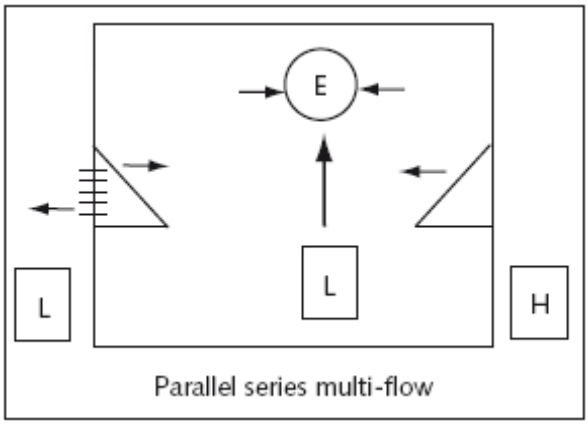
Parallel-series multi-flow rooms

A4.17 These rooms are similar to those in paragraph A4.14 above, but because the room is of equal cleanliness to one of the adjacent rooms the nominal pressures will be equal and air may flow through the adjoining doorway in either direction. (for example the Prep (SPS) in standard layout 6 of Appendix 3).



Parallel series multi-flow

A4.18 Where the nominal room pressure equals that of the higher-pressure adjacent room, the best use of air is by supplying air required for bacterial dilution only and allowing this to exhaust via a transfer grille to the area of equal cleanliness. The doorway to the lower pressure area is protected by the combination of the supply air and the air that will flow inwards through the transfer grille from the area of equal cleanliness.

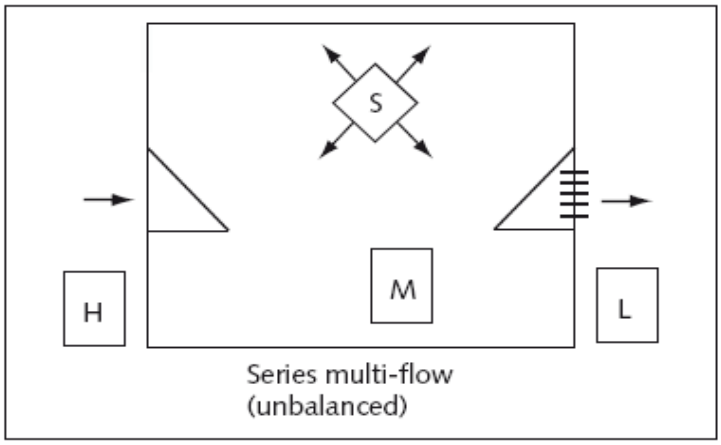


Parallel series multi-flow

A4.19 Conversely, where the nominal pressure equals that of the lower-pressure adjacent room, extract ventilation and a transfer grille to the lower pressure adjacent room should be provided. (for example, the disposal room in standard layout 8 of Appendix 3).

Series multi-flow (unbalanced)

A4.20 These rooms are somewhat similar to those in paragraph A4.15 above, but because the pressure lies between that of the rooms on either side, the back-flow problem does not exist.



Series multi-flow (unbalanced)

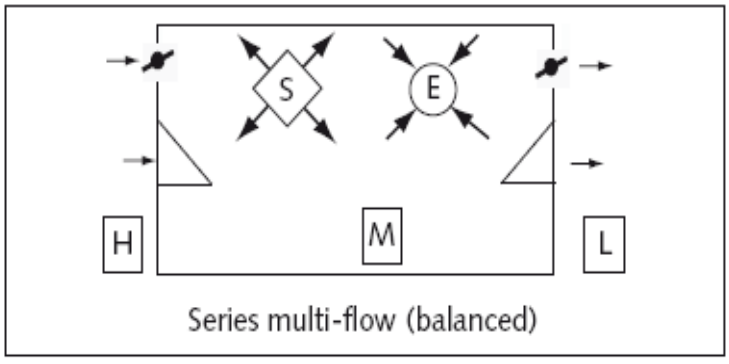
A4.21 Where the room has a net surplus of mechanical supply air, a transfer grille should be located in or adjacent to the door through which air flows outwards, and the mechanical supply flow rate to the room should be chosen to give protection when this door is open.

A4.22 Where the room has a net surplus of mechanical extract air, a transfer grille should be located adjacent to the door through which the air flows inwards, and the mechanical extract flow rate to the room should be chosen to give protection when this door is open.

A4.23 The grille must be sized for the protection requirement of the opposing door when open. When the room on the high-pressure side depressurises, there is a possibility of back-flow through gaps around the door, but this problem may be ignored.

Series multi-flow (balanced)

A4.24 In these rooms, a transfer device adjacent to each doorway is required in order to provide a flow path for the air required to protect the opposing door when opened.



Series multi-flow (balanced)

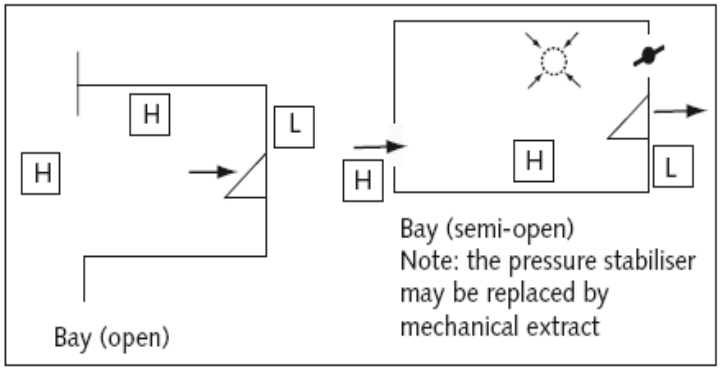
A4.25 These transfer devices will normally be pressure stabilisers, although transfer grilles may be used where a large amount of excess air is to be exhausted from the operating room when all doors are closed. (for example, anaesthetic rooms).

A4.26 The calculation procedure is to assume that pressure stabilisers are being used; then (if there is sufficient excess air) change to transfer grilles as described in paragraph A4.50.

Bay

Open bay

A4.27 A bay of the open type (for example scrub-up) is considered to be part of the operating room. Provided air movement is satisfactory, no specific extract is required.



Semi-open bay

A4.28 In a bay of the semi-open type, protection of one area from the other is possible. (for example scrub-up).

A4.29 As stated previously, the need for protection between operating room and scrub-room is not very great. Better use of air can therefore be achieved in this case by installing a pressure stabiliser between the scrub-room and clean corridor. This will allow a flow of air through the scrub-room at all times, except when a door is opened elsewhere in the suite. The pressure stabiliser will then close and the air will be diverted to the other door. When it is considered necessary to protect the scrub-room at all times, either a transfer grille to the corridor or mechanical extract in the scrub-room should be provided.

Operating room

A4.30 Once the peripheral rooms have been considered, the operating room requirements may then be decided and the supply flow rate required for air-movement control calculated. This flow rate should be such that, with any one door open, the correct air movement directions are maintained. There will be one door in the suite that will require the largest supply flow rate to the

operating room for protection when open. This is called the “key door” and is discussed separately in paragraph A4.33. Use of this concept avoids repetitive calculations for each door in turn. Having established the required supply flow rate, a relief route must be provided to the clean corridor for any excess air when the doors are closed. This would be via transfer grilles or pressure stabilisers through a series-flow room or via pressure stabilisers to the clean corridor directly.

Corridors

A4.31 All surplus air from the suite, except that lost through structure leakage and any passing to the outer corridor, will arrive in the patient/staff corridor. Should this air be insufficient to achieve the required air-change rate (see Appendices 1&2), some additional air supply should be provided. (The air balance should take account of structural leakage.)

Door opening

A4.32 Whereas the resulting pressures are dependent on ductwork layout, room relationships and characteristics of the fan, the generalisations shown in Appendix 2 can be used to estimate the change in room pressure when a door is opened.

A4.33 The “key door” will be the open double door which leaves the operating room at the highest pressure, and/or requires the largest air flow. This should be determined using the procedure in worksheet WS3.

Transfer grilles

A4.34 These may be used to limit the pressure differences across the closed door of a single-flow room or, in some instances, for protection of a series-flow or parallel-series-flow room. They allow airflow in both directions and may not be suitable for all applications.

A4.35 The free area of a grille is calculated from the following equation:

$$A = \frac{Q}{0.84\sqrt{\Delta P}}$$

where:

A is free area (m^2)

Q is flow rate (m^3/s)

P is pressure difference (Pa).

A4.36 The flow through a grille at a different pressure may be found from the following equation:

$$Q_2 = Q_1\sqrt{\frac{\Delta P_1}{\Delta P_2}}$$

where:

Q_1 and P_1 are original flow and differential pressure

Q_2 and P_2 are new flow and differential pressure.

A4.37 The transfer grille may be replaced by carefully proportioned door undercuts of the equivalent free area.

A4.38 The function of the transfer grille is to provide a means of airflow control by which the volume and pressure loss can be established. If a grille is used, it should have an easily removable core to facilitate cleaning.

Pressure-relief dampers

A4.39 The functions of a pressure-relief damper are now carried out by pressure stabilisers. Accordingly, all further mention of them has been removed from this document.

Pressure stabilisers

A4.40 Pressure stabilisers can be adjusted to hold the pressure constant over a wide range of flow rates. They are used where requirements exist for accurate room-pressure control or rapid shut-off on pressure fall.

A4.41 The installation of a grille or baffle in association with a stabiliser will alter the operating characteristics. It is recommended that a location be chosen to avoid the need for visual screening, for example, at high level. The location should be chosen to minimise the likelihood of damage.

A4.42 The stabilisers used should be virtually silent in operation, adjustable on site, maintenance-free and of a type that cannot be wrongly inserted. They should not be used in external walls or where the pressure difference is less than 5 Pa. The required size of a pressure stabiliser is dependent on the design pressure difference across it and flow rate through it. The manufacturer should provide data relating pressure difference to mean velocity (or flow rate per unit area). From this, the required area can be calculated and then rounded-up to the nearest size manufactured or nearest combination of smaller sizes.

A4.43 It is sometimes possible to arrange for a pressure stabiliser to perform two tasks. In an anaesthetic room, for example, the two pressure stabilisers may be

made to pass the open door protection air, and also control the operating and anaesthetic room pressures with the door closed. To achieve this, the stabilisers are sized for the flow rate required with one of the doors open, but the pressure setting is adjusted to be the value required with the doors closed. This is shown in Figure A4/1.

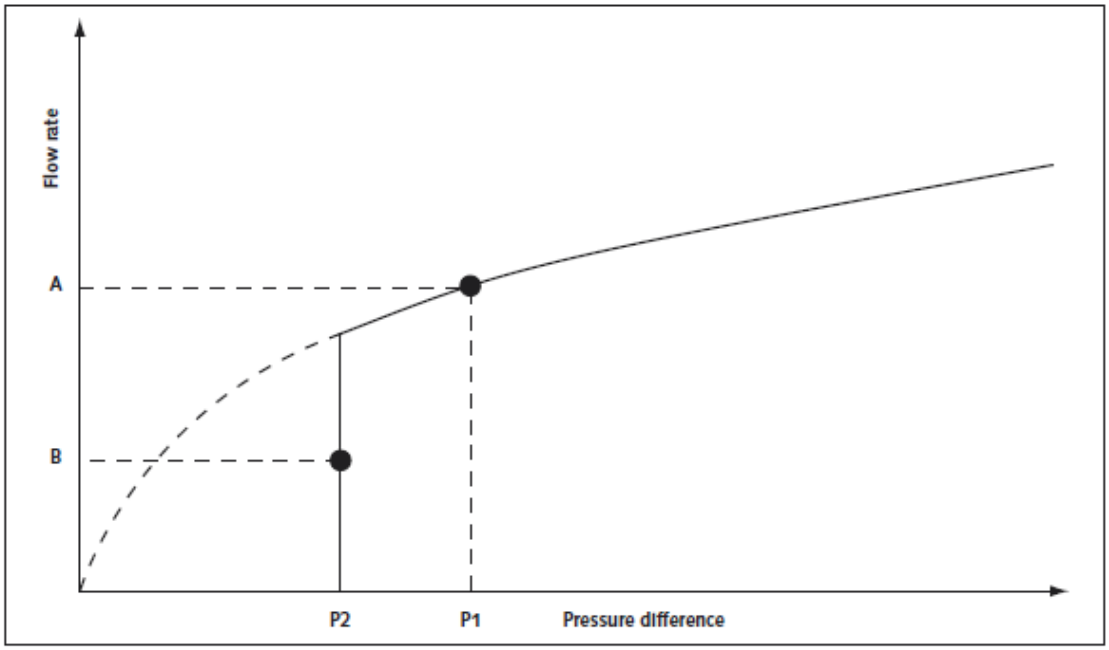


Figure A4/1

Door leakage flows

A4.44 For an air-movement control scheme to work satisfactorily, it is essential that the estimates of door-gap leakage made at the design stage are closely related to those which are achieved in practice. The calculation of gap-flows is complicated by the fact that such flows generally fall into the transition region between laminar and turbulent flow and hence do not follow the normal flow equations. The gaps assumed are 4 mm along the bottom, 3 mm at the top and sides, and 2 mm between double leaves. Doors should not have wider gaps than these. Tighter gaps would result in lower flow-rate requirements and hence lower fan power, but care should be taken to ensure that all doors in the suite have similar gap dimensions. It may be possible to ignore the door leakage and so reduce the airflow requirement (see the notes in Appendix 3).

Room temperature estimation

A4.45 The air-flow rate required to prevent back-flow through an open door is dependent on the temperature difference across the door. The design figures shown in Appendix 3 are based on the temperature differences that will normally occur in practice, assuming heat gains and losses in accordance with Appendix 2.

A4.46 In accordance with the airflow design process, the temperature differences across the doors of all rooms classed as “sterile” is calculated. Worksheet WS6 is recommended for the calculations, using the following criteria:

- assume that the operating room is being controlled at 20°C and calculate the incoming air-supply temperature as shown on worksheet WS6;
- the calculation should be repeated for both summer and winter conditions, with an operation in progress;
- assume all doors are closed;
- use the room supply flow rates from WS1;
- use the inward air flows through air-transfer devices and closed door leakages from WS2a to WS2e;
- the formula used in worksheet WS6 is as follows:

$$T = \frac{(t_1Q_1 + t_2Q_2 + \cdots + t_nQ_n) + 0.828H}{(Q_1 + Q_2 + \cdots Q_n)}$$

where:

Q = flow rate from source (m^3/s)

t = the temperature of source (°C)

H = the room heat gain (kW).

A4.47 If the evaluated temperature differences between rooms do not exceed 2°C, the solution is satisfactory; otherwise proceed as follows:

- check the assumption on which the heat gains are based;
- take steps to reduce the heat gains;
- if the door is to a corridor, the flow through the open door will be larger than the value given in Appendix 2. Calculate on WS3, assuming it is the “key door” with door-flow unknown, and the supply as known;
- if the door leads to a room with mechanical supply, install a trimmer heater in the supply to the room controlled by either a differential thermostat or a thermostat slaved to the operating room thermostat to ensure that T is minimized.
- If the door leads to a room with no mechanical supply, increase the door protection flow as follows:

$$Q_{new} = Q_{old}\left[\frac{\Delta T + 1}{2}\right]$$

A4.48 These options should be considered in the above order, and the first three should be investigated thoroughly before proceeding to the latter two. The mechanical supply may need to be increased in order to achieve the desired air-change rates.

Relief of excess air from operating room when all doors are closed

A4.49 As the mechanical supply to the operating room is sized to provide an appropriate flow outward through any door that is opened, it follows that when all doors are closed, there will be more air supplied to the operating room than can exit from it via leaks etc. This “excess” air can be relieved by either of the two methods described in paragraphs A4.50 - 4.54.

By transfer devices via the anaesthetic room

A4.50 For door protection, the transfer devices in the anaesthetic room are typically designed to pass 0.47 m^3/s at a differential pressure of 14 Pa. When the doors are closed, the differential pressure will change to 11 Pa between theatre and anaesthetic room, and 14 Pa between anaesthetic room and corridor; the volume of air passed by the transfer devices will be modified as shown in the following formula:

$$Q = Q_1\left(\frac{\Delta P_1}{\Delta P_2}\right)^{1/2}$$

$$= 0.47\left(\frac{11}{14}\right)^{1/2}$$

$$= 0.42\ m^3/s$$

where:

Q = “excess” air to be vented with doors closed;

Q_1 = air-flow required for door protection through transfer device;

ΔP_1 = nominal differential pressure with door to operating room closed and door to corridor closed;

ΔP_2 = nominal differential pressure between either the anaesthetic room and corridor when the operating room door is open, or the anaesthetic room and operating room when the corridor is open. This differential pressure is used when selecting size of both devices.

A4.51 If the “excess” air is less than 0.42 m^3/s, a pressure stabiliser is required to ensure that the correct protection airflow is available to pass through the door.

A4.52 If the “excess” air is greater than 0.42 m^3/s, a transfer grille is acceptable because at all times the airflow will exceed the flow required for door protection.

By pressure stabilisers to the corridor

A4.53 If it is undesirable to pass operating room air through the anaesthetic room, it may be passed directly to a corridor via a separate pressure stabiliser.

A4.54 If there is sufficient “excess” air, the transfer grille solution at paragraph A4.52 should be adopted, as it provides the simplest solution and, once set up, will require no further maintenance. With less excess air, it is recommended that the air be passed through the anaesthetic room via the pressure stabilisers as at paragraph A4.51, thus keeping the number of pressure stabilisers to a minimum. Both these solutions increase the air-change rate in the anaesthetic room, but care should be taken to avoid passing excessive amounts through that would cause discomfort to the occupants.

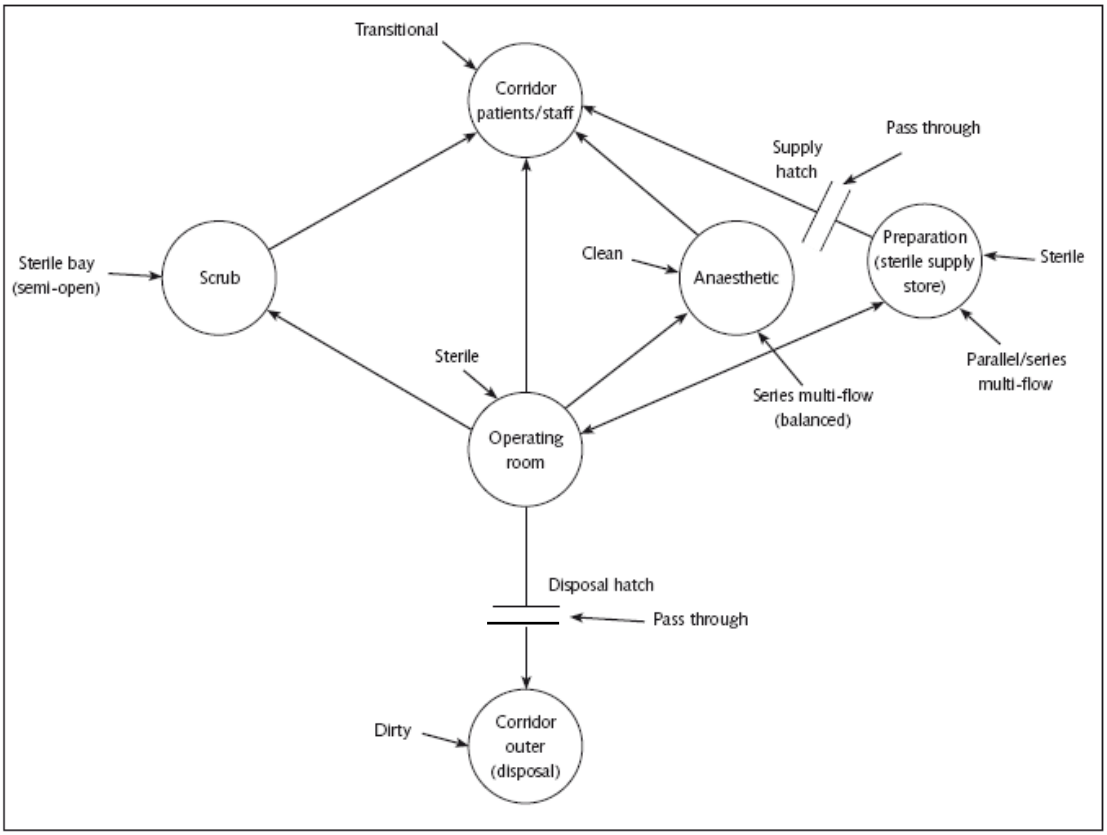
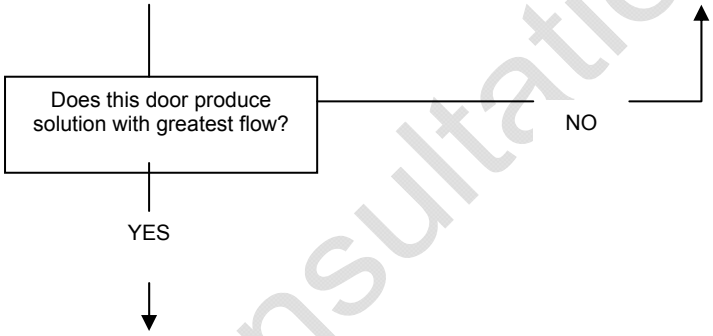
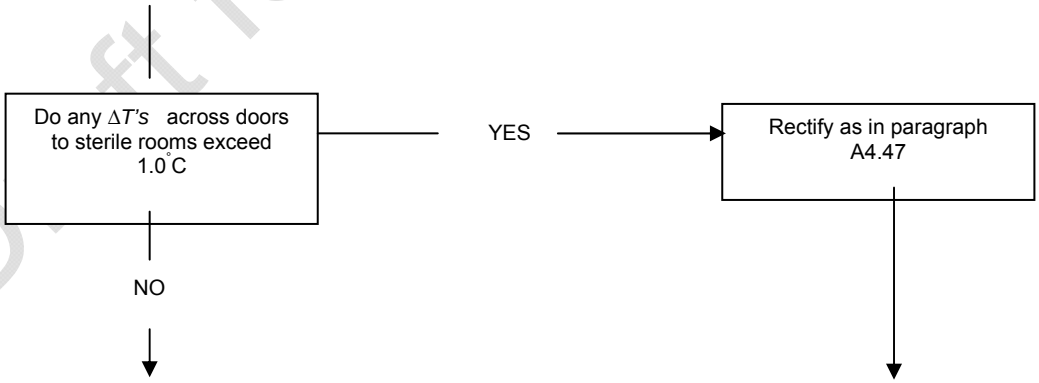


Figure A4/2: An example of an airflow network

Step	Description	Worksheet
1	Show nominal room pressures and air flow directions on the plan of the theatre suite and WS!	WS1
2	Enter heat/loss/gain data and calculate supply airflow rates for temperature control only. Categorise room types, e.g sterile, clean etc	WS1
3	Enter airflows required for bacterial contamination control or air change rate whichever is the greater, add supply and extract volumes (S_D, E_D) on the plan.	WS1
4	Define peripheral room types, see paragraphs A4.5-A4.11, and select appropriate worksheets.	Select from WS2a to WS2e
5	Locate air transfer devices, enter details on worksheets and locate on the plan and Figure A4/2	Selected worksheets from WS2a to WS2e
6	For each peripheral room, determine air flows through doors when open and calculate mechanical supply or extract and transfer device flows	As above
7	Select "Key Door" and calculate air supply for operating room	WS3



8	Transfer to WS1 and select final rate S_F and E_F	WS1, WS3
9	Make provision for relief of excess air with doors closed	Selected Worksheets and WS3
10	Calculate supply and extract flow rates for corridor(s)	WS4, WS5
11	Calculate room temperatures (all doors closed) and ΔT's	WS4, WS5



12	Make summary of flows	WS6a and WS6b
13	Size transfer devices, size ductwork, central plant etc	WS7
14	Design ductwork layout, control plant etc	-

Figure A4/3: Airflow design procedures

Calculation sheet for						**Worksheet WS1** **Reference:**
Room Name:						
1. Summer Temperature Control Heat Gain	kW					
2. Acceptable Δt	°C					
3. Air flow rate (S_G) $= \frac{\text{Gain}}{\Delta t \times 1.2}$	m^3/s					
4. Winter Temperature Control Heat Loss	kW					
5. Acceptable Δt	°C					
6. Air flow rate (S_L) $= \frac{\text{Loss}}{\Delta t \times 1.2}$	m^3/s					
7. Dilution of bacterial contaminations Air flow rate	m^3/s					
S_D or E_D						
8. Desired air change rate	ac/hr					
$\frac{\text{AC/hr x room volume } (m^3)}{3600}$	m^3/s					
9. Maximum of S_G, S_L, S_D or E_D or air change rate from Step 8	m^3/s					
10. Air movement control	S m^3/s					
Air flow for air movement control S_{AMC} or E_{AMC} (from WS2, WS3, or WS4)	E m^3/s					
11. Final Supply Flow Rate (S_F)	m^3/s					
12. Final Extract	m^3/s					
13. Total Supply	m^3/s					
14. Total Extract	m^3/s					

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Air Movement Control **Peripheral Room ..... type, single flow**	**Worksheet WS2a** **Reference:** **Nominal Pressure: ..... Pa**

Consider door to ..... open

Flow required through doorway to give protection	Pa	Δt	Air flow, m^3/s Out	In	Remarks
Total					

S_{AMC} $(\sum_{OUT} - \sum_{IN})$ _____ m^3/s

or

E_{AMC} $(\sum_{OUT} - \sum_{IN})$ _____ m^3/s

Transfer S_{AMC} or E_{AMC} to WS1

Consider door to .....closed

Closed door leakage	Pa	Δt	Out	In	Remarks
Total					

Return S_F and E_F to WS1 _____ _____

Flow through transfer grille outward ($S_F – E_F - L_{OUT}$ _____

or

Flow through transfer grille inward ($E_F – S_F - L_{IN}$) _____

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Air movement control **Peripheral Room ..... type, parallel/series multi-flow**	**Worksheet WS2b** **References:** **Nominal Pressure: Pa**

Door from this room to ..... (room of equal cleanliness) is not to be protected.
A transfer grille is located in, or adjacent to, this door.

Consider door to ..... open

Room pressure now becomes ____ or ____ or ____ Pa (see Appendix 6)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
Mechanical supply or extract (S_F/E_F)					
		Total			

X ($\sum_{OUT} - \sum_{IN}$) ____ Or Y ($\sum_{IN} - \sum_{OUT}$) ____

Transfer grille required:

or from high-pressure zone Flow = *X* ____ at ____ ΔPa

to low-pressure zone Flow = *Y*

Size of transfer grille (free area) A1 ____

Consider doors and hatch closed – room pressure becomes ____ Pa (nominal)

Closed door leakage from Appendix 4 (assuming no transfer grille)	Pa	ΔP	Out	In	Remarks
Mechanical supply or extract					
		Total			

Air flow required through transfer grille = IN – OUT = Z' ____

or OUT – IN = Z'' ____

Transfer grille required flow *Z' or Z''* ____ @ ____ ΔP

Size of transfer grille (free area) A2 = ____

Select larger of A1 or A2 ____

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Air movement control **Peripheral Room ..... type, parallel multi-flow high/low or series multi-flow (unbalanced)**	**Worksheet WS2c** **References:** **Nominal Pressure: Pa**

Consider door from this room to ..... open.

Room pressure now becomes [ ] or [ ] or [ ] Pa (see Appendix 6)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
		Total			

S_1 ($\sum_{OUT} - \sum_{IN}$) [ ] Or E_1 ($\sum_{IN} - \sum_{OUT}$) [ ]

Consider door from this room to ..... open

Room pressure then becomes [ ] or [ ] or [ ] Pa

			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
		Total			

S_2 ($\sum_{OUT} - \sum_{IN}$) [ ] Or E_2 ($\sum_{IN} - \sum_{OUT}$) [ ]

Consider doors closed. Closed doors leakage from Appendix 4

Door to:	Pa	ΔP	Out	In	Remarks
		Total			

Return S_F and E_F to WS1 [ ] [ ]

Flow through transfer grille outward ($S_F - L_{OUT}$) [ ] to .....

or

Flow through transfer grille inward ($E_F - L_{IN}$) [ ] from.....

Transfer grille [ ] Pressure relief damper [ ]

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Air movement control **Peripheral Room .....** **type, parallel/series multi-flow**	**Worksheet WS2d** **References:** **Nominal Pressure:** **Pa**

Note: In this type of room the supply and extract air flow rates are equal and take no part in the air movement control (AMC)

First, open door to higher pressure area.

Room pressure then becomes [ ] or [ ] or [ ] Pa (see Appendix 2)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
Total					

Q_1 ($\sum_{IN}$ - $\sum_{OUT}$) [ ] (+ve inwards)

Next, open door to lower pressure area.

Room pressure then becomes [ ] or [ ] or [ ] Pa

			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
Total					

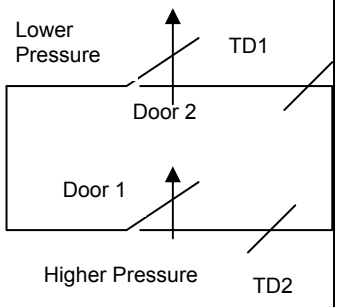
Q_1 ($\sum_{IN}$ - $\sum_{OUT}$) [ ] (+ve inwards)

Flow through transfer device (TD1) to protect Door 1 = Q1 [ ] at resultant

ΔP .....

Flow through transfer device (TD2) to protect Door 2 = Q2 [ ] at resultant

ΔP .....



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Air movement control **Peripheral Room …….. type bay (semi-open)**	**Worksheet WS2e** **References:** **Nominal Pressure:** **Pa**

Note: If the room is of the open bay type (i.e. opening is larger than normal single doorway), then room should be considered part of the main room. No air movement control considerations need then be made, and this sheet can be discarded. Supply and/or extract flow ill be based on air distribution considerations.

Consider permanent opening

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
		Total			

E_{AMC} _____ or flow outward through transfer ($\sum_{IN} - \sum_{OUT}$) _____

Transfer S_{AMC} or E_{AMC} to WS1

Transfer device – transfer grille _____

– pressure stabiliser _____

Size select transfer device for flow rate _____ @ ΔP _____

Note: A door from the bay is considered with the peripheral room to which it leads or, if it leads to the corridor, it is considered with the main room.

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Air movement control **Operating Room**			**Worksheet WS3** **References:** **Nominal Pressure:** **Pa**		

Note: To avoid considering each door open in turn, the "key door" concept is introduced. This is the door which requires the greatest mechanical flow when open. See paragraph A4.33

Select "key door" (see above).

Consider this door open – room pressure now becomes _____ Pa (See Appendix 2)

See Appendix 3 for room pressures

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Air flow "out" or "in" via doors, transfer devices etc.	Pa	ΔP			
Mechanical extract					
Total					

S_{AMC} $(\sum_{OUT} - \sum_{IN})$ _____ Transfer S_{AMC} to WS1

Consider all doors closed.

Return S_F and E_F to WS1 _____ Room pressure now _____ Pa (nominal)

Air flow "out" or "in" via door leakage, transfer devices etc	Pa	Δt	Out	In	Remarks
Mechanical extract					
Total					

Flow $(\sum_{IN} - \sum_{OUT})$ through transfer device _____ @ ΔP _____ to……

For final selection of transfer device see paragraphs A4.50 – A4.54

Surveyor (AP(V)/CP(V))…… Date……

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Air movement control **Corridor**			**Worksheet WS4** **References:** **Nominal Pressure:** **Pa**		
Consider all doors closed					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Leaks through closed doors, transfer devices, permanent openings etc.	Pa	ΔP			
Total flow inwards (S_1)					
Add mechanical input (S_2) if necessary to increase S_1 to give 7 AC/hr					
Total Flow Outwards and Inwards					
$S_{AMC} = (\sum_{OUT} - \sum_{IN} + S_2)$		Transfer to WS5			
or $E_{AMC} = (\sum_{IN} - \sum_{OUT} + S_2)$		Transfer to WS5			

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Air movement control **Corridor**	**Worksheet WS5** **References:**

Summary of Air Supply and extract for an Operating Suite

Consider all doors closed

Air Flow to Corridor	All Doors Closed	Anaesthetic (key door open)
	m^3/s	m^3/s
From Preparation		
From Operating Room		
From Scrub		
From Anaesthetic		
Total (a)		
Air Flow to Corridor from Disposal		
From other source		
Total (b)		
Other Room Supplies.....Total (c)		
Total Air Supply (a) + (b) + (c)		

Consider corridor ventilation (see Appendix 2) and calculate air volume required, based on 7 ac/hr (see Note 1)

	m^3/s
Additional Air to Ventilate Corridor	
Additional Air to Ventilate Service Corridor (see Note 2)	
Air Extract The size of the extract plant should be of the order of 10% below the supply to assist in maintaining the department under positive pressure relative to the outside departments.	
	m^3/s
Extract Plant = Supply less Leakage	
Less 10% of Supply	
Total Extract (see Note 3)	

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Room Temperature - Summer | **Worksheet WS6a**

References:

Find summer supply temperature T_{SS} = 20 – 0.828 H/(O/R) _____ = T_{SS} _____ °C

Q(O/R) _____

Note: The temperature of a space may be calculated from

$$T = \frac{t_1 Q_1 + t_2 Q_2 + \ldots\ldots\ldots\ldots + t_n Q_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source (1°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Summary of Air Supply and extract for an Operating Suite

Consider all doors closed

Room	Heat Gain kWh	Supply		Flows Inwards										Temperature °C T
				From		From		From		From		From		
		Q	T_{SS}	Q	t	Q	t	Q	t	Q	t	Q	t	

Check Doors to Sterile Areas

Door Between	Calculated Room ΔT (°C)	Maximum ΔT *Permitted*	Remarks

Surveyor (AP(V)/CP(V))…… **Date**……

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Room Temperature - Winter | **Worksheet WS6b**

References:

Find winter supply temperature T_{SW} = 20 – 0.828 H/(O/R) _____ = T_{SW} _____ °C

Q(O/R) _____

Note: The temperature of a space may be calculated from

$$T = \frac{t_1 Q_1 + t_2 Q_2 + \ldots\ldots\ldots\ldots + t_n Q_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source (1°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Summary of Air Supply and extract for an Operating Suite

Consider all doors closed

Room	Heat Gain kWh	Supply		Flows Inwards										Temperature °C T
		Q	T_{SW}	From		From		From		From		From		
				Q	t	Q	t	Q	t	Q	t	Q	t	

Check Doors to Sterile Areas

Door Between	Calculated Room ΔT (°C)	Maximum ΔT *Permitted*	Remarks

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Transfer Grilles, Pressure Relief Dampers and Pressure Stabilisers	**Worksheet WS7** **Reference:**

Transfer Grilles – see paragraphs A4.34 – A4.38

Check Doors to Sterile Areas

No	Location	Pressure Difference Pa	Flow Rate m^3/s	Free Area m^2	Model	Resultant Δp Pa	Remarks

Pressure Relief Dampers – see paragraph A4.39

No	Location	Pressure Difference Pa	Flow Rate m^3/s	Free Area m^2	Pressure Setting Pa	Remarks

Pressure Stabilisers –see paragraphs A4.40 – A4.43

Note: where a stabiliser is acting both as series room door protection and operating pressure control, "pressure difference" and "flow rate" are from WS2d; "pressure setting" is from WS3

No	Location	Pressure Difference Pa	Flow Rate m^3/s	Free Area m^2	Pressure Setting Pa	Remarks

Surveyor (AP(V)/CP(V))…… Date……

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NHS National Services Scotland

Scottish Health Technical Memorandum 03-01:

Ventilation for healthcare premises
Part B: Operational management and performance verification

Health Facilities Scotland
Engineering and Environment

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Preface

About Scottish Health Technical Memoranda

Scottish Engineering Health Technical Memoranda (SHTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Scottish Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle.

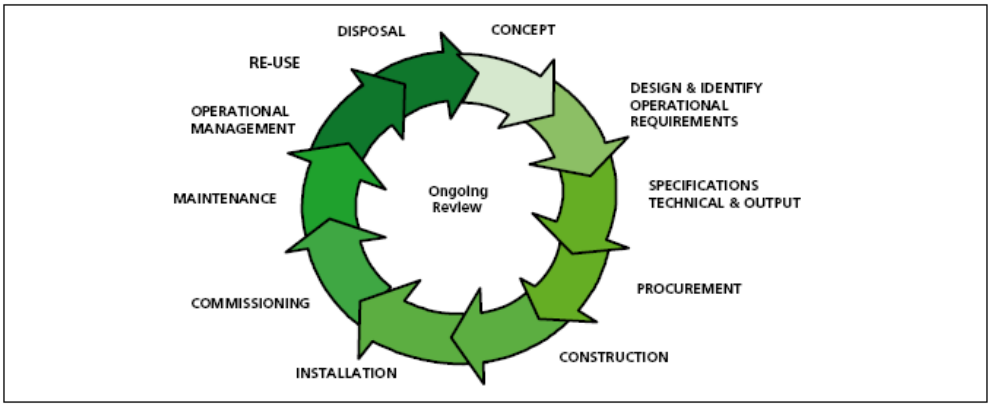

Figure 1: Healthcare building life-cycle

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

It is not the intention within this suite of documents to repeat unnecessarily international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of eight subject areas provides access to guidance which:

- is more streamlined and accessible;

- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.

Structure of the Scottish Health Technical Memorandum suite

The series of engineering-specific guidance will ultimately contain a suite of eight core subjects pending a re-assessment of Firecode SHTMs 81-86.

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water systems

Scottish Health Technical Memorandum 05: Reserved for future use.

Scottish Health Technical Memorandum 06: Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Scottish Health Technical Memorandum 06-02 Part A will represent Electrical Services – Electrical safety guidance for low voltage systems.

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent Environment and Sustainability - EnCO_2de.

All Scottish Health Technical Memoranda are supported by the initial document Scottish Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

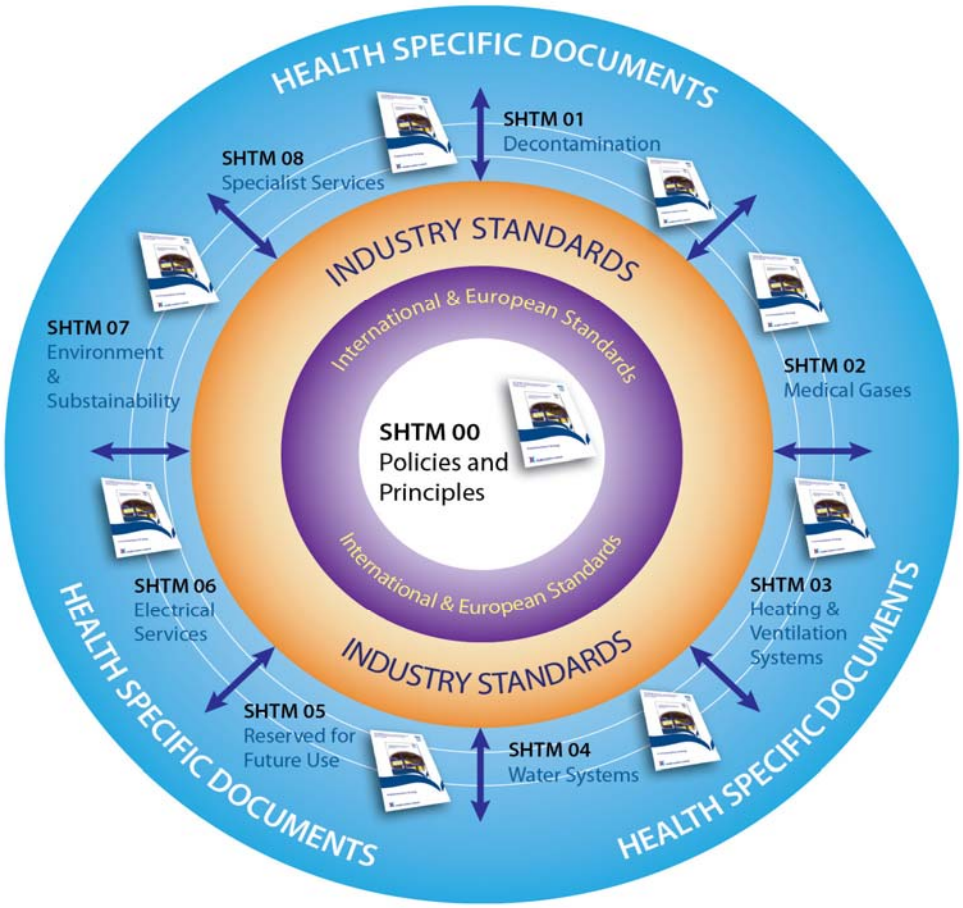

Figure 2: Engineering guidance

Executive summary

Scottish Health Technical Memorandum 03-01: 'Ventilation in healthcare premises' is published in two parts. Part A deals with the design and installation of ventilation systems; Part B covers operational management.

The document gives comprehensive advice and guidance on the legal requirements, design implications, maintenance and operation of specialised ventilation in all types of healthcare premises.

The guidance contained in this Scottish Health Technical Memorandum applies to new installations and major refurbishments of existing installations.

Scottish Health Technical Memorandum 03-01 supersedes all previous versions of Scottish Health Technical Memorandum 2025: 'Ventilation in healthcare premises'.

Who should use this guidance?

This document is aimed at healthcare management, estates managers and operations managers.

Main recommendations

- all ventilation plant should meet a minimum requirement in terms of the control of *Legionella* and safe access for inspection and maintenance;
- all ventilation plant should be inspected annually;
- the performance of all critical ventilation systems (such as those servicing operating suites) should be verified annually.

1. Introduction

1.1 Scottish Health Technical Memorandum 03-01: 'Specialised ventilation in healthcare premises' is published in two parts. Part A deals with operation of general and specialised ventilation; Part B covers operational management.

1.2 The document gives comprehensive advice and guidance to healthcare management, design engineers, estates managers and operations managers on the legal requirements, design implications, maintenance and operation of specialised ventilation in all types of healthcare premises.

1.3 The guidance contained in this Scottish Health Technical Memorandum applies to new installations and major refurbishments of existing installations.

1.4 Scottish Health Technical Memorandum 03-01 supersedes all previous versions of Scottish Health Technical Memorandum 2025: 'Ventilation in healthcare premises'.

Ventilation in healthcare premises

1.5 Ventilation is used extensively in all types of healthcare premises to provide a safe and comfortable environment for patients and staff. More specialised ventilation is provided in areas such as operating departments, critical care areas and isolation facilities for primary patient treatment.

1.6 It is also installed:

- to ensure compliance with the quality assurance requirements of items processed in pharmacies and sterile services departments;
- to protect staff from harmful organisms and toxic substances (for example in laboratories).

Statutory requirements

1.7 Increased health risks to patients will occur if ventilation systems do not achieve and maintain the required standards. The link between surgical site infection and theatre air quality has been well established.

If the ventilation plant has been installed to dilute or contain harmful substances, its failure may expose people to unacceptable levels of contamination. Proven breaches of the statutory requirements can result in prosecution and may also give rise to a civil suit against the operators.

Health and Safety at Work etc Act 1974

1.8 The Health and Safety at Work etc Act 1974 is the core legislation that applies to ventilation installations. As these installations are intended to prevent

contamination, control closely the environment, dilute contaminants or contain hazards, their very presence indicates that potential risks to health have been identified.

COSHH

1.9 The Control of Substances Hazardous to Health (COSHH) Regulations 2002 place upon management an obligation to ensure that suitable measures are in place to protect their staff and others affected by the work activity. These methods may include both safe systems of work and the provision of a specialised ventilation system. In laboratories the requirements are often met by the provision of fume cupboards and microbiological safety cabinets.

1.10 Where specialised ventilation plant is provided as part of the protection measures, there is a statutory requirement that it be correctly designed, installed, commissioned, operated and maintained. The local exhaust ventilation (LEV) section of COSHH requires that the system be examined and tested at least every 14 months by a competent person and that management maintain comprehensive records of its performance, repair and maintenance.

1.11 Certain substances have workplace exposure limits (WELs) set out in the Health and Safety Executive's Guidance Note EH40 – 'Workplace exposure limits: containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended)'. If specialised ventilation systems are provided in order to achieve these standards, they will be subject to the COSHH Regulations as above.

Fire regulations

1.12 The Fire Regulations require that if ventilation ductwork penetrates the fabric of a building, it should be designed and installed so as to contain the spread of fire (see Firecode: SHTM 81: 'Fire Precautions in New Hospitals, Version 3' and the requirements of the Scottish Technical Handbooks, Non-Domestic, Section 2: Fire, published by the Scottish Building Standards Agency).

1.13 It is management's responsibility to ensure that the standards applied during the design and installation are not reduced during the subsequent operation and maintenance of the equipment.

Plants installed in units manufacturing medicinal products

1.14 Plants installed in units manufacturing medicinal products to the standards set out in the current European guide to good manufacturing practice (http://ec.europa.eu/enterprise/pharmaceuticals/ eudralex/homev4.htm) may also be subject to particular legislation with regard to their operation and maintenance.

1.15 There are specific requirements under the Medicines Act 1968 to maintain accurate records of plant performance, room conditions and maintenance

events. Such records would need to be preserved for up to 35 years as part of a quality assurance audit trail.

Plants installed in laboratories

1.16 Specialised ventilation plants installed in laboratories dealing with research, development or testing, whether involving drugs, animals or genetically modified organisms, may be subject to particular legislation with regard to their operation in addition to that mentioned above.

Codes of practice and guidance

1.17 All ventilation systems should conform to the principles set out in the Health and Safety Commission's Approved Code of Practice and guidance document 'Legionnaires' disease: the control of *Legionella* bacteria in water systems' (commonly known as L8), and Scottish Health Technical Memorandum 04-01: 'The control of *Legionella*, hygiene, 'safe' hot water, cold water and drinking water systems'.

1.18 Scottish Health Facilities Note 30: 'Infection Control in the Built Environment, Design and planning' guides and stimulates thinking on the planning of and execution of new construction and refurbishment works in all types of healthcare facilities. Ventilation systems (covered in this guidance) play an important role in reducing the risk of Healthcare Associated Infection.

Management responsibilities – general

1.19 It is a management responsibility to ensure that inspection, service and maintenance activities are carried out safely without hazard to staff, patients or members of the public.

1.20 Those required to monitor and/or maintain ventilation equipment will need to show that they are competent to do so (see Section 2).

1.21 Maintenance procedures should be reviewed periodically to ensure that they remain appropriate.

System information

1.22 When new ventilation systems are accepted for use, full information as to their designed mode of operation together with recommended maintenance procedures should be provided as part of the handover procedure.

1.23 In many existing systems, original design and commissioning information will not be available. It will therefore be necessary to determine a suitable level of system performance based on the function, purpose and age of the installation.

1.24 Part A of this Scottish Health Technical Memorandum gives design parameters for new installations.

1.25 Section 3 of this document sets out the minimum standards for all air-handling units (AHUs) and their air distribution systems.

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

Note 1: In the event of a reportable incident connected with ventilation equipment or the area that it serves; all records and plant logbooks will need to be collected as evidence.

1.27 A set of specimen maintenance checklists is given in Appendix 1.

Frequency of inspections and verifications

1.28 All ventilation systems should be subject to, at least, a simple visual inspection annually.

1.29 Ventilation systems serving critical care areas should be inspected quarterly and their performance measured and verified annually. The quarterly inspection should be a simple visual check; the annual verification will be a more detailed inspection of the system together with the measurement of its actual performance.

1.30 The LEV section of the COSHH Regulations contains a statutory requirement that systems installed to contain or control hazardous substances be examined and tested at least every 14 months by a competent person.

1.31 Regular tests, at intervals agreed with the local fire prevention officer, will need to be carried out in order to demonstrate the continuing efficiency of the fire detection and containment systems. These may be in addition to the inspections detailed above. Records of these tests should be kept.

Implications of PPP/PFI Procurement

1.32 While the ultimate responsibilities as set out in this SHTM in terms of overall management remain with Health Boards, when a new or recent hospital has been procured via the Public-Private Partnership (PPP) or Private Finance Initiative (PFI) routes, there are changes in the chain of responsibilities.

1.33 More often than not, the operator of the facility will subcontract or enter into partnership with a Facilities Management (FM) Provider who will maintain and operate mechanical and electrical installations, including ventilation systems. It is not unknown for the FM provider to be the Health Board's own estates staff. Whichever organisation carries out the functions set out in this SHTM, it will be

necessary for the same practice and procedures to be carried out, records maintained and reports prepared to maintain an audit trail. These have to be submitted to the Health Board for which the hospital has been established. The Health Board will retain in-house estates staff and/or technical advisers to monitor these records and reports, having the right to comment where performance standards are not being achieved, inspect installations, and seek to ensure that remedial measures are put in hand and monitored as to their effect.

In the event that a civil suit is served on a Health Board, they would seek redress from the operator of the Hospital, where appropriate.

1.34 Issues related to control of infection where mechanical ventilation systems are implicated will be the remit of the Health Board's control of teams set up for the purpose and representation should be arranged for estates staff or the FM Provider so that any remedial action agreed can be can be set in motion without delay.

2. Functional responsibilities

Management responsibilities

2.1 Clear lines of managerial responsibility should be in place so that no doubt exists as to who is responsible for the safe operation and maintenance of the equipment.

2.2 A periodic review of management systems should take place in order to ensure that the agreed standards are being maintained.

2.3 Those required to inspect, verify or maintain ventilation equipment will need to show that they are competent to do so. As a minimum they should have sufficient knowledge of its correct operation to be able to recognise faults.

2.4 It is anticipated that training in the validation and verification of specialised healthcare ventilation systems for Authorised Persons and Competent Persons will become available during the life of this Scottish Health Technical Memorandum.

Designated staff functions

2.5 A person intending to fulfil any of the staff functions specified below should be able to prove that they possess sufficient skills, knowledge and experience to be able to perform safely the designated tasks.

Management

2.6 Management is defined as the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable for the safe operation of premises.

Designated Person

2.7 This person provides the essential senior management link between the organisation and professional support. The Designated Person should also provide an informed position at board level.

Authorising Engineer (Ventilation) (AE(V))

2.8 The AE(V) is defined as a person designated by Management to provide independent auditing and advice on ventilation systems and to review and witness documentation on validation.

Authorised Person (Ventilation) (AP(V))

2.9 The AP(V) will be an individual possessing adequate technical knowledge and having received appropriate training, appointed in writing by the Designated Person (in conjunction with the advice provided by the AE(V)), who is responsible for the practical implementation and operation of Management's safety policy and procedures relating to the engineering aspects of ventilation systems.

Competent Person (Ventilation) (CP(V))

2.10 The CP(V) is defined as a person designated by Management to carry out maintenance, validation and periodic testing of ventilation systems.

Infection Control Officer

2.11 The Infection Control Officer (or consultant microbiologist if not the same person) is the person nominated by management to advise on monitoring the infection control policy and microbiological performance of the systems.

2.12 Major policy decisions should be made through an infection control committee. The infection control committee should include representatives of the user department and estates and facilities or their nominated representative (that is, the Authorised Person).

Plant Operator

2.13 The Plant Operator is any person who operates a ventilation installation.

User

2.14 The User is the person responsible for the management of the unit in which the ventilation system is installed (for example head of department, operating theatre manager, head of laboratory, production pharmacist, head of research or other responsible person).

Contractor

2.15 The Contractor is the person or organisation responsible for the supply of the ventilation equipment, its installation, commissioning or validation. This person may be a representative of a specialist ventilation organisation or a member of the general manager/chief executive's staff.

Records

2.16 A record should be kept of those appointed to carry out the functions listed above. The record should clearly state the extent of the postholder's duties and responsibilities, and to whom they are to report.

2.17 Substitute or replacement staff should be designated in order to cover for sickness, holidays and staff transfers.

Training

2.18 Routine inspection and maintenance procedures can cause risks to the health of staff carrying out the work and those receiving air from the plant. All those involved should be made aware of the risks, and safe systems of work should be agreed. Suitable safety equipment should be provided as necessary, and training in its use should be given.

2.19 Any training given should be recorded, together with the date of delivery and topics covered.

2.20 Training in the use of safety equipment and a safe system of work will need to be repeated periodically in order to cater for changes in staff.

Specific health and safety aspects

2.21 Staff engaged in the service and maintenance of extract ventilation systems from pathology departments, mortuaries, laboratories, source-protective isolation facilities and other areas containing a chemical, biological or radiation hazard may be particularly at risk. In these cases, the risk should be identified and assessed.

2.22 The means by which the system can be rendered safe to work on should be determined, and a permit-to-work on the system implemented.

2.23 Training in the exact procedures should be given to all staff involved.

2.24 Some healthcare facilities may contain specialised units that are subject to access restrictions (for example pharmacy aseptic suites). Estates or contract staff requiring access may need additional training or to be accompanied when entering the unit.

Note 2: See also the following guidance published by the Health and Safety Commission's Health Services Advisory Committee:

- 'Safe working and the prevention of infection in clinical laboratories and similar facilities';
- 'The management, design and operation of microbiological containment laboratories';
- 'Safe working and prevention of infection in the mortuary and post-mortem room'.

3. Ventilation systems – minimum requirements

General requirements

3.1 All ventilation systems should be inspected annually to ensure conformity with minimum requirements, which are designed to:

- ensure safe access when carrying out routine service and maintenance activities;
- prevent or control risks associated with *Legionella* and other potential hazardous organisms;
- check that the system remains fit for purpose;
- maintain records of outcomes.

3.2 Every effort should be made to ensure that all AHUs achieve the minimum requirement set out below.

Location and access

3.3 AHUs should be secured from unauthorised access.

3.4 Units located on roofs must have a safe and permanent means of access. Suitable precautions must be in place to prevent personnel or equipment from falling during maintenance activities.

3.5 Units located outside at ground level should be secured within a compound to prevent unauthorised access. Vehicles should be excluded from the vicinity to ensure that exhaust fumes will not be drawn into intakes.

3.6 All parts of the AHU should be easily and safely accessible for routine inspection and service.

3.7 The area around an AHU within a building should be tanked to prevent water penetration to adjacent areas, and should be adequately drained.

3.8 Fire precautions should be in accordance with Firecode.

3.9 Combustion equipment must not be located in a fire compartment that houses air-handling equipment.

3.10 Plantrooms that house AHUs must not be used for general storage. Care should be taken to ensure that combustible material is not kept in the plantroom.

Basic requirements

3.11 The plant must not contain any material or substance that could support the growth of microorganisms.

3.12 The plant must not contain any material or substance that could cause or support combustion.

3.13 Access to items that require routine service, such as filters, coils and chiller batteries, should be via hinged doors.

3.14 Items requiring infrequent access such as attenuators may be via clipped or bolted-on lift-off panels.

3.15 All doors and panels should be close fitting and without leaks.

3.16 Every effort should be made to ensure that access is via fixed ladders and platforms or pulpit-style movable steps.

3.17 Electrical and mechanical services should not restrict or impede access to those parts of the AHU that require inspection.

3.18 Viewing ports and internal illumination should be fitted in order to inspect filters and drainage trays.

3.19 Internal illumination should be provided by fittings to at least IP55 rating. Fittings should be positioned so that they provide both illumination for inspection and task lighting.

3.20 A single switch should operate all of the lights in a unit.

AHU intakes and discharges

3.21 Intake and discharge points should not be situated where they will cause vitiated air to be drawn into a system (see paragraphs 3.61-3.71) in Part A, which give detailed information). In existing systems, it may be necessary to extend the intake or discharge point to a suitable position.

3.22 Each intake and discharge point should be fitted with corrosion-resistant weatherproof louvres or cowls to protect the system from driving rain. The inside of the louvres should be fitted with a mesh of not less than 6mm and not more than 12mm to prevent infestation by vermin and prevent leaves being drawn in.

3.23 The duct behind a louvre should be self-draining. If this is not practicable, it should be tanked and provided with a drainage system. Cleaning access must be provided either from the outside via hinged louvres or by access doors in the plenum behind the louvre. Where a common plenum is provided, cleaning access should be via a walk-in door.

AHU drainage system

3.24 All items of plant that could produce moisture must be provided with a drainage system. The system will comprise a drip-tray, glass trap, air break and associated drainage pipework.

3.25 Some existing units may not have been mounted far enough above the floor to permit the correct installation of a drainage system. If the AHU cannot be raised to an adequate height, an alternative arrangement (such as a pump-out system) must be provided.

3.26 The drip-tray should be constructed of a corrosion-resistant material (stainless steel is preferred) and be so arranged that it will completely drain. To prevent 'pooling', it is essential that the drain connection should not have an up-stand and that a slope of approximately 1 in 20 in all directions should be incorporated to the drain outlet position. The tray must be completely accessible or, for smaller units, easily removable for inspection and cleaning.

3.27 Each drip-tray should be provided with its own drain trap. The drain trap should be of the clear (borosilicate) glass type. This permits the colour of the water seal to be observed, thus giving an early indication of corrosion, biological activity or contamination within the duct (Part A, Section 4, paragraphs 4.20-4.25 refer and paragraph 3.29 of this Part B).

3.28 The trap should have a means for filling and should incorporate couplings to facilitate removal for cleaning. It should be located in an easily visible position where it will not be subject to casual knocks. The pipework connecting it to the drainage tray should have a continuous fall of not less than 1 in 20.

3.29 Traps fitted to plant located outside or in unheated plantrooms may need to be trace-heated in winter. The trace heating should be checked for operation and must not raise the temperature of water in the trap above 5°C.

3.30 Water from each trap must discharge via a clear air gap of at least 15mm above the unrestricted spill-over level of either an open tundish connected to a drainage stack via a second trap, or a floor gully (or channel). A support should be provided to ensure that the air gap cannot be reduced. More than one drain trap may discharge into the tundish, providing each has its own air break.

3.31 Drainage pipework may be thermoplastic, copper or stainless steel. Glass should not be used. The pipework should be a minimum diameter of 22mm and have a fall of at least 1 in 60 in the direction of flow. It should be well supported, and located so as not to inhibit access to the AHU.

Dampers

3.32 AHUs serving critical areas and those areas that are shut down out of hours should be fitted with motorised low-leak shut-off dampers located immediately behind the intake and discharge of each supply and extract system.

Fan drives

3.33 Fan-drive trains, whether supply or extract, should be easily visible without the need to remove access covers. Protecting the drive train with a mesh guard is the preferred option. For weatherproof units designed to be located outside, the fan drive should be enclosed. It should be easily visible through a viewing port with internal illumination and be accessed via a lockable, hinged door.

3.34 The motor windings of induction-drive ‘plug’ motor arrangements and in-line axial fans having a pod motor within the air stream must be protected from over-temperature by a thermistor and lockout relay.

3.35 It is necessary to ensure that – should the computer control system or its software develop a fault – the fan can be switched to a direct start with fixed speed and manual operation. This is particularly important for critical care systems serving operating suites, high dependency care units of any type, isolation facilities, laboratories and pharmaceutical production suites.

Heater & Frost batteries

3.36 Access for cleaning must be provided to both sides of frost batteries and heater-batteries.

3.37 Where auxiliary wet heater-batteries are located in false ceilings, they should be fitted with a catch tray and leak alarm. The catch tray should be installed under both the battery and the control valve assembly to protect the ceiling from leaks. A moisture sensor and alarm should be fitted in the tray. Placing wet heater batteries in ceiling voids should be avoided if at all possible.

Cooling coils

3.38 Each cooling coil – whether within the AHU or within a branch duct – must be fitted with its own independent drainage system as specified above. A baffle or similar device must be provided in the drip-tray to prevent air bypassing the coil, and the tray should be large enough to capture the moisture from the eliminator, bends and headers.

3.39 The cooling-coil control valve should close upon selection of low speed, system shutdown, low air-flow or fan failure.

3.40 Where auxiliary wet-cooling coils are located in false ceilings, they should be fitted with a catch tray and leak alarm. The catch tray should be installed under both the battery and the control valve assembly to protect the ceiling from leaks. A moisture sensor and alarm should be fitted in the tray.

Humidifiers

3.41 Humidifiers are not generally required. Where they are fitted, but have been out of use for a significant period of time, they should be removed. All associated pipework should also be removed back to its junction with the running main.

3.42 Where humidifiers are fitted and their use is still required, they should fully conform to the installation standard set out in Section 4 of Part A.

3.43 The section of ductwork containing the humidifier may need to be periodically decontaminated. Hinged access doors with viewing ports and internal illumination should be provided.

3.44 All humidifiers must be fitted with their own independent drainage system as detailed above.

3.45 Only steam-injection humidifiers, whether mains fed or locally generated, are suitable for use in air-conditioning systems within healthcare facilities. Water humidifiers, if fitted, should be removed.

3.46 Self- and locally-generated steam humidifiers must be supplied with potable water. The installation should be capable of being isolated, drained and cleaned. Section 4 in Part A of this Scottish Health Technical Memorandum gives further details.

3.47 Some steam generators are of a type that requires regular cleaning and descaling. The installation should enable them to be physically isolated from the air duct in order to prevent contamination of the air supply by cleaning agents.

3.48 The humidifier control system should fully conform to the standard set out in Sections 4 and 6 of Part A.

Filtration

3.49 Filters must be securely housed and sealed in well-fitting frames that minimise air bypass. Air bypass significantly reduces filter efficiency: the higher the filter grade, the greater the effect. Mounting frames should be designed so that the air flow pushes the filter into its housing to help minimise air bypass.

3.50 All filters should be of the dry type. Panel filters are generally used as prefilters and should be positioned on the inlet side of the supply fan, downstream of the frost battery. Where required, secondary filters (these will be bags or pleated paper) should be on the positive-pressure side of the fan.

3.51 The filter installation should provide easy access to filter media for cleaning, removal or replacement; therefore, a hinged access door should be provided. The upstream side of the filter should be visible for inspection through a viewing port with internal illumination.

3.52 All filters should be provided with a means of checking the differential pressure across them. Direct-reading dial-type gauges marked with clean and dirty sectors are preferred.

High-efficiency filters – HEPA and ULPA

3.53 Where fitted, HEPA filters should be of the replaceable-panel type with leak-proof seals. Their installation should permit the validation of the filter and its housing.

3.54 HEPA filters are sometimes used in extract systems for the containment of hazardous substances or organisms. They may be fitted with prefilters to extend their service life.

3.55 When used for the containment of hazardous substances, the installation should incorporate design provision for the subsequent safe removal and handling of contaminated filters by maintenance staff.

Energy recovery

3.56 Energy recovery, where fitted, will require cleaning access to both sides of the device.

3.57 Whichever type of energy recovery device is fitted, the extract side should be protected by a G3 filter and provided with a drainage system to remove condensate.

3.58 The heat-recovery device should be controlled in sequence with the main heater-battery, and may need to incorporate a control to prevent the transfer of unwanted heat when the air-on condition rises above the plant's required set point.

Attenuation

3.59 Cleaning access should be provided at both ends of any attenuator unit.

Identification and labelling

3.60 All supply and extract ventilation systems should be clearly labelled. The label should identify both the AHU and the area that it serves. The lettering should be at least 50mm high and be mounted in an easily visible place near the fan of the unit. Any sub-systems and the principal branch ducts should be similarly labelled.

3.61 The direction of air-flow should be clearly marked on all main and branch ducts.

3.62 All air-flow test-points should be clearly identified, and the size of the duct given.

Pressure stabilisers

3.63 Pressure stabilisers should be unobstructed and silent in operation.

4. Annual inspection and verification requirements

Ventilation systems inspection

4.1 All ventilation systems should be subject to at least a simple visual inspection annually.

4.2 The purpose of the inspection is to establish that:

- The system is still required;
- The AHU conforms to the minimum standard (see Section 3);
- The fire containment has not been breached;
- The general condition of the system is adequate for purpose;
- The system overall is operating in a satisfactory manner.

4.3 It is recommended that a simple check sheet be used to record the result of the inspection. Examples are given in Appendices 1 and 2.

Critical ventilation systems

4.4 All critical ventilation systems should be inspected quarterly and verified at least annually. In some circumstances the verification may need to be carried out more frequently.

4.5 The quarterly inspection should be as detailed in paragraphs 4.1 – 4.3.

4.6 The purpose of the annual verification will be to ensure additionally that the system:

- Achieves minimum standards specific to the application;
- Is operating to an acceptable performance level;
- Remains fit for purpose.

Definition of a critical system

4.7 Ventilation systems serving the following are considered critical:

- Operating theatres of any type, including rooms used for investigations (for example catheter laboratories);
- Patient isolation facility of any type;
- Critical care, intensive treatment or high-dependency unit;
- Neonatal unit;

- Category 3 or 4 laboratory or room;
- Pharmacy aseptic suite;
- Inspection and packing room in a sterile services department;
- MRI, CAT and other types of emerging imaging technologies that require particularly stable environmental conditions to remain within calibration;
- Any system classified as an LEV system under the COSHH Regulations;
- Any other system that clearly meets the definition.

4.8 The loss of service from such a system would seriously degrade the ability of the premises to deliver optimal healthcare.

Annual verification

4.9 The annual verification is intended to establish that:

- the system is still required;
- the AHU conforms to the minimum standard (see Section 3);
- the fire containment has not been breached;
- the general condition of the ventilation system is adequate;
- the fabric of the area served is satisfactory;
- the system performance is adequate with respect to the functional requirement – this will require:
  - a full measure of the supply and extract air-flow rates;
  - the calculation of room air-change rates if applicable;
  - the measurement of room differential pressures if applicable;
  - the measurement of room noise levels;
  - air-quality checks if appropriate;
  - a check on the control functions.

4.10 An assessment should then be made as to whether the system overall is fit for purpose and operating in a satisfactory manner.

Fabric of the area served

4.11 The building elements in the room or rooms served by a critical ventilation system should also be suitable for the function. As an example, in a suite of rooms comprising an operating theatre complex, the following elements should be checked:

- the ceiling should be complete and, if tiled, all tiles should be clipped down and sealed;

- the walls and floors should be free from significant construction and finish defects;
- windows and their trickle vents should be sealed and locked shut;
- the doors should close completely and the door closers should be correctly adjusted to hold them against the room pressure;
- all service penetrations and access panels should be sealed to prevent uncontrolled air flow between rooms and service voids;
- steps should have been taken (if necessary) to prevent portable equipment and stock items from obstructing low-level supply, transfer or extract airflow paths.

4.12 Failure to achieve a suitable standard will render even the most sophisticated ventilation system ineffective.

4.13 All fire dampers should be tested as part of the annual verification.

4.14 LEV systems will be subject to an examination and test by a competent person at least every 14 months.

4.15 Table 1 below provides a model for the verification of critical ventilation systems.

Critical ventilation systems – verification standards

4.16 Unless otherwise specified below, the ventilation system should achieve not less than 75% of the design air-change rate given in Appendix 1 of Part A, or its original design parameters.

4.17 The pressure regime should achieve not less than 75% of the design value given in Appendix 1 of Part A, or its original design parameters; and the pressure gradient relationships with regards to surrounding areas must be maintained.

4.18 The sound levels given in Table 2 below are maximum permissible levels and should not be exceeded. Measurements should be made using at least a Type 2 sound meter fitted with a muff. Its accuracy should be checked using a calibration sound source before use.

Step	Question	Information/standard required	Comment
1	Is the system still required?	Why was it installed?	Is that function still required?
2	Does the AHU achieve the minimum standard?	Health and safety aspects Intake/discharge positions Inspection access *Legionella* control and drainage Fire and electrical safety Leaks, cleanliness and insulation Filtration	Inspect to ascertain compliance with minimum standards set out in Section 3 Part B of this SHTM
3	Is the air distribution system satisfactory?	Access Fire dampers Cleanliness Insulation Identification Room terminals Pressure stabilisers	Inspect to ascertain continued fitness for purpose
4	Does the measured system performance still accord with the design intent and achieve a minimum acceptable standard?	Design air velocities Design air-flow rates Room air-change rates Pressure differentials Noise levels Air quality	Establish the design values Measure the system output to verify its performance
5	Does the control system function correctly?	Desired environmental conditions Control sequence logic Run; set back, off philosophy	Establish the design requirement Inspect/test to verify performance
6	Having regard to the foregoing, is the system 'fit for purpose' and will it only require routine maintenance in order to remain so until the next scheduled verification?		Yes or No
7	What routine service and maintenance will be required for the system to remain fit for purpose and function correctly until the next scheduled verification?	Filter changes System cleaning Performance indication Performance monitoring Performance measurement	Decide inspection frequency and maintenance schedule

Table 1: Operational management and routine verification process model

Location	Design sound level (NR)	Measured sound level (dB (A))
Ultra-clean operating room	50	55
Conventional operating room	40	45
All other non-specified rooms	40	45
Corridors	40	45
Recovery room	35	40
Ward areas, sleeping areas	30	35

Table 2: Maximum sound levels (service noise only)

Vertical ultra-clean operating theatres

4.19 The following additional measurements should be taken:

- The average air velocity at the 2 m level under the canopy: it should achieve a minimum average of 0.38 m/s for a partial wall system and 0.3m/s for a full wall system;
- the air velocity within the inner zone at the 1 m level: every reading should achieve a minimum velocity of 0.2 m/s.

4.20 The air velocity measurements are to be taken using the equipment, test grid and method set out in Section 8 of Part A.

Note 3: There is no requirement to carry out filter scanning or entrainment tests at the annual verification unless the HEPA filters or recirculating air fans are changed, or the system is in some other significant way disturbed or altered. Changing the filters in the AHU or recirculating air filters does not constitute a significant disturbance to the ultra-clean ventilation (UCV) unit.

4.21 Should the UCV terminal fail to achieve a suitable standard, resulting in the need to disturb or replace the HEPA filters or recirculating air fans, the unit should be revalidated using the procedure given in Section 8 of Part A.

Note 4: Scottish Health Technical Memorandum 08-01 gives detailed guidance on acoustics and the measurement of sound

Horizontal ultra-clean operating theatres

4.22 The following additional measurements should be taken:

- the discharge velocity test at 1 m, 1.5 m and 2 m in front of the terminal: the average velocity should be not less than 0.4 m/s.

4.23 The measurements are to be taken using the equipment, test grid and method set out in Section 8 of Part A.

Note 5: There is no requirement to carry out filter scanning at the annual verification unless the HEPA filters or recirculating air fans are changed; or the system is in some other significant way disturbed or altered. Changing the filters in the AHU or recirculating air filters does not constitute a significant disturbance to the UCV unit.

4.24 Should the UCV terminal fail to achieve a suitable standard, resulting in the need to disturb or replace the HEPA filters or recirculating air fans, the unit should be revalidated using the procedure given in Section 8 of Part A.

Category 3 and 4 laboratories and rooms

4.25 These areas should conform to the requirements of current information published by the Advisory Committee on Dangerous Pathogens and the Health and Safety Executive:

- 'The management, design and operation of microbiological containment laboratories';
- 'Biological agents: managing the risks in laboratories and healthcare premises'; and
- 'Biological agents: the principles, design and operation of Containment Level 4 facilities'.

Pharmacy aseptic suites

4.26 Pharmacy aseptic suites should conform to the requirements of the European guide to good manufacturing practice (http://ec.europa.eu/enterprise/pharmaceuticals/eudralex/homev4.htm) and the requirements of the Medicine Inspectorate if a licensed manufacturing unit.

Sterile services department – inspection and packing rooms

4.27 Inspection and packing rooms should conform to the requirements of BS EN ISO 14644 and any additional requirements for the processing of medical devices, if applicable (see also Scottish Health Planning Note 13 – 'Sterile services department').

LEV systems

4.28 LEV systems should conform to the Health and Safety Executive's 'The maintenance, examination and testing of local exhaust ventilation'.

Critical system verification failure

4.29 Should a critical system be unable to achieve the standard set out above, it should be taken out of service. If healthcare provision needs prevent the system being taken out of service, the senior manager of the user department should be informed in writing that the system performance is suboptimal. A copy of the notice should be sent to the infection control committee.

4.30 If a critical system is refurbished in order to bring it to a suitable standard, it should be subject to the full validation procedure set out in Section 8 of Part A or other application-specific guidance as appropriate.

5. Inspection and maintenance

General

5.1 Inspection and maintenance activities should be assessed to ensure that they do not create a hazard for those who undertake the work or for those who could be affected by it.

5.2 The degree and frequency of maintenance should relate to the function of the system, its location, its general condition and the consequence of failure.

5.3 Specimen inspection and maintenance checklists are given in Appendices 1 & 2.

Inspection and maintenance of critical systems

5.4 The loss of service of these systems would seriously degrade the ability of the premises to deliver optimal healthcare. In order to ensure reliable service provision, it is essential to inspect, verify and maintain these systems at appropriate intervals.

5.5 For many of these systems a permit-to-work will need to be completed to ensure that taking the ventilation system out of service does not compromise the activities of the user department. In any event, it will be necessary to liaise with the user department when switching the system off to carry out routine inspection and maintenance.

AHU drainage

5.6 AHU drainage systems comprise a drainage tray, glass trap, connecting pipework and an air break. The system should be inspected to ensure that it is clean and operating correctly. The cleanliness of the drainage tray and colour of the water in the trap will give an indication of a fault condition (see Table 3 below).

Colour of water	Probable cause and comment
Normal	Satisfactory.
Green	Copper corrosion of pipework Possible leak in battery tubing.
White	Aluminium corrosion of battery fins.
Black	General dirt Filter faulty allowing air bypass System is overdue for a thorough clean Urgent action required.
Brown/red	Iron corrosion (rust) within the duct May indicate a specific *Legionella* hazard Immediate action required.
Bubbly/slimy	Microbiological activity within the duct May indicate a specific *Legionella* hazard Immediate action required.

Table 3: Colour of water in glass trap

Filter changing

5.7 Dirty supply air filters may pose a general dust hazard when being changed.

5.8 Dirty extract- and return-air filters may pose an increased level of hazard. This will relate to the particular contamination within the air that they have filtered. Filters handling extract air from general areas are unlikely to present a significantly greater hazard than that posed by dirty supply air filters.

5.9 Care should be taken to protect staff from inhaling the dust. If there is a need to enter the duct when changing filters, a dust mask should be worn.

5.10 Dirty filters should be carefully removed and placed in the box that contained the replacement filters or in a plastic bag. On completion of the work, the dirty filters should be removed from the plantroom and disposed of appropriately.

5.11 The duct in the area of the filter housing should be carefully vacuumed before fitting the replacement filters. This will prevent particles (that is, those that are shed when the dirty filters are disturbed) being blown into the system downstream.

5.12 It is important to ensure that replacement filters are fitted the right way round. Most panel filters are manufactured with a membrane or wire support mesh on their downstream side. Alternatively they may be colour-coded. The manufacturer's instructions regarding fitting should be followed.

5.13 Bag filters should be fitted with the pockets vertical. Care should be taken to remove any transit tapes and to ensure that the individual pockets are separate and free to inflate.

Changing extract filters containing hazardous substances

5.14 Filters handling extract air from an LEV system will obviously present a hazard and should be subject to a safe system of work.

5.15 Filters used in an extract system for the containment of hazardous substances or organisms should incorporate design provision for their safe removal when so contaminated. This may be achieved by:

- sealing the hazardous substance into the filter before it is removed;
- a system to fumigate the filter to kill any organisms;
- housing it in a 'safe change' unit that permits the filter to be ejected into a bag and sealed without staff having to come into direct contact with it.

5.16 The method chosen should reflect the nature of the hazard.

5.17 Filters fitted to remove hazardous substances from extract air are classed as hazardous waste and should be handled and disposed of accordingly.

Ventilation system cleaning

5.18 The intake section of a ventilation system should be vacuumed-out as necessary to remove visible particles.

5.19 AHUs should be vacuumed-out and/or washed down internally as necessary to remove obvious dust and dirt.

5.20 Chiller batteries, humidifier units, energy-recovery batteries or plates and their drainage systems should be washed down with hot water annually to remove visible contamination.

5.21 Supply air distribution ductwork conveys air that has been filtered. It will require internal cleaning only when it becomes contaminated with visible dirt. The frequency of cleaning will depend on the age of the system and grade of the AHU final filter but will typically be in excess of ten years. There is no requirement to clean ductwork annually. A rapid build-up of visible dirt within a supply duct is an indication of a failure of the filtration or its housing.

5.22 Extract air systems handle unfiltered air. They should be cleaned as frequently as necessary in order to maintain their operating efficiency. Room extract terminals, particularly those sited at low level in critical care areas, will need regular cleaning.

5.23 On completion of cleaning, the ductwork should not be 'fogged' with chemicals. This treatment has no lasting biocidal effect and is responsible for initiating the breakdown of the galvanised coating of ductwork. This will result in accelerated corrosion of the inside of the duct, with the products of corrosion being shed into the air stream. It will also significantly shorten service life.

5.24 Following duct cleaning, all service hatches should be checked to ensure that they have been correctly replaced and do not leak.

5.25 Duct-cleaning equipment that uses rotating brushes or a vacuum unit can easily damage flexible sections of ductwork. On completion of cleaning, all flexible duct sections should be checked for rips and tears. The straps that secure them to rigid duct sections and air terminals should also be checked to ensure that there is no air leakage.

Chilled beams

5.26 The efficiency of these units will rapidly decline if they become blocked with fluff/lint. They should be inspected every six months and cleaned as appropriate.

Split and cassette cooling units

5.27 These units incorporate internal recirculation air filters and a drainage system to remove condensate from the cooling coil. The systems should be inspected and cleaned every three months.

Portable room cooling units

5.28 Portable units are sometimes kept in-store or hired-in to cope with temporary local situations giving rise to excessive temperatures. They typically incorporate internal recirculation air filters and a drainage system to remove condensate from the cooling coil. Units employing an internal water reservoir and wick to promote evaporative cooling must not be used in healthcare premises.

5.29 The infection control team must be consulted before these types of unit are deployed.

5.30 The units should be inspected and thoroughly cleaned before being taken into use. Units that are to be used in areas containing immunocompromised patients will, unless new, need to be fumigated before use.

5.31 All portable units should be inspected and cleaned every week that they remain in use.

Self-contained mobile filter and/or ultraviolet (UV) light units

5.32 The efficacy of these units is directly related to their cleanliness. In this respect, the manufacturer's instructions regarding service/maintenance and lamp and filter replacement should be closely followed.

5.33 Units that have been used in isolation rooms or areas containing infective patients will need to be fumigated before being used in other locations, or returned to store or to the hirer.

5.34 Filters fitted to remove hazardous substances from the recirculated room air are classed as hazardous waste and should be handled and disposed of accordingly (see also Scottish Health Technical Note 3: NHS Scotland Waste Management Guidance Parts A-D).

Inspection and maintenance records

5.35 Records of inspection and maintenance activities should be kept for at least five years.

Appendix 1 - Annual inspection of critical ventilation systems – AHU and plantroom equipment

Definition of terms used on survey form

General condition

End of useful life
This should be clear from the condition of the AHU and its associated services and plant. The main indicators will be: • extensive internal and/or external corrosion of the AHU casing; • failure of filter housings to prevent air bypass; • general corrosion of heater and cooling battery fins, attenuator surfaces etc; • significant failure to meet minimum standards; • associated plant services and control elements in a poor condition or not able to fulfil their purpose; • AHU aged 20 years or more.
Action: Urgent replacement indicated.

Poor
Should be fairly apparent but should include an assessment of the degree of corrosion; • cleanliness of coils and batteries; • quality of filter mountings and their ability to prevent air bypass; • fan and drive train condition; • the control system elements' ability to fulfil their function; • condition of the access doors and inspection covers. The age of the AHU is generally less important.
Action: Extensive refurbishment or prolonged replacement indicated.

Average
Some faults but generally free of significant corrosion, clean internally and conforming to minimum standards.
Action: Faults capable of correction at next maintenance period.

Good
Conforming to the minimum standards, obviously cared for and subject to routine maintenance.
Action: Routine maintenance will preserve standard of equipment.

Compliance with minimum standards (questions 2 to 23, 32 and 33)

Poor
More than three answers are negative.
Action: Management action require by estates/facilities department.

Average
No more than 3 answers are negative.
Action: Maintenance action required.

Good
No answers are negative, full compliance.
Action: None.

Maintenance quality (questions 5, 12, 26 to 31 and 34 to 40)

Poor
More than three answers are negative.
Action: Management action required by estates/facilities department.

Average
No more than three answers are negative.
Action: Maintenance action required.

Good
No answers are negative.
Action: None.

Annual inspection of critical ventilation systems – AHU and plantroom equipment

Hospital ☐

Plantroom ☐

Air-handling unit ☐ **Age of unit** ☐

Area served by unit ☐

Date of survey ☐ **Name** ☐

General condition: End useful life ☐ **Poor** ☐ **Average** ☐ **Good** ☐

Compliance with minimum standards **Poor** ☐ **Average** ☐ **Good** ☐

(Questions 2 to 23; 32 and 33)

Maintenance quality **Poor** ☐ **Average** ☐ **Good** ☐

(Questions 5, 12, 26 to 31, 34 to 40)

No	Survey question	Yes	No	Comments
1	Plant running?			
2	Are the unit and its associate plant secure from unauthorised access?			
3	Is the unit safely accessible for inspection and maintenance?			
4	Is the air intake positioned to avoid short-circuiting with extract or foul air from other sources such as gas scavenging outlets?			
5	Are all inspection lights operating?			
6	Are motorised dampers fitted to the intake and discharge?			
7	Are the fan motor(s) outside of the air stream?			

No	Survey question	Yes	No	Comments
8	Is the fan drive train visible without removing covers?			
9	Is the cooling coil located on the discharge side of the fan?			
10	Is an energy-recovery system fitted (state type)?			
11	Are condensate drainage systems fitted to all energy recovery systems, cooling coils and humidifiers in accordance of Section 3 of Scottish Health Technical Memorandum 03-01, Part B?			
12	Are drainage traps clean and filled with water? (see Table 3 in SHTM 03-01, Part B)			
13	Is the drain trap air break at least 15mm?			
14	If a humidifier is fitted, state the type			
15	Is the humidifier capable of operation?			
16	Is there space to safely change the filters safely?			
17	Are there test holes in the principal ducts?			
18	Are the test holes capped?			
19	What is the general condition of the exterior of the AHU?			
20	Are the principal ducts lagged?			
21	What is the general condition of the associated control valves and pipework?			
22	Is the pipework adequately lagged?			
23	Is the system clearly labelled?			
24	Record prefilter differential pressure.			

No	Survey question	Yes	No	Comments
25	Record main filter differential pressure.			

Switch plant off. Fit padlock to isolator.				
26	Did the motorised dampers close on plant shutdown?			
27	Is the vermin/insect screen clean?			
28	Is the intake section including the fog coil clean?			
29	Are the prefilters correctly fitted with no air by-pass?			
30	Are all drive belts correctly aligned and tensioned?			
31	Is the cooling-coil matrix cleaned?			
32	Are all drip trays fully accessible or capable of being removed for cleaning and have a fall to drain?			
33	Are the drainage trays stainless?			
34	Are the drainage trays clean?			
35	Are the drainage traps free of water?			
36	Is the matrix clean for each heater-battery?			
37	Have the main filters been correctly fitted with no air by-pass?			
38	Are AHU and its associated main ductwork clean internally?			
Remove padlock and Re-start plant.				
39	Did unit restart satisfactorily?			
Test automatic fan-motor change-over, if fitted				
40	Did automatic changeover operate satisfactorily?			

Additional comments
(For example: air leaks from access doors; control valves leaking or passing; general cleanliness of the area around the unit; or any other items of concern.)

Competent person/Authorised person……

Appendix 2 - Operating suite annual verification

Definition of terms used on survey form

Assessment of compliance with Scottish Health Technical Memorandum 03-01 (all questions relevant to the type of theatre)

Poor
• air volumes and hence air-change rates is less than 75% of the design; • room pressure differentials do not ensure a flow from clean to less clean areas; • supply or extract air diffusers are not clean; • pressure stabilisers not clean and/or not operating correctly; • significant faults or failures of indicators on surgeon's panel; • visible faults in the fabric of the suite; • doors unable to close completely; • general air of neglect.
Action: Urgent management action required

Average
• air pressure and room pressure differentials approximate to the original design values; • supply air diffusers clean but extracts visibly fouled; • most pressure stabilisers clean and operating correctly; • some of the indicators on the surgeon's panel not working; • minor faults in the fabric and décor of the suite.
Action: Maintenance action required

Good
Better than average
Action: None

Maintenance quality (all questions relevant to the type of theatre)

Poor
More than three answers are negative
Action: Management action required by estates/facilities department

Average
No more than three answers are negative
Action: Maintenance action required

Good
No answers are negative
Action: None

Annual verification of theatre ventilation systems - Theatre suite information

Hospital ☐

Theatre name/no. ☐ **Type of Theatre** ☐

Date of survey ☐ **AHU location & ID** ☐

Name ☐

Compliance with SHPN & SHTM **Poor** ☐ **Average** ☐ **Good** ☐

Maintenance quality **Poor** ☐ **Average** ☐ **Good** ☐

No	Survey question	Yes	No	Comments
1	Has the annual verification of the AHU been carried out?			
2	Are windows hermetically sealed?			
3	Is the theatre /are the theatre and prep room complete and sealed?			
4	Are there any significant faults in the fabric of the rooms in the suite?			
5	Are room light fittings correctly sealed?			
6	Do all doors close completely and hold against the room pressure?			
7	Are the pressure stabilisers operating correctly and silently?			
8	Are the supply and extract air terminals and pressure stabilisers visibly clean?			
9	Measure and record the operating room temperature			
10	Does this accord with that displayed on the surgeon's panel?			

No	Survey question	Yes	No	Comments
11	Measure and record the operating room relative humidity.			
12	Does this accord with that displayed on the surgeon's panel?			
13	Measure and record the supply and extract airflow in the principal ducts.			
14	Measure and record the airflow at all supply and extract terminals.			
15	Does the derived air-change rate achieve at least 75% of the design?			
16	For UCV units, also measure and record the air velocities within the canopy using the method set out in Section 8 of Scottish Health Technical Memorandum 03-01 (Part A)			
17	Do the air velocities achieve the standard appropriate for the type of canopy?			
18	Measure and record the room differential pressures			
19	Do the room differential pressures ensure a flow of air from the clean to the less clean areas?			
20	Measure and record the noise levels in the principal rooms of the suite.			
21	Do the noise levels fall below the limits set out in Table 2 of SHTM 03-01 Part B			
22	Check the operation of all ventilation control functions represented on the surgeon's panel.			
23	Do the indicators accurately represent the operational state of the ventilation system(s)?			

No	Survey question	Yes	No	Comments
24	For UCV systems: are the UCV and AHU interlocked to ensure that the AHU runs at full speed when the UCV is at operating speed or at set-back? (see Table 7 in Scottish Health Technical Memorandum 03-01, Part A)			
25	With the UCV running at setback, does the system maintain the standard of a conventional operating room?			
26	For all theatres: with the system running at set-back, does it maintain a flow of air from the clean to the less clean areas?			

Additional comments
(For example: the general décor; are the suite and its ventilation systems suitable for their designated functions?)

Competent person/Authorised person…….

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A52859616

From:	Brough, Katharine
To:	McFadden, Jim; Collins, Peter; Sullivan, Graham; "Alan.Gallagher[redacted]"
Cc:	McIntyre, Alex; Kane, Mary Anne; Hunter, William; Maclean, Alistair; Pace, David; Wilson, Brian; Bell, Lyndsey; Cameron, Clare; Gardner, Andrew; Mackie, Christine; Matheson, Fiona; McPhail, Pamela; Speirs, Karen; Wallace, Mandy; Powrie, Ian
Subject:	SCART Self Assessment - STAGE 2 [2 of 4 emails]
Date:	28 October 2011 13:58:26
Attachments:	Ventilation Evidence Pack - Batch 2 of 2.msg

Please refer to first email.

As per the agreed programme for implementation of the evidence based process please now find attached electronic copies of:

SCART No 15 -Ventilation in Healthcare Premises (Incorporating SHTM 03-01)
SCART No 25 - Confined Spaces Regs 1997

Further documentation will be circulated by email later week. Hard copy folders will again be prepared and distributed to you for population with supporting evidence by Site Estates teams.

The remaining programme is as per below:

- Monday 7th Nov: Site Estates Teams to return completed self assessment checklist to Ian Powrie, populate evidence packs for local retention and future audit by H&S department)
- Week of the 7th Nov: Ian Powrie/SEM's carry out gap analysis and produce action plans
- Monday 14th Nov: Return Gap Analysis/Action plan to Mary Anne for review.
- Monday 21st Nov: Mary Anne to issue Gap Analysis/Action plan to SEMs.

Stage 3

- Monday 28thst Nov: Issue of priority 7, 8 & 9 SCART self assessment checklists in parallel with the associated evidence packs (Hard copy issued FYI & population with supporting evidence by site Estates teams)
- Monday 5th Dec: Site Estates Teams to return completed self assessment checklists to Ian Powrie, populate evidence packs for local retention and future audit by H&S department)
- Week of the 5th Dec: Ian Powrie/SEM's Carry out gap analysis and produce action plans
- Monday 12th Dec: Return Gap Analysis/Action plan to Mary Anne for review.
- Monday 19th Dec: Mary Anne to issue Gap Analysis/Action plan to SEMs.

Stage 4

- Monday 9th Jan: Issue of priority 7, 8 & 9 SCART self assessment checklists in parallel with the associated evidence packs (Hard copy issued FYI & population with supporting evidence by site Estates teams)

.

Monday 16th Jan: Site Estates Teams to return completed self assessment

- checklists to Ian Powrie, populate evidence packs for local retention and future audit by H&S department)
- Monday 23rd Jan: Ian Powrie/SEM's Carry out gap analysis and produce
- Monday 30th Jan: Return Gap Analysis/Action plan to Mary Anne for review.
- Monday 6th Feb: Mary Anne to issue Gap Analysis/Action plan to SEMs.

I appreciate that the time scale for turn around of these self audits and preparation of the evidence packs are tight, but this should be viewed in context of the risk of non-compliance should NHS GG&C find its self under investigation by the HSE.

Once again I state that your support and efforts in completing this task are appreciated.

Alex McIntyre
Director of Facilities

Sent by Katharine Brough on behalf of Alex McIntyre
PA Facilities
MacQuaker Building
Victoria Infirmary
Tel: [redacted] / Ext [redacted]

From: Cassidy, Kym
To: Brough, Katharine
Subject: Ventilation Evidence Pack - Batch 2 of 2
Date: 25 October 2011 09:34:21
Attachments: SHTM 03-01 Part A.pdf
SHTM 03-01 Part B.pdf

Health Facilities Scotland

NHS National Services Scotland

Comments on consultation

Name: Date:
Document Title: SHTM 03-01 Part A: Please return comments to [redacted] before 1st March 2010

[1]**T= Technical; G= General; E=Editorial**

Paragraph No.	Page	Type[1]	Comment

Health Facilities Scotland

NHS National Services Scotland

Paragraph No.	**Page**	**Type[1]**	**Comment**

NHS National Services Scotland

SHTM 03-01

Ventilation for healthcare premises
Part A – Design and validation

Health Facilities Scotland
Engineering and Environment

January 2010

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Acknowledgements

Health Facilities Scotland would like to thank the principal contributors and the Steering Group led by the Department of Health for their efforts in producing the HTM 03-01 Part A document.

HTM 03-01 Part A has been updated and amended by Health Facilities Scotland for use in NHSScotland as SHTM 03-01 Part A

Health Facilities Scotland

NHS National Services Scotland

Preface

About Scottish Health Technical Memoranda

Engineering Scottish Health Technical Memoranda (SHTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Scottish Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle.

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

It is not the intention within this suite of documents to repeat unnecessarily international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of eight subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.

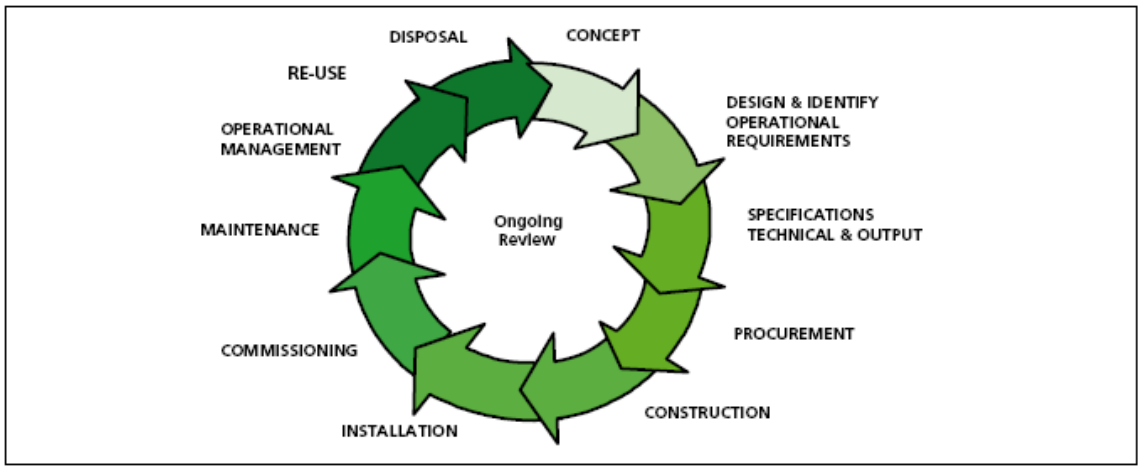


Figure 1: Healthcare building lifecycle

Structure of the Scottish Health Technical Memorandum suite

The series of engineering-specific guidance contains a suite of eight core subjects:

Scottish Health Technical Memorandum 00 - Policies and principles (applicable to all Scottish Health Technical Memoranda in this series).

Scottish Health Technical Memorandum 01 - Decontamination.

Scottish Health Technical Memorandum 02 - Medical gases.

Scottish Health Technical Memorandum 03 - Heating and ventilation systems.

Scottish Health Technical Memorandum 04 - Water systems.

Scottish Health Technical Memorandum 05 - Reserved for future use.

Scottish Health Technical Memorandum 06 - Electrical services.

Scottish Health Technical Memorandum 07 - Environment and sustainability.

Scottish Health Technical Memorandum 08 - Specialist services.

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical Services – Electrical safety guidance for low voltage systems.

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent:

Environment and Sustainability – EnCO_2de.

All Scottish Health Technical Memoranda are supported by the initial document Scottish Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

Figure 2: Engineering guidance

1. Introduction

1.1 Ventilation is used extensively in healthcare premises for primary patient treatment in operating departments, high dependency units and isolation facilities. It is also installed to ensure compliance with quality assurance of processed items in pharmacy and sterile supply departments and to protect staff from harmful organisms and toxic substances, for example, in laboratories.

1.2 This edition of Scottish Health Technical Memorandum 03 'Ventilation in healthcare premises' is published in two sections. It is equally applicable to both new and existing sites. It gives comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design implications, maintenance and operation of general and specialised ventilation in all types of healthcare premises.

1.3 Current statutory legislation requires both 'management' and 'staff' to be aware of their collective responsibility.

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

1.5 Ventilation systems in themselves present little danger to patients or staff; however, they do possess the ability to transmit hazards arising from other sources to large numbers of people. The danger may not become apparent until many patients and staff have been affected.

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

1.7 The Health and Safety at Work etc Act 1974 (HSW Act 1974) is the core legislation that applies to ventilation installations. As these installations are intended to prevent contamination, control closely the environment, dilute contaminants or contain hazards. Their very presence indicates that risks to health have been identified.

Statutory requirements

1.8 The Control of Substances Hazardous to Health (COSHH) regulations place upon management an obligation to ensure that suitable measures are in place to protect their staff and others affected by the work activity. These methods may include both safe systems of work and the provision of a specialised

ventilation system. In laboratories the requirements are often met by the provision of fume cupboards and safety cabinets.

1.9 The existing requirements to provide ventilation, implicit under HSW Act 1974 and COSHH, have been made explicit by the Management of Health and Safety at Work Regulations 1999, the Workplace (Health, Safety and Welfare) Regulations 1992 and the Provision and Use of Work Equipment Regulations 1998, all issued as a result of European Directives.

1.10 Where specialised ventilation plant is provided as part of the protection measures there is a statutory requirement that it be correctly designed, installed, commissioned, operated and maintained. The local exhaust ventilation (LEV) section of the COSHH regulations requires that the plant be inspected and tested at least every 14 months by an independent organisation and that management maintain comprehensive records of its performance, repair and maintenance.

1.11 Certain substances have Occupational Exposure Limits (OEL) set out in Guidance Note EH 40 published annually by the Health and Safety Executive. If special ventilation systems are provided in order to achieve these standards they will be subject to the COSHH regulations as above.

1.12 All ventilation systems should conform to the principles set out in the 'Approved Code of Practice on the Prevention or Control of Legionellosis' published by the Health and Safety Commission and Scottish Health Technical Memorandum SHTM 04-01 – The control of *Legionella*, hygiene, "safe" hot water, cold water and drinking water systems.

1.13 Special ventilation plants installed in laboratories dealing with research, development or testing, whether involving drugs, animals or genetically modified organisms, may be subject to particular legislation with regard to their operation in addition to that mentioned above. Further information is given by the Health and Safety Commission Health Services Advisory Committee in:

- safe working and prevention of infection in clinical laboratories;
- safe working and prevention of infection in clinical laboratories: model rules for staff and visitors;
- safe working and prevention of infection in clinical laboratories in the mortuary and post-mortem room.

1.14 Plants installed in units manufacturing medicinal products to the standards set out in the current European Guide to Good Manufacturing Practice may also be subject to particular legislation with regard to their operation in addition to that mentioned above.

1.15 Records should be kept of equipment design and commissioning information. The Health and Safety Executive, Medicines Inspectorate and other interested bodies have a statutory right to inspect them at any time. All records should be kept for at least five years.

1.16 The fire regulations require that if ventilation ductwork penetrates the fabric of a building it should be designed and installed so as to contain the spread of fire.

1.17 Increased health risks to patients will occur if the more specialised ventilation systems installed to supply high quality air to operating departments do not achieve and maintain the required standards. The link between post-operative infection and theatre air quality has been well established. Plants serving conventional operating departments, for instance, will be required to ensure the separation of areas within the suite by maintaining a specific direction of air flow between rooms, even when doors are opened. They will also maintain the selected operating department environmental conditions regardless of changes in the outside air conditions or activities within the space. In addition ultra-clean operating ventilation systems which are designed to provide an effectively particle-free zone around the patient while the operation is in progress, have been shown to reduce significantly post-operative infection in patients undergoing deep wound surgery. Their use for other forms of surgery may well be indicated.

1.18 Ventilation systems that can be shown to be inappropriate, inadequate or ineffective and that give rise to proven failures can result in a civil suit by the patient against the operators.

1.19 If the plant has been installed to dilute, extract or contain harmful substances, its failure may expose people to unacceptable levels of hazard. Proven failures can give rise to a civil suit against the designers and operators by the individuals who have been affected. This would be in addition to the actions brought as a result of breaching the statutory requirements.

1.20 There is a statutory requirement to provide ventilation in all enclosed workspaces. It may be provided by either natural or mechanical means. The following are some of the factors that determine the ventilation requirements of a workspace:

- human habitation (minimum fresh air requirement);
- the activities of the department, that is, extraction of odours, aerosols, gases, vapours, fumes and dust – some of which may be toxic, infectious, corrosive, flammable, or otherwise hazardous (see Control of Substances Hazardous to Health (COSHH) regulations;
- dilution and control of airborne pathogenic material;
- thermal comfort;
- the removal of heat generated by equipment (e.g. catering, wash-up, sterilising areas, electrical switch rooms, Uninterruptible Power Supply (UPS) cupboards and some laboratory areas);
- the reduction of the effects of solar heat gains where other forms of reducing the solar effect is not available or practical, i.e. solar blinds;
- the reduction of excessive moisture levels to prevent condensation (for example Hydrotherapy pools);

- combustion requirements for fuel burning appliances (see BS5376, BS5410 and BS5440);
- 'make-up' supply air where local exhaust ventilation (LEV) etc is installed.

Mechanical ventilation systems are expensive in terms of capital and running costs, and planning solutions should be sought which take advantage of natural ventilation either where the use of the area in question is not critical to airflow patterns or pressures, or where backup systems are available when natural ventilation cannot be achieved.

1.21 When new ventilation systems are accepted for use, full information as to their designed mode of operation together with recommended maintenance procedures should be provided as part of the handover procedure.

Requirement	Reason	Application
Statutory	Health and Safety at Work etc Act	Operating department Laboratories Pharmacy
	COSHH regulations	Areas containing identified biological or chemical hazards Areas containing oxygen displacing gases
	Local Exhaust Ventilation (LEV)	Enclosed work-spaces Workshops
Functional	Comfort	Situations where the quality of the environment for staff and patients is critical to their general performance and well-being
Clinical	Post-operative infection reduction	Operating suites used for general surgery, casualty, obstetrics/gynaecological and maternity procedures
	Reduction of deep wound sepsis	Ultra-clean operating suites for transplant, deep wound surgery, hip replacement, bone grafting and bone marrow transplant procedures
	Isolation from contact with bio hazards	Isolation rooms for neutropeanic patients Isolation rooms for infective patients

Table 1 – Reasons for providing ventilation

Functional overview – Terms in use

1.22 The terms 'ventilation' and 'air-conditioning' are often incorrectly used to describe the same equipment. A general explanation of the terms is given below.

Ventilation

1.23 Ventilation is a means of removing and replacing the air in a space. In its simplest form this may be achieved by opening windows and doors. Mechanical ventilation systems provide a more controllable method. Basic

systems consist of a fan and either collection, (extraction) or distribution (supply) ductwork. More complex systems may include the ability to heat and filter the air passing through them. Ventilating equipment may be required in order to remove smells, dilute contaminants and ensure that a supply of 'fresh' air enters a space.

Air-conditioning and mechanical cooling

1.24 Air-conditioning is the ability to heat, cool, dehumidify and filter air. For full air-conditioning, humidification may also be provided. This means that the climate within a space being supplied by an air-conditioning plant can be maintained at a specific level regardless of changes in the outside air conditions or the activities within the space. Mechanical cooling may be provided where close control of 'comfort conditions' within a space is required but humidity control is not needed.

Special ventilation

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

- to remove, contain or dilute specific contaminants and fumes;
- to ensure the isolation of one space from another;
- to preserve a desired air flow path from a 'clean' to a 'less clean' area;
- to provide control of the cleanliness of a space;
- to provide 'close' control of temperature;
- to provide 'close' control of humidity.

1.26 The following departments will usually have specialised ventilation requirements, either for a single room or throughout a suite of rooms:

- operating department;
- laser surgery unit;
- intensive treatment unit;
- infectious diseases isolation unit;
- manufacturing pharmacy;
- specialist imaging, X-ray and scanning unit;
- pathology containment laboratories;
- mortuary and dissection suite;
- research laboratory;

- sterilising and disinfecting unit (SDU);
- endoscopy unit;
- renal dialysis suite;
- ultrasound facilities;
- audiology room.

1.27 Ventilation may be provided in a wide variety of ways. These will include:

- extensive purpose-built air-conditioning units housed in their own plant rooms;
- proprietary 'packaged' systems often sited outside on a roof or;
- wall-mounted electric fans located at the point of use.

1.28 A fixed volume of air may be supplied, often expressed in terms of the resulting number of air changes per hour (ac/h) within the space being ventilated. It may also be expressed in terms of litres/second/person. Alternatively the volume of air supplied may be varied in order to maintain a specific pressure relationship between the area supplied and other surrounding areas. In some situations a combination of both methods may be adopted.

1.29 Modern plants are fitted with the means to recover energy from the extract air where this can be justified without causing contamination of the incoming supply air.

1.30 Ultra-clean systems use the same basic plant and equipment as standard air-conditioning but are in addition fitted with a terminal device that supplies the air in a unidirectional manner to the working area. Their standard of filtration will be capable of delivering air with a very low particle count to the space that they serve.

Local exhaust ventilation

1.31 Local exhaust ventilation (LEV) is a term used to describe systems installed to prevent hazardous substances from entering the general atmosphere of the room in which they are being used. Their primary function is to protect staff from the effects of their work activity.

1.32 Simple LEV systems comprise a capture hood, extract ductwork and fan. These are used to contain industrial types of hazard such as fumes from welding processes, gas discharges from standby battery banks and dust from woodworking machinery. The vapour given off when large quantities of chemicals are decanted into ready-use containers and fumes from X-ray film processing units are further examples of chemical hazards often controlled by LEV systems.

1.33 In laboratories, pharmaceutical manufacturing facilities and operating suites, LEV systems usually take the form of semi-open fronted cabinets within which the hazardous substance is manipulated. These cabinets either have their own

filtered air supply or are fed with air from the room. The air extracted from the cabinet is passed through a high-efficiency filter before being discharged either to the atmosphere or back into the room. Microbiological safety cabinets, laboratory fume cupboards, cytotoxic drug cabinets and fixed or mobile disinfection enclosures are all examples of this type of facility.

1.34 Mortuaries and dissection suites may have LEV systems incorporated within the dissection table, specimen bench and bone saw.

Management action

1.35 The guidance contained in this SHTM should be applied in full to new installations and major refurbishments of existing installations.

1.36 Ventilation will need to be provided:

- as a requirement for patient care;
- in order to fulfil a statutory duty.

1.37 In assessing the need for more specialised ventilation and the standards desired for patient care, managers will need to be guided by their medical colleagues and by information published by Health Facilities Scotland.

1.38 The statutory need for ventilation falls into two categories:

- in the first, the need for specialised ventilation and the standards to be adopted are clearly set out in specific pieces of legislation. An excellent example of this is the current legislation surrounding the manufacture of medicinal products in the European Community. The managers of the departments affected by this type of legislative requirement should be aware of their needs and be able to advise on the standards to be achieved;
- the second type of statutory requirement arises due to the interpretation of both the Health and Safety at Work etc Act and the Control of Substances Hazardous to Health (COSHH) regulations. The person tasked with conducting COSHH assessments will be able to advise as to the need for, and standard of, ventilation in each particular case.

Design and validation process

1.39 It is essential when undertaking the design of a specialised ventilation system that the project be considered as a whole. The process model set out below should ensure that all relevant factors are considered.

Step	Question	Design statement and information required	Comment
1	Why is the system required?	Healthcare applications Statutory elements Non healthcare applications	
2	What is the required system performance?	Room air flow pattern Air change rate Differential pressures Air quality Room air condition Noise limits	
3	What are the constraints on the distribution system?	Location, Size, Materials Dampers, Access, Insulation Fire considerations Room terminals	
4	What are the minimum requirements for the AHU(s)?	Intake / Discharge positions *Legionella*, Health and Safety Access, Fire, Electrical safety Leaks, Insulation, Cleanliness Filtration, Drainage	
5	What control functions are required?	User control requirements Estates control functions Energy management Environmental conditions Control sequence logic Run, Set back, Off philosophy	
6	How will the system performance be validated?	Validation methodology Instruments used Design information required [*Design air flow rates* *Design air velocities* *Pressure differentials* *Noise levels* *Air quality* *Installation standard*]	
7	The system will only 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.		
8	Handover to client	Basic design information Commissioning results Validation report	

Table 2: Design and Validation process model

Use and function of typical equipment used in ventilation plant

1.40 Typical equipment used in ventilation systems is listed below together with a brief description of both function and use.

General

1.41 The equipment built into the ventilation system and its ductwork should be of a type that will neither cause nor sustain combustion. No materials that could sustain biological activity should be used in the construction or assembly of the system.

Air Intake

1.42 An uncontaminated air supply to the system is essential. In order to achieve this, the air intake will be positioned so that air discharged from extract systems or other dubious sources cannot be drawn in. Exhaust fumes from vehicles can present particular problems. The area surrounding the intake will need to be kept clean and free of vegetation and waste material in order to reduce the possibility of bio-hazards or fire. The intake itself will be protected by a louvre and mesh screen to prevent rainwater, vermin and insects etc from entering the system.

Damper

1.43 Several types may be fitted:

- automatic dampers fitted immediately behind the air intake and extract louvres. They will automatically close when the system is shut down in order to prevent an uncontrolled circulation of air;
- balancing dampers are fitted into each branch of the air distribution ductwork system so that the design air flow rate can be set during the commissioning process;
- where ductwork passes through a fire compartment wall, ceiling or floor a fire and/or smoke damper may be required;
- plant isolating dampers are fitted so that the main plant can be isolated from its air distribution duct system. They are manually operated and enable cleaning and maintenance of the air-conditioning equipment to be carried out.

Ducting

1.44 The means by which air is conveyed from the intake to its point of use. Ducting is usually constructed of galvanised steel and will normally be insulated to reduce noise and conserve energy. Ducts can also be formed in concrete, brickwork, stainless steel or plastic and may be rigid or flexible.

Fan

1.45 A series of rotating blades that move the air in the direction required. Fans are usually powered by electric motors either directly connected to them or driven through belts and pulleys. A fan may be arranged either to force air into or draw air from a ductwork system.

Attenuator / silencer

1.46 A device that will contain and absorb the noise emitted by a fan. They may be required to reduce disturbance caused by noise breaking out through the air intake and also noise transmitted along the ductwork to the conditioned space.

Filter

1.47 A filter consists of a labyrinth of fibrous material contained in a frame. It is designed to capture and hold particles being carried in the airstream. Because of the size range and number of particles that exist in air no filter can remove them all. The purpose of filtration is to reduce their number and size range to an acceptable level. Filters of progressively higher grades are fitted through the ventilation system:

- primary filters (coarse) are designed to collect the larger particles and are intended to keep the air-conditioning plant clean;
- secondary filters (fine) will remove the staining particles from air and keep the conditioned space visibly clean;
- high efficiency particulate air filters (HEPA/absolute) will remove virtually all particles from air. These may be required in order to reduce contamination in the working area either biologically or in terms of particle count.

Filters may be fitted to extract systems to protect energy recovery devices. They may also be fitted to remove biological, radiation or chemical hazards and if so, are often contained in a ‘safe change’ facility in order to protect those carrying out maintenance.

Activated carbon filters will reduce odours in extracted or recirculated air.

Heater battery / heater coils

1.48 A series of heater batteries or heating coils with or without fins through which steam or hot water is circulated. Heat is given up to the air passing over the battery thus increasing its temperature. Heating is usually carried out in stages, the final battery being controlled by the end user. Small batteries may be electric.

Humidifier

1.49 A device for increasing the humidity of air by adding moisture. For ventilation in healthcare premises this is normally achieved by releasing ‘clean’ steam into an

air supply duct. The steam will be completely absorbed into the air, increasing its humidity. The level of humidity may be preset or controlled by the end user.

Cooler battery / cooling coil

1.50 A series of finned coils mounted in the air supply duct. Either chilled water or refrigerant is circulated through the coils causing heat to be removed from the air. This will reduce its temperature and may also condense moisture out of the air. As free moisture in a duct can be a source of contamination the coil will be fitted with an eliminator and drainage system.

Eliminator

1.51 A device for catching and removing water droplets from an air stream. It may form part of a cooling coil or be a separate device.

Drainage system

1.52 A means of removing water from ductwork and disposing of it safely. Typically it will consist of a tray mounted in the duct to catch moisture, a glass water seal trap, continuously falling drainage pipework and an air break in the drain run to prevent waste water returning and contaminating the duct.

Access doors and observation ports

1.53 Doors and removable panels providing access for routine maintenance and cleaning. The doors should be fitted with glazed ports and suitable lighting provided so that the correct operation of devices such as cooling coils, humidifiers and filters can be easily observed without needing to switch off the plant.

Energy recovery

1.54 Many plants are fitted with the means to recover energy from the extract air without causing contamination of the incoming supply air. These devices will be fitted with a drainage system and may incorporate an eliminator. Several types of energy recovery systems are available.

1.55 Precise definitions of ventilation and air-conditioning terms are given in the CIBSE Guide.

Typical plant

1.56 The layout of a typical plant that conforms to the requirements for healthcare applications is shown in Figure 1 below. It contains most of the equipment described above.

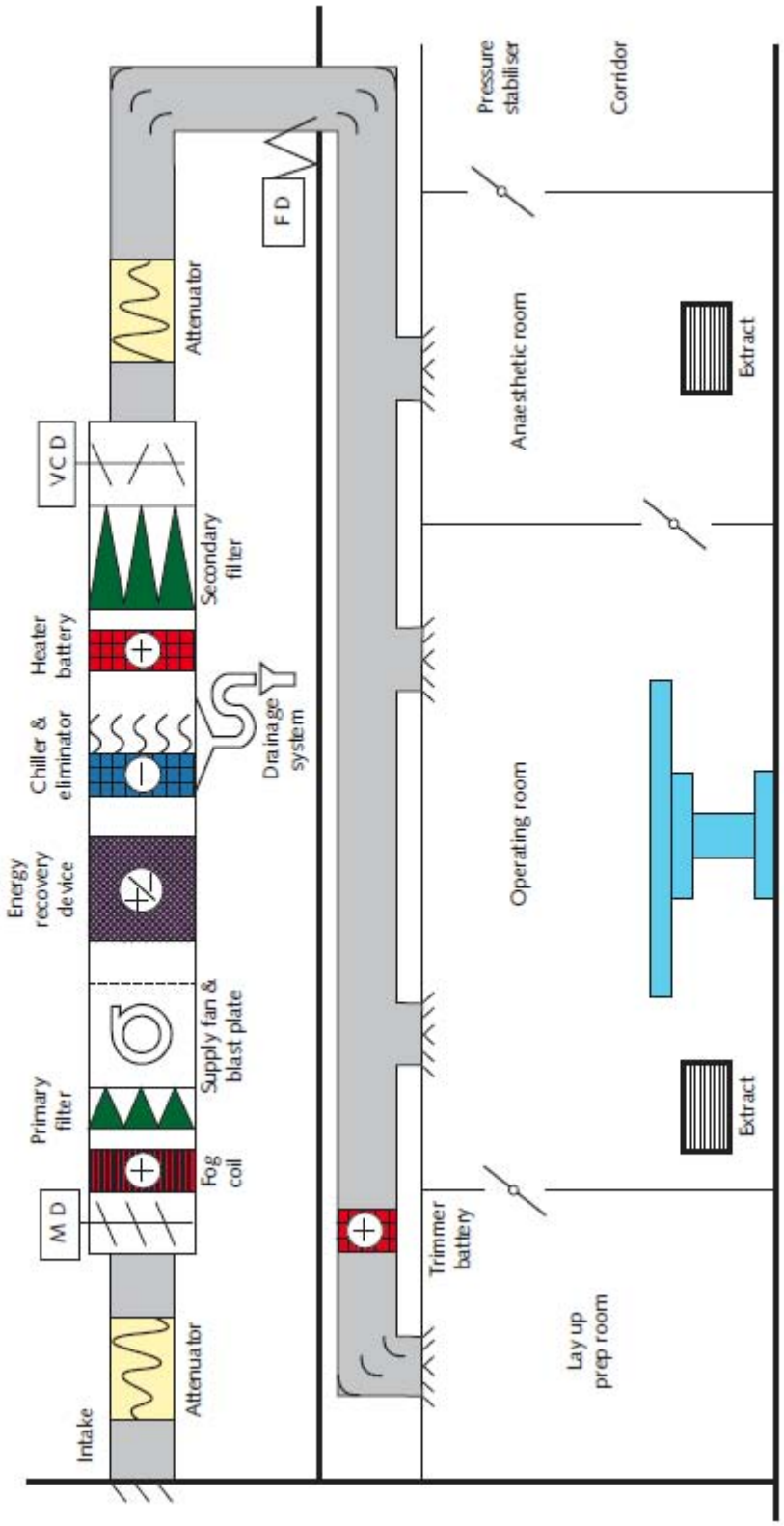


Table 2: Design and Validation process model

2. Provision of ventilation in healthcare buildings

2.1 It is acknowledged that planning constraints imposed by the building shape and/or functional relationships of specific areas will invariably result in some measure of deep planning thus reducing the opportunity for natural ventilation. However, ventilation costs can be minimised by ensuring that where practicable, core areas are reserved for rooms that have a functional requirement for mechanical ventilation. Examples are sanitary facilities, dirty utilities and those rooms where clinical or functional requirements have specific environmental needs; and where for reasons of privacy, absence of solar gain etc., windowless accommodation is acceptable. Other spaces appropriate to core areas are those which have only transient occupation and therefore require little or no mechanical ventilation, for example circulation and storage areas.

Natural ventilation

2.2 Natural ventilation is usually created by the effects of wind pressure. It will also occur if there is a temperature difference between the inside and the outside of the building. The thermo-convective effect frequently predominates when the wind speed is low and will be enhanced if there is a difference in height between inlet and outlet openings. Ventilation induced by wind pressures can induce high air change rates through a building provided air is allowed to move freely within the space from the windward to the leeward side.

2.3 As the motivating influences of natural ventilation are variable, it is almost impossible to maintain consistent flow rates and ensure that minimum ventilation rates will be achieved at all times. This variability is normally acceptable for general areas including office accommodation, general wards, staff areas, libraries rooms, dining rooms and similar areas which should, where possible, be provided with opening windows of a design that facilitates natural ventilation.

2.4 Current guidance restricts the amount windows can be opened for safety reasons and as many designs are top-hung, their ability to permit natural ventilation is limited. It may therefore be necessary to provide dedicated ventilation openings in the fabric of the building to allow a sufficient natural flow of air into and out of the space.

2.5 In all cases, excessive heat gain, indoor air quality requirements or external noise may limit or preclude the use of natural ventilation.

Extract ventilation systems

2.6 Separate extract ventilation will be required for sanitary facilities, lavage areas, dirty utilities and in rooms where odorous, but non-toxic fumes are likely, in order to ensure air movement into the space. 10 air changes per hour have been found necessary, particularly in geriatric and psychogeriatric

accommodation. A single fan/motor unit can be suitable for individual rooms, but multi-room systems should be provided with duty and standby fans or motors to meet this need. There is no healthcare requirement to provide a separate foul extract system over and above that required by the building regulations, but this is almost universally provided for control of infection purposes.

2.7 Toilets should have an extract rate as set out in the building regulations. Where WC's are located in shower and bathroom spaces, the ventilation required for the WC will normally be adequate for the whole space.

Supply only ventilation

2.8 Mechanical supply ventilation will be required in areas where it is important to maintain a positive pressure in order to prevent the ingress of less clean air, e.g. in pharmacy aseptic suites, sterile supply packing rooms, operating theatres and their preparation rooms. (air change rates are given in Table A1 within Appendix 1).

Supply and extract ventilation

2.9 Mechanical supply and extract ventilation should be provided in rooms where there is a need to control room pressure in relation to adjacent spaces. ICU, isolation suites and treatment areas are typical applications.

Mechanical or comfort cooling

2.10 Cooling is very expensive in terms of energy costs and should be provided only where necessary to maintain a comfortable environment for staff and patient, or to ensure satisfactory operation of equipment. The imaging department in particular may require cooling to offset the equipment load.

2.11 Calculations and thermal modelling should be undertaken to ensure that during the summertime, internal temperatures in patient areas do not exceed 28°C (dry bulb) for more than 50 hours per year taking into account the level of design risk for the application.

2.12 Certain non-patient areas may also require cooling and will typically include some laboratories, central wash-up and other areas which are subject to high equipment heat gains.

2.13 Where deep planning of other continuously occupied spaces, for example offices, is unavoidable, there will also be occasions when acceptable levels of comfort can only be maintained by cooling. Planning solutions of this type however will be exceptional.

2.14 Refrigeration plant should be of sufficient capacity to offset heat gains and maintain areas at a temperature that does not exceed the external design

shade temperatures by more than about 3°C taking into account the level of design risk for the application.

Air-conditioning

2.15 Full air-conditioning is only required in a very small number of areas within healthcare buildings and due to the capital and running cost its inclusion should be kept to a minimum. Paragraphs 3.14, 3.15 and 4.91-4.93 also refer.

2.16 Areas whose functions may warrant the installation of air-conditioning include operating departments, intensive therapy units, manufacturing pharmacies and areas with particularly sensitive equipment.

Specialised ventilation

2.17 Due to the nature and extent of activities carried out in healthcare buildings, there will be a need for a wide range of specialised ventilation systems. The types of system which are generally required in individual departments and typical arrangements are given in Section 7.

2.18 The activities within some departments will require the provision of local exhaust ventilation (LEV). This is a statutory requirement under COSHH wherever the escape of chemicals, toxic fumes, biological material or quantities of dust into the general area would present a hazard to the occupants.

Ventilation for general areas

2.19 Table A1 in Appendix 1 provides recommended air change rates, temperatures and pressures for general areas which require mechanical ventilation in healthcare buildings.

Use of natural ventilation

2.20 The air tightness of new buildings has improved to the point that infiltration through building leakage can no longer be relied upon to provide sufficient air flow. Attention must therefore be given to the provision of purpose made ventilation openings to achieve the necessary flow rates. The air entering the openings may need to be controlled by motorised dampers linked to temperature and / or occupancy sensors in the ventilated space.

2.21 Internal partitions, fire compartment walls and closed doorways can often impede the flow path, and when this happens, the process will be more dependent on single-sided ventilation. Nevertheless, even with this degree of compartmentation, acceptable ventilation may still be achieved without window openings which would prejudice safety, security or comfort.

2.22 Some types of window, for example, vertical sliding, can enhance single sided air change by temperature difference, and these will improve the overall rate of

natural ventilation in protected or sheltered areas where the effect of wind pressure is likely to be minimal.

2.23 It is generally considered that natural cross-flow ventilation is able to give reasonable air distribution for a distance of up to 6 metres inwards from the external facade, provided that reasonably clear air paths are maintained. Beyond this distance in areas where clear air paths cannot be maintained and in areas where high minimum air change rates are specified, mechanical ventilation should be provided.

2.24 Further information can be found in SHTM 55 'Windows', BS5925 'Code of practice for ventilation principles and designing for natural ventilation' and CIBSE Applications Manual AM10: 'Natural ventilation in non-domestic buildings'.

Mixed mode ventilation

2.25 This comprises an assisted form of natural ventilation. Fans are fitted in the purpose made damper-controlled ventilation openings. Alternatively a separate ventilation unit may be installed. In both cases the dampers and fans are controlled under the dictates of temperature and occupancy sensors to ensure a minimum air flow rate while taking advantage of natural ventilation effects when present.

2.26 Where natural or mixed mode ventilation is adopted with complex air paths, the designer should produce an air flow diagram in order to ensure correct provision of air transfer devices. CIBSE Applications Manual AM13: 'Mixed mode ventilation in non-domestic buildings' gives guidance.

Mechanical extract ventilation

2.27 General extract systems can vary in complexity from a single wall-mounted fan to a ducted air system with dual extract fans.

2.28 Replacement air is generally provided by a central supply system (as described below). Unless special precautions are taken, the latter may result in an unacceptable level of draughts occurring in winter, and possible risk of unacceptable levels of noise transmission.

2.29 If individual systems are used, the ventilation can be operated intermittently, provided it continues to run for at least 15 minutes after the room is vacated, as with light switch-operated fans in individual toilets.

2.30 If general exhaust systems are used; it is recommended that filtered and tempered replacement air is provided via a central supply plant to adjoining lobbies or corridors, to prevent the risk of discomfort caused by the ingress of cold air. Fire compartmentation requirements must be maintained.

2.31 Information on specialised extract systems is given in Section 7.

Mechanical supply systems

2.32 Where mechanical supply systems are required, the fresh air should be tempered and filtered before being delivered to the space, to avoid discomfort.

2.33 The air should be heated using a constant or variable temperature source, but generally only to the space air temperature. In most instances, the low pressure hot water heating (LPHW) should offset any fabric loss, so that set-back room temperatures can be maintained during unoccupied periods without the need for the ventilation system to operate.

Balanced ventilation

2.34 Balanced ventilation systems are merely a combination of a supply and extract system of equal volume; and either a single space or a whole building may be considered to be balanced. A balanced system is necessary in instances where it is essential to maintain consistent air movement within an area, for example, treatment rooms.

Cascade ventilation

2.35 In operating departments it is normal practice to supply air to the operating room, and allow it to pass through less clean areas – corridors, utility rooms etc. (from where it is eventually extracted).

Recirculation systems

2.36 Due to the nature of the use of mechanical ventilation systems within healthcare buildings, there are few opportunities for the application of recirculation air systems. They are however normally used for HEPA filtered clean room applications where the extract air is significantly cleaner than the outside supply. Recirculation is also routinely used in the canopy section of Ultra Clean Operating theatre ventilation systems.

2.37 Where the designer is considering the installation of a recirculation air system, due account must be taken of:

- minimum fresh air supply volume required by the Building Regulations (currently 20%);
- prevention of contamination of supply air from vitiated air in extract systems;
- prevention of stratification occurring within plenum chambers and mixing boxes which may result in freezing of downstream coils;
- ensuring sufficient velocities through control dampers (ideally 5-6 m/s) to provide suitable authority; and good shut-off;
- modulating control of mixing to provide optimum on-plant conditions;

- use of 'free cooling' by cycling the dampers to minimum fresh air when the enthalpy of the outside air is above that of the extract air under conditions when cooling is required.

Chilled beams

2.38 The use of chilled beams for the provision of heating, cooling and ventilation is increasingly common in healthcare premises. The use of Active Chilled Beams providing tempered filtered air to a heating / cooling device within the room can provide effective local control of environmental conditions.

2.39 Care should be taken in positioning chilled beams to ensure the avoidance of cold draughts particularly when used in the cooling mode. The control settings should ensure that the external elements of the beam are always above dewpoint.

2.40 Consideration should be given to the ease with which specific types of chilled beam units can be accessed for cleaning having regard to the need to control the infection risk. The impact of maintenance requirements on room availability should also be considered.

Split comfort air-conditioners

2.41 Split comfort air-conditioners, room conditioners or cassette units are used increasingly where there is a small local requirement for cooling for operational purposes. They can provide an effective economic solution to cooling needs, where a central refrigeration system is not practicable.

2.42 The units re-circulate room air so provision for a fresh air make up, either by natural or mechanical means, to the standard required by the Building Regulations must be provided.

2.43 The recirculation of room air presents problems with indoor air quality (IAQ) and may increase the risk of healthcare associated infection (HAI). Split units should not therefore be used in critical patient areas.

2.44 Split units may be used for single room applications or as multiple linked units that can independently provide either heating or cooling, all served by a single outdoor unit. These systems enable good temperature control of a number of rooms with maximum energy efficiency.

2.45 Whether single or multiple systems are used, it is essential that the designer gives due consideration to the source of electrical supply, location of the heat rejection unit, environmental effects to the refrigerant used and drainage provision for the cooling coil condensate.

2.46 The units will require routine maintenance for filter change and cleaning; they should therefore be installed in an accessible position.

Dilution ventilation and clean air flow paths

2.47 Dilution ventilation has in the past been used to control levels of hazardous substances in a space. This approach is no longer considered acceptable. The COSHH Regulations require that known hazardous substances should be substituted for safe alternatives. If this is not possible then they should be controlled at source by the use of closed systems such as anaesthetic gas scavenging units or exhaust protective enclosures such as fume cupboards.

2.48 The exposure of staff to casual spillages of substances such as medical gases in anaesthetic rooms should in the first instance be dealt with by establishing a clean air flow path. Air should be supplied at high level and extracted at low level directly behind the anaesthetic equipment position. The philosophy of establishing a clean air flow path from the supply point; to the staff; on to the patient and out via a low level extract would also apply in recovery rooms and maternity delivery rooms including labour, delivery, recovery & post partum (LDRP) Rooms. A suitable air change rate will provide dilution ventilation as an additional safeguard, see Table A1 in Appendix 1 and Table A2 in Appendix 2, Note c.

2.49 In operating theatres the patient will be on a closed breathing circuit in a room with a high air change rate. Under these circumstances the dilution effect would be considered sufficient to control any casual exposure to anaesthetic gases.

Mechanical ventilation systems

System selection

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

Choice of central/local plant

2.51 Mechanical ventilation is expensive to operate, and as such, should be controlled to operate when the space being served requires to be ventilated. In addition, loads on refrigeration plant are rarely constant owing to changes in solar gain, occupancy and use of heat-generating equipment and lights, therefore control of temperature is critical.

2.53 If the ventilation of loads throughout a department or building are in phase, or are not significant, a central plant with single zone control can be adopted. However, this is rarely the case, and elsewhere, the condition or quantity of supply air to different areas or zones of the building must be varied accordingly. This can be done by providing either individual plants to each zone, or separate zone terminal control. Where there is a high density of rooms with similar ventilation requirements in an area of a building or department, it is usually economical to combine them into a central system.

2.54 In large buildings, a choice between a single distribution system and multiple smaller systems may arise. Large distribution systems and their plant can have the advantage of lower operating costs, but require more space for vertical shafts. In general, very long runs of ducting should be avoided to prevent undue heat losses or gains, excessive leakage, and difficulties in balancing during commissioning. As the pressure losses in the long runs will be greater and a higher initial static pressure with be required, this will lead to a more expensive class of ductwork. Multiple smaller distribution systems may be more expensive in capital and operating costs but they avoid long runs, large ducts and vertical shafts, and this may reduce overall building costs. They also provide a more robust service as the failure of an individual system does not prevent the use of the rest of the building.

Zoning of the building

2.55 The efficiency and effectiveness of any ventilation or air-conditioning installation depends largely on the zoning and control of the installation. The factors to consider when determining the zoning of a ventilation system for a building or department are:

- periods of occupancy;
- fresh air/ventilation requirements;
- smoke control.

2.56 Where the ventilation system is not merely tempering the air, but also providing the heating and/or cooling requirements, the following additional factors will need to be considered:

- internal or peripheral location;
- orientation of windows;
- variation in internal loads;
- level of control required.

2.57 For single zone plant in staff areas, local control (with a run-on timer if required) is recommended, as this can be turned off when the space is not in use, thus saving both thermal and electrical energy. Most supply and extract systems, conversely, are required to operate continuously while the department is occupied, thus some form of time or use control is necessary.

2.58 The control of individual plant items is covered in Section 4, with examples of typical control strategies in Section 6. For control of particular specialised ventilation and air-conditioning systems refer to Section 7 of this document.

2.59 On very rare occasions a duplicate standby air handling plant may be justified. If installed it must be provided with a gas-tight damper at its junction with the supply distribution duct, so that no back-flow can occur. Standby plants can become sources of contamination if warm moist air is allowed to dwell within them. Their design and control system must ensure that this cannot happen.

Specific requirements for hospital departments

2.60 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).

3. Assessment of service requirement

Selection of design criteria

External design conditions

3.1 The most accurate data that is available for the summer and winter conditions at the site should be used. The Metrological office can supply data for the United Kingdom.

3.2 Healthcare mechanical ventilation systems will normally be 'full fresh air'.

3.3 Local adjustments such as for height above sea level, exposure factor, or other climate peculiarities, should be made as appropriate.

Internal design conditions

3.4 The design conditions selected within patient areas must strike a balance between the comfort requirements of staff and patients, who often have very different levels of clothing and activity.

3.5 Recommendations for the dry resultant temperature and humidity of individual spaces are shown on Activity Database (ADB) A-Sheets. Appendix 1 Table A1 gives a summary.

Minimum fresh air requirements

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

3.7 Where odour dilution is the overriding factor, it is recommended that 10 litres/second/person should be taken as the minimum ventilation rate.

3.8 Smoking is not permitted in healthcare premises. If permitted for example in residential care, it will be confined to designated areas. It therefore follows that these areas will contain a high percentage of smokers so the ventilation rate would be at least 36 litres/second/person for these applications (CIBSE Guide A; Table 1.10).

3.9 In non-standard applications such as laboratories, aseptic suites, operating departments, etc. the particular requirements for each area should be considered independently in order to determine the overriding minimum requirement for ventilation.

Limiting supply air conditions

3.10 For most applications in healthcare buildings, it is the temperature differential between the supply and room air, rather than the actual temperature of the supply air which is the critical factor. The maximum recommended supply-to-room air temperature differential is:

summer cooling: - 7K

winter heating: + 10K

3.11 It is also necessary to keep supply air humidity below 70% during winter in order to minimise risks associated with condensation.

Air purity

3.12 In healthcare premises, the standard of filtration will depend on the activities within the occupied spaces. With the exception of special areas, (for example manufacturing pharmacies), the requirement for aerobiological needs is not stringent and filtration is only required to:

- maintain hygienic conditions for the health and welfare of occupants, or for processes such as food preparation;
- protect finishes, fabrics and furnishings; to reduce redecoration costs;
- protect equipment either within the supply air system that is, to prevent blocking of coils, or in the space itself to prevent dust collection.

3.13 Given that almost all viable particles will originate from the occupants of a space and not from the incoming air, dilution is the more important factor aerobiologically. Therefore, for general areas a G4 filter will be suitable. More critical areas will require a F7 filter. HEPA filters will only be required in Ultra Clean systems.

Humidity control requirements

3.14 Providing humidification is expensive in terms of plant, running costs and maintenance, and therefore its use should be restricted to where it is necessary for physiological or operational reasons.

3.15 Humidification was originally required for some healthcare applications e.g. operating theatres, in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased. Humidification is therefore no longer required unless there is a very specific application requirement.

Maximum noise levels

3.16 Noise will be generated in an air distribution system by the fan, ductwork fittings, dampers and grilles. The specified maximum noise level will depend on the activities within the occupied spaces.

3.17 The overall noise levels should not exceed the values given in Scottish Health Technical Memorandum 08-01 – 'Acoustics', although general requirements are given in Table 3.

3.18 Attenuation should be incorporated into the ductwork system or plant arrangement as necessary to reduce noise from fans and plant items in order to achieve the acceptable limits within the rooms at the design air flows.

3.19 Plant noise should not be greater than 80 dB(A) within the plant room from the fans, coolers, heaters, humidifiers etc, when starting up or running; and should be reduced to lower noise levels where the plant is near to departments sensitive to noise.

3.20 Attention must be given to the reduction of tonal components. High tonal components from air diffusers etc. can seriously disturb concentration over longer periods even when the overall noise level is low. Broadband noise causes less annoyance. Reference should be made to SHTM 08-01 'acoustics'.

3.21 The designer requires knowledge of the total hospital layout and operational policies, to assign acceptance magnitudes to all the possible noise sources, in order to arrive at the correct rating.

Room	Overall noise level - NR	Ventilation plant commissioning - NR	Ventilation plant design - NR
Operating department	50 (55)	45	40
Ward areas	33	30	30
Sanitary facilities	45	40	35
Industrial areas	50	45	40
Circulation areas	50	45	40

Table 3: Interior noise level

3.22 In Table 3 the overall noise level takes account of all internal and external noise sources. The commissioning noise level is the level measured with a sound level meter in the unoccupied room, taking account of the external noise together with the noise generated by the ventilation system. When occupied and in use, this commissioning level will constitute a continuous background noise which will allow the overall noise level to be achieved. The ventilation plant design noise level is that generated by the plant alone with no other noise source being considered. The levels suggested make recognised allowance for the ingress of environmental noise which must be considered in the overall design, that is, in specifying the attenuation of walls, partitions, ceilings, etc.

3.23 The recommended criterion is measured as the “A” weighted sound pressure level expressed in decibels, which should not be exceeded for more than 10% of the time.

3.24 The designer must also consider noise escaping to the external environment and this must not be unacceptable to occupants of adjacent buildings.

Calculation of building loads

Air infiltration

3.25 Air infiltration occurs due to a complex combination of wind pressure, thermal effects, location relative to other features and the construction standard of the building. The infiltration rate is governed by the size and number of openings in the building envelope and the complexity of internal air paths.

3.26 CIBSE Guide A; (2006) Section 4 provides information and formulae for the calculation of air infiltration and natural ventilation of buildings. In all cases the requirements of the appropriate section of the Building Regulations must be met.

Summertime temperatures

3.27 The calculation method for determining the summertime temperature is described CIBSE Guide A; Section 5. However, it is very important to select the time of day and time of year of peak loadings for the calculations, which is dependent upon the orientation and proportion of solar to total heat gain. In establishing outside design values, the design risk having regard to the function and occupancy of the building should be considered.

3.28 Where calculations indicate that internal temperatures will frequently exceed the selected design external shade temperature by more than 3K for a period that exceeds the building design risk, methods of reducing temperature rise should be implemented. Options include;- reducing solar and casual gains, the use of chilled beams or ceilings, increasing ventilation rates or providing mechanical cooling. In some situations it may be possible to alter the thermal mass of the structure to ‘move’ the peak temperature event time so that it occurs outside of the occupancy period. Calculations and thermal modelling should be undertaken to ensure that during the summertime internal temperatures in patient areas do not exceed 28^{o}C dry bulb for more than 50 hours per year. It has been found that there is a relationship between preferred indoor temperatures and mean outside temperature. Fig A2 in CIBSE Guide A indicates this relationship.

Peak heating load

3.29 Peak heating local calculations are necessary on all mechanical supply systems to establish the size of heater batteries and subsequently the central plant.

3.30 Where ventilation systems provide tempered air to spaces which have supplementary LPHW to offset the building fabric losses, the plant heating load should be calculated based on the external winter design temperature, the design internal air temperature, and the calculated total air volume (including a suitable allowance for leakage).

3.31 Where the ventilation system is the only means of heating a space, an increase in load equivalent to the calculated fabric heat losses from the space should be added to the ventilation load. A check of supply temperature difference should be made. If it exceeds 10K the ventilation supply volume should be increased to suit.

Condensation risk

3.32 A check should be made to ensure that the selected air condition will not lead to surface condensation on low-temperature elements of the ventilated space.

3.33 Where there are local sources of moisture that would require excessive levels of ventilation to avoid condensation, the designer should consider the capture and removal of moisture at the source of the evaporation via an exhaust hood or similar device.

3.34 In intermittently heated buildings, it is necessary to consider the condensation risk at night set-back conditions as well as during normal operation. Calculation methods for this assessment are given in CIBSE's Guide A.

Peak cooling load

3.35 In addition to the base data of air flow rates and temperatures, when calculating cooling loads, the designer must take into account:

- solar cooling loads;
- surface conduction cooling loads;
- internal gain cooling loads;
- cooling loads due to high-level humidity control;
- method of control of internal conditions;
- fluctuations in internal temperatures.

3.36 When the peak internal loads have been assessed and a suitable allowance made for non-coincidence, the supply temperature can be calculated.

3.37 Once the lowest required supply temperature of the air handling unit has been established, and an allowance made for temperature rise through the fan and ductwork (usually 1K for low pressure systems), the off-plant enthalpy can be established from a psychrometric chart or table.

3.38 The cooling loads for all plants on the chilled water system should be calculated at each of the individual peak times in order to establish accurately the required (diversified) capacity of the chiller.

Annual energy consumption

3.39 Annual energy consumptions of simple heating-only ventilation systems are simple to calculate, based on supply-to external air temperature rise, and frequency of occurrence of external temperatures as given in CIBSE Guide A.

3.40 Minimum air volumes are usually fixed by the room loads or fresh air requirements. However, the designer may increase air flow to some rooms or zones in order to balance loads, as detailed in the paragraphs on “Calculation of plant requirements.”

3.41 The method of zoning and control can significantly influence energy consumption.

3.42 The nature of air-conditioning operation, that is cooling and reheating for humidity or zonal temperature control, makes prediction of energy consumption very complex. It is imperative that these calculations are performed to ensure optimum energy efficiency.

3.43 The concept of load and plant operation charts is outlined in the CIBSE Guide A. The method requires the designer to establish the minimum and maximum loads on all zones across the range of external temperatures between winter and summer design conditions. Once the load chart is complete, the plant chart converts the loads to supply temperatures, which are then superimposed on external air temperatures.

3.44 When all temperatures for all zones are plotted on the plant operation chart, set points and resetting schedules can be established. From this information, the outputs of individual heaters, coolers and humidifiers can be established at any given external temperature. When those loads are computed against annual frequency of occurrence of external temperatures as given in CIBSE Guide A, the annual energy consumption of individual elements, and thus the air-conditioning system, can be established.

3.45 In order to prevent surface condensation occurring, it is necessary to provide sufficient ventilation to maintain the maximum and ambient dew-point temperature below the lowest surface temperature, the coldest usually being the glazing. Paragraphs 3.33 and 3.34 also refer.

Calculation of plant requirements

Air supply volumes

3.46 The minimum air supply volume for a room is determined by the greatest of the three criteria, viz:

- the minimum fresh air requirement;
- the minimum supply volume for the room load as determined by the maximum heating or cooling supply temperature differential;
- the desired/required air change rate.

Plant sizing

3.47 Once the design air flow has been established the cross-sectional area of the air-handling unit can be calculated based on a maximum coil face velocity of 2.0 m/s.

3.48 In order to establish the length of the air-handling unit, it will be necessary to refer to manufacturers' literature, ensuring all necessary access panels and components are included as detailed in Chapter 4.

3.49 The fan duty should be calculated by adding the resistances of all elements which contribute to the pressure drop of the index circuit.

3.50 The main elements which must be considered are:

- inlet or discharge louvres;
- plant entry and discharge;
- attenuators;
- components within the air-handling unit;
- duct-mounted heaters and filters (including a dust allowance);
- ductwork distribution;
- ductwork fittings, including: fire dampers, volume control dampers, bends and sets, tees, changes of section;
- air terminal device;
- discharge velocity.

3.51 Where packaged air-handling units are installed, the fan pressure drop is usually quoted as external plant resistance, and thus the designer does not need to calculate the resistances of individual plant items. The designer should, however, ensure that an allowance has been made for filter clogging; and confirm whether the fan pressure quoted is fan total or static pressure.

3.52 Resistances of ductwork and fittings may be obtained from the CIBSE Guide A. However, the designer should exercise some care when using tabulated pressure loss information for fittings which are relatively close together.

3.53 Upon completion of the resistance calculation exercise, the designer should make allowances for calculation and construction tolerances as indicated in Table 4.

Criteria	Low pressure systems	Medium/high pressure systems
Volume flow rate margin for leaking and balancing requirements	+5%	+5%
Total pressure loss margin A. for increase in volume flow rate (above)	+5%	+5%
B. for uncertainties in calculation	+5%	+10%
Combined total pressure loss margin	+10%	+15%

Table 4: Typical fan volume and pressure margins

Plantroom size and location

3.54 The ventilation plant and associated equipment should be positioned to give maximum reduction of noise and vibration transmitted to sensitive departments; while at the same time, achieve an economic solution for the distribution of services.

3.55 It is not recommended that noise and vibration generating plant be housed either directly above or below sensitive areas (for example, operating or anaesthetic rooms) unless there is no alternative, in which case, additional care and attention must be given to the control measures.

3.56 The plant must also be located so that it is remote from possible sources of contamination, heat gains and adverse weather conditions. The design should ensure that wind speed and direction have a minimal effect on plant throughput.

3.57 Safe access to and around plant is essential to facilitate inspection, routine maintenance, repair and plant replacement.

Provision of primary services

3.58 Where more than one air-handling plant requires cooling, remote central cooling plants with piped chilled water are preferred. In the case of a single plant, a multi-stage direct expansion cooling coil with refrigerant piped from an adjacent compressor/condensing plant could be considered. If this option is selected, a refrigerant gas detector mounted in the base of the duct and an alarm system audible to the end-user will also need to be provided (COSHH regulations).

3.59 Clean dry steam is preferred for humidification, provided that the boiler water treatment does not render the steam unusable for direct humidification.

3.60 If a suitable supply of steam cannot be obtained from the steam main, a steam generator should be provided locally, or a self-generating humidifier installed. Electric humidifiers require considerable electrical loads and if a gas supply can be derived, this would be preferable. The location of a local steam generator is critical if condensate is to drain back into it.

Inlet and discharge sizing and location

3.61 Air intakes and discharge points should preferably be located at high level, to minimise the risks of noise nuisance to surrounding buildings, contamination and vandalism.

3.62 Intakes and discharges should be designed and located so that wind speed and direction have a minimal effect on the plant throughput.

3.63 Helicopter landing pads in the vicinity of ventilation intakes and discharges can result in large short term pressure changes. This can cause pressure surges in supply systems and reverse air flows in extracts. Exhaust fumes from the helicopter may also be drawn into intakes.

3.64 Intake points should be situated away from cooling towers, boiler flues, vents from oil storage tanks, fume cupboards and other discharges of contaminated air, vapours and gases, and places where vehicle exhaust gases may be drawn in.

3.65 Where intakes have necessarily to be sited at or near ground level, the area around them should be paved or concreted to prevent soil or vegetation being drawn in. They should also be caged or located within a compound to prevent rubbish being left in the vicinity. The likely proximity of vehicle exhausts should also be taken into account when determining the protected area around the intake.

3.66 The discharge from an extract system must be located so that vitiated air cannot be drawn back into the supply air intake or any other fresh-air inlet. Ideally, the extract discharge will be located on a different face of the building from the supply intake(s). In any event, there must be a minimum separation of 4 metres between them, with the discharge mounted at a higher level than the intake.

3.67 Discharges from LEV systems should preferably be vertical and usually not less than 3m above roof level. They should not be fitted with a cowl that could cause the discharge to be deflected downwards.

3.68 Each intake and discharge point should be fitted with corrosion-resistant weatherproof louvres or cowls to protect the system from driving rain. Louvres should be sized based on a maximum face velocity of 2 m/s in order to prevent excessive noise generation and pressure loss.

3.69 The inside of the louvres should be fitted with a mesh of not less than 6 mm and not more than 12 mm to prevent infestation by vermin.

3.70 The duct behind louvres should be self-draining. If this is not practicable, it should be tanked and provided with a drainage system.

3.71 Cleaning access must be provided either from the outside via hinged louvres or by access doors in the plenum behind the louvre. Where a common plenum is provided, cleaning access should be via a walk in door.

Heat rejection devices

3.72 The design conditions given in Chapter 2 make no allowance for the elevated temperatures that can occur on the roof of buildings. Refrigeration condensers and cooling towers should, if practicable, be shaded from direct solar radiation, or the design adjusted to take account of the gain.

3.73 Air-cooled condensers must always be the first choice for heat rejection from any refrigeration plant. Evaporative cooling systems must not be used in healthcare premises unless limitations of space mean that they are the only way that the cooling load can be met. If they are used, national guidance on preventing and controlling *legionellae* must be closely followed.

3.74 Reference should be made to Scottish Health Technical Memorandum 04-01: 'The Control of *Legionella*, hygiene, 'Safe' hot water, cold water and drinking water systems, Part A: Design, Installation and Testing, and Part B: Operational Management, published by Health Facilities Scotland, 2010.

4. Air handling unit design and specification guidance

General requirements

Location and access

4.1 Air-handling units should be located in an accessible area secured from unauthorised entry. Siting units in ceiling voids above occupied spaces is not appropriate.

4.2 Units located on roofs must have a safe means of access together with suitable precautions to prevent personnel or equipment falling or being blown off during maintenance activities.

4.3 Units located at ground level should be secured within a compound to prevent unauthorised access. Measures should be taken to exclude vehicles from the vicinity to ensure that exhaust fumes will not be drawn into intakes.

4.4 Units may have a working life of 20 to 25 years. It can be anticipated that over this period there will be a need to access every element within the unit for deep cleaning. It is also quite possible that the main fan and individual heater and chiller batteries will need replacement. Suitably positioned service connection joints and adequate spacing should permit these items to be withdrawn without the need to dismantle other installed plant or equipment. Batteries which are significantly wider than 1metre should be split to permit withdrawal from both sides.

4.5 It is essential that air-handling units are positioned so that all parts are easily and safely accessible for routine inspection and service. If a unit is located against a wall or backs onto another unit then access to all parts must be available from the front. Units greater than 1metre wide should preferably have access from both sides or access doors large enough to permit the full and safe entry of maintenance personnel.

4.6 Water may be used during routine cleaning or spilt when maintenance is being undertaken. The area around the unit should be tanked to prevent water penetration to adjacent areas and adequately drained.

4.7 Fire precautions should be incorporated in accordance with Firecode. Guidance is available in BS5588: Part 9 and Sections 5 & 6 of this document.

4.8 Combustion equipment must not be located in a fire compartment that houses air handling equipment.

4.9 The basic technical requirements of the whole of the ventilation system should meet the relevant clauses of the Health Technical Specification. It should be noted that the Specification contains a menu of clauses that cover a wide range of applications, so it is important to select only those that are relevant to the specific application.

Note 1: At the time of writing, Health Technical Specification C04 was due for revision in order to bring it into line with the revised standards as set out in this Scottish Health Technical Memorandum. Where conflicts in specification arise, the Scottish Health Technical Memorandum takes precedence.

4.10 It is essential that the main plant/ductwork is located far enough above the floor to permit the correct installation of drainage systems for cooling coils, humidifiers and heat recovery systems. Easy access for maintenance of drainage systems and their associated pipework must be provided.

4.11 Organic materials or substances that can support the growth of micro-organisms must not be used in the construction of the plant or its distribution system. The water fittings and materials directory lists suitable materials for sealants and gaskets.

4.12 The plant and its distribution system must not contain any material or substance that could cause or support combustion.

4.13 Plants should have a high standard of air-tightness. The double-skin method of construction with insulation sandwiched between two metal faces is recommended. The panels may be available in a variety of colours at no additional cost. This can aid identification by colour-coding of units in a plant room, e.g. green for general ventilation; blue for theatres; red for laboratories and isolation facilities; grey for extract etc.

4.14 The inside of the plant should be as smooth as possible. Channels, rolled angles or formed sections that could trap or hold moisture should be kept to a minimum. If stiffeners are required, they should be fitted externally. If internal bracing has to be fitted it must be of a design that will not trap or hold moisture.

4.15 Airflow across air treatment components such as filters, heat exchangers and humidifiers will be influenced by the pattern of the approaching airstream. If unsatisfactory conditions are created, the performance of the component will be reduced.

4.16 Access to items that require routine service such as filters, frost batteries and chiller batteries should be via hinged doors. The doors should be large enough e.g. 450mm minimum to allow easy access. Items requiring infrequent access such as attenuators may be via bolted on, lift off panels. All doors and panels should be close fitting and without leaks.

4.17 Care should be taken during installation to ensure that electrical and mechanical services are not installed in positions that will reduce or impede access.

4.18 It can be difficult to turn off AHUs in order to inspect filters and drainage trays. Viewing ports and internal illumination will therefore facilitate routine inspection of such items. Viewing ports should be at a convenient height so that temporary ladders are not required. Internal illumination should be provided by fittings to at least IP55 rating. Fittings should be positioned so that they provide both illumination for inspection and task lighting. All of the lights in a unit should be operated by a single switch.

4.19 Access to AHUs and items in the distribution system such as filters or heater / chiller batteries should be via fixed ladders and platforms or pulpit style moveable steps. The installation of distribution ductwork and other electrical or mechanical services should provide sufficient clearance to allow the pulpit steps to be easily wheeled into position.

AHU drainage system

4.20 All items of plant that could produce moisture must be provided with a drainage system. The system will comprise a drip tray, glass trap, air break and associated drainage pipework.

4.21 The drip-tray should be constructed of a corrosion-resistant material (stainless steel is preferred) and be so arranged that it will completely drain. To prevent 'pooling', it is essential that the drain connection should not have an upstand; and that a slope of approximately 1 in 20 in all directions should be incorporated to the drain outlet position. The tray must be completely accessible or, for smaller units, easily removable for inspection and cleaning.

4.22 Each drip tray should be provided with its own drain trap. The drain trap should be of the clear (borosilicate) glass type. This permits the colour of the water seal to be observed thus giving an early indication of corrosion, biological activity or contamination within the duct. The trap should have a means for filling and incorporate couplings to facilitate removal for cleaning. It should be located in an easily visible position where it will not be subject to casual knocks. The pipework connecting it to the drainage tray should have a continuous fall of not less that 1 in 20.

4.23 Traps fitted to plant located outside or in unheated plant rooms may need to be trace heated in winter. The trace heating must not raise the temperature of water in the trap above 5^{o}C.

4.24 Water from each trap must discharge via a clear air gap of at least 15mm above the unrestricted spill-over level of either an open tundish connected to a foul drainage stack via a second trap, or a floor gully (or channel). A support should be provided to ensure that the air gap cannot be reduced. More than one drain trap may discharge into the tundish providing each has its own air break.

4.25 Drainage pipework may be thermoplastic, copper or stainless steel. Glass should not be used. The pipework should be a minimum diameter of 22 mm and a fall of at least 1 in 60 in the direction of flow. It should be well supported and located so as not to inhibit access to the AHU.

Layout of air handling unit

4.26 The AHU should be arranged so that the majority of items are under positive pressure. Any item of plant requiring a drain should be on the positive pressure side of the fan. A recommended layout is given in schematic from in Figure 1.

4.27 A separate extract unit will generally be required for the area served by each supply unit.

4.28 An energy recovery system will normally be fitted between the supply and extract units.

Provision of dampers

4.29 Fire or smoke dampers shall be provided at the locations required by Firecode. (See paragraphs 5.17 to 5.21).

4.30 Motorised low leakage shut off dampers should be located immediately behind the intake and discharge of each supply and extract system respectively. They should be of the opposed blade type, opening through a full 90^{o} and must close automatically in the event of power failure or plant shutdown to prevent any reversal of the system airflow.

4.31 The quality of motorised dampers is critical. They should be rigid, with square connections fitted with end and edge seals of a flexible material and with minimal play in linkages. The leakage on shut-off should be less than 2%.

4.32 A manually operated isolating damper should be installed between the main AHU and its distribution system to enable the unit to be isolated when cleaning is in progress.

4.33 Good practice will require the fitting of a main volume control damper so that the design airflow rate can be set at commissioning. The damper should be lockable in any position. If it will also be used for plant isolation, it should be capable of being reset to give the design airflow without the need for re-measurement.

4.34 Internal plant isolating dampers or provision for the fitting of shut-off plates between items within a unit are not required.

Vibration

4.35 Vibration from a remote plantroom can be transmitted by the structure of the building, may be regenerated and may sometimes be magnified many times. Units should be selected to have the minimum vibration generation and installed on suitable anti-vibration mounts. Pipe and ductwork should incorporate anti-

vibration couplings, preferably in two planes at right angles, as close to the vibration source as possible. Consideration should be given to the use of anti-vibration pipe hangers and supports.

Sequence of components

4.36 The following arrangement of plant components is typical although in many instances not all elements will be required:

- fresh air intake;
- motorised isolation damper;
- frost / fog coil;
- pre-filter;
- energy recovery device;
- attenuator;
- fan;
- blast plate;
- attenuator;
- chiller battery;
- eliminator;
- heater battery;
- humidifier;
- final filter;
- isolation / volume control damper.

Note 2: Attenuators may be located in the intake and discharge duct if they are of a suitable type (See clause paragraphs 4.159 to 4.162)

There may be instances where the above arrangement is not appropriate and the plant arrangement should be planned accordingly.

Fans

General requirements

4.37 The fan should be selected for good efficiency and minimum noise level, but the overriding factor should be the selection of a fan characteristic such that the air quantity is not greatly affected by system pressure changes due to filters becoming dirty or external wind effects.

Acceptable types

4.38 Fans can be of the axial, centrifugal, cross flow, mixed flow or propeller type, depending upon the requirements of the system.

4.39 Where used, centrifugal fans should preferably be of the backward blade type, and give an efficiency of not less than 78%. Alternatively, where noise levels are more critical and pressure requirements are lower, forward curved blade fans are acceptable. For high power applications, aerofoil blade fans may be appropriate.

Selection

4.40 Generally, large ventilation systems will use centrifugal fans due to their efficiency, non-overloading characteristics, and developed pressures.

4.41 Forward curved centrifugal fans can overload if allowed to handle more air than they are designed for.

4.42 Alternatively, it may be appropriate to use mixed flow fans in high pressure systems.

4.43 Axial flow or propeller fans are generally only used in local through-the-wall systems, or systems with very low pressure requirements.

4.44 Cross-flow fans have very low operating efficiencies, and thus their use is restricted to applications such as fan coil units.

Location and connection

4.45 Fans are normally positioned to ‘blow through’ the central plant so that the cooling coil and humidifier drains will be under positive pressure.

4.46 The fan performance figures given by manufacturers in their catalogue data are based on tests carried out under ideal conditions, which include long uniform ducts on the fan inlet/outlet. These standard test connections are unlikely to occur in practice, the designer should therefore ensure as far as is practical that the fan performance will not be significantly de-rated by the system. This objective can be approached by ensuring that the fan inlet flow conditions comprise uniform axial flow velocities with low levels of turbulence.

4.47 Where the outlet duct is larger than the fan discharge connections, there should be a gradual transition, with a following section of straight duct, having a length equivalent to three duct diameters.

4.48 The design of the fan intake connection must be carefully considered to avoid swirl in the airstream. When the air spins in the same direction as the impeller, the performance and power consumption of the fan are reduced. When the air spins in the opposite direction to the impeller the power consumption and noise will increase with hardly any pressure increase. Airstream swirl is usually

induced by large variations across the fan intake caused by the air passing round a tight bend immediately before the intake.

4.49 Where a centrifugal fan is located with an open intake, the clear distance between the suction opening and the nearest wall should be not less than half the diameter of the inlet. If two fans with free inlets are positioned within the same chamber, their adjacent suction openings should be at least 1 diameter apart.

4.50 Airtight flexible joints should be provided at fan inlet and outlet connections. They should be equal in cross-section to the points of connection and not longer than 200mm or shorter than 100 mm.

4.51 For centrifugal fans, a diffuser screen / blast plate should be fitted immediately downstream of their discharge.

Supply fan drive arrangements

4.52 Where the fan drive is via a motor driven belt and pulley, it should be external to the air stream. This arrangement has the following advantages:

- the fire risk is reduced;
- the drive is visible so it is simple to check that the belt is still there;
- particles shed from the drive belt are outside of the air stream;
- if the belt slips, the “burning rubber smell” is not transmitted down into occupied areas of the premises;
- noise generated by the motor and drive will not be transmitted along the ductwork;
- waste heat is excluded from the system;
- the drive may be through a vee or toothed belt and pulley. The latter have the advantage of eliminating belt squeal on start up and have a longer service life. They are particularly suitable where the fan drive motor is fitted with a soft start and should be located external to the air stream.

4.53 The drive train should be easily visible without the need to remove access covers. Protecting the drive train with a mesh guard is the preferred option. For weatherproof units designed to be located outside, the fan drive will be external to the duct but enclosed. It should be easily visible through a viewing port with internal illumination and access via a lockable hinged door.

4.54 For direct coupled fan and motor units, the motor should be out of the air stream.

4.55 For induction drive ‘plug’ motor arrangements (where the motor is fitted within the fan and is integral to it) and in line axial fans with a pod motor; the fan / motor combination may be within the air stream **provided** the motor windings are protected from over temperature by a thermister and lockout relay.

Extract fan drive arrangements

4.56 The preferred method where the fan drive is via a motor driven belt and pulley arrangement will be to locate it external to the air stream.

4.57 The fan drive and motor may be located inside the duct within the air stream **provided** the motor windings are protected from over temperature by a thermister and lockout. The drive train should be easily visible through a viewing port, have internal illumination and access via a lockable hinged door.

4.58 Where the system air is explosive, aggressive or has high moisture content, the extract fan motor must be located outside the air stream. This is generally achieved with axial fans by using a bifurcated unit.

Control

4.59 Fans in healthcare applications are normally either single or two-speed. Where there is a requirement for two-speed operation, this is generally via a local user control (for example, in a hood extract system to provide a boost facility) or via a time schedule for energy saving during unoccupied periods.

4.60 Normally only a single motor is required with a standby motor available for fitting as necessary or fitted but not belted. Twin, run and standby motors with the standby being jockeyed around are not required.

4.61 Where there is a specified requirement for stand-by fans, the system should incorporate an automatic changeover facility activated via an airflow sensor. Fault indication should be provided.

4.62 The control of fans in terms of start up and run is increasingly being vested in computer software. Inverter drive, variable speed, soft start systems are becoming a standard approach. It should be remembered that most healthcare applications require known amounts of air to be delivered while the system is in use. Constant volume systems that deliver specified air change rates are therefore the norm. Duct or room pressure controlled, variable speed systems have a very limited application in healthcare.

4.63 It is necessary to ensure that should the computer control system or its software develop a fault then the fan can be switched to a direct start, fixed speed, manual operation. This is particularly important for critical care systems serving operating suites, high dependency care units of any type, patient isolation facilities, laboratories and pharmaceutical production suites. Off site software support is no substitute for the ability of on site staff to override the automatic control and keep the system operating in an emergency. Under these circumstances actions that may shorten the life of the plant are considered of secondary importance to that of preserving the health and safety of patients and staff.

Heater batteries / heater coils

General requirements

4.64 Frost batteries are installed to protect the downstream filters from low temperature, high humidity intake air conditions. As they handle unfiltered air they should be constructed of plain tubing without fins and be as near to the outside as possible to minimise condensation during cold weather. Access for cleaning will need to be provided to both sides of the coil.

4.65 Where steam coils are used for a frost battery, they may be constructed using spiral fined copper tube. As they will be prone to fouling the tube layout and spacing should permit easy access for regular cleaning.

4.66 Main and branch heater batteries should be constructed of solid drawn copper tube coils with copper fins, generally connected in parallel.

4.67 Where there is a wet heating system in the areas served, the main heater battery should be sized for the ventilation requirements only, and not for the fabric loss.

4.68 Access for cleaning must be provided to both sides of all frost batteries and heater batteries.

Acceptable types

4.69 Electric, water or steam heater batteries may be considered. However, electric heater batteries are expensive to operate and where there are alternatives, their use should be restricted to low power use, for example trimming control.

4.70 Where steam supplied heater batteries are used, their control, venting and trapping systems should be designed so that a vacuum cannot occur within the coil. The condensate drainage arrangements should not allow pressure to build in the main resulting in a back up of condensate in the coil.

Location

4.71 Where possible, wet trimmer heater batteries should be located in plant areas.

4.72 Where it is necessary to locate heater batteries in false ceilings etc, consideration should be given to the use of electric heaters. If this is not practicable, drip-trays should be installed under both the battery and the control valve assembly to protect the ceiling. A moisture sensor and alarm should be fitted in the tray. In any event, to facilitate maintenance access, they should be located above corridors or other non-critical areas and never above patient occupied spaces.

4.73 Auxiliary fan coil units should not be installed in the ceiling above an occupied space. They should be accessible for routine maintenance and cleaning without the need to cause significant disruption to the operation of the department that they serve.

Control

4.74 LPHW frost coils should be controlled by an off-coil temperature sensor operating a motorised valve to provide a minimum plant "on temperature" of between 2°C and 5°C. The off-coil temperature of the frost coil is generally sensed by a serpentine thermostat downstream of the coil or upstream of the next plant item. This thermostat will shut the fan down if any part of the air stream is below the minimum set-point.

4.75 Steam supplied frost coils should be fitted with an on/off control operated by a temperature sensor mounted upstream of the battery. These are normally set to open the control valve fully when the outside temperature drops to +1°C. This will ensure that there is no standing condensate in the base of the coil.

4.76 The main heater battery should be controlled in the same manner under the dictates of either an off-coil temperature sensor, or a room temperature sensor, depending on the plant configuration and method of control. Trimmer heater batteries are generally controlled by one or more averaging temperature sensors within the room or rooms in the zone.

4.77 Heater battery control valves should drive closed on system shutdown or fan failure. The control system should then automatically set to provide frost protection.

Cooling coils

General requirements

4.78 Cooling coils will need to be decontaminated periodically. They must have good access both up and downstream. Hinged access doors with viewing ports and illumination inside the duct should be provided both sides of the coil.

4.79 An eliminator will be required downstream of all cooling coils. The eliminator may take the form of an extension of the coil fins or be a separate device. If a separate device it should be removable as a unit to permit cleaning of the coil face.

4.80 All cooling coils must be fitted with their own independent drainage system as specified above. A baffle or similar device must be provided in the drip tray to prevent air bypassing the coil. The tray should be large enough to capture the moisture from the eliminator, bends and headers.

4.81 Where coils are greater than 1m high, intermediate drip-trays will be required.

Selection

4.82 Cooling coils supplied with chilled water are the preferred option. For small loads or where chilled water is not available, direct expansion coils may be used.

4.83 Care must be taken in selection to minimise electrolytic action resulting from condensation on the air side. Coils constructed from copper tubes with copper fins extended on the downstream side in the form of an eliminator, and electro-tinned after manufacture are preferred. Aluminium fins should only be used if vinyl-coated.

4.84 All parts of the coil and its associated ductwork in contact with moisture must be manufactured from corrosion-resistant materials. Pressed steel coil headers, even if treated, have been shown to be prone to corrosion over time and should not be used. Steel mounting frames and casings present similar problems so stainless steel is preferred.

Location

4.85 Micro-organisms which multiply in moisture cannot be avoided when the coil is dehumidifying, but the risk of infection will be reduced by locating the final filter downstream of the coils.

4.86 Cooling coils in AHUs should be located upstream of the final filter.

4.87 Where any cooling coil has to be located above a ceiling, drip-trays should be installed under both the coil and the control valve assembly to protect the ceiling. A moisture sensor and alarm should be fitted in the tray. To facilitate maintenance access, they should be located above corridors or other non-critical areas and never above patient occupied spaces.

Control

4.88 There are two basic methods of control for cooling coils:

- off-coil control – used in multi-zone systems or single-zone systems where close humidity control is required, to provide a constant maximum off-plant condition which satisfies the temperature and high humidity requirements of the zone with the highest load;
- sequential control – used in single-zone systems, or multi-zone systems with averaging sensors where close control is not required. A room or duct temperature sensor controls the cooling coil and heater battery in sequence to maintain constant room conditions.

4.89 The advantage of off-coil control is that accurate humidity control can be provided without relying on humidity sensors, which are prone to inaccuracy and drift. Off-coil control is however, expensive to operate in terms of energy consumption, due to the fact that there is no feedback of room loads, and thus at low loads and in systems where there are large zonal variations, significant over-cooling and reheating will occur.

4.90 On systems with two-speed operating, it is usual to isolate the cooling coil upon selection of low speed. In addition, on system shutdown, low airflow or fan failure, the cooling coil must be isolated.

Humidifiers

Design need

4.91 Humidification was originally required for some healthcare applications in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased. Humidification is therefore no longer required unless there is a very specific application requirement.

4.92 Operating theatre AHUs do not generally require humidifiers but provision for their retro-fitting in terms of space provision and a capped drainage system should be provided.

4.93 Where humidification is required, it will be subject to the specific requirements set out below. These are intended to ensure that the unit will operate safely and not become a source of contamination.

General requirements

4.94 The most important requirement for a humidifier is to create complete mixing of the steam with the air; and the manufacturers' instructions should be followed regarding minimum distances, which should be allowed before bends or other components. This is particularly important with respect to a filter mounted downstream. If it becomes saturated by the humidifier, organisms can grow through the filter and be released into the duct. These may then be carried on the airstream into an occupied space.

4.95 The section of ductwork containing the humidifier may need to be periodically decontaminated. Hinged access doors with viewing ports and internal illumination should be provided. A label warning that the device emits live steam and should be isolated prior to opening should be affixed to the access door.

4.96 All parts of the humidifier and its associated ductwork in contact with moisture must be manufactured from corrosion-resistant materials. Stainless steel is preferred.

4.97 The electrodes of self generating electrode boiler type humidifiers should be stainless steel.

4.98 All humidifiers must be fitted with their own independent drainage systems as detailed in paragraphs 4.72 and 4.87 or 4.20 to 4.25.

4.99 For self-and locally-generated steam humidifiers, the cleanliness of the water supply is essential for their safe operation. Provision should be made for draining down supply pipework and break tanks for periodic disinfection and cleaning during periods when they are not required in service.

4.100 The addition of treatment chemicals for continuous control of water quality for humidifier/air handling units should be avoided. Consideration could be given to installing a UV system to control microbiological growth. Given the limitations of

UV systems, however, this will require filtration to high quality to ensure the effectiveness of exposure of organisms to the UV irradiation. As with all water treatment systems the unit should be of proven efficacy and incorporate UV monitors so that any loss of transmission can be detected.

Acceptable types

4.101 Only steam injection manifold-type humidifiers are considered suitable for use in health building air-conditioning systems. Water humidifiers of any type should not be used.

4.102 Steam may be derived from the central steam supply, or generated locally either within or adjacent to the humidifier.

4.103 The introduction of steam should be by an appliance specially designed to discharge dry steam into the air-conditioning system without objectionable noise or carry-over of moisture.

4.104 During the design stage, consideration should be given to the proposed methods for the regular cleansing of the humidifier(s) and their components.

Selection

4.105 The number and length of steam injection manifolds to be used is dependent on various factors such as duct cross-sectional area, air velocity, dry bulb temperature and manifold design. Guidance from the manufacturer should be closely followed.

4.106 A mains steam humidifier can be noisy and will be difficult to control if it is operated at an excessive steam pressure. It should be sized for an operating pressure of approximately 1 bar. The pipework supplying it should be provided with a dirt pocket, pressure reducing valve and steam trap installed as close as practicable to the humidifier, so that the steam condition at entry is as dry as possible. A temperature switch on the condensate line (or equivalent design provision by the humidifier manufacturer) should be incorporated to prevent ‘spitting’ on start-up.

4.107 Most operational problems with mains steam humidifiers arise because of back-pressure in the condensate discharge line which will result in flooding into the duct. Unless the condensate from the device can be discharged and collected at atmospheric pressure, it should be discharged directly to drain.

4.108 A local steam generator, where used, must be fed with potable quality water. Additional water treatment to the standard set out above may be required. If the humidifier is unused for a period exceeding 48 hours, it must automatically drain its water content, including that contained in the supply pipework, right back to the running main and leave itself empty.

4.109 Some steam generators are of a type that requires regular cleaning and descaling. The design must allow for them to be installed such that they can be

physically isolated from the air duct in order to prevent contamination of the supply by cleaning agents while this is taking place.

Location

4.110 Careful sitting of the humidifier injection manifold is required to prevent the steam impinging onto the side(s) of the duct, condensing and generating excess moisture.

Control

4.111 Accurate humidity control can only be provided on single-zone systems, or multi-zone systems with zonal humidifiers. In the above systems, humidity sensors control the humidifier for low-level humidity control, and override the temperature controls to open the cooling coil valve for high-limit humidity control.

4.112 Multi-zone systems are more usually controlled by a minimum humidity sensor located in the supply duct(s) following the last heater battery.

4.113 Overriding controls separate from the normal plant humidistat should be installed. Their purpose is to prevent excessive condensation in the conditioned space when starting up. A time delay should be incorporated into the humidifier control system such that the humidifier does not start until 30 minutes after the ventilation/plant start-up. In addition, a high limit humidistat should be installed to limit the output of the humidifier so that the saturation in the duct does not exceed 70%. This humidistat is to control the added moisture. It is not necessary to install a de-humidifier to reduce the humidity of the incoming air if it already exceeds 70%. The humidifier control system should ensure that the humidifier is switched off when the fan is not running.

4.114 On systems with two-speed operating, it is usual to isolate the humidifier upon selection of low speed. In addition, on system shutdown, low airflow or fan failure, the humidifier should be isolated.

Filtration

General requirements

4.115 The purpose of filtration is to reduce the level of airborne contamination in an air stream. It is generally carried out in stages.

4.116 Filters must be securely housed and sealed in well-fitting frames that minimise air by pass. Air by pass significantly reduces filter efficiency, the higher the filter grade the greater the effect. Mounting frames should be designed so that the air flow pushes the filter into its housing to help minimise air bypass. Mounting frames that withdraw so that the filter can be changed without having to reach into the unit are preferred.

4.117 Neither the filter media, nor any material used in the construction of the filters, should be capable of sustaining combustion. The filter media should be such that particles of it do not detach and become carried away by the airflow.

4.118 Filters need to be readily accessible for replacement so a hinged access door should be provided. The upstream side of the filter should be visible for inspection through a viewing port with internal illumination.

4.119 All filters should be provided with a means of visually checking the differential pressure across them. Direct-reading dial-type gauges marked with clean and dirty sectors are preferred.

4.120 A complete spare set of filters must be provided at handover.

Definition of filter terms

4.121 Particulate air filters are divided into four categories:

- general ventilation filters grades G1 to G4;
- fine filters grades F5 to F9;
- high efficiency particulate filters (HEPA) graded H10 to H14;
- ultra low particulate air filters (ULPA) graded U15 to U17.

4.122 General filters are graded in terms of their 'Synthetic dust weight 'Arrestance'. This represents the percentage of a test dust captured by a filter. 'Arrestance' provides a good indication of a filter's ability to remove the larger, heavier particles found in outdoor air. These are of a size to block finned batteries and large enough to settle out in the air distribution system.

BSEN 779 grade (Eurovent grade)	% Arrestance	Notes and typical healthcare application
G1 - (EU1)	< 65	Metal mesh grease filter
G2 - (EU2)	65 to < 80	Coarse primary filter
G3 - (EU3)	80 to < 90	Primary air intake; return air; energy recovery device protection
G4 - (EU4)	> 90	General purpose tempered air supply

Table 4a - General Filters

4.123 Fine filters are graded in terms of their 'Atmospheric dust spot Efficiency'. This is a measure of the filter's ability to remove the very fine staining particles found in outdoor air. It will indicate how 'visibly' clean a filter will keep a ventilated space. The staining particles are approximately the same size as most common bacteria so it is also a rough measure of the filter's ability to remove micro-organisms.

BSEN 779 grade (Eurovent grade)	% Efficiency	Notes and typical healthcare applications
F5 - (EU5)	40 to 60	General purpose panel / bag filter
F6 - (EU6)	60 to < 80	Basic grade bag filter
F7 - (EU7)	80 to < 90	Medium grade bag or pleated paper Conventional operating theatre supply air
F8 - (EU8)	90 to < 95	High grade bag or pleated paper
F9 - (EU9)	> 95	Basic HEPA filter – Level 8 clean rooms

Table 5 - Fine Filters

4.124 High efficiency filters (HEPA and ULPA) are graded in terms of their ability to capture their 'Most Penetrating Particle Size' (MPPS). High-efficiency filters self select the particle that they are least able to trap, hence the MPPS. They are then tested against that size of particle. These filters are designed to provide very high-efficiency filtration of particles in the sub-micron size range.

BSEN 1822 grade (Eurovent grade)	% Efficiency @ MPPS	Notes and typical healthcare application
H10 - (EU10)	85	
H11 - (EU11)	95	
H12 - (EU12)	99.5	Orthopaedic theatre UCV terminal
H13 - (EU13)	99.95	
H14 - (EU14)	99.995	Pharmacy aseptic suite Category 3 room extract
U15 – U17	-	Not generally used in healthcare

Table 6 - High Efficiency (HEPA) Particulate Filters

Selection primary filters

4.125 All filters should be of the dry type. Panel filters are cheap and disposable with relatively low dust-holding capacity. They are generally used as pre-filters to eliminate large particles which would otherwise clog or cause damage to the fan and finned heating and cooling batteries. Stainless steel frames that hold disposable pre-cut filter pads are preferred.

4.126 General ventilation supply plant should incorporate primary air filters of grade G3, sized for a maximum face velocity of 2.0 m/s. Additional coarse pre-filters may be justified where the intake air is exceptionally polluted. They are sometimes fitted as a temporary measure when building work is being carried out in the vicinity of the air intake.

Secondary filters

4.127 Where a higher standard of filtration is required, secondary bag or pleated paper panel filters would be used. Rigid frame filters incorporating pleated paper elements are preferred over bag filters for critical care applications such as operating theatres.

4.128 In urban or other areas of high atmospheric pollution, a higher standard of filtration may be justified to reduce the level of staining to internal finishes.

Extract air filters

4.129 Extract filtration will generally only be required where heat-recovery devices are installed. There are a very limited number of specialised applications (microbiological safety cabinets and similar LEV systems) where contaminated air is required to be filtered prior to discharge to atmosphere. If it is safe for staff to work in a room without wearing respiratory protective equipment, it is safe to discharge the room air to atmosphere without filtration.

Return air filters

4.130 They are used to reduce the load on HEPA filters in re-circulating applications such as Ultra Clean operating suite ventilation canopies and pharmacy aseptic suites.

High efficiency filters – HEPA and ULPA

4.131 HEPA filters are expensive so their use should be kept to a minimum. Applications requiring HEPA filters include the air supply to aseptic suites in manufacturing pharmacies, the discharges from microbiological safety cabinets and isolation facilities.

4.132 If used HEPA filters should be of the replaceable panel type with leak-proof seals. They should be installed in a manner that permits on-site validation of the filter and its housing. This may involve the release of a Dispersed Oil Particle (DOP) challenge smoke through an injection point upstream of the filter and a measurement of the DOP penetration across the downstream face. Alternatively a particle counting method may be used.

4.133 HEPA filters are sometimes fitted in extract systems to capture hazardous substances or organisms. Design provision must be made for the subsequent safe handling of contaminated filters by maintenance staff. This may be achieved by:

- sealing the hazardous substance into the filter before it is removed;
- providing a system to fumigate the filter to kill any organisms;
- housing it in a ”safe change” unit that permits the filter to be ejected into a bag and sealed without staff having to come into direct contact with it.

4.134 In view of the costs and problems associated with placing HEPA filters in extracts, it is recommended that a full risk assessment be carried out at the design stage. This should include defining the true need for HEPA filters in an extract; validation of its performance at installation; the method of safely changing a contaminated filter; and its subsequent disposal.

4.135 ULPA filters are very expensive and are designed to remove particles below a size that are either surgically or aero biologically significant. There would have to be exceptional circumstances in order to justify their use in healthcare ventilation systems.

Activated carbon filters

4.136 Activated carbon filters are able to remove gases and vapours from an air stream and are graded according to the range of substances they can remove. They are not normally fitted in air-conditioning supply systems.

4.137 They are occasionally fitted retrospectively because the main air intake has been poorly sited and is drawing in traffic fumes. Where used they must be protected by a particulate air filter.

4.138 Activated carbon filters are more commonly used in specialised fume extraction systems when the location of the discharge means that dilution cannot be relied upon to disperse noxious fumes.

Location

4.139 The primary filter should be positioned on the inlet side of the supply fan, downstream of the frost coil. The secondary filter, when fitted, should be on the positive-pressure side of the fan. This will prevent air being drawn into the system after the filter and capture any particles shed by items of equipment within the AHU.

4.140 The filter installation must be arranged to provide easy access to filter media for cleaning, removal or replacement, with side or front withdrawal as required.

Control

4.141 Differential pressure transducers should be provided to monitor and alarm remotely on excessive filter pressure drop. In critical areas dirty filter indication lights should be provided at the point of use.

Energy recovery

General requirements

4.142 Energy recovery will normally be fitted to all healthcare ventilation systems. It may be omitted only where it would clearly be uneconomic. Where the economic case is marginal, space should be allowed for the retro fitting of an energy recovery system.

4.143 For systems in healthcare premises, a plate heat exchanger or ‘run-around coil’ system is suitable. Thermal wheels may be used providing they are fitted with a purge sector. The small amounts of air leakage across those devices are not considered significant. Other systems such as heat pumps or heat pipes are also suitable. Selection should be based on relative locations of the supply and

extract units, ease of maintenance and practicality. Cleaning access will be required to both sides of any energy-recovery device.

4.144 The following are the minimum energy transfer efficiencies required for devices handling equal air volumes:

Run around coil – 45%;

Plate heat exchanger – 50%;

Thermal wheel – 65%;

Any other energy recovery device – 50%.

4.145 If a plate heat exchanger is chosen, the plates should be constructed of metal. Plastic should not be used for internal bypass dampers and drive gears.

4.146 Whichever energy recovery device is chosen the extract side will need to be protected by a G3 filter and provided with a drainage system as described in Section 4; Paragraphs 4.20 to 4.25, to remove condensate.

Location

4.147 Energy recovery devices should be located downstream of the frost battery and prefilter, prior to the cooling coil or main heater battery on the supply side.

Control

4.148 It is essential to consider the control of both the energy recovery device and the frost battery when assessing the economics of recovery, as all energy provided by the frost battery will directly reduce the heat exchange of the recovery device. To this end, the off-coil setting of the frost coil should be the minimum possible to protect the primary filter; e.g. +2^{o}C.

4.149 The energy recovery device should be controlled in sequence with the main heater battery, and should incorporate a control to prevent the transfer of unwanted heat when the air-on condition rises above the required plant set-point.

4.150 In instances where the plant is cooling the air, it may be possible to remove heat from the supply air at high ambient conditions, under the dictates of enthalpy sensors in the intake and extract ducts.

Attenuation

General requirements

4.151 Noise will be generated in an air distribution system by the fan, plant items and airflow. The ductwork is a very effective transmitter of this noise hence there is generally a need to limit the noise transmission to meet the requirements of the

building. This normally involves the provision of sound attenuation treatment as part of the overall ductwork system design.

4.152 A thorough assessment of the design should be made to assess the noise impact. This should take into account the following primary factors:

- fan and plant noise generation;
- air-flow generated noise in ductwork fittings and dampers;
- noise generated at grilles, diffusers and other terminals;
- noise break-in and break-out of ductwork;
- cross-talk and similar interference;
- the noise limitations for the building and surrounding areas;
- external noise generation.

4.153 A method of assessment of these factors and the sound attenuation requirements of ductwork systems is given in CIBSE Guide B.

4.154 The fan is usually the main source of system noise. The sound power that it generates varies as the square of the fan pressure, and thus to limit the fan noise level the system resistance should be kept as low as economically possible. As a general rule the selected fan should operate close to its point of maximum efficiency to minimise its noise generation. Where there is disturbance to the airflow at the fan inlet, the manufacturer's stated fan noise levels should be increased by up to 5 dB. More precise guidance on this aspect may be available from the manufacturers.

4.155 Fans radiate noise through both the inlet and outlet connections and it may be necessary to provide attenuation to limit the noise from both of these connections. It is always preferable and more economic to control noise and vibration at source, or as close to source as possible. It should be noted that attenuators offer a resistance to airflow. The resistance must be included in the fan and ductwork calculations.

4.156 Provided care is taken in the design and construction of low pressure systems to avoid significant noise generation in the ductwork, attenuation should only be needed to absorb fan noise.

4.157 Noise break-out from all equipment housed in the plantroom must be taken into consideration if control is to be satisfactory. Any ductwork within the plantroom after the silencer should be acoustically insulated to prevent noise break-in or the silencer relocated at the point of entry or exit of ductwork to and from the plant room.

4.158 There is no complete means of control over external noise generation from such as road traffic, aircraft, factory and community noise. Consideration must be given to this at the design and planning stage.

4.159 The noise levels produced by ventilation and other plant should be reduced by either lining the inside of the duct with sound absorbing material or fitting bespoke attenuator units.

4.160 In supply systems, sound absorbing material should not be applied to the inside surface of a duct system downstream of the final filter, owing to the risk of mechanical damage and the subsequent dispersal of the media into the ventilation system.

4.161 In supply and extract systems, sound absorbing material must not be applied to the inside of a duct within 1 metre of a fire damper. The material should be non particle shedding and fire resistant (Further guidance can be found in SHTM Firecode suite of documents). Where sound absorbing material is applied in a section of duct that will be routinely exposed during maintenance activities it should be protected from mechanical damage.

4.162 Bespoke attenuator units with a sound-absorbing infill suitable for the quality of air being handled and protected by a perforated sheet metal casing are the preferred option for critical systems. Absorption of moisture, dirt and corrosive substances into the 'in-fill' and the release of fibrous particles into the airstream should be prevented by the use of a membrane. The membrane material should have a declared service life of at least 25 years. If these conditions can be met then the attenuator may be located in the supply ductwork downstream of the final filter. When so located cleaning access should be provided at both ends of the attenuator unit.

5. Air distribution system

Air distribution arrangements

Ductwork distribution systems

5.1 Ductwork systems for ventilating and air-conditioning applications are referred to by their velocity or pressure category, that is, as low, medium or high velocity or pressure systems. Heating & Ventilating Contractors Association (HVCA) limits are up to 10 m/s or 1,000 Pa; 20 m/s or 1,750 Pa: and 40 m/s or 3,250 Pa in the case of conventional low, medium and high pressure systems respectively. High pressure systems are disappearing because of the constraints of the Building Regulations but existing systems may sometimes need to be altered or extended.

5.2 For normal applications in healthcare buildings, low velocity systems are recommended; and the use of higher velocities than those recommended is not likely to be economical. Future trends are likely to be towards even lower optimum duct velocities; however, velocities below 2.5 m/s are unlikely to be justified.

5.3 The site will often dictate the main routing of ductwork systems, but in general, the design should seek to make the layout as symmetrical as possible; that is, the pressure loss in each branch should be as nearly equal as possible. This will aid regulation and may reduce the number and variety of duct fittings that are needed.

5.4 Main distribution ductwork should not be routed above sleeping areas. Where there is no alternative route, additional acoustic insulation will be required.

5.5 Where auxiliary cooling units, fans, filters or trimming devices are installed in the distribution system, they must be independently supported and fitted with a suitable drainage system where appropriate. If they are a source of vibration they should be linked to the distribution ductwork via flexible connections.

5.6 The fan of a Local Exhaust Ventilation (LEV) system provided under the COSHH regulations should be located outside of the building so that all of the ductwork within the building is under negative pressure. Where the fan has to be within the building it should be located as close as practicable to the outside with an absolute minimum run of discharge ductwork within the building. The discharge ductwork within the building will be under positive pressure so it must not be penetrated by test holes or inspection hatches.

Ductwork materials and construction

5.7 The choice of duct material should take account of the nature of the air or gas being conveyed and the environment in which the duct will be placed.

5.8 Galvanised sheet steel is generally suitable and most economical for normal ventilating and air-conditioning applications. Its inherent mechanical strength renders it resistant to casual damage both during the construction phase and throughout its service life when mechanical and electrical services around it are altered. It also readily withstands the impacts sustained when rotary equipment is used to clean it internally.

5.9 In instances where moisture levels and/or corrosive elements in the air being conveyed are very high, aluminium, stainless steel, PVC or GRP ducts should be used. Stainless or black steel are the only suitable materials for high temperature ductwork.

5.10 In inherently wet areas, such as the base of fresh air inlet ducts and some extract systems, the ductwork may require draining to prevent a build up of standing water. The layout of the drains should be as specified in Section 4 Clauses 4.20 to 4.25.

5.11 Where builderwork plenum chambers or ducts are used, these may be constructed of various materials. However all such ducts must be rendered and sealed to prevent dust shedding. A greater allowance may need to be made for leakage.

5.12 Galvanised, black and stainless steel ductwork should be manufactured and installed to DW144 – HVCA specification for sheet metal ductwork, but excluding the use of bolt-through supports.

5.13 GRP and PVC ductwork should be manufactured and installed to DW154 – HVCA specification for plastic ductwork.

5.14 Phenolic board ductwork is unsuitable for use in healthcare applications and should not be used.

5.15 Flexible duct work is unsuitable for air distribution in healthcare applications. It should only be used to make the final connection to a terminal (See clauses 5.54 and 5.55).

5.16 The inside of the ductwork should be free from structural projections and as smooth as possible. Flanged, gasketed joints are preferred.

Fire aspects, damper types and locations

5.17 It is essential that all relevant fire aspects of ducting systems are agreed with the fire officer before the design is finalised.

5.18 Ductwork must be fire-stopped where it penetrates fire compartment walls, floors and enclosures, cavity barriers and sub-compartment walls or enclosures, and provided with weatherproof collars where roofs or external walls are penetrated.

5.19 Fire/smoke dampers shall be provided at the locations required by Firecode. The fire damper mounting frame must be securely attached to the building fabric. Where a fire damper is not mounted directly in a fire compartment wall, it

must be correctly supported and the ductwork between it and the fire wall must posses the same fire rating as the fire wall that it penetrates. The fire rated portion of ductwork must not be penetrated by test holes or inspection hatches. All fire/smoke dampers shall be capable of remote re-setting via the Building and Energy Management System or equivalent, after periodic testing procedures.

5.20 An access hatch shall be provided adjacent to each fire damper so that its correct operation can be directly observed.

5.21 Smoke-diverting dampers must be provided on recirculation air systems to divert automatically any smoke-contaminated return air to the outside of the building in the event of a fire; and arranged so that the normal open smoke-diverting damper on the return air branch to the input unit closes and all the return air is exhausted through the extract fan. Guidance is available in SHTM 81 and BS5588: Part 9.

Duct sections

5.22 Ducting is generally available in rectangular, circular and flat oval sections, although other sections may be made for special situations.

5.23 Rectangular ducting is most common on low pressure systems, for the following reasons:

- it can readily be adapted to fit into the space available;
- fittings are cheaper than those for circular or flat oval ductwork;
- it can readily be joined to such component items as heating and cooling coils, and filters.

5.24 When sizing ductwork, the designer should take into account:

- both installation and operating costs;
- space limitations imposed by the structure and other services;
- operating noise levels;
- requirements of regulation at the commissioning stage.

5.25 For overall economy and performance, the aspect ratio should be close to 1:1, since high aspect ratios increase the pressure loss, heat gains or losses and overall cost (for example, changing the aspect ratio from 1:1 to 1:4 can typically increase the installed cost of the ductwork by 40% and add 25% to the heat gains or losses).

5.26 Rectangular ducting should not be the first choice for high pressure systems, and should be avoided in systems operating at high negative pressures, because the strengthening of the flat sides and the sealing requirements necessary to make rectangular ducts suitable for these high pressures are costly.

5.27 Circular ducting is preferable for high pressure systems; and for systems operating at high negative pressures. In the case of the latter, additional stiffening rings may be necessary. Machine-formed spirally-wound ducting and a standard range of pressed and fabricated fittings can sometimes make circular ducting more economical, particularly in low pressure systems having a relatively low proportion of fittings.

5.28 Flat oval ducting provides an alternative to circular ducting, principally where there is a limitation on one of the dimensions in the space available for the duct run.

5.29 Other sections may be used, such as triangular sections to pass through roof trusses. Such sections present difficulties in the provision of fittings, and connections to standard plant items, and are likely to be more expensive than traditional sections.

Standard ductwork fittings

5.30 All fittings should conform to DW144. Wherever possible, long radius bends, large radius main branches, not more than 45° angle sub-branches and long taper transformations shall be used.

5.31 Fittings should be arranged with vanes in sub-branches connected directly to grilles and diffusers, and turning vanes in square bends (when used). When vanes are used, additional cleaning access will be required.

5.32 The number of duct fittings should be kept to a minimum and there should be a conscious attempt to achieve some standardisation of types and sizes. Increasing the number and variety of fittings in a system can markedly raise its overall cost.

5.33 Bad design in relation to air flow can lead to vibration of flat duct surfaces, increases duct-generated noise and pressure loss, unpredictable behaviour in branch fittings and terminals, and adverse effects on the performance of installed plant items, such as trimmer batteries.

Branches

5.34 There are many designs of branches and junctions in use. The important features are that the flow should be divided (or combined) with the minimum interference and disturbance. Changes in duct sizes should not be made at the branch but a short distance downstream (or upstream). A good dividing branch design cannot be effective if the flow entering the branch is not uniform across the section.

Changes of section

5.35 The expansion of a duct section should be formed with sides having a total included angle of no more than 30°, and preferably less than 20°. If the angle of expansion is greater, the flow is not likely to remain attached to the walls of the duct and large eddies will be formed with flow reversal at the walls. This leads

not only to a high pressure loss, but also to non-uniform velocity pattern at the outlet. Where there is insufficient space for a gentle expansion and a greater angle is necessary, internal splitters should be used.

5.36 A contraction in a duct section is less critical, but the total included angle of the taper should not exceed 40^{o} (or 20^{o} where the contraction is made on one side of the duct only)

5.37 The most economical way to change the section of a rectangular duct is to restrict the change of duct size to one side only. If the calculated reduction or increase to the side dimension is 50mm or less, it is usually not economical to change the size at the position. The minimum size of a rectangular duct should usually be 150 mm x 100 mm.

Other fittings

5.38 As a general rule, fittings should avoid abrupt changes in direction and sharp edges which cause the flow to separate and form eddies, thus limiting pressure loss and causing noise generation. If the fitting leads to the flow preferentially attaching to one side of the outlet, then a significant length of straight downstream duct is necessary before the next branch or fitting; this length should be greater than five equivalent diameters.

Thermal insulation

5.39 Thermal insulation is applied to ductwork to reduce heat exchange, and to prevent condensation.

5.40 In a duct system, the air temperature changes can be significant, especially when passing through untreated space, and these have the effect of reducing the heating or cooling capacity of the air and of increasing the energy input to the system. The heat transmission to and from the surrounding space can be reduced by effective insulation of the ducts.

5.41 Condensation can arise in ductwork systems conveying cooled air and, apart from creating conditions conducive to corrosion of ductwork, condensation affects the heat and vapour-resisting properties of insulating materials themselves which may induce further condensation.

5.42 In normal circumstances, the insulation thickness for heat resistance is sufficient to prevent surface condensation, but in extreme conditions the insulation thickness for vapour resistance may be greater than that for heat resistance. When cold ducts pass through areas of high dew-point, carefully selected vapour barriers should be applied externally to the insulation.

Noise generation within the ductwork

5.43 Noise is generated in ductwork at sharp edges, by tie rods, damper blades, duct obstructions and sharp bends etc. This air flow-generated noise becomes an important factor if it is about the same or greater level than the upstream noise level. (Air flow-generated noise is often referred to as “re-generated noise”)

5.44 The noise level generated by air flow in ductwork is very sensitive to the velocity. The sound power of this noise is approximately proportional to the sixth power of the velocity; that is, a doubling of the duct velocity will increase the sound power by a factor of 64. The duct velocities should therefore be kept as low as possible. In general, duct fittings which have lower pressure loss factors in similar flow conditions will generate less noise.

5.45 Ductwork serving quiet areas should not be routed through noisy areas where noise break-in can occur and increase the noise level in the ductwork.

5.46 Grille, register and louvre noise should be kept to the minimum by selecting types having low noise-producing characteristics, without high tonal noise; and should be fitted with acoustically treated external inlet and outlet louvres.

5.47 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required. They will normally be of the 'through-the-ceiling, 'up and over' type and may include a fire damper if required.

Volume control damper locations

5.48 Manually operated balancing dampers are needed generally:

a in the main duct downstream of the fan;

b in branches of zone ducts;

c in sub-branch ducts serving four or more terminals;

d at terminals not covered by (c) above.

5.49 Dampers integral with terminals should only be used for final trimming of air volumes, otherwise noise and air distribution problems may ensue.

5.50 Dampers in rectangular ducts should be single-bladed when the longer side is up to 450 mm and opposed-blade multi-leaf type above this size. In circular ducts, iris-type dampers are recommended. Dampers must be accessible, incorporate a position indicator and means of locking in the commissioned position. Dampers should be located as far away as possible from adjacent branches or plant items.

Access door locations

5.51 Access doors are required to facilitate access to plant items and ductwork components for inspection, maintenance, cleaning and replacement, and must be of sufficient size to permit safe access for the required functions.

5.52 Recommended locations for access doors are given in DW144 and are generally provided to give access to:

- every regulating damper;

- every fire and motorised damper;
- filter (to facilitate filter withdrawal);
- both sides of cooling/heating coils;
- humidifiers;
- fans and to provide access to motors and impellers.

5.53 Care should be taken when siting access doors to ensure that no other services to be installed will prevent reasonable access.

Flexible ducting

5.54 Flexible ductwork may be used for final connections to grilles and diffusers provided it is constructed to meet the fire precautions recommended in BS8313. It must not pass through fire compartment walls, floors or enclosures of sub-compartment walls or enclosures, or through cavity barriers.

5.55 Flexible ducting will cause a significant frictional loss and may be difficult to clean and should never be used in lieu of a bend. Where installed it should take the most direct route and be as short as possible, never exceeding 1 metre in length.

Diffuser and grille selection and sizing

5.56 The effectiveness of all ventilation and air-conditioning systems depends on the methods by which air is introduced to, and vitiated air is removed from, the space. The usual results of poor air terminal selection and/or positioning are:- draughts, stagnation, poor air quality, large temperature gradients and excessive noise.

5.57 Air can be supplied to a space in a number of ways, although any device can be broadly placed into one of two categories; that producing a diffused supply, or that producing a perpendicular jet. Diffusers may be radial or linear, and normally utilise the Coanda effect (that is, adhesion of the air stream to an adjacent surface), to reduce the risk of excessive room air movement. A perpendicular jet is formed by discharging air through grilles, louvres or nozzles, which are generally adjustable.

5.58 Air-flow patterns produced by both types of terminal are dependent to a large extent on the presence of the Coanda effect.

5.59 Supply air terminals can be incorporated into any room surface, for example, floors, walls (high or low level), desktop etc.

5.60 As they operate on the jet principle, the use of sidewall and linear grilles is restricted to areas where air change rates are low, that is, less than 10 per hour. Perforated rectangular diffusers can provide acceptable conditions within the occupied zone at up to 15 air changes per hour. In areas where a higher air change rate is required, square or circular ceiling mounted diffusers should be used.

5.61 The performance of supply air terminal devices is provided, based on three criteria; throw, spread and drop. Throw is defined as perpendicular or parallel distance from the terminal to the point at which the air velocity is 0.5 m/s isovel. Spread is defined as the width of the 0.5 m/s isovel; and drop is defined as the vertical distance from the centre line of the terminal to the bottom edge of the 0.25 m/s isovel.

5.62 It is necessary to consider each of these parameters in both summer and winter conditions to ensure satisfactory operation of the air terminal device, as warm jets behave very differently from cold jets.

5.63 A warm jet tends to rise until it attaches itself to a horizontal surface, while a cold jet falls. Care must be taken to ensure that this does not lead to unacceptable temperature gradients in winter, or excessive air velocities in the occupied zone in summer.

5.64 In order to ensure satisfactory air movement within a space, it is necessary to consider interaction between air movement from adjacent terminals, and ceiling mounted fixtures (light fittings etc), as well as interaction between air movement and room surfaces.

5.65 If the supply and extract terminals are too close, short-circuiting may occur, while if they are too far apart, stagnant zones may be formed. Where two opposing air streams meet, the individual velocities must not be greater than 0.25 m/s.

5.66 Supply and extract grilles and diffusers should be fitted with opposed-blade dampers for fine balancing purposes.

5.67 Further guidance on the selection of grilles and diffusers is given in the CIBSE Guide B.

5.68 In operating theatres, the supply terminals must be able to produce a down flow movement of air in the operating zone 1 metre above floor level. Ceiling mounted diffusers with fixed directional vanes that provide a downward turbulent airflow are the preferred option. Plenum boxes fitted with perforated screens to produce a laminar down are also acceptable. Nozzles or jets of any type are not acceptable. Sidewall mounted linear diffusers that utilise the Coanda effect to send air across the ceiling and ‘drop’ it into the operating zone are also not suitable. However linear ceiling mounted diffusers that provide a direct downward airflow around the operating zone may be used.

Transfer grille - size and location

5.69 Air transfer grilles in walls, partitions or doors form an integral part of the building’s air distribution system. Modern door sets have very low leakage rates so cannot be relied upon to permit even quite small airflows. Failure to make adequate provision for air to move from room to room will result in excessive pressure differentials and ‘door whistle’.

5.70 Transfer grilles are required in locations where there is a significant imbalance between the supply and extract rates in a room. They will relieve any pressure differentials which may affect the operation of the spaces and/or the ventilation system and permit airflow in a known direction. However, transfer grilles are vulnerable to damage and, in many instances, provided the equivalent free area is provided, they can be substituted with undercut door.

5.71 Care needs to be taken to ensure that the positioning of transfer grilles does not interfere with the fire or smoke integrity of the building. In general, the air transfer grilles should not be installed within fire-resisting boundaries, although if this is unavoidable, they should be fitted with fire or smoke dampers.

5.72 Where installed, transfer grilles should be of the non-vision type, sized for a maximum face velocity of 1.5 m/s.

5.73 In photographic dark rooms, lightproof transfer grilles will be required.

5.74 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where individual room confidentiality is required. (See also paragraphs 5.43 to 5.47).

Pressure stabilisers - size and location

5.75 Pressure stabilisers are required in lieu of air transfer grilles in areas where it is necessary to maintain pressure differentials between adjacent rooms to prevent reversal of air flows for example, in operating suites, isolation facilities and clean rooms. (See also Section 7 paragraphs 7.24 – 7.28).

5.76 Fire precautions for pressure stabilisers are the same as for transfer grilles. For sizing criteria, refer to Section 7 paragraph 7.23

5.77 Pressure stabilisers should be of the balanced blade type, with the facility to make fine adjustment of the pressure setting. They should be silent in operation and give a seal as tight as practicable when closed. The materials of construction and method of assembly should allow for cleaning and disinfection.

5.78 Pressure stabilisers should be installed in a visible location so that their operation can be readily observed.

5.79 Cross-talk attenuators may be necessary where noise intrusion between adjacent spaces can arise and where confidentiality is required. In these cases, the pressure stabiliser and cross-talk attenuator should be mounted in a short length of ductwork within the ceiling void.

5.80 Pressure stabilisers may need to be fitted with a stand-off baffle on their discharge side to prevent a sight line in situations where a laser will be used. Baffles may also be required to preserve privacy or prevent discharge air causing draughts or disturbing the air distribution pattern in the adjoining room. They are also useful in low-level locations to prevent the air-flow path being obstructed by portable equipment.

6. Automatic controls

6.1 Various options for control of single and multi-zone air-conditioning systems are given in CIBSE Guide B.

General requirements

6.2 The basic requirements for an automatic control system are as follows:

- facilities to start, set-back and stop the plant;
- facilities to control the volumetric air-flow;
- facilities to control the system or room pressure;
- temperature control and indication;
- humidity control and indication;
- devices to monitor and indicate the plant operating state;
- alarms to indicate plant failure, low air-flow, and filter state.

The control functions actually provided will depend on the purpose of the ventilation system.

6.3 There will also be a need to determine the control strategy in the event of a fire either within the zone being served or within an adjoining zone.

6.4 The designer should consider whether it is necessary for the supply and extract fans to be interlocked, either so that the supply fan will not operate unless air-flow is established within the extract system, or vice-versa depending on the required pressures within the rooms being served.

6.5 The sequence switching of units in order to prevent transient reverse airflows will be particularly important in laboratory and pharmacy areas that also contain fume cupboards, safety cabinets and other LEV systems.

6.6 Alarms should be provided to show ‘filter fault’ and ‘low air-flow’. The “filter fault” alarm should be initiated by a predetermined increase of pressure differentials across the filter. The ‘low air-flow’ alarm should be initiated when the supply air quantity falls to 80% of the design value.

Objectives of control system

6.7 The primary objective of ventilation plant control system is to maintain the space served within the required environmental control limits, at the appropriate times, regardless of external conditions or internal loads and with the minimum energy consumption.

6.8 Often, it is not possible to predict accurately building load variation at the design stage, and thus optimum set points cannot be assessed. Information provided by monitoring the operation of the plant via a Building and Energy Management System (BEMS) will enable optimum set points to be established and energy consumption reduced. Control of most systems will be via a BEMS. This will enable the operating conditions and control tolerances to be set and monitored. The BEMS may also be set to log the actual energy consumed by the system together with that recovered by the energy-recovery device. This will provide a useful check on overall operating efficiency and provide evidence that energy targets are being achieved.

6.9 BEMS incorporating self-adaptive control algorithms that automatically adjust the set point to the suit the usage and load are preferred. The provision of movement sensors within the controlled space in order to determine the actual occupancy will facilitate this process.

6.10 The failure of specialised ventilation systems can have grave consequences for the delivery of healthcare. Control systems should therefore be simple, robust and reliable.

6.11 Computer software-driven control systems are becoming the norm in building services. However, it should be remembered that healthcare ventilation systems will need to be available to operate outside of normal working periods when software support is not available. Should the software fail, it will be left to site staff who may have little knowledge of the control algorithms to restart the ventilation system. It is therefore essential to ensure that a simple means of re-starting critical systems in the event of a software failure is provided (see also paragraphs 4.62 - 4.63)

Location of controls

6.12 Whether within the plant, duct or room, sensors should be located to provide accurate measurement of the condition of the air being monitored.

6.13 Sensors and control items such as control valves should be located close to the element being sensed or plant item being controlled, in order to minimise time lags within the system which may create over-shoot of conditions beyond the design envelope and result in additional energy consumption.

6.14 There are practical advantages in locating all control valves for an Air Handling Unit in a bank (at a convenient height) at one end of the unit. (This will not normally result in an undue additional control lag.)

6.15 Some applications require intermittent mechanical ventilation, frequently at a high air change rate, (for example, in bathrooms and treatment rooms.) Local controls to facilitate this mode of operation should be placed in a prominent position to encourage economical use.

6.16 Local controls that enable the user to select more than one mode of operation should be clearly labelled to identify the particular mode selected. Where the system allows different room pressures to be selected then a direct reading

pressure gauge should be fitted within the eye line of the users to provide an independent confirmation of the resultant mode of operation. A clear description of the selectable modes of operation should be mounted adjacent to the control switch.

Fire aspects

6.17 A fire control panel should be mounted at the entrance of the area that the ventilation serves. The panel should have restricted access for the fire officer and include independent on/off controls and indication of the supply and extract systems.

6.18 In certain critical care departments it is preferable to maintain the supply ventilation in case of a fire within the area. For example, in an operating department, while undergoing surgery the patient cannot always be easily moved without significant risk. In the event of a fire in a staff or support area of the department, or adjoining zone, the continued supply of air to a theatre will maintain it at a positive pressure and protect the patient and staff from the effects of smoke. This will allow time for the patient to be stabilised so that he/she can be safely evacuated if necessary. A similar situation occurs for patients in ITU and other critical care units. In all of these cases the ventilation to the critical area should continue to operate unless the AHU starts to draw in smoke. For these departments, a notice should be affixed to the fire control panel drawing attention for the need to liaise with departmental staff before switching off fan units.

6.19 All supply AHUs should have a smoke sensor mounted in the main supply duct immediately downstream of the AHU. In the event of a fire in the AHU or smoke being drawn into the system from an outside source, it should cause the supply air fire damper to close and shut down the AHU.

Time switching

6.20 Facilities to start, set-back and stop the plant should be provided in the plantroom. Remote start and set-back control and indication, if required, should be provided at a manned staff location, for example, at the reception or staff base or, in theatres, within the Surgeon's Panel.

6.21 Many ventilation systems may be completely shut down when the area served is not in active use. Alternatively, where there is a need to maintain a background condition, the ventilation output can be reduced by "setting back" the system. This will significantly reduce energy consumption and extend the life of filters and other system components.

Start-up control

6.22 The plant's start control should contain a control logic that will start the plant in the sequence set out in the following algorithms, Figures 2-5

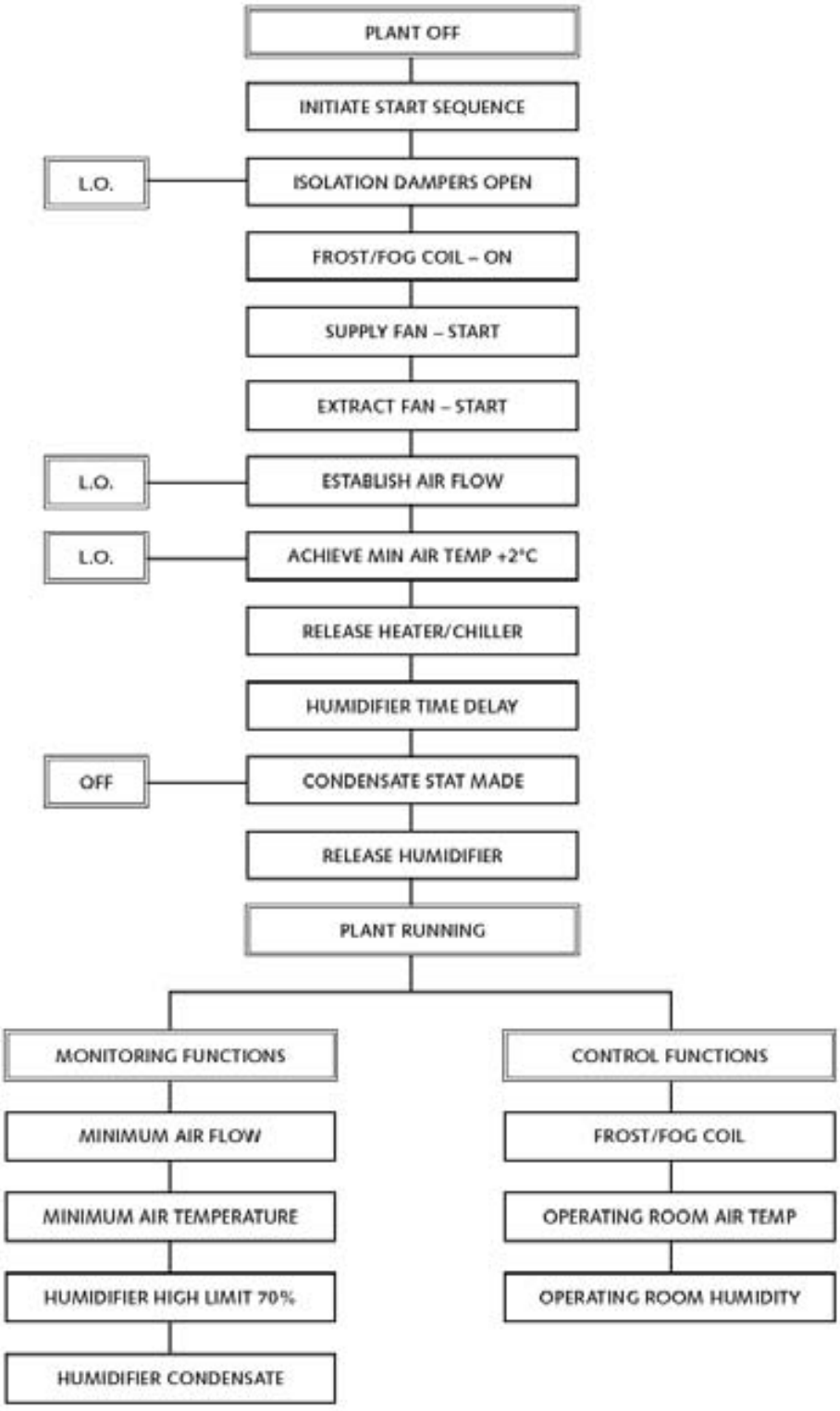


Figure 2: Typical plant control algorithm – normal start-up sequence

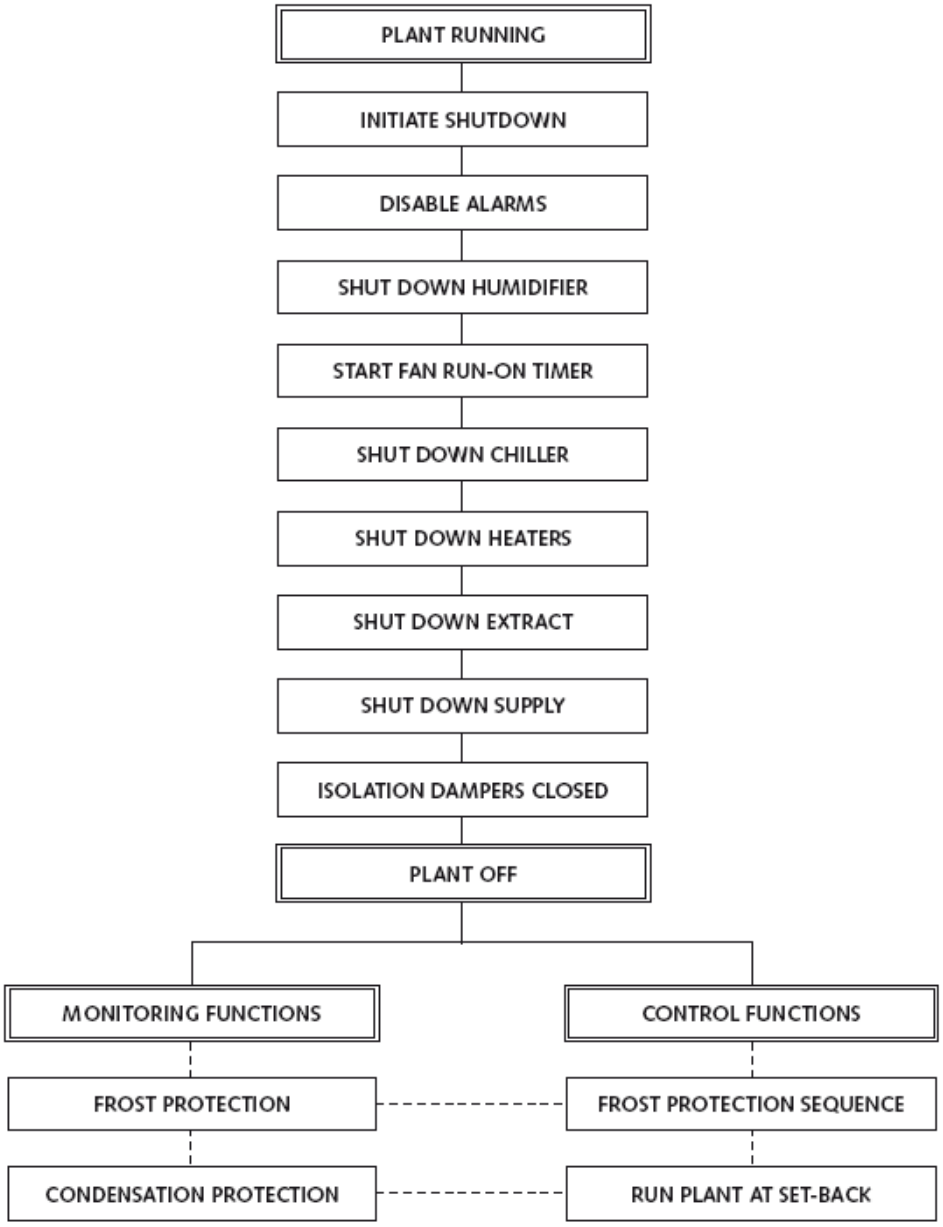


Figure 3: Plant control algorithm – normal shut-down sequence

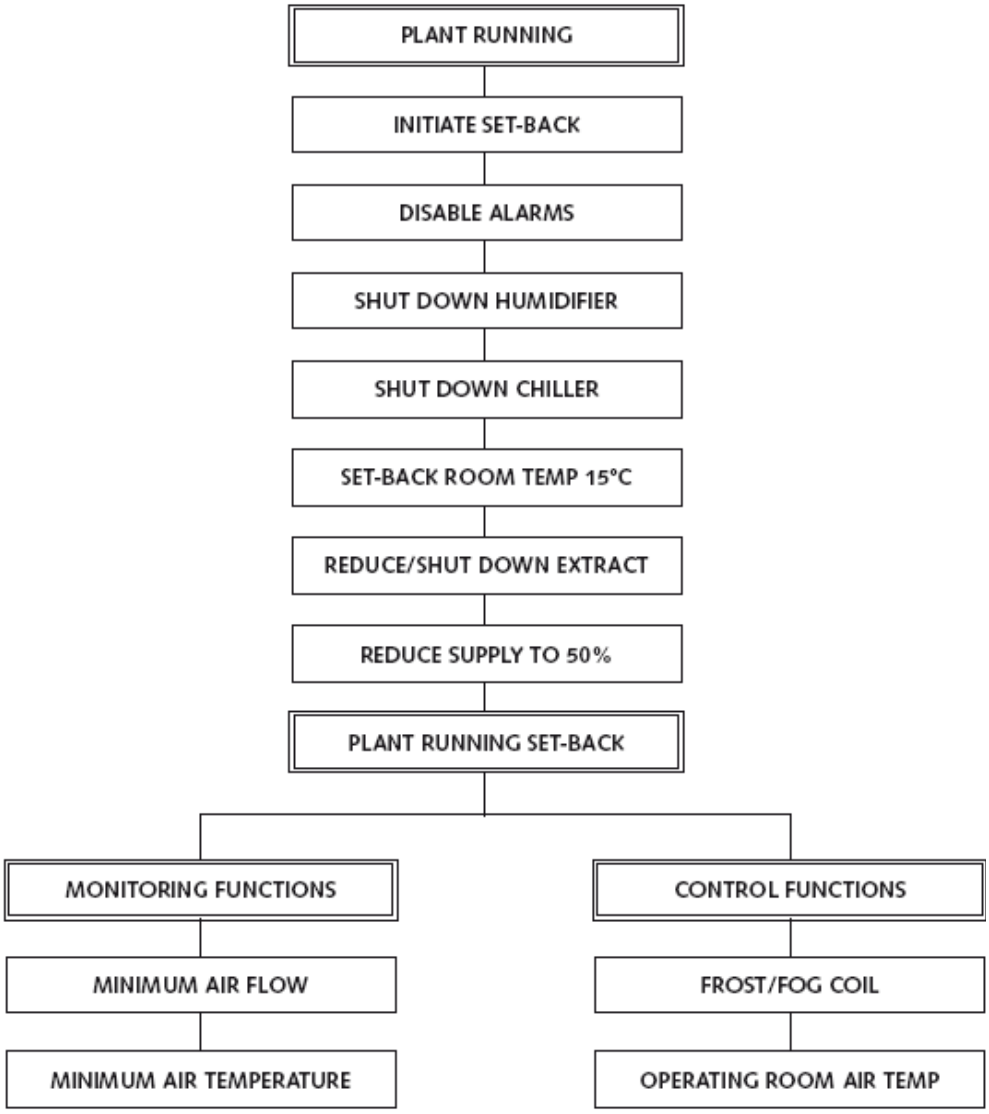


Figure 4: Plant control algorithm – set back sequence

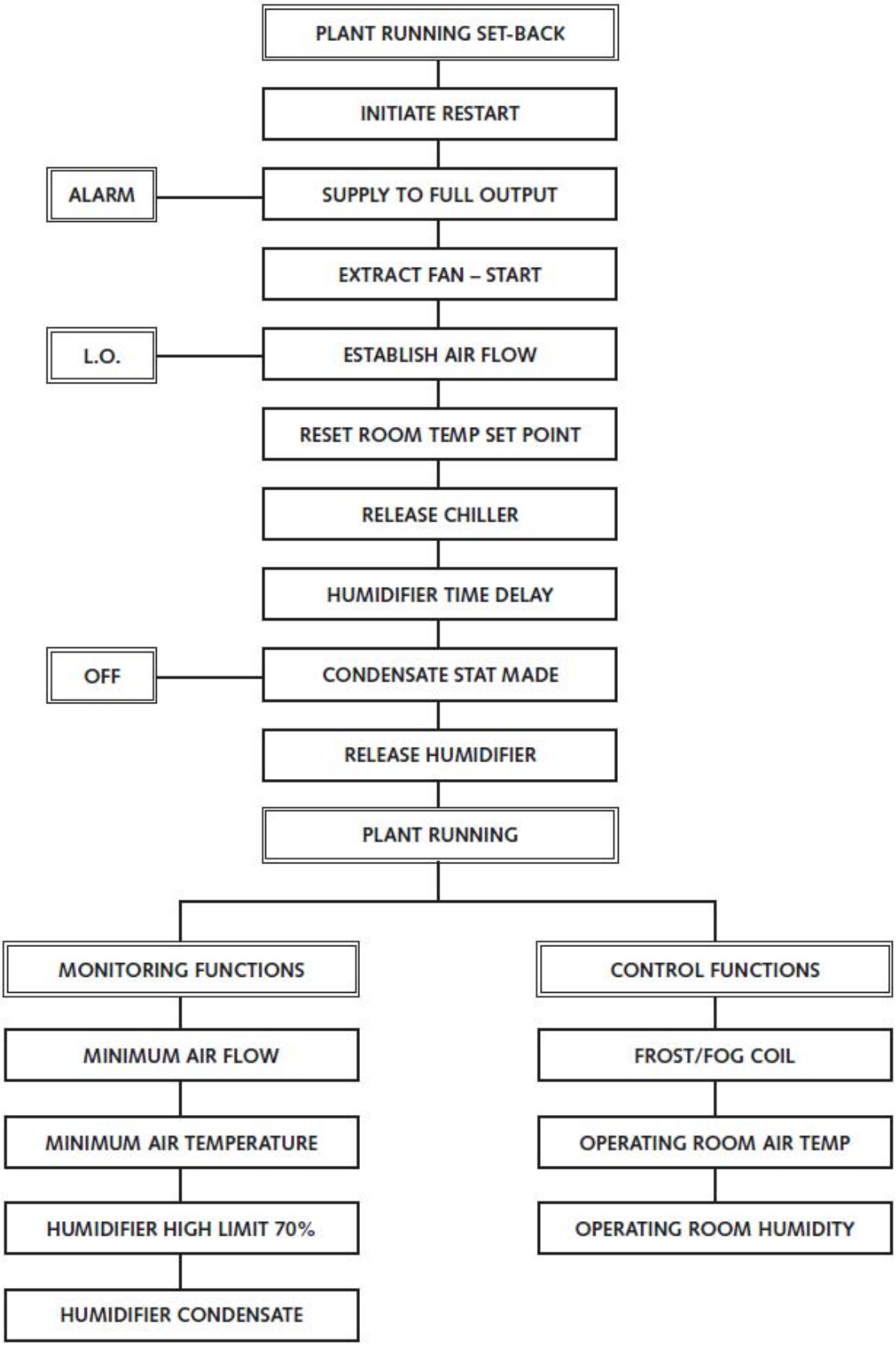


Figure 5 Plant control algorithm – restart from set-back

Set-back control

6.23 Where variable speed controls are installed, the set-back facility for each plant should depress the control temperature to around 15°C; exclude any humidification and cooling from the system; and reduce the supply and extract air volumes to around 50%. The extract fan can also be turned off as long as the desired direction of air movement from clean to less clean will be maintained (See also figures 2-5).

Use control

6.24 The installation of movement detectors allows for “use control” of ventilation systems. A simple control logic that reduces the system to a “set-back” condition if there has been no movement detected in the space for, say, 30 minutes and that switches the system “off” if no movement is detected for one hour is recommended for many applications, including operating suites.

6.25 A variation on this can be provided by linking ventilation controls to lighting. For example, in an operating theatre, the system may be off outside of working hours, could run at set-back when the general lighting was switched on and increase to full speed when the operating lamp is switched on. As with movement detection, a 30-minute run-on should be provided at each stage when the lights are turned off.

6.26 Either of the above control strategies may be refined by linking to the BEMS to provide a control logic related to normal working hours and associated ‘real-time’ movement within the zone being controlled. This should result in significant energy savings.

Environmental control

Temperature control methods and application

General

6.27 All control valves must fail safe, that is, close in the event of power or air-flow failure, with the exception of the fog/frost battery control valve, which should open upon power or air-flow failure.

6.28 Control valves should be located in an accessible position. Isolation valves should be provided to enable the control valve to be removed for service without the need to drain down the system.

6.29 Care should be taken to ensure that the installation of control valves and their associated pipework do not obstruct access to the AHU inspection doors and hatches.

Room temperature control

6.30 The limits for room temperature set point are generally between 16°C and 25°C depending on the particular application, and in some specialised instances (for example, operating departments) are adjustable within a predetermined range by the user.

6.31 The selection of temperature set point for each room or zone, may be by a control facility in the room / zone, or remotely at the control panel or BEMS. Where the control device is mounted within the room / zone and adjustable by the user, it should be marked either 'raise' and 'lower' or '+'and' -'. It should control within a specified temperature range to suit the user requirement with a control tolerance of ±1°C. All other control set points should be selectable either on the control panel or at the BEMS interface.

6.32 Where local control is provided, an indication of temperature will be required locally, or at a staff base (if appropriate), using an analogue or digital indicator. The indicator should be large enough to be read from the normal working position. e.g. at the operating table in a theatre. This may be mounted in a supervisory or, "surgeon's" control panel, with the signal repeated on the main system control panel or BEMS. It is important that this indicator displays the actual measured temperature and not the selected temperature.

6.33 Where the supply and extraction systems are designed for ventilation only and there is a wet heating system providing background heating care must be taken to avoid one system trying to heat the space while the other system is trying to cool the area.

Frost battery control

6.34 Steam-supplied frost batteries must be operated as on/off devices with their sensor mounted upstream of the battery. This will give 'open loop' control. A set point of +1°C is recommended.

6.35 Low pressure hot water (LPHW)-supplied frost batteries should be controlled using the proportional mode. Their sensor should be located downstream of the battery to give 'closed loop' control. A set point of between 2°C and 5°C is recommended.

6.36 If the temperature downstream of the frost battery, as sensed by a serpentine thermostat, falls below the required set-point over any part of the coil, the plant must automatically shut down in order to prevent damage to the other batteries. The serpentine thermostat must not be in direct contact with the coil.

Off-plant control

6.37 The control logic must prevent the chiller and pre-heater being on at the same time.

Humidity control methods and application

6.38 In order to prevent excessive condensation when starting up from a total plant shut-down, a time delay should be incorporated into the control system such that the humidifier does not start until 30 minutes after the ventilation plant starts up.

6.39 Irrespective of the method of control, a high-limit humidistat should be installed to ensure that when the humidifier operates, the condition of the air in the duct does not exceed 70% saturated, particularly during plant start-up.

6.40 With certain types of steam humidifiers, it may be necessary to install a thermostat in the condensate line from the humidifier's steam supply, to ensure that the steam at the control valve is as dry as possible before it is injected into the air supply.

6.41 The humidifier and cooling-coil control must be interlocked so that they cannot be on at the same time.

6.42 The humidifier control system should ensure that it is switched off with the fan. It is preferable to design the control system so that the humidifier is isolated for an adequate time before the fan is turned off so as to purge humid air from the system.

6.43 All control valves must fail safe (that is, close in the event of power failure) and the humidifier must be interlocked with the low air-flow switch.

Multi-zone control methods and application.

6.44 Close control of all air-conditioning parameters may be difficult to achieve with multi-zone systems, since each zone will in theory require a reheater and humidifier to give total control of humidity if that is what is required. In reality such close control is rarely required in practice. It is therefore usual with multi-zone systems to provide control of zonal temperature only, with humidity control where fitted being based on average conditions within all zones, or minimum conditions within one zone.

6.45 Where there is a requirement for close control of air-conditioning parameters in a number of zones (e.g. an operating department) separate plants should be provided for each zone in order to avoid the need for expensive over-cooling and reheating of individual zones.

6.46 Most multi-zone systems within healthcare premises are controlled based on off-coil control within the central plant, with trimmer heater batteries on individual zones.

Alarms and indication

6.47 Supply and extract systems should include indicator lamps on the control panels to confirm the operational status of each system. Where the usage is on

a regular daily pattern, time control with a user-operated timed manual over-ride should be provided.

6.48 Where a system is provided for a particular space, the indicator should be in, or immediately adjacent to, that space and local controls should be provided with labels clearly defining their function (eg. isolation suites.)

6.49 The 'plant failure' and 'low air-flow' alarm should be initiated by a paddle switch or other device located in the main air supply duct. This should operate when the air quantity fails to reach or falls to around 80% of the design value and will give indication of fan failure, damper closed, access door left open, or any other eventuality that could cause a reduction of air quantity. Monitoring the current drawn by the fan motor is not a substitute for a sensing device that is directly affected by the air-flow.

6.50 The 'filter fault alarm' should be initiated by a predetermined increase of pressure differential across the filters, thereby indicating a dirty filter.

6.51 Direct reading gauges or manometers should be installed across filters to give maintenance staff an indication of their condition.

6.52 Visual indication should be provided at a manned staff location (for example, the reception or staff base) and on the main control panel and BEMS to show 'plant failure' and 'low airflow'.

BEMS

6.53 Control of most systems will be via a Building Energy Management System. This will enable the operating conditions and control tolerances to be set and monitored. The BEMS may also be set to log the actual energy consumed by the system and recovered by the energy recovery system. This will provide a useful check on the overall operating efficiency and provide evidence that energy targets are being achieved.

7. Specialised ventilation systems

7.1 This section contains design information for a range of healthcare ventilation applications.

7.2 The following departments will require a degree of specialised ventilation.

- the Operating department;
  - treatment rooms;
  - endoscopy, daycase and minimum invasive suites;
  - cardiology and operative imaging suites;
  - conventional operating theatres;
  - Ultra Clean Ventilation (UCV) operating theatres;
  - barn theatres;
  - recovery and ancillary areas.
- Obstetrics;
  - maternity theatres;
  - birthing rooms;
  - LDRP Rooms;
  - SCBU.
- critical areas and high-dependency units of any type;
- Isolation facilities;
  - infectious diseases units;
  - bone marrow and other transplant units;
  - chemotherapy and oncology units.
- Sterile Supply and Decontamination Units;
  - wash rooms;
  - inspection and packing rooms;
  - sterile pack stores.
- the Pharmacy departments;
  - aseptic suites;
  - extemporaneous preparation areas;
  - radio pharmacies.
- the Pathology department;
  - laboratories;

  - cat 3 and 4 rooms.
- the Mortuary and Post mortem suite;
  - mortuaries;
  - post-mortem rooms;
  - specimen stores.
- Hydrotherapy units;
- Burns units;
  - burns theatres;
  - treatment rooms;
  - isolation rooms;
  - tissue banks.
- Emerging specialties;
  - gene therapy units;
  - stem-cell laboratories.
- Infrastructure;
  - plant rooms housing combustion equipment;
  - welding facilities;
  - wood working workshops;
  - electric vehicle charging areas.

7.3 Design information for many of these applications is given in Appendix 1 Table A1, Appendix 2 and in the following Chapters within this section.

7.4 It is not possible within this existing document to give definitive guidance for every healthcare specific ventilation application. Additional detailed guidance may be issued in due course in the form of supplements.

General information

7.5 The section on operating theatres is the most extensive and contains much information that is common to other applications. Where no specific guidance is given then the principles set out below should be followed:

- the foregoing sections of the document contain general information on healthcare-specific aspects of ventilation system design and specification;
- a set of standard solutions for the design of general operating theatre suites to conform to past and new standards is given in new standard layouts Nos 1, 3, 5 and 7 and those for UCV theatres in new standard layouts Nos 2, 4, 6 and 8 within Appendix 3;
- the CIBSE Guides A & B contain basic information on ventilation design that can be applied to most applications;

- where a British or European standard exists that is specific to the application (e.g. a clean room) it should be used as the basis of the design requirement;
- air should always move from clean to less clean areas. A hierarchy of room cleanliness is given in Appendix 2 Table A2;
- differential pressure will prevent contamination between areas when doors are closed. Information on air leakage through closed doors and hatches for a range of differential pressures is given in Appendix 2 Table A3;
- the flow of air will prevent contamination between areas when doors are open. Information on air leakage through open doors and hatches for a range of differential pressures is given in Appendix 2 Table A4;
- if anaesthetic gases are used, 15 air changes per hour will be required;
- a methodology for calculating a design solution for a non-standard suite of operating rooms is given in Appendix 4. This may be adapted as necessary to suit other less complex applications where air is required to cascade from clean to less clean areas.

7.6 The supply of air to a room has four main functions:

- to dilute airborne contamination;
- to control air movement within such that the transfer of airborne contaminants from less clean to cleaner areas is minimized;
- to control the temperature and if necessary the humidity of the space;
- to assist the removal of and dilute waste gases where used.

7.7 Because of the complexities of controlling air movement patterns, much design effort will be required for this aspect. It is important that the design makes the best possible use of the air available, as excessive supply air flows for the control of air movement should not be used. The amount of air supplied will be determined by the number of doors and desired air change rate.

7.8 There are four routes whereby airborne contaminants may appear in a room:-

- through the supply air;
- shed directly by the room occupants;
- arising as a result of the work activities;
- transferred from adjacent spaces.

7.9 Particles entering with the supply air can be controlled by the selection of suitable filter grades.

7.10 Particles shed directly by the room occupants can be controlled by:

- restricting access to essential persons only;
- the choice of the occupants' clothing;

- the room air change rate.

7.11 Particles arising as a result of the work activity can be controlled by:

- enclosing, semi-enclosing or otherwise controlling the work-based source;
- the room air change rate.

7.12 The transfer of particles from adjacent spaces can be controlled by:

- differential pressure;
- air-flow paths.

7.13 Air change rates are given in Appendix 1 Table A1. These figures have been found to give sufficient dilution of airborne contaminants, provided the mixing of room air is reasonably uniform.

7.14 A downward displacement turbulent air distribution is generally preferred. The supply and extract diffusers should be positioned to ensure that all parts of the room are actively ventilated and that where necessary the staff will be in a clean air-flow path. (See Section 5 for additional guidance on supply terminals).

7.15 Horizontal flow room air distribution with or without a Coanda effect can be a source of draughts and difficult to set up correctly. Its use should be confined to non-critical areas.

Air movement control

7.16 The design of the system should seek to minimise the movement of contaminated air from less clean to cleaner areas. Transfer grilles enable air to pass in either direction between rooms of equal class and pressure. Pressure stabilisers operate in one direction only; they allow excess air to be directed to the area desired and assist in maintaining room pressure differentials. When closed they prevent significant reverse air flow.

7.17 The relative locations of supply and extract terminals and their design air volume rates will determine the basic air flow between adjacent spaces. Transfer grilles and pressure stabilisers will permit and control the flow of air between spaces ensuring a flow from the clean to less clean areas. Failure to provide such devices will lead to uncontrolled air flows when personnel move between rooms. They may also result in doors being held partially open by air pressure

Temperature and humidity control

7.18 Supply flow rates to achieve the required room conditions, are calculated conventionally, taking account of all heat and moisture gains and losses, and of maximum permissible temperature differences between the room and supply air. In most applications the base heating load will be provided by a heating system. In critical systems the room or suite being considered will be within the

heated building envelope so the ventilation will be sized to suit the casual gains or losses.

7.19 Temperature differences of up to 10K for winter heating and 7K for summer cooling must not be exceeded.

7.20 It is acceptable for the humidity to swing uncontrolled between 35% and 70% saturation.

Removal and dilution of waste anaesthetic gases

7.21 Anaesthetic gases are subject to occupational exposure limits. Waste anaesthetic gas must be contained and removed by a suitable gas scavenging system. Some leakage from the anaesthetic equipment and the patient's breathing circuit will occur with all systems, particularly during connection and disconnection; and from the interface with the patient. The air movement scheme should ensure that this leakage is diluted and removed from the room. Anaesthetic agents are heavier than air so placing the supply terminal at high level with an extract at low level adjacent to the anaesthetic gas terminal units will ensure that staff are in a clean air-flow path.

7.22 In LDRP and delivery rooms the use of anaesthetic gas is controlled on demand by the patient. This may result in significant leakage which, in order to reduce staff exposure, will need to be controlled by establishing a clean air-flow path. A supply at high level at the foot end of the bed with extract at low level at the head-end will provide such a path.

Fire aspects

7.23 When considering the overall air-flow movement, careful thought needs to be given to the operation of the ventilation system, to limit smoke spread in the event of a fire.

Door protection

7.24 Air should flow from the cleaner to the less clean areas as shown in Appendix 2 Table A2. There are several factors that affect the likelihood of a reverse air flow through doorways:

- when a person passes through a doorway, both the passage of the person and the movement of the door flap cause a transfer of air between the areas separated by the door;
- when a door is left open there is a transfer of air between the two areas separated by the doorway. This is caused by air turbulence, but is greatly increased by any temperature differential between the areas (a 1.4 m wide doorway may allow the transfer of 0.19 m^3/s of air in each direction when there is no temperature difference, but when the temperature differential increases to say 2K, the volume transferred may increase to 0.24 m^3/s).

7.25 Two methods of door protection are used in order to reduce the likelihood of contamination of clean area by a reverse air-flow from a less clean area:

- closed door protection – A pressure differential is created across a closed door so that any air leakage is from the clean to the less clean area. Appendix 2 Table A3 gives details of closed door leakage rates for a range of differential pressures;
- open door protection – The pressure differential drops (See Appendix 2 Table A5) and is effectively replaced by a flow of air through the doorway from the clean to the less clean area. The flow of air needs to be sufficiently large to ensure that significant reverse air-flow cannot occur and will be related to the relative cleanliness of the areas being considered. Appendix 2 Table A4 gives air-flow rates for open door protection related to door / opening size and classification of the adjoining areas.

7.26 Pressure stabilisers enable the room differential pressure to be set when the doors are shut, thus providing closed-door protection. When a door is opened the stabilisers will close forcing air to be directed through the doorway thus providing open-door protection.

7.27 The recommended air-flow rates to achieve this are given in Appendix 2 Table A3. Provided that the dilution criteria in Appendix 1 Table A1 are met, the occasional small back-flows created (when two doors are opened simultaneously; or when there is a high temperature difference across an open door) will have little effect on the overall air cleanliness of the affected room.

7.28 In applications where it is critical to maintain a specific air flow and /or pressure regime (for example isolation rooms) all windows in the zone should be locked shut or sealed. Trickle vents, if fitted, will also need to be sealed.

Systems design

7.29 The design of the ventilation system for an area depends on the overall configuration of the department. Where the department is served by more than one AHU the control of the units may need to be interlocked so that reverse air-flow patterns do not occur.

7.30 Dual-duct high velocity systems have advantages, but are noisy, costly and may give rise to unacceptable values of humidity. Single-duct, low velocity/pressure systems are preferred.

7.31 Extract grilles should be sited and balanced to promote air movement in the desired direction.

7.0 (a) Operating department ventilation systems

7.32 The information given in this section relates to General Operating Suites. It will be applicable to other types of theatre suite such as Maternity, Burns, Cardiac, etc. The standard values given may need to be adjusted to reflect non-standard room sizes, pressure regimes and air change rates.

7.33 A method of obtaining a design solution for non-standard theatres is given in Appendix 4.

7.34 Additional information for UCV theatres is given in Section 7.0 (b).

General

7.35 The supply of air to an operating room has four main functions:

- to dilute airborne contamination;
- to control air movement within the suite such that the transfer of airborne contaminants from less clean to cleaner areas is minimized;
- to control the temperature and if necessary the humidity of the space;
- to assist the removal of, and dilute, waste anaesthetic gases.

7.36 Because of the complexities of controlling air movement patterns, much design effort will be required for this aspect. It is important that the design makes the best possible use of the air available, as excessive supply air flows for the control of air movement should not be used. The amount of air supplied to the operating room will be determined by the number of doors and desired air change rate.

7.37 The detailed considerations upon which the supply air-flow rate is based are as follows.

Dilution of airborne bacterial contaminants

7.38 There are four routes that airborne contaminants may appear in an operating room:

- through the supply air;
- shed by operating staff;
- produced by the surgical activities;
- transferred from adjacent spaces.

7.39 Supply flow rates for the main rooms of the operating suite are given in Appendix 3. For the other areas where room sizes and activities vary from site to site, air change rates are given in Appendix 1; Table A1. These figures have been found to give sufficient dilution of airborne bacterial contaminants, provided the mixing of room air is reasonably uniform.

7.40 A downward displacement air distribution is preferred; it may be either turbulent or laminar flow. For turbulent flow the supply air diffusers should be positioned either in the centre of each quadrant of the ceiling or along a line between the centres of each quadrant. This should ensure that all parts of the room are actively ventilated and that there will be adequate air movement at the operating table. Laminar flow would be provided by a perforated plenum terminal centred

above the operating table. (See Section 5 for additional guidance on supply terminals).

7.41 Suspended articulated equipment is usually fitted in theatres. These require significant structural steelwork in the ceiling void to cater for the loads imposed by the resulting bending moments. It is important to ensure that the void is deep enough to accommodate both the steelwork and the ventilation ducts. The location of the steelwork must not prevent a suitable layout of the ventilation ductwork and correct positioning of the supply air terminals. It needs to be recognised that the correct ventilation of an operating theatre plays a significant part in controlling healthcare acquired infections and is not subordinate to the desire to make equipment easy to move.

7.42 Horizontal flow distribution with or without a Coanda effect can be difficult to set up correctly and are unlikely to be as effective in Theatre applications. It should not be used in new installations. However space constraints may force its retention or replacement when refurbishing existing installations. Where fitted, the supply grilles will require a means of directional adjustment.

7.43 For general operating theatres, the air supply would be filtered in the AHU. Terminal HEPA filters are not generally required.

Air movement control

7.44 The design of the system should seek to minimise the movement of contaminated air from less clean to cleaner areas. Transfer grilles enable air to pass in either direction between rooms of equal class and pressure. In older designs suitably dimensioned door undercuts were often used in lieu of transfer grilles. Pressure stabilisers operate in one direction only; they allow excess air to be directed to the area desired and assist in maintaining room pressure differentials.

7.45 The relative locations of supply and extract terminals and their design air volume rates will determine the basic air-flow between adjacent spaces. Transfer grilles and pressure stabilisers will permit and control the flow of air between spaces ensuring a flow from the clean to less clean areas of the suite. Failure to provide such devices will lead to uncontrolled air-flows when personnel move between rooms and doors being held partially open by air pressure.

Temperature and humidity control

7.46 Supply flow rates to achieve the required room conditions, are calculated conventionally, taking account of all heat and moisture gains and losses, and of maximum permissible temperature differences between the room and supply air. In most applications the room being considered will be within the heated building envelope.

7.47 Temperature differences of up to 10 K for winter heating and 7 K for summer cooling must not be exceeded.

7.48 It is acceptable for the humidity to swing uncontrolled between 35% and 60% saturation.

Removal and dilution of waste anaesthetic gases

7.49 Anaesthetic gases are subject to occupational exposure limits. The air movement scheme should ensure that staff are in a clean air flow path. (See Section 7 paragraph 7.21).

7.50 Air extracted from operating suites should not be re-circulated, as it may contain malodorous contaminants, however an energy recovery system should be fitted in the extract in order to reduce the plant energy consumption. (See Section 4 paragraphs 4.142 - 4.147).

Fire aspects

7.51 When considering the overall air-flow movement, careful thought needs to be given to the operation of the ventilation system, to limit smoke spread in the event of a fire. However, this is a highly staffed department with a low fire risk/load status and these factors need to be recognised when developing the fire strategy. It is considered satisfactory to treat the complete operating department as a single fire compartment providing there are at least two exits from it. Over compartmentalisation can lead to difficulties in establishing clean air-flow paths and room-air dilution rates. This will lead to an increased risk of healthcare-associated infections. Staff areas within the department should be treated as a sub-compartment. (See Section 6 paragraph 6.18).

Door protection

7.52 Air should flow from the cleaner to the less clean areas as shown in Appendix 2 Table A2. The factors that affect the likelihood of a reverse air flow through doorways are discussed in Section 7 paragraphs 7.24 - 7.26.

7.53 It is not possible to design an air movement scheme, within the restraints of the amount of air available that will protect the operating room when two doors are simultaneously opened. The design process that has been used considers that each door is opened in turn and ensures that the direction and rate of airflow through any open doorway is sufficient to prevent any serious back-flow of air to a cleaner area.

7.54 Provided that the air change rates in Appendix 1 Table A1 are met, dilution will be sufficient to ensure that the occasional small back-flows created (when two doors are opened simultaneously; or when there is a high temperature difference across an open door) will have little effect on the overall air cleanliness of the affected room.

7.55 The following general points should be taken into consideration during the design of operating suites;

- number of exits – the fewer the number of rooms (and therefore doorways) leading from the operating room the better, as traffic is reduced and less complicated air movement control schemes are required;
- scrub and hand-wash facilities – these may be a part of the operating room, often in a bay. The bay would count as part of the operating room volume and should have a low-level active or passive extract to remove the moisture-laden air. Should a separate room be required for the scrub area, a door between the scrub-up room and the operating room is an inconvenience to scrubbed staff, and could be replaced by an opening. This opening should be larger than a normal single doorway, but the scrub would not, in these circumstances, be considered part of the operating room volume.
- If an alcohol scrub regime is employed, individual theatre scrubs may not be required and would be replaced by a common departmental pre-/post-operation scrub position in the corridor. This would require local extract to prevent a build-up of moisture
- preparation 'Sterile Pack Store' (SPS) – if it is intended to 'lay up' instruments in the operating room, the preparation room is then used simply as a sterile pack store. The nominal room pressure can therefore be the same as that of the operating room and the air flow between the two rooms in either direction. Air supplied to the preparation room may be directed into the operating room either through a door mounted transfer grille or if no door is fitted, through the opening. Alternatively, stock ready-use sterile items can be located in a bay within the theatre. In this case, a portion of the total theatre supply air should be provided in the bay to ensure it is actively ventilated;
- preparation room 'lay-up' – when the preparation room is used as an instrument 'lay-up' room, it should be regarded as being of greater cleanliness than the operating room, and the design should minimise the transfer of air from the operating room to the preparation room. Air supplied to the room may be directed to the operating room through a pressure stabiliser taking care not to compromise the air-flow pattern in the operating room. The air may also be directed into a corridor;
- service corridor – if materials to be disposed of are placed in impervious material for transportation, it is not necessary to have a separate corridor for this purpose. However, a service corridor has many operational advantages it terms of the flow of materials through the theatre suite. It also permits routine service and maintenance access without compromising the use of adjacent theatre suites.

Standard air-movement control schemes

7.56 In the previous versions of this guidance standard air movement control schemes were given that provided a range of design solutions to typical operating suite layouts. These were satisfactory design solutions for 'standard' sized rooms within the suite but were never intended to be universal for any sized room or suite. Guidance on operating suites contained in HBN 26 (2004) has increased the recommended size of operating room from approximately 35m^2 to 55m^2. Associated room sizes and air change rates have also

increased. This means that the original standard solutions are no longer appropriate for new build installations.

7.57 Because of the resulting increase in the volume of air supplied to the theatre, provision needs to be made either to actively remove it or allow it to escape passively through pressure stabilisers. The increase in room size has also made the number and position of air supply terminals critical to the effective ventilation of the room.

7.58 Four new standard solutions have been developed to reflect the current guidance on theatre suite layout and room sizes given in HBN 26 (2004) as well as the general increase in air change rates.

7.59 The most commonly used original standard solutions have been revised and updated. They have been retained in this guidance as they will remain applicable to older theatre suites that are being refurbished to their original performance standards. They will also be applicable in existing departments where space constrains do not permit the upgrading of suites to the latest standard of performance or where a pre-built “shell” is being fitted out.

7.60 It is important to recognise that in any situation where a “non-standard” room size or theatre suite layout is being considered, the designer must return to first principles when developing a solution. Examples of non-standard configurations would be:

- cardiac theatres that typically have an operating room half as big again as normal, a perfusion laboratory and no anaesthetic room;
- operating departments served by a central instrument lay-up preparation area rather than individual prep rooms;
- balanced-flow theatres for infectious cases.

Appendix 4 contains a methodology for assisting the designer to arrive at a suitable solution.

7.61 The new and revised standard design solutions are as follows:

No 1 – Typical Conventional theatre – room sizes as HBN 26;

No 2 – Typical UCV theatre – room sizes as HBN 26;

No 3 – HBN 26 illustrated Conventional theatre;

No 4 – HBN 26 illustrated theatre with UCV terminal fitted;

No 5 – Pre 2006 Conventional theatre, single corridor (SHTM 2025; 1b);

No 6 – Pre 2006 UCV theatre, single corridor (SHTM 2025; 1a);

No 7 – Pre 2006 Conventional theatre, two corridor (SHTM 2025; 5b);

No 8 – Pre 2006 UCV theatre, two corridor (SHTM 2025; 5a).

7.62 Details of these standard solutions are given in Appendix 3. They contain diagrams that show the relationship of rooms and the various doors and transfer devices between them, but should not be regarded as architectural layouts. The schemes have been developed using the calculation procedure described in Appendix 4. Important features of the solutions are:

- zone trimmer heaters – a trimmer heater battery is advocated when calculations indicate that the temperature differential between rooms may be greater than 2 K. Generally this will only be the case in the preparation room when designated as a lay-up;
- the preparation room (sterile pack store)/operating room interface – these rooms are deemed to be of equal cleanliness, and thus a transfer grille is required between these rooms or the door can be replaced with an opening wider than a standard door;
- preparation (lay-up)/disposal room interface – pressure relief dampers are recommended here to provide an air path when doors are closed, while preventing back-flow when a door is opened elsewhere;
- operating room/anaesthetic room interface – pressure stabilisers, or in some cases, carefully sized transfer grilles are recommended here, and between the anaesthetic room and corridor, and between the operating room and corridor;
- operating room/scrub room interface – an opening is provided between these rooms. The flow of air through the opening provides protection, and gives bacterial dilution within the scrub room; the air is then exhausted to the corridor via a pressure stabiliser.

7.63 No mechanical supply or extract ventilation is provided in the scrub room, and thus when a door is opened elsewhere in the suite, the stabiliser will close, allowing the air to be re-directed to help protect the doorway. If the scrub is a bay within the theatre then a suitably positioned pressure stabiliser and / or active extract should be provided to ensure air movement and prevent a local build up of moisture.

7.64 Any other scheme may be used and the standard solutions applied, if the following conditions are met:

- room relationships in air network terms are as shown in the plans;
- door gaps approximate to those given in Component Data Base, see Appendix 2 Table A3 and the comment below;
- casual heat gains are accounted for;
- a trimmer battery is installed in the air supply system to the preparation room;
- leakage through the structure is kept to a minimum.

Note 3: It should be noted that many doors are now fitted with cold smoke seals as standard. These will significantly reduce the door leakage rate when new and undamaged. It is therefore recommended that provision for the design door leakage be factored into the sizing of the appropriate transfer grille or pressure stabiliser. Failure to do this will result in air gap whistles and doors being held partially open by air pressure.

7.65 It is recommended that every effort should be made to adopt one of the schemes described above.

Air terminals and air distribution within rooms

7.66 The selection and sighting of air diffusers will be critical in establishing an efficient pattern of mixing. To this end the diffusers selected must be fit for purpose. Ceiling mounted circular 'air master' style, square 'four way blow' or similar diffuser designs that provide a downward displacement, turbulent air flow are the preferred option. (See Section 5 paragraph 5.68).

7.67 Plenum style 'laminar'-flow-style diffusers with a footprint that encompasses the operating site are acceptable but may be prone to buoyancy effects as a result of temperature difference. Manufacturers' type-test data should be consulted to ensure that the terminal will achieve the required performance envelope. Note that these are not true laminar flow systems in the strict sense of the word but produce a downward-displacement parallel-flow style of air distribution.

7.68 The diffuser equipment chosen should not cause 'dumping' and it should provide a velocity 1 metre above floor level at the operating position of between 0.2 m/s and 0.3 m/s.

7.69 In the operating room, the supply air terminals must be at high level, and should all be adjustable for rate of flow as well as being easily cleaned and silent in operation.

7.70 In order to ensure that all parts of the operating room are actively ventilated, there should be an air-out path on each face or in each corner of the theatre. This may be provided by a pressure stabiliser, transfer grille, active or passive extract terminal. A minimum of three and preferably four air-out paths, approximately equally spaced, should be provided.

Automatic control

7.71 The automatic control of ventilation in operating suites needs to be simple and robust. Over-reliance on complex room pressure and flow relationships linked to automatic fan speed control are unnecessary and in the long term have been shown to be unreliable. Complex software algorithms that can only be accessed and interpreted by off-site specialists should not be used. Whichever control strategy is chosen it is important that on-site staff have the facility to override the control system and keep the ventilation operating at least until the surgical procedure is complete. (See also Section 6; paragraph 6.11)

7.72 Theatre air-conditioning control sensors should be actively ventilated. They would typically be located in a sampling extract duct mounted in the surgeon's panel, positioned at normal working height (1.8m above finished floor level) and be accessible for cleaning and the removal of fluff and lint.

7.73 Wall-mounted passive temperature and humidity sensors are not recommended.

7.74 Controls should be provided to enable operating department ventilation plants to be closed down when the operating suites are unoccupied. (See also Section 6 paragraphs 6.24-6.26)

7.75 When in the 'off' mode, the control system should ensure that the ventilation plant is automatically reinstated if the space temperature falls below 15°C.

7.76 The theatre control panel should include plant status indication; clearly readable temperature and humidity indicating gauges; and means of adjusting the set-point for temperature. Theatre ventilation plant status indication should be located at the staff control base.

7.77 Where it is considered necessary to fit a humidifier, it should be selected to humidify to 40% saturation at 20°C during the design winter outside conditions. The cooling coil should be able to remove sufficient moisture so that 60% saturation at 20°C is not exceeded during the design summer outside conditions.

7.78 Each operating suite should be served by an independent supply and extract plant.

Ventilation of operating department ancillary areas

General

7.79 There are advantages in providing mechanical ventilation to all areas of the department. Maintaining operating suite air-flow patterns is simpler and grilles and diffusers can be sited to eliminate condensation on windows. Where radiators or embedded wall or ceiling panels are installed they should be confined to the corridors and staff-only areas of the department.

Ventilation requirements

7.80 Appendix 2 Table A2 gives guidance on the operating department areas in descending order of cleanliness, and this should be considered in the overall design of the department ventilation systems. The specified flow rates of air through doors given in Appendix 2 Table A4 for the operating suite are not necessary for other areas of the department. However, the airflow directions must be maintained from the clean to the less clean areas.

7.81 All windows in the department should be double-glazed and hermetically sealed in order to ensure that the desired air-flow pattern is maintained under all external environmental conditions and to avoid infestation. Trickle vents if fitted will need to be sealed.

Systems design

7.82 The design of the ventilation system for the ancillary rooms depends on the overall configuration of the department. The plant for the ancillary rooms may need to be interlocked to the theatre suite plants so that reverse airflow patterns do not occur.

7.83 Extract grilles should be sited and balanced to promote air movement along the clean and access corridors towards the reception/transfer areas. This should not affect the air distribution in the operating suite(s).

Reception

7.84 The aim in these areas is to provide comfortable conditions having regard to the movement control requirements of the department as a whole. The number of air changes will depend on the particular design.

Central sterile pack store

7.85 The store needs to be maintained at a positive pressure in order to preserve the cleanliness of the outside of the packs; 6 air changes are recommended.

Recovery

7.86 The air change rate in the recovery room will be rather higher than that needed merely to provide clean, comfortable conditions, as it is necessary to control the level of anaesthetic gas pollution; 15 air changes are recommended, with a balanced air flow.

7.87 The supply air terminals should be ceiling mounted above the foot-end of the recovery bed positions. Extract should be at low (bed height or below) level behind the bed head positions or in the corners. This will establish a clean airflow path so that staff do not inhale anaesthetic gases exhaled by recovering patients.

7.0 (b) Ultra-clean ventilation systems

General requirements

7.88 The design philosophy of a conventionally ventilated operating suite is based on the need to dilute contaminants and control both the condition and movement of air in an operating suite. Ultra-clean ventilation (UCV) is a means of significantly increasing the dilution effect by providing a large volume of clean filtered air to the zone in which an operation is performed and sterile items are exposed. Air is discharged above the operating zone and while not truly laminar, its downward displacement purges the clean zone of contaminants and particles generated by the activities within it. The air flow in and around the clean zone also serves to prevent particles originating outside the zone from entering it. The resulting reduction in contaminants has been shown to reduce significantly post-operative sepsis following certain orthopaedic procedures.

7.89 The number of bacteria that are present in the air at the wound site and exposed surgical items is dependent on the operating team, their procedural

discipline, choice of clothing and the type of UCV system. Ultra-Clean air is defined as that containing not more than 10 CFU/m^3.

7.90 UCV systems are very successful in reducing contaminants at the wound site so it is often considered that there is no need for complex air movement control schemes in the rest of the suite. However when designing the ventilation scheme it should be noted that the users may switch the UCV terminal to "set-back" when non-orthopaedic surgery is taking place. This is because the high air-flow rates can cause increased moisture evaporation of exposed tissue which may be detrimental to the surgical outcome. In recognition of this, the ventilation scheme should be capable of providing operating conditions to at least a "conventional" theatre standard throughout the suite with the UCV in set-back mode. It should also be remembered that suitable levels of ventilation will always be required in the peripheral rooms.

7.91 UCV systems can be designed and built from first principles or a range of bespoke modular units of varying shapes and sizes are available with each manufacturer having a slightly different approach to UCV design. Some systems are fitted with partial or full walls to delineate the clean zone and direct a laminar or exponential downflow of air within it. Other designs utilise slotted linear supply terminals to produce an air curtain around the clean zone together with laminar flow diffusers to provide a downward-displacement supply within it. **Notwithstanding any variation in the design philosophy, all UCV systems will be required to achieve completely the performance standard set out in the "Validation" section of this document**. (Section 8)

7.92 As with conventional theatres, each UCV operating suite should have its own dedicated air handling unit (AHU) to the standard set out in Section 4 of this document. To ensure operational flexibility and permit routine maintenance, air handling units should not be shared between suites.

7.93 In retro-fit installations, site conditions may preclude individual AHUs for each suite. In these circumstances an AHU may be shared between not more than two operating suites providing each suite has its own control of temperature. An accessible air-flow measurement test point should be provided in the supply branch duct to each theatre so that the primary air volume to each UCV canopy can be determined. In addition the branch supply and extract should be capable of being physically isolated and the main air-flow rate reduced so that either suite can be taken out of use without detriment to operating conditions in the other.

7.94 An inherent feature of a UCV system is its large air-flow so it is essential to re-circulate the air supplied to the operating theatre and/or to recover its energy in order to optimise operating costs.

7.95 The primary fresh air volume supplied to an UCV suite will be the same as in a conventional suite and it should be dispersed to the rooms in the suite in the same manner. This is an important aspect of the design and requests by UCV suppliers for increased primary air supply volumes should be resisted.

7.96 Laying-up in the clean zone is preferable for infection control reasons. Where a Sterile Pack Store (SPS) Preparation room is provided a transfer grille will be required in the preparation room / theatre door.

7.97 If the Preparation room is intended to be used for laying-up instruments, a pressure stabiliser will be required between the prep room and theatre. It should be fitted with a stand-off baffle to prevent air transfer interfering with the ultra-clean air-flow distribution.

7.98 Separate scrub-up or disposal facilities are not necessary for air cleanliness although operational policy may prefer such a provision. A separate anaesthetic room should, however, be provided.

7.99 There is no aerobiological reason why two or more UCV systems should not be installed in a common area as long as adequate spacing is provided. These are known as Barn theatres and require special design considerations and operational discipline. The relative positions of the UCV units, temperature control range and location of doors and openings to other areas will all significantly affect the air-flow at the operating positions.

Types of UCV system

Remote plant systems

7.100 In a remote plant system, all the air-conditioning equipment is located outside of the operating room, except for the uni-directional air-flow terminal, terminal filter, air diffuser and the return air grilles.

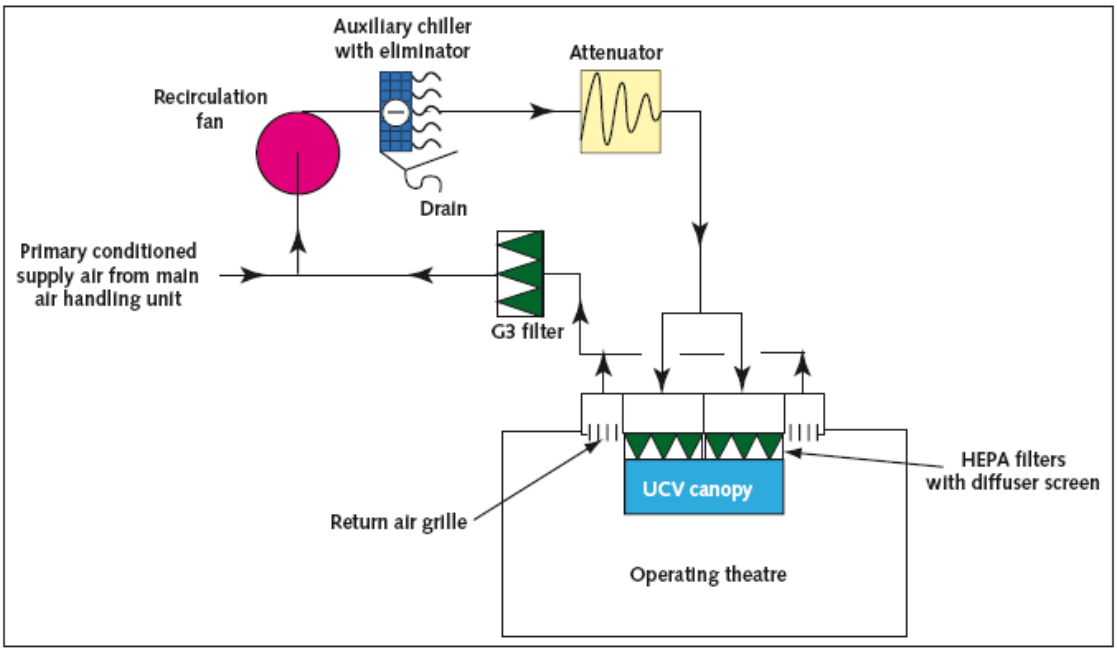


Figure 6 - UCV theatre with remote air recirculation

7.101 This arrangement is the preferred option for new installations as it has the following advantages:

- the recirculation fans are out of the theatre thus reducing noise. Multiple recirculation fans can be replaced by a single fan unit with its drive out of the air stream;
- casual heat gains from recirculation fan(s), canopy lights, equipment and people within the theatre can be removed by a chiller battery in the return air stream. This will prevent heat build up in the theatre;
- the return air filters can be changed without needing access to the theatre making routine maintenance more feasible;
- the opportunity exists to locate the HEPA filter in the primary supply duct rather than the theatre terminal. This will reduce the number of filters required and allow them to be changed without entering the theatre.

Modular systems

7.102 Modular systems are frequently used in retro-fit applications. Vertical or horizontal units are available.

7.103 Vertical-flow modular units comprise a ceiling-mounted air-terminal module containing return-air filters, return-air fans, final filter and air diffuser. Primary air is supplied by a remote air-conditioning unit at the volume and to the standard required for a conventional operating suite. (see Figure 7)

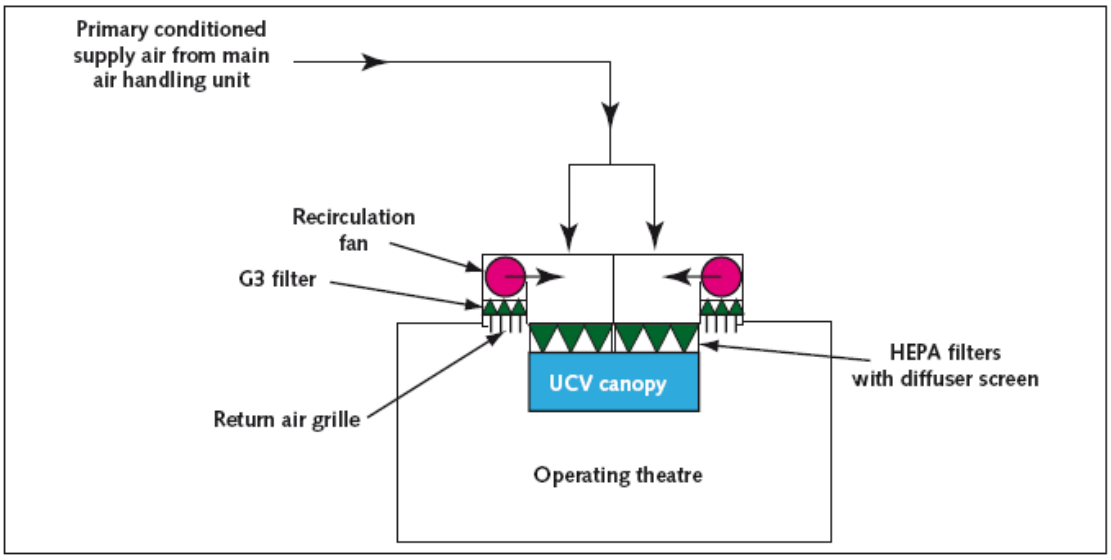


Figure 7 - UCV theatre with modular system

7.104 Horizontal or cross-flow modular units comprise a wall-mounted air-terminal module standing vertically to produce a horizontal flow of air and containing final filter/diffuser, return-air filters and fans. The module may incorporate a cooling unit or be supplied with 'fresh air' from a separate primary cooling system.

Vertical flow UCV systems

7.105 Vertical-flow systems have a superior performance and are more effective at reducing infection risks. Air-curtain or partial-wall systems are acceptable, but are known to be more susceptible to problems arising from performance deterioration, poor operating team-discipline and high occupancy rates than is the case with full-wall systems. A full-wall is considered to be any wall terminating not more than one metre above the finished floor level.

7.106 Because of the large volume of air being moved in a relatively small space, the siting of the return-air grilles can cause short-circuiting of the air discharged through the UCV terminal. If the return-air grilles are positioned at high level, partial walls should be provided to control short-circuiting. The partial-walls shall be not less than 1m from the operating room walls and terminate at least 2m above floor level. The clearance should be increased proportionally for larger terminals (that is, 1.15m for 3.2m x 3.2m units and 1.25m for 3.5m x 3.5m units). In all cases, the side walls should terminate at 2m above floor level.

7.107 Siting the return-air grilles around the periphery of the theatre at low level will eliminate short circuiting, remove the need for partial walls and give an improved air-flow path. In any event there should be an ‘air-out’ path on each face or in each corner of the theatre. These may be provided by combination of pressure stabilisers and passive or active low level extract grilles. Failure to provide ‘air-out’ paths on all faces of the theatre may result in the surplus air causing entrainment into the clean zone.

7.108 Vertical systems should have a clean zone large enough to encompass the operating site and all of the instrument trays likely to be needed for the surgical procedures to be undertaken. Ophthalmic and minor hand surgery would typically require a 1·4m circular or rectangular terminal. For major orthopaedic procedures a minimum size of 2·8m x 2·8m will be required. This is the area projected on the floor under the supply air terminal within the partial walls, full walls or air curtain. Any air outside this zone cannot be guaranteed to be ultra-clean although given the dilution factor the level of microbiological contamination will be much lower than the general level in a conventional operating room. The use of lines or a coloured area on the floor delineating the extent of the clean zone will assist staff and is therefore essential.

7.109 When upgrading an existing conventional theatre to an ultra-clean standard the only solution may be the installation of a modular system. In these units, the heat gains from the return-air fans and terminal lights may warrant the inclusion of supplementary cooling within the module although modern luminaries contribute substantially less unwanted heat. However issues of cooling coil drainage, condensate removal and maintenance access within the space constraints of the module may make this option impracticable. The additional cooling load should then be catered for by conditioning the primary air to compensate.

7.110 If an existing AHU is to be retained, it may require modification to ensure that it achieves the minimum standards set out in Section 4 of this document. The fan may need re-rating to accommodate the change in system resistance. The

cooling coil may also need to be upgraded to cater for the increased load resulting from the return air fans and terminal lights. Failure to make adequate provision for this may make the theatre unusable during prolonged warm spells.

7.111 A factor affecting the air-flow pattern is the supply or room air temperature difference. When the supply-air temperature is significantly above room temperature, buoyancy effects will reduce the volume of air reaching the operating zone. If it is anticipated at design stage that this will be a regular occurrence, then a system incorporating full-walls should be used. Demountable extensions that convert a partial-wall to a full-wall unit are available.

7.112 Convection up-currents from the surgical team and operating lamp tend to counter the movement of clean air towards the operating site, hence the air velocity reaching the operating level is critical. The minimum velocity given below has been selected to take account of these factors and is greater than the theoretical minimum value.

7.113 For all vertical UCV systems the design discharge velocities will be as follows:

Air velocity 2 metres above floor level:

- partial-wall system = 0.38 m/s average;
- full-wall system = 0.30 m/s average.

Air velocity 1 metre above floor level:

- all systems = 0·2m/s minimum within the operating zone.

The validation Section 8 paragraphs 8.75 – 8.86 gives details of the method of measurement.

7.114 Variable-speed recirculation fans with differential pressure control may be the most suitable solution for maintaining consistent performance and energy saving.

Horizontal UCV systems

7.115 Horizontal UCV air-flow systems have been shown to be less effective than vertical systems and are not the preferred solution. There may be occasions, however, where architectural, engineering, economic or workload considerations prevent the installation of a vertical-flow system and only a horizontal-flow system can be installed.

7.116 Horizontal- or cross-flow modular units comprise a wall-mounted air terminal standing vertically to produce a horizontal flow of air across the operating field. The terminal module contains the final filters, air diffuser, return-air grilles, filters and fans. The module may incorporate a full air-conditioning unit or be supplied with ‘fresh-air’ from a separate primary air-conditioning system. In the later case the return-air fan power may warrant the inclusion of a supplementary cooling coil within the module.

7.117 The system should have side-wall panels at least 2·4m apart. The panels may fold to facilitate cleaning of the theatre. The minimum height of the terminal should be 2·1m and a deflector at the top of the filter/diffuser will be acceptable as an alternative to a full roof. These dimensions reflect currently available equipment and may impose operational constraints in addition to a lower level of performance common to these systems.

7.118 In the horizontal flow systems, personnel working between the filter and surgical wound will disperse bacteria that are more likely to contaminate exposed surgical instruments and enter the wound. This may be minimised by the use of improved clothing and operating procedure to reduce dispersion of bacteria. The use of lines on the floor delineating the extent of the clean zone and hatching or colour coding the 'no-entry' zone between the air diffuser and patient will serve to prompt staff and are therefore essential.

7.119 The air discharge velocity as measured 1m from the diffuser face should have a mean value of 0·4 m/s. The validation Section 8 gives details of the method of measurement.

Filters

7.120 The main plant primary and secondary filters should be to the standards and in the location set out in Section 4.

7.121 Terminal filters should be provided within the air-flow terminal or in the air supply to it. High efficiency particulate air (HEPA) filters grade H10 as specified in BS EN 1822 will be required as a minimum. There is no aerobiological benefit in fitting filters of a higher grade than this.

7.122 In some modular UCV units, the terminal filter is used as a pressure equaliser to balance air-flow and filters of a higher grade with a greater pressure drop may be recommended by their manufacturer. The increased resistance may affect the velocity of air reaching the operating level and there will be penalties in terms of installed fan power and higher noise levels.

7.123 The final filters should be installed in a leak-proof housing in a manner which allows the terminal unit, filters and their seals to be validated. A challenge test will be carried out during commissioning to prove the effectiveness of the complete installation.

7.124 Where UCV units are constructed in sections, a means of measuring the pressure drop across the terminal filters in each section should be provided. The pressure test points should be located outside of the partial wall, capped to prevent air leakage and accessible within the theatre without the need to open the unit inspection panels. Alternatively direct-reading pressure gauges should be fitted.

7.125 The UCV system will require a return-air filter to capture the relatively coarse particles which would otherwise significantly reduce the life of the final filter. This should be at least a G3 grade to BS EN 779. In remote recirculation

systems there may be advantages in fitting a higher grade return air filter as it will reduce the load on the terminal HEPA filters and extend their life.

Noise level

7.126 If sound attenuating material is used to line any portion of the inside of the UCV unit it should be non-particle-shedding and fire-resistant. (Further guidance can be found in SHTM Firecode suite of documents).

7.127 The maximum noise level in an operating room fitted with a UCV terminal of any type shall not exceed 50 NR. The validation section gives details of the method of measurement.

Lighting and operating lights

7.128 CIBSE lighting guide LG2 and BS EN 12464-1 give detailed information of lighting requirements. Operating luminaires should comply with the photometric requirements detailed in relevant sections of BS EN 60601.

7.129 The position of the UCV light fittings and style of partial walls, where fitted, should neither adversely disturb the air flow nor result in significant spatial variations in illuminance levels.

7.130 In vertical units, specialised task lighting should be provided by toroidal, cruciform or small multiple dome-shaped luminaires as they have good aerodynamic properties. The ideal luminaire will have a minimal effect on the air flow regardless of where it is positioned. Large diameter saucer-shaped luminaires should not be used in vertical flow systems as they will occlude the air flow in the critical central zone. It is important to consider the suitability of existing luminaires when retro-fitting UCV systems.

7.131 In vertical UCV installations a minimum of 2·75m from floor to underside of the diffuser is required to allow for supporting mechanisms and lamp articulation. When upgrading existing systems this dimension may not be achievable. However, when parked, the lowest point of the central light stem, luminaire and articulation arms should never be less than 2m above floor level.

7.132 The traditional means of light support is a central column that passes through the UCV terminal and is rigidly fixed to the building structure. The position of the support therefore prevents air being supplied at the centre of the terminal. Separate supports displaced from the centre of the clean zone would lead to improved air flow. This approach was advocated in the 1994 version of HTM 2025 but at the time of writing no UK manufacturer has chosen to adopt this solution.

7.133 In horizontal units the size or shape of the specialised task luminaire has little effect on the air flow pattern.

Controls and instrumentation

7.134 The functions of the supply AHU and extract ventilation should be continuously monitored by a BEMS control unit. The controls and instrumentation for the main plant are set out in Section 6.

7.135 UCV systems will additionally require:

- a set-back facility that can reduce the air supplied through the UCV terminal to a volume that equates to not less than 25 air changes per hour of the operating room gross volume whilst still leaving the supply AHU operating at full speed;
- a facility to turn the entire system, supply AHU and UCV terminal, off. (N.B. An emergency stop is not required);
- a readout sufficiently large to be clearly visible from the operating table that shows the temperature of the air being supplied by the UCV terminal;
- a readout sufficiently large to be clearly visible from the operating table that shows the relative humidity of the air being supplied by the UCV terminal;
- a red indicator light that will illuminate when either the supply AHU or the UCV terminal fails, either or both are switched off or are at set-back;
- an amber indicator light that will illuminate when the UCV terminal is at set-back and the supply AHU is running;
- a green indicator light that will illuminate when both the supply AHU and UCV terminal are operating at full speed;
- a blue indicator light that will illuminate when the UCV terminal air flow, as detected by a differential pressure sensor, falls below 80% of the design flow rate.

AHU	UVC terminal	Indicator light	Comment
Off or Fault	Off or Fault	Red	Ventilation not operating at a suitable level to commence surgical procedures
Off or Fault	On (set-back)		
Off or Fault	On (full speed)		
On (set-back)	Off or Fault		
On (full speed)	Off or Fault		
On (set-back)	On (set-back)		
On (full speed)	On (set-back)	Amber	Ventilation provided to at least conventional theatre standard
On (full speed)	On (full speed)	Green	Full UCV standard conditions
–	–	Blue	HEPA-filter resistance causing low air flow

Table 7 - Indicator light logic table

7.136 The switching devices and indicators should be incorporated in the surgeon's panel and their functions clearly labelled. In retrofit installations an auxiliary panel for the UCV may be the most practical option. If fitted it should be mounted adjacent to the surgeon's panel and their control functions interlocked as necessary.

7.137 When a system is designed to have partial walls with full-wall extensions, a volume control facility may be incorporated to allow the system to be run with

reduced velocity when the demountable full-walls are in place. It would be the responsibility of the user to ensure correct operation of the system. To assist the user an explanatory notice should be included on the theatre control panel.

7.138 A direct-reading gauge should be fitted in the theatre to show a representative pressure drop across the final filters. If the UCV control box is located out of the theatre and has a means of manually adjusting the return air-fan speed then it should also be fitted with a direct-reading differential pressure gauge. The means of adjusting the return-air fan speed should be lockable to prevent casual adjustment. The direct-reading gauges should be fitted with a means of indicating the correct operating pressure range.

7.139 The UCV-unit manufacturer's control box should be located in an accessible position preferably in the operating department adjacent to the operating theatre that it serves. A service corridor, if provided, is an ideal location. The control box should be clearly labelled with the identity of the operating theatre that it serves.

7.0 (c) Extract systems

7.140 Extracts may be provided for a variety of reasons including:

- simple odour control (for example in a WC or mortuary);
- to receive and remove moisture laden air (for example, in a kitchen);
- as part of a combined supply/extract balanced system (for example, in an operating suite);
- to capture a hazardous substance at source (for example a safety cabinet).

7.141 Devices that use an inflow of air to control exposure of staff to hazardous substances are classified as Local Exhaust Ventilation (LEV) systems under the COSHH Regulations.

7.142 An LEV system may comprise a self-contained unit incorporating its own carbon filter such as a simple bench-top fume cupboard. Alternatively it may be a complete "ventilation system" comprising a make-up air supply, multiple-exhaust- protected work stations, branch and central extract ductwork, duplex extract fans and a high-level discharge terminal. It may also incorporate a special filtration system appropriate to the hazardous substance being controlled. Such systems could be required for workshops containing woodworking machinery or large centralised pathology laboratories housing multiple safety cabinets, dissection benches, fume cupboards and specimen stores.

7.143 It is important to recognise at the design stage whether an extract is being provided for comfort or as an LEV system. Typical systems in healthcare include:

- microbiological safety cabinets and Cat 3 containment rooms;

- fume cupboards;
- welding-fume extracts;
- woodworking machinery duct collectors;
- battery-charging bay extracts;
- powered plaster and bone saws;
- pharmaceutical preparation cabinets and tablet machines;
- dissection benches, cut up tables and some specimen stores;
- medium-and high-risk infectious disease isolation facilities;
- dental furnaces, grinders and polishers.

7.144 General design information and guidance for LEV systems is produced by the Health and Safety Executive (HSE) as HS(G)37. Information on the design and installation of microbiological safety cabinets is given in BS5726 and that for fume cupboards is given in BS EN 14175. Their recommendations should be closely followed.

7.145 LEV systems are statutory items that will be subject to an independent inspection every 14 months.

Hood extract systems

Special requirements

7.146 Extract canopies will be required over steam-and-heat-emitting appliances, for example sterilisers, catering and washing equipment; and for the extraction of toxic fumes over benches used for mixing, sifting and blending procedures.

7.147 Perimeter-drain gulleys and corrosion-proof grease eliminators should be provided on kitchen hoods.

Typical arrangements

7.148 The air-flow rate must be sufficient to ensure an adequate capture velocity in the vicinity of the process; typical values are as follows:

- evaporation of steam and like vapours 0.25 m/s to 0.5 m/s;
- chemical and solvent releases 1.0 m/s;
- vapour of gases 5 m/s to 6 m/s;
- light dusts 7 m/s to 10.0 m/s.

Excessive velocities will be wasteful of power and generate noise.

7.149 The lowest edge of the canopy should be 2m above finished floor level, with a minimum of 300mm overhang beyond the edge of the equipment on all sides.

7.150 A compact arrangement of equipment (but with access for maintenance) will minimise the canopy area, and hence reduce the air volume necessary to achieve the optimum capture velocity.

7.151 Hoods required for the control of heat gain and vapours may be connected to the general extract system when it is convenient to do so, but where non-corrosive ductwork materials are necessary, a separate discharge is preferred.

7.152 Lighting and internal divider plates are often required to be built into the perimeter of large canopies; however, built-in shelving systems are not recommended, as they interfere with the airflow, and constitute a maintenance problem.

Control of hood extracts

7.153 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the hood extract and any associated supply can be shut down. To this end, local control should be provided.

Bench extract systems

Special requirements

7.154 Bench extract ventilation is required in departments such as pathology and mortuary, where activities involve the release of malodorous or toxic fumes which should not be inhaled. Where hazardous substances are being controlled, the system should be designated an LEV.

Typical arrangements

7.155 Each ventilated position will usually be accommodated in a continuous run of benching, which should not be more than 650 mm from front to rear and which should be provided with a continuous upstand at the rear. Each position should have a 1200mm x 150mm linear extract grille mounted on a purpose-designed plenum box (incorporating guide vanes as necessary), with its face flush with the upstand. The bottom of the grille should be as close as practicable to the level of the working surface (usually 75mm above, to allow for cleaning). The minimum velocity across any part of the grille should be 1 m/s. The grille should be readily demountable to allow for cleaning.

Control of bench extract systems

7.156 Provided that it does not interfere with the operation of the department when not in use, the ventilation system for the bench extract and any associated make-up supply can be shut down. However, a run-on timer with a minimum setting of 30 minutes must be provided. To this end, local or automatic-use control should be provided.

7.157 Processes that produce hazardous vapours, fumes, dusts or noxious vapours should be enclosed or semi-enclosed in a suitable cabinet or exhaust protected work station.

Safety cabinet and fume cupboard extract systems

7.158 Safety cabinets and fume cupboards are devices that use an inflow of air to control exposure of staff to hazardous substances. The units, their exhaust systems, filters, fans and discharge terminals are all classified as Local Exhaust Ventilation (LEV) systems under the COSHH Regulations. The make-up air system to a room that contains an LEV system may also be considered as an essential part of the system and be included in the LEV classification. Information on the design and installation of microbiological safety cabinets is given in BS 5726 and that for fume cupboards is given in BS EN 14175. Their recommendations should be closely followed.

7.159 The Advisory Committee on Dangerous Pathogens (ACDP) publishes 'The Management, Design and Operation of Microbiological Containment Laboratories' covering the general environment in which they are used and operational considerations.

Special requirements

7.160 The supply air system should not distort the unidirectional and stable air pattern required for fume cupboards and microbiological safety cabinets. In general, supply air ceiling diffusers should not discharge directly towards fume cupboards or safety cabinets, unless the terminal velocity is such that the air-flow pattern of the cabinet is unaffected. The design should ensure that high air change rates, and/or the opening and closing of doors do not have any adverse effect on the performance of safety cabinets or fume cupboards. A damped door-closure mechanism may help.

7.161 In order to safeguard the user, all safety cabinets and fume cupboards must be fitted with a clear indication that they are operating correctly. Direct-reading gauges or falling-ball indicators are preferred (in addition to electronic pressure indicators). The system should be set to alarm audibly if the face velocity falls below the minimum safe operating level.

Arrangements for safety cabinet installations

7.162 The manufacture and installation of microbiological safety cabinets must be in accordance with the relevant national standards and guidance issued by the Advisory Committee on Dangerous Pathogens (ACDP).

7.163 A Class 1 microbiological safety cabinet must be specified for routine work involving Group 3 pathogens. It should be housed in a Category 3 containment room. Specific design information on containment rooms is issued by ACDP in conjunction with the Health and Safety Commission.

7.164 Siting and installation of microbiological safety cabinets are of particular importance because:

- the protection afforded to the operator by the cabinet depends on a specific and stable unidirectional air flow through the open front;

- the protection to the environment by the cabinet depends on the high efficiency particulate air (HEPA) filters. The exhaust air should never be considered as totally free from microbiological hazard.

7.165 Microbiological safety cabinet is HEPA filtered prior to being discharged to outside. The extract ductwork should as far as practicable be kept under negative pressure while inside the building.

7.166 Current standards permit the installation of microbiological safety cabinets with integral fans, provided that the extract ductwork can be kept short (that is, less than 2m); such an installation however, is likely to be noisy and is not recommended for use in new buildings.

7.167 The discharge from the cabinet should be fitted with a back-draft damper. In multiple installations where several cabinets discharge into a common extract and discharge duct, it must be possible to isolate each cabinet from the system when not in use.

7.168 Roof-level discharge, wherever practicable, is preferred since it removes much of the uncertainty over air re-entering the building through ventilation inlets and/or windows. In such an installation, the extract fan should be situated separately from the cabinet and close to the discharge outlet, to maintain the duct within the building under negative pressure. The discharge point on a flat roof should be through a 3 metre high terminal. This is required to safeguard staff who may need to access the roof periodically for maintenance. This requirement will also be applicable to fume-cupboard discharges.

7.169 Where this is impracticable, discharge into the room via a double HEPA filter has been accepted. The preferred method however is to discharge 3 meters above the roofline in line with the similar standard for fume cupboard designs.

Arrangements for fume cupboard installations

7.170 The manufacture and installation of fume cupboards must be in accordance with the relevant national standards and associated guidance.

7.171 The primary factors which contribute to the effective performance of fume cupboards include:

- an adequate volume of supply air;
- an effective exhaust system to promote the safe dispersal of waste products to atmosphere.

7.172 The air velocities through sash openings must be sufficient to prevent hazardous materials from entering the laboratory while avoiding excess flow rates that interfere with the investigation process. Average face velocities should be between 0.5 and 1.0 m/s, with a minimum at any point within 20% of the average, the upper end of the range being applicable to the containment of materials of high toxicity. The design velocity must be maintained irrespective of whether the sash opening is varied, or whether doors or windows are open or

closed. Variable Air Volume (VAV) cupboards are available which offer a reduction in energy use.

7.173 The possibility of a fire or explosion which may not be contained by a fume cupboard must always be considered. A fume cupboard should not, therefore, be sited in a position where exit to an escape route will necessitate passing directly in front of it.

7.174 Fume cupboard fans should be installed as near as possible to the termination of the duct, thus maintaining the maximum amount of ductwork at negative pressure.

7.175 Where there are adjacent buildings with opening windows, or where downdraughts occur, it may be necessary to increase the height of discharge ducts in order to achieve adequate dispersal. In complex locations, air-flow modelling or wind tunnel tests may be required to determine the optimum height of the stack. (see also paragraph 7.167)

7.176 Fume cupboards for certain processes must have separate extract systems. However, where appropriate, individual fume cupboard exhaust systems may discharge via non-returning dampers into a single collection duct rather than having a large number of separate stacks. The collection duct should have a large cross-sectional area to minimise its effect on the individual exhaust systems; be open to atmosphere upstream of the first connection; and be designed to discharge a total air volume at least equal to the combined individual extract systems.

7.177 Individual fume cupboard extract systems, discharging either directly to atmosphere or into a collection duct, do not require duplex fans. However, a collection duct designed to provide dispersal of effluent from a number of individual extracts, should have duplex fans with automatic change-over.

7.178 Some fumes are particularly corrosive, so the choice of material for the ductwork, and type of extract fan fitted should reflect the nature of the fume being conveyed.

Control of extract systems

7.179 It is desirable to provide local control of safety cabinets in order to maximise the life of the HEPA filter, and to permit the sealing of the cabinet and room for fumigation if spillage occurs.

7.180 To cope with the risk of an accident or spillage outside safety cabinets, a ‘panic button’ should be provided to switch off the supply to that area; and discharge all extracted air to atmosphere.

7.181 In pathology departments, it will be necessary to have one or more microbiological safety cabinets and one or more fume cupboards available for use at all times, including weekends, therefore, local overriding controls for all these items and any associated ventilation plant will be necessary.

7.0(d) Plantroom ventilation

General requirements

7.182 Plant rooms are required to be ventilated in order to maintain acceptable temperatures for satisfactory operation of the plant and controls, and for maintenance activities. In the case of plant rooms housing combustion equipment, a secondary function of the ventilation is to provide make up air for the combustion process.

7.183 The air required for these purposes should be introduced into the space through inlets positioned to minimise the discomfort to occupants; they should be unlikely to be blocked, closed deliberately (except in the case of fire shutters if required), or rendered inoperative by prevailing winds.

7.184 Plantroom ventilation air should not be used for any other purposes, such as make-up air for extract; and where the plantroom contains combustion equipment, the appliance pressure must not fall below the outside air pressure.

7.185 Specialised healthcare air handling equipment must not be located in a fire compartment that houses combustion equipment.

7.186 Statutory regulations for plantroom ventilation are contained in the Building Regulations, and further guidance is given in CIBSE Guides A & B.

Assessment of ventilation levels

7.187 Ventilation requirements must take into account all heat sources within a plantroom, and where there are large glazing areas, solar gains. The ventilation rate should limit the maximum temperature within the plantroom to 32^{o}C.

7.188 As the level of equipment operating during mid-season and summer is often lower than the winter condition, and the cooling effect of the outside air is reduced, it is necessary to calculate the minimum volume for each season of operation, and the inlet and outlet grilles or fan sizes should be chosen to cater for the largest seasonal air volume.

7.189 Replacement air should not be drawn through pipe trenches or fuel service ducts. Where metal ducts penetrate walls and floors, effective sealing should be provided to confine the ventilation to the boiler room and to meet fire protection requirements. Penetration of fire barrier walls by ventilation ducts should be avoided if possible.

7.190 Fire dampers in plant room ventilation ducts should be electrically interlocked with the boiler plant.

7.191 Care must be taken to prevent any noise generated in the boiler room emerging from natural or mechanical ventilation openings to the detriment of the surrounding environment. Particular care is necessary with mechanical flue draughts and fan-diluted flue systems.

7.192 Information on required air volumes in contained in the CIBSE Guide A & B.

7.193 Where combustion plant is installed, the high-level (outlet) openings should be sized to cater for the total ventilating air quantity; and the low-level (supply) openings sized to cater for the total combined ventilating and combustion air quantity.

Choice of ventilation system

7.194 Ventilation air may be introduced and exhausted by either natural or mechanical means or a combination of both. However, where possible, natural systems are preferred.

7.195 Generally, small installations at or above ground level should have their combustion and ventilation air provided by natural means, employing both high- and low-level openings.

7.196 Basement, internal and large installations at or above ground level will usually require a combination of natural and mechanical ventilation. If the air-flow rate is difficult, both supply and extract may require mechanical means.

7.197 Whether natural or mechanical, the system should be designed to avoid both horizontal and vertical temperature gradients. Both inlet and outlet openings should be placed on opposite or adjacent sites of the building to reduce the effect of wind forces.

7.198 Where mechanical air supply is employed, electrical interlocks with the boiler plant should be provided to prevent damage in the event of failure of the supply fan(s) once the air volume is established.

7.199 The necessary free opening areas for a naturally ventilated plantroom may be calculated using either the method in A4 of the CIBSE Guide A or the table in section B13 of CIBSE Guide B.

7.200 A combined natural and mechanical ventilation system should allow for natural extract at high level, to take advantage of convective forces in the room, with mechanical supply at low level. The high level natural ventilators should be sized to cope with the total quantity of ventilation air, as above.

7.201 To prevent leakage of flue gases and to ensure that the flue draught is not impeded at any time, the air pressure in the boiler room must not exceed the prevailing outside pressure. Therefore, the fan duty should exceed the calculated total combined combustion and ventilation air quantity by at least 25%. Fan-powered inlets should be arranged to flow outside air into the space at a point where cross-ventilation will ensure pick-up of heat without causing discomfort to occupiers.

7.202 Where it is impractical to provide sufficient natural ventilation to remove the heat emitted by the plant, both mechanical supply and extract will be required.

7.203 The high-level extract should be sized to cater for the total ventilating air quantity and the low-level supply should exceed the total combined combustion and ventilating air quantity by at least 25%, as above.

7.0(e) Ventilation of hydrotherapy suites

General requirements

7.204 In a hydrotherapy suite heat recovery should be via heat pump.

7.205 The quantity of supply air should be calculated as 25 litres/sec/m^2 wetted surface, with the wetted surface taken as 110% of the pool water surface area.

7.206 A re-circulation plant is recommended, with a minimum of 20% fresh air.

7.207 As far as practicable, re-circulated pool air should be provided to the ancillary changing and recover accommodation, with the only extract from the toilets, laundry/utility room and pool hall.

7.208 Supply air to the pool hall should be introduced at high level and directed towards the perimeter to mitigate condensation, with extract air taken from directly over the pool. Dampers should not be located over the pool water.

Control of hydrotherapy pool installations

7.209 The supply and extract fans should be interlocked so that the supply fan does not operate until flow is established within the extract system.

7.210 Time-clock control should be provided, with a local override switch to extend the normal operating period as required.

7.211 Night set-back temperature (in the range of 21-25^{o}C) and high humidity control (in the range of 60-75% sat) should be provided to override the time-clock in order to prevent condensation. The exact set-points should be ascertained post-installation.

7.212 A remote indication panel should be provided in the pool hall, giving a visual display of the pool water and pool air temperature.

8. Validation of specialised ventilation systems

Definitions

Commissioning - Commissioning is the process of advancing a system from physical completion to an operating condition. It will normally be carried out by specialist commissioning contractors working in conjunction with equipment suppliers. Commissioning will normally be the responsibility of the main or mechanical contractor.

Validation - 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 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.*"

Commissioning is often sub divided into sections e.g. air handling unit, automatic controls, air-side balance, building fabric and fittings. Each section may be commissioned by its specialist installer and they are often accepted in isolation. Validation differs from commissioning in that its purpose is to look at the complete installation from air intake to extract discharge and assess its fitness for purpose as a whole. This involves examining the fabric of the building being served by the system and inspecting the ventilation equipment fitted as well as measuring the actual ventilation performance.

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 independent Authorised Person appointed by the Health Board.

It is anticipated that training in the validation of specialised healthcare ventilation systems for independent Authorised Persons will become available during the life of this SHTM.

Commissioning general

8.1 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.

8.2 The duct-sizing procedure should take into account the requirements of system balancing, and the position and number of regulating dampers included in the design should be sufficient for this purpose.

Location of dampers and test holes

8.3 Balancing/commissioning dampers will be required in each branch of the distribution ductwork.

8.4 Test holes for the measurement of air-flow will be required at carefully selected points in main and all branch ducts. The number and spacing of holes are given in the BSRIA Application Guide Set COMPAK 1. Their positions must be identified at the design stage.

8.5 The test positions need to be accessible for commissioning to take place. They may also be required for subsequent annual verification of the system performance so they should not be covered by permanent lagging.

8.6 The measurement point should be in a straight length of duct as far away as possible from any upstream bends, dampers or other elements that could cause disturbance to the air flow. The actual location should be:

- at least 1.5 duct diameters upstream of sources of turbulence such as dampers and bends;
- if this is not possible, 10 diameters downstream of dampers, bends or tees, and 5 diameters downstream of eccentric reducers;
- where there is enough space round the duct to insert the pitot tube and take readings;
- where the duct has a constant cross-sectional area.

8.7 Test holes for measuring total air-flow from a fan should be located either 4 diameters upstream, or 10 diameters downstream of the fan. Provision should also be made for measuring the speed of rotation.

Information to be provided

8.8 It is essential that the designer should pass on his intentions fully to the commissioning engineer by indicating which parts of the system are high, medium and low pressure, and by providing:

- relevant parts of the specification;
- schematic drawings indicating performance data as indicated in Table 8;
- equipment schedules;
- controller and regulator schedule;
- fan performance curves;
- wiring diagrams for electrical equipment, including interlock details.

Items in system	Information to be provided
Fans	Fan total pressure Volume flow rate at high and low speed Maximum motor current
Plant items	Type and identification numbers from equipment schedules Fluid and air volume flow rates Fluid and air side pressure losses Dry bulb temperatures Wet bulb temperatures Humidity
Dampers, including motorised and fire dampers	Identification numbers from equipment schedules Location Identification number Volume flow rate
Main and branch ducts	Dimensions Volume flow rates and velocities Identification numbers from equipment schedules
Terminal	Location Identification number Grille or diffuser factor Volume flow rate and neck velocity Operating static pressure
Test holes and access panels	Location Identification number
Controllers	Set points

Table 8 - Information to be provided on schematic drawings

Notes: For Table 8

1. Fan total pressure is the difference between the total pressure (static pressure + velocity pressure) at the fan outlet and the total pressure at the fan inlet.

2. Where volume flow rates are variable, maximum and minimum values should be provided.

Commissioning personnel

8.9 It is unlikely that all of the required commissioning skills will be possessed by one individual; a commissioning team is therefore usually needed. The objective of commissioning is to ensure that the necessary performance and safety requirements are met.

8.10 During the commissioning process a great deal of information will be generated which will form an invaluable future source of reference about the plant. It is essential to ensure that it is collected together in the form of a commissioning manual and handed over to the client on completion of the contract together with the 'as fitted' drawings. This information should be both in hard copy and electronic format.

8.11 In order to be successful the commissioning process must start before practical completion as many parts of the system will become progressively less accessible. The correct installation of those parts will need to be witnessed and leak -rate tests carried out as construction proceeds. Failure to establish responsibility for commissioning early enough will delay the completion of the project or lead to unsatisfactory plant performance.

Commissioning brief

8.12 The commissioning team will require a detailed brief from the system designer. This should include:

- a 'user' brief comprising a description of the installation and its intended mode of operation;
- the precise design requirements with regard to the scheme of air movement, room static pressures, supply and extract air-flow rates and acceptable tolerances;
- full details of the design conditions both inside and out, for winter and summer together with the control strategy;
- equipment manufacturer's type test data, commissioning, operation and maintenance recommendations;
- drawings showing the layout of the system, positions of air-flow measurement test points, dampers, regulating devices and filters within the duct runs, together with sizes of ducts and terminal fittings. It will save time if these drawings are annotated with the design volumes and static pressures required at each branch and outlet point;
- wiring diagrams for all electrical equipment associated with the air handling systems including motor control circuit details and any interlocking and safety devices such as emergency-stop buttons adjacent to the item of plant.

8.13 The CIBSE Commissioning Code, Series 'A' – "Air Distribution", provides full guidance on the information that will be required by the commissioning team.

8.14 The designer should include in the contract document instructions on verifying the accuracy of test instruments which should be supported by reference to relevant calibration certificates.

8.15 The system, on completion, should be operated by the contractor as a whole and subject to performance tests in accordance with the contract requirements.

For critical systems, these may include independent validation of the system performance on behalf of the client.

8.16 Prior to dynamic commissioning, it is essential that builders' work in the area served by the system is complete, all rubbish and dust is removed, concealed plumbing (IPS-type) panels are in position and ceiling tiles are in place and clipped. Floors should be mopped and visible dust removed from all other surfaces.

8.17 Once the system is shown to meet the design intent the handover documentation should be completed. In the event of performance not being acceptable, the matter should be dealt with in accordance with the contract arrangements.

Pre-commissioning checks

8.18 The pre-commissioning checks consist of visual inspection, manual operation of equipment, static measurements and functional tests of individual components. They should be carried out prior to setting the system to work and undertaking the dynamic commissioning process set out in paragraph 8.29 onwards of this guidance.

Standard of installation

8.19 During the installation of the system the following must be witnessed:

- that the plant and installations have been provided and installed in accordance with the design specification and drawings;
- that only approved sealants have been used in the installation;
- that all components function correctly;
- that the satisfactory sealing of access doors and viewing ports have been carried out;
- that air pressure tests and air-leakage tests on ventilation ducting have been carried out in accordance with the methods set out in the HVCA's DW/143: Ductwork Leakage Testing. It is usual to carry out these tests, a section at a time, as the ductwork is installed and before its insulation is applied. The results must be recorded in the commissioning manual;
- that gaps around doors and hatches are as specified in the design;
- that the correct operation of pressure stabilisers, control dampers, isolating and non-return dampers have been checked and installed in the correct orientation for air-flow;
- that test holes have been provided in their specified locations and are sealed with suitable grommets;
- that control dampers are secured and their quadrants fitted correctly;
- that any interlocks are operative and in accordance with specification;

- that the electric circuits are completed, tested and energised;
- that electric motors have been checked for correct direction of rotation both at full speed and set-back;
- that cooling and heating media are available at correct temperatures and pressures and in specified quantities;
- that the air-conditioning plant components and controls function correctly;
- that the air-conditioning plant interlocks and safety controls function correctly;
- that the plant is physically complete, insulation is applied and all ducts and pipework are identified as specified;
- that the building housing the ventilation plant is generally in a fit condition for commissioning and performance tests to commence, that is, windows, doors, partitions etc are completed, surfaces sealed and their final finish applied;
- that the areas containing the ventilation plant and those being served by it are clean;
- that access to all parts of the system is safe and satisfactory.

Cleanliness of installation

8.20 During installation it must be established that ductwork is being installed to the 'advanced level' as defined in the HVCA (2005) 'TR/19 – Guide to good practice: internal cleanliness of ventilation systems'. This specifically includes ensuring that ductwork sections arrive on site and are stored with their open ends sealed and that open ends remain sealed during installation to prevent the ingress of builders' dust.

8.21 Should any doubt exist whether the guidance has been observed, the ducts must be cleaned internally to restore them to this standard before being taken into use.

8.22 "Builders work" ducts of brick or concrete must be surface sealed to prevent the release of dust before being taken into use.

8.23 The area around the supply air intake must be free of vegetation, waste, rubbish, builders' debris or any other possible source of contamination.

Certification of equipment

8.24 The following test certificates should be assembled by the commissioning team and be available for inspection at any time during the contract period. They will form part of the handover information and should be placed in the commissioning manual:

- type-test performance certificates for fans;
- pressure test certificates for:

  - heater batteries;
  - cooling coils;
  - humidifiers (if appropriate);
- type-test certificates for attenuators;
- type-test certificates for primary and secondary filters;
- individual test certificates for high efficiency particulate air (HEPA) filters.

Equipment tests

8.25 Prior to setting the system to work, the checks in paragraphs 8.26-8.28 should be witnessed, and proving tests should be carried out as detailed.

Filters

8.26 The quality of filter housing and in particular, the seals is a critical factor in maintaining the efficacy of the filtration system by ensuring that air does not bypass the filter panels. Therefore, the following checks should be made:

- filter seals should be fitted and in good condition;
- filters should be installed correctly with respect to air flow;
- bag filters should be installed so that the bags are vertical and their pockets free;
- HEPA filters should be installed in a sealed housing and their seals tested to DIN 1946 if specified;
- all filters should be checked to ensure they are free of visible damage;
- the differential pressure indicators should be checked for accuracy and that they are marked with the initial and final filter resistance.

Drainage arrangements

8.27 The drain should conform in all respects to the “Design considerations” of this SHTM. In addition the following must be proved:

- that the drain tray is easily removable;
- that a clear trap is fitted and is easily removable;
- that the drain has a clear air gap of at least 15mm;
- that the pipework is supported so that the air break cannot be reduced;
- that the drain system from each drain tray is independent up to the air break;
- that the operation of the drainage system is proved by introducing water into the duct at the drain tray and observing that it completely drains out. This check is to be repeated both at normal speed and set back once the fans

have been commissioned. At this time the clear trap can be marked to indicate the normal water level with the fan running.

Fire dampers

8.28 The following must be witnessed and proving tests should be carried out as detailed:

- the operation of all fire dampers;
- the access provided to enable the dampers' to be visually inspected and / or re-set should be sufficient for the purpose;
- indication should be provided of the dampers' position (open/tripped);
- indication of the fire dampers' location should be provided both on the ductwork and at a visible point on the building fabric if the ductwork is concealed.

Dynamic commissioning

Air-handling and distribution system

8.29 The fan drive, direction of rotation, speed and current drawn should be set in accordance with their manufacturer's instructions.

8.30 After the installation has been checked to ensure that it is in a satisfactory and safe condition for start up, it should be set to work and regulated to enable the plant to meet its design specification. The proportional balancing method described in the CIBSE Commissioning Code "A" must be followed. The air-flow rates must be set within the tolerances laid down in the design brief. This will normally be the design air flow rate +10%; -0%.

8.31 When combined supply and extract systems are to be balanced and the area that they serve is to be at or above atmospheric pressure then the supply should be balanced first with the extract fan switched off, and then the extract balanced with the supply fan(s) on.

8.32 For combined systems where the area that they serve is to be below atmospheric pressure then the extract should be balanced first with the supply fan switched off and then the supply balanced with the extract fan on.

8.33 On completion of the balance all volume air-flows in supply and extract ducts and from grilles and diffusers must be measured and recorded. The true air change rate can them be calculated from the data obtained.

8.34 The main supply and extract duct volume control dampers must be locked and their position marked.

8.35 All grille and diffuser volume control registers must be locked to prevent alteration and their final position marked.

Room air distribution

8.36 The pressure relief dampers and pressure stabilisers must be set to achieve the specified room static pressures and locked. The grille direction control vanes and diffuser cones must be set to give the specified air movement pattern. Visualisation techniques may need to be employed in order to prove that the required air flow pattern is being achieved. This may be a potential requirement when commissioning LEV systems or rooms that contain them.

Air-conditioning plant

8.37 The specified flow rate and/or pressure drops must be set for all heater batteries, cooling coils and humidifiers. The methods described in the CIBSE Commissioning Codes “W” and “R” should be followed. On completion their regulating devices must be locked to prevent alteration.

Control system

8.38 The control system should not be commissioned until both the air distribution system and air-conditioning equipment have been commissioned.

8.39 Because of the specialised nature of control systems and the fact that each manufacturer’s system will contain its own specialist components and settings, the commissioning should be completed by the supplier and witnessed by a representative of the user.

8.40 The location of all control and monitoring sensors should be checked and their accuracy proved.

8.41 The control system’s ability to carry out its specified functions must be proved.

8.42 If the plant is provided with a “user’s” control panel in addition to the one located in the plantroom then the operation of both must be proved. This will typically apply to operating departments and laboratory systems.

Specific performance standards

Air movement

8.43 The performance of the system should be measured and compared with information provided by the designer.

Plant capacity and control

8.44 When setting to work and proving the design, both the manufacturer of the air handling plant and the control specialist should attend site together and jointly commission the system.

8.45 If any doubt exists as to the capacity of the installed system, then its ability to achieve the specified inside design conditions with the plant operating at winter

and summer outside design conditions must be proved. Artificial loads will be required in order to simulate the internal gains/losses and the outside design conditions.

8.46 On completion of the plant performance test, recording thermo-hygrographs should be placed in each room/area served by the plant and also the supply air duct upstream of the frost battery. The plant should be run for 24 hours with all doors closed. During this period the inside conditions must stay within the tolerances specified. The BEMS should be used to obtain the information required wherever possible.

Noise levels - general

8.47 The commissioning noise level is the level measured with a sound-level meter in the unoccupied room and taking account of the external noise together with the noise generated by the ventilation system. When occupied and in use this commissioning level will constitute a continuous background noise which will allow the overall noise level to be achieved. The ventilation plant design noise level is that generated by the plant alone with no other noise source being considered. The levels suggested make recognised allowance for the ingress of environmental noise.

8.48 The noise levels apply at the maximum velocity for which the system is designed to operate. Acoustic commissioning tests should be carried out with all plant and machinery running normally and achieving the design conditions of air flow, temperature and humidity.

8.49 An industrial-grade sound-level meter to BS3489 or IEC 651 Type 2 will normally be sufficient to check the noise level.

8.50 The noise level readings are to be taken at typical normal listening position 1.5m above floor level and at least 1m from any surface and not on any line of symmetry. In critical rooms the noise should be measured at the centre of the room and at the centre of each quarter. The mean of the 5 readings should then be calculated.

8.51 In the event of a contractual deficiency, a Type 1 precision-grade sound-level meter should be used and the noise level determined by the procedure given in Scottish Health Technical Memorandum 08-01. (forthcoming)

Filter challenge

General ventilation filters

8.52 In situ performance tests will not normally be required for primary and secondary filters and their housings. However the filters should be visually inspected for grade, tears, orientation and fit within their housing. Filters should be clean and a replacement set available. Bag filters should be installed so that their bags are vertical and spaced so that air can move through them freely. Any filter found to be wet should be replaced and the cause investigated.

HEPA filters (for exhaust protective enclosures and laboratories)

8.53 Pathogenic material may be discharged through damaged or badly installed HEPA terminal filters. The complete installation must be tested using the method set out in BSEN: 14644 'Method of Testing for the Determination of Filter Installation Leaks'.

8.54 The challenge tests may be carried out using either of the following techniques:

- use DOP (Dispersed Oil Generator) to provide the challenge and a photometer to detect leaks;
- use a Discrete Particle Counter (DPC) to detect leaks. In order to obtain a sufficient challenge it may be necessary to remove temporarily the supply AHU secondary filters.

8.55 In both cases the upstream challenge should be measured. A measurement of particle penetration through a representative section of the HEPA filter media is then taken and used as the reference background level. These two readings enable the range of the detecting instrument to be set.

8.56 A challenge aerosol of inert particles of the type produced by a DOP generator should be introduced into the air, upstream of the HEPA filter. The downstream face of the filter, its mounting seal and housing would then be scanned for leakage using a photometer. A leak should be deemed to have occurred if a steady and repeatable reading on the photometer at any point exceeds 0.01% of the upstream reading.

8.57 Alternatively a Discrete Particle Counter (DPC) may be used. For the Discrete Particle Counter method the filter face is sampled at several points to establish the smallest non-penetrating particle size. If particles at or above this size are detected when subsequent scans of the filter face, its seal and housing are made, then there is deemed to be a significant leak at, or near, the test position.

8.58 Should the HEPA filter fail this test it must be replaced. Should the filter mounting seal or housing fail this test it may be repaired and the test repeated.

Bacteriological sampling

General ventilation systems

8.59 Bacteriological sampling will not normally be required for either general or local exhaust ventilation (LEV) systems unless otherwise specified.

Conventional operating rooms

8.60 The level of airborne bacteria introduced by the supply air can be checked by closing all doors and leaving the operating room empty with the ventilation system running for 15 minutes. An active air sampler set to 1 cubic metre and mounted on the operating table should then be activated remotely. Aerobic

cultures on non-selective media should not exceed 10 bacterial and/or fungal colony forming units per cubic metre (CFU/m^3).

8.61 The results should be examined to establish the broad category of organisms present. A high preponderance of fungal organisms may be an indication of inadequate filtration for the particular installation. Precise guidance is inappropriate and will depend on local circumstances.

8.62 It may be appropriate to carry out a check of airborne bacteria during a surgical operation. If required this should be carried out as soon as possible after handover. Unless there are unusually high numbers of personnel or extensive activity in the room, the number of airborne bacterial and/or fungal CFU averaged over any five minute period, would be unlikely to exceed 180 per cubic metre.

8.63 Information on the additional validation testing of UCV Operating suites is given in Section 8.0(a).

Ventilation system commissioning/validation report

8.64 Following commissioning and/or validation a full report detailing the findings should be produced. The system will only 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.

8.65 The report shall 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);
- estates and facilities.

8.0(a) Validation of UCV operating suites

General

8.66 Commissioning of a UCV terminal will normally be carried out by its supplier. Commissioning of the air handling unit, fire dampers, distribution ductwork and control systems may be undertaken by different teams. It is therefore important to recognise that the UCV terminal is only one element of the specialised ventilation system serving the operating suite and it cannot be accepted in isolation.

8.67 In order to ensure that the complete system operates correctly it will be necessary to validate the system as a whole from the air intake through to the extract discharge. It is unlikely that “in house” staff will possess the knowledge or equipment necessary to undertake this process. Validation of Ultra Clean

operating theatre ventilation systems should therefore be carried out by a suitably qualified independent Authorised Person appointed by the client.

8.68 It is anticipated that training in the validation of specialised healthcare ventilation systems for independent Authorised Persons will become available during the life of this SHTM.

8.69 The following regime of inspection and testing should be applied to the validation of new installations designed to provide Ultra-Clean conditions in an Operating suite. The test regime has been devised to ensure that the system as installed fully achieves the design requirement for these systems as set out in Section 7.0 (b) of this document.

Basic requirement

8.70 The operating suite to be validated should be physically complete with final finishes applied. All ventilation systems serving it should be operating correctly and delivering their design air flow rates.

8.71 In order to avoid preloading the UCV terminal recirculation ducts and HEPA filters, the Operating suite should be free of any obvious dust and at least "builders clean" before the recirculation fans are set to work.

8.72 The validation procedure for a conventional theatre suite should have been satisfactorily completed to the standard set out in Section 8 prior to attempting to validate the UCV unit. In particular:

- the supply AHU will have achieved the minimum standard;
- the operation of all fire dampers will have been proved;
- the supply and extract air-flow rates as measured in ducts and at room terminals will achieve their design values +10%; -0%;
- room differential pressures will be correct.

Evidence of the satisfactory achievement of the foregoing standard should be available for inspection and independently measured as necessary prior to validating the UCV unit.

UCV unit validation procedure

8.73 Tests to validate the suitability and performance of an Ultra-Clean Operating suite should be undertaken in the order that they appear below. Should an item fail to meet the required standard it should be rectified and successfully retested before passing on to the next test.

Summary of test regime

- Challenge tests to ensure that:
  - the UCV terminal unit is correctly assembled and sealed so that no air will bypass the filters;

  - the terminal filters are correctly sealed in their housings;
  - the terminal filters are of the same grade, of uniform quality and undamaged.

- Air velocity measurements to ensure that
  - a sufficient quantity of air is being delivered by the terminal;
  - the terminal quadrants are in balance;
  - the air flow has sufficient velocity to reach the working plane.
- An entrainment test to ensure that contaminants arising outside of the UCV terminal footprint are not drawn into it.
- Visualisation techniques to gain an understanding of the overall system performance.
- Noise measurement to ensure that working conditions are satisfactory.
- Control system checks to ensure that the system operates as specified.
- Biological monitoring to determine how effective the system is in use.

Test and measuring conditions

8.74 While validating the UCV terminal, the conditions in the Operating room shall be stable and within the given ranges.

temperature: – 19 - 23°C dry bulb.

humidity: – 30 – 65% Relative humidity.

Test and measuring equipment

8.75 Any test or measuring equipment used should have a certificate to prove that it has been validated within the previous 12 months at a calibration facility using traceable national standards.

8.76 In the case of a noise meter, its “matched sound source” should have a certificate to prove that it has been validated within the previous 12 months at a calibration facility using traceable national standards. The noise meter should be calibrated to the sound source on each occasion that it is used.

Test grid – vertical units

8.77 A test grid should be constructed on the floor within the Ultra-Clean terminal footprint as projected by the inside dimensions of the side walls or boundary air curtain. A suitably marked test sheet will provide a consistent standard of test grid.

8.78 The test grid should comprise test squares of 280mm each side.

8.79 The test grid should be aligned along the centre lines of the terminal footprint with its centre under the centre point of the terminal.

8.80 Any test square with 80% of its area within the UCV footprint should be used as a test position.

8.81 An inner zone should be designated that is not less than 36% of the total footprint. It should be made up of a number of test squares distributed symmetrically about the terminal footprint centre line. Regardless of the shape of the terminal footprint, the inner zone should comprise a minimum grid of 6 x 6 test squares.

8.82 Unless specified otherwise, a test position should be in the geometric centre of a test square.

8.83 Test position 1 should be the leftmost test square in the row nearest to the operating room wall that houses the surgeon's panel.

(For an example of a grid for a 2.8 x 2.8 metre terminal see Figure 8)

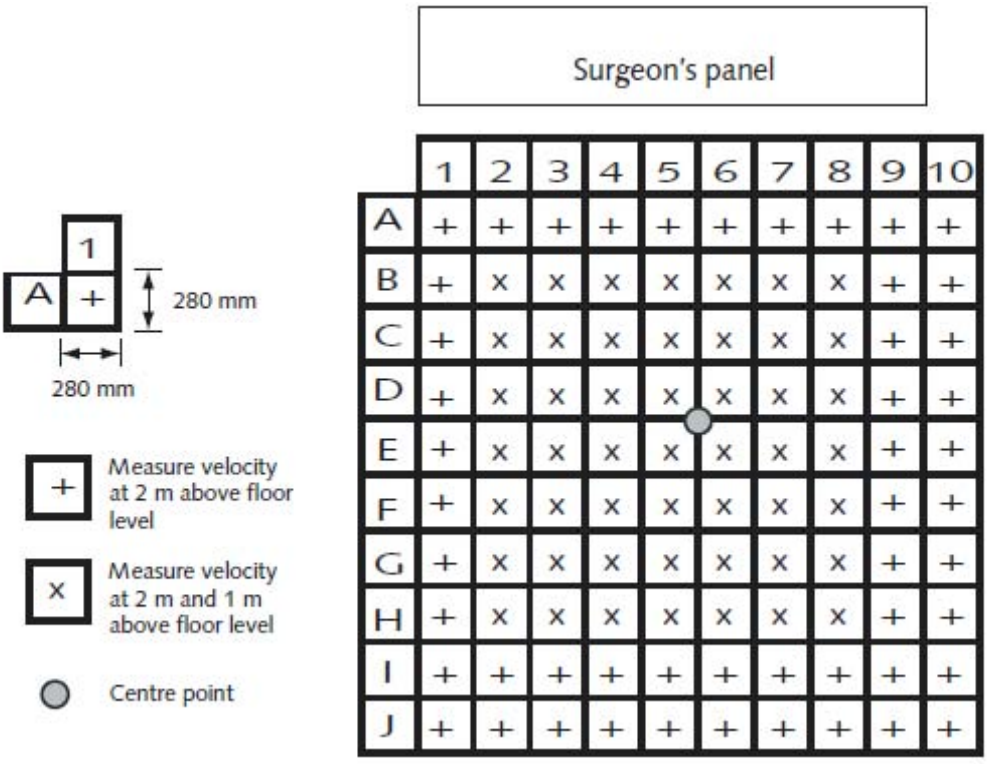


Figure 8: EXAMPLE of a TEST GRID for a 2.8m x 2.8m UCV TERMINAL

Test grid – horizontal units

8.84 A line of test positions should be marked on the floor 1m in front of the face of the UCV terminal.

8.85 A test position should be marked in the centre of the line. Additional test positions should be marked at 280mm spacing along the line either side of the centre position, up to the full face width of the unit.

UCV terminal challenge tests (Vertical and horizontal systems)

8.86 The diffuser screen fitted below the face of the terminal HEPA filters should be lowered or removed while the challenge tests are being carried out.

8.87 The installed HEPA filters should be checked to ensure that their grade accords with the design specification and that their performance has been certified by the manufacturer.

8.88 The challenge tests may be carried out using either of the following techniques:

- use DOP to provide the challenge and a photometer to detect leaks;
- use a Discrete Particle Counter (DPC) to detect leaks. In order to obtain a sufficient challenge it may be necessary to remove temporarily the supply AHU secondary filters.

8.89 In both cases the upstream challenge should be measured. A measurement of particle penetration through a representative section of the HEPA filter media is then taken and used as the reference background level. These two readings enable the range of the detecting instrument to be set.

8.90 For the DOP test this should be set as the reference level and a leak will be declared significant if penetration greater than 0.01% of the range is detected. (See paragraph 8.56 for details).

8.91 For the Discrete Particle Counter (DPC) method the filter face is scanned to establish the smallest non-penetrating particle size. If significant particles at or above this size are detected when subsequent scans are made then there is deemed to be a significant leak at, or near, the test position. (see paragraph 8.57 for details)

UCV terminal unit clean zone leak test

8.92 This test will confirm that there is no unfiltered air bypassing the HEPA filter.

8.93 The joints and service penetration points under the UCV terminal within its side walls or boundary air curtain should be scanned to prove that there are no leaks.

8.94 A leak is defined as a significant rise above the background level.

Terminal HEPA filter seal leak test

8.95 The test will confirm that there is no unfiltered air bypassing the HEPA filter's seal.

8.96 Each HEPA filter's seal should be scanned to prove that there are no leaks.

8.97 A leak is defined as a significant rise above the background level.

Terminal HEPA filter media leak test

8.98 The test will confirm that the HEPA filters have not sustained damage while being installed.

8.99 The face of each HEPA filter should be scanned to prove that there are no leaks.

8.100 A leak is defined as a significant rise above the background level.

Vertical UCV terminal air velocity tests

Test set up

8.101 The terminal face diffuser screen should be in place for these tests.

8.102 Take spot readings to establish that the room is within the specified temperature and humidity test conditions.

8.103 Set out the test grid as described previously.

8.104 Swing the operating lamp arms and any other stem arms so that they align to present the least resistance to air flow, are perpendicular to the front edge of the test sheet and face the back edge. Any lamp and equipment heads should as far as practicable be outside of the UCV terminal footprint.

Test instrument

8.105 The measuring instrument should be a hot-wire anemometer with a digital read-out. The instrument resolution should be at least 0·01m/s, have a tolerance of ±0·015m/s or 3% of that reading and be calibrated down to 0·15m/s or lower. An alternative instrument may be used providing it is of no lesser specification.

Test method

8.106 The instrument should be mounted on a test stand and set to take a mean reading over a 10 second sample interval.

8.107 It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. Alternatively they could be downloaded to a computer or data logger at the end of the test.

8.108 The test stand to be positioned on each test point in turn and the reading taken when the instrument has stabilised.

8.109 When taking a reading the test person should not stand within the same quadrant as the test instrument.

8.110 Readings are to be taken at the test positions with the instrument probe facing the wall housing the surgeon's panel, commencing at the first test position.

Readings are taken working along the row from left to right and back, or for all text positions in one quadiant at a time.

8.111 When all the test positions under one half of the terminal have been covered, readings of temperature and humidity are then taken at the specified height in the centre of the terminal. The read-outs on the surgeon's panel should be recorded at the same time.

8.112 Having completed one half of the test grid, the operating lamp arms and any other stem arms should be swung round through 180^{o} and the test stand reversed so that the wall housing the surgeon's panel is behind the test person. Readings are recommenced starting at the right of the test row and working from right to left a quadrant at a time, as above.

UCV high level discharge velocity test

8.113 Measurements of air velocity are to be taken at every test position 2m above floor level and the results averaged.

8.114 The average of the total readings taken is to be not less than:

0.38 m/s for a partial-wall system;

0.30 m/s for a full-wall system.

The average air velocity for each quadrant should not exceed ±6% of the measured average velocity for the terminal

UCV low level air velocity test

8.115 Measurements of air velocity are to be taken at each of the inner zone test position 1m above floor level.

8.116 The measured velocity at every test position in the inner (operating) zone shall be not less than 0·2m/s.

Horizontal UCV terminal air velocity test

Test set up

8.117 Set out the line of test positions as described previously.

8.118 Swing the operating lamp arms and any other stem arms so that they align to present the least resistance to air flow and are perpendicular to the line of test positions.

Test instrument

8.119 See that specified for vertical systems (paragraph 8.105 refers).

Test method

8.120 The instrument should be mounted on a test stand and set to take a mean reading over a 10 second sample interval.

8.121 It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. Alternatively, they could be downloaded to a computer or data-logger at the end of the test.

8.122 The test stand should be positioned on each test point in turn and the reading taken when the instrument has stabilised.

8.123 When taking readings the test person should stand well downstream of the instrument.

8.124 Readings are to be taken at the test positions with the instrument probe facing the UCV terminal, commencing at the first test position on the left and working along the row from left to right at the specified height.

8.125 The instrument should be reset to the next specified height and the test repeated and so on.

8.126 Readings of temperature and humidity should be taken at the specified height in the centre of the terminal. The read-outs on the surgeon's panel should be recorded at the same time.

UCV discharge velocity test

8.127 Measurements of air velocity are to be taken at all test positions at 1m, 1·5m and 2m above floor level.

8.128 The average of the total readings taken should be no less than 0·4m/s.

UCV entrainment test (Vertical systems only)

Rationale for the entrainment test

8.129 The performance of UCV systems may be compromised by room air being drawn into the ultra-clean airflow, a phenomenon known as "entrainment." Significant levels of entrainment could lead to microbial contamination of items left exposed on instrument trolleys laid out beneath the canopy.

8.130 UCV systems having permanently fitted full side walls do not need to be tested, as the side walls physically prevent entrainment.

Principle of the test

8.131 A source of particles is produced outside of the UCV terminal and is used to challenge the system. A detector is placed within the ultra-clean airflow and used to determine the percentage penetration of the test particles at predefined

locations under the UCV terminal footprint. The source and detector are moved in tandem around the UCV canopy and pairs of readings taken, from which the percentage penetration at specified locations is calculated. The degree of penetration should be below specified maximum limits if entrainment is to be declared not significant.

8.132 The entrainment test may be carried out using either of the following techniques:

- use DOPs to provide the challenge source at the specified release position and a photometer to measure the entrainment; or
- duct non-HEPA-filtered air to the specified release position and use a DPC to measure the entrainment.

Test set up

8.133 The terminal face diffuser screen should be in place for these tests.

8.134 The test should be performed without any equipment in place beneath or closely adjacent to the UCV terminal.

8.135 The theatre lights should be moved to a central position beneath the terminal and raised to 2m above floor level, so as not to interfere with the peripheral airflows.

8.136 Take spot readings at the centre of the canopy, one metre from floor level, to establish that the room is within the specified temperature and humidity test conditions.

8.137 Set out the test grid as described previously.

8.138 For either of the following entrainment tests, a measurement of particle penetration through a representative section of the HEPA filter media is to be taken and used as the reference background level.

Test equipment, challenge source, measuring instrument and detector head

8.139 The challenge and detector equipment should be chosen so that:

- the tracer particles are mainly within the size range 0.3 to 5 microns and thus capable of remaining airborne for a substantial time;
- the particles used should not be able to penetrate the terminal filters in sufficient numbers to cause a background count that is more than 0.1% of the challenge count;
- the choice of particle and detector will enable a minimum of 3 logarithm (1,000-fold) range of counts to be recorded between the highest (i.e. source) and lowest (i.e. background) readings expected. (A concentration of approximately 10^5 particles per cubic metre of source air has been shown to be adequate.)

Source – Dispersed Oil Particles (D.O.P.)

8.140 The DOP generator should be able to produce a cloud of test particles in the form of a visible smoke. The test smoke should be delivered via an aperture so that it flows vertically downward from the lowermost edge of the partial wall, on the outside of the UCV canopy.

8.141 The test smoke is to be delivered via an aperture.

Note 4: To prevent undue contamination of the theatre and filters with deposits of oil, DOP should only be reteased for the minimum amount of time necessary to complete the test.

Challenge source – natural particles

8.142 The source unit should be a fan/blower or other method that takes non-HEPA-filtered air and expels it via a delivery head at the specified release position to provide the particle challenge. The challenge air should be delivered vertically downwards from the lowermost edge of the partial wall, on the outside of the UCV canopy, parallel to the airflow coming from the diffusers. The challenge air velocity should be the same as the measured average velocity at 2m from the terminal under test.

Note 5: The use of DOP for testing is gradually being phased out and replaced by a natural challenge measured with a DPC. At the time of writing research is under way to define more precisely a challenge source unit for natural particles. It is anticipated that such a unit, together with a matching test methodology, will become available during the life of this Scottish Health Technical Memorandum.

The detector (defined in terms of range and resolution)

8.143 This may be a photometer or a DPC. It is recommended that a printer be linked to the test instrument so that readings are recorded automatically. The instrument should be capable of sampling a minimum a 28.3 litres of air per minute and in the case of the DPC, provide readings for particle size ranges from 0.3 microns to 5.0 microns and greater. The instrument should be compliant with the requirements of BS EN ISO 14644-1. An alternative instrument may be used providing it is of no lesser specification.

Test positions and orientation of source and detector

8.144 The test positions should be at the centre of each test square, as defined for the velocity test.

8.145 For rectangular UCV terminals, measurements of penetration are to be taken at the four corner test squares of the test grid and at intermediate positions along the line of test squares between the corners. The number of intermediate test positions will be as equally spaced as possible around the periphery with no fewer than 3 and no more than 5 complete test squares between test positions.

8.146 A further series of measurements are to be obtained around the periphery of the inner zone. Measurements of penetration are to be taken at the four corner test squares of the inner zone of the test grid and if necessary at intermediate positions along the line of test squares between the corners as equally spaced as possible, with no fewer than 3 and no more than 5 complete test squares between test positions.

8.147 A single measurement should be taken at the geometrical centre of the UCV terminal footprint. The centre measurement will be taken with the detector head mounted vertically upwards 1 metre above floor level.

8.148 The centre of the challenge particle source should be aligned with the centre of the designated test square, with its longer edge against the outer edge of the partial wall and delivering the challenge from the lower edge of the partial wall. The air containing challenge particles is directed vertically downwards from the lower edge of the partial wall, in a plane parallel to the adjacent partial wall. Where there is physical interference due to obstructions such as gas pendants, the source will be moved to the next available non-obstructed test-square location nearest to the stipulated sampling position. The detector should then also be moved to remain opposite the source.

8.149 In the case of non-rectangular terminals, an interpretation of the above strategy should be adopted that will yield a no less searching examination of the unit's ability to control entrainment.

Test method

8.150 The sampling head of the detector instrument is mounted on a test stand with its sampling orifice facing outwards horizontally from the centre of the UCV canopy, 1m above floor level. The sampling head should be orientated at right angles to the partial wall when sampling along the sides of the test grid but will be set to bisect the angle when measuring at the corner test positions (Figure 8 in section 8, at paragraph 8.84 illustrates the challenge and detector orientations when evaluating a 2.8m x 2.8 m UCV terminal).

8.151 The test will commence at the first test position, this being designated the leftmost corner of the test grid when facing the wall housing the surgeon's panel. The penetration will also be measured at the corresponding test point on the inner zone commencing at the corner nearest to the first test position. When these tests have been completed, the source and detector equipment should be moved to the next test positions, working around the test grid in a clockwise direction.

8.152 The test stand should be positioned on each test point in turn and a pair of readings (challenge, then penetration) taken when the instrument has stabilised. The detector should be set to take a reading over a 15 second sample interval.

8.153 When taking a reading the test person should stand within the UCV terminal footprint but not in the same quadrant as the detector head.

Analysis and interpretation

8.154 The following standard is to be achieved:

- penetration to be not greater than 10% of the challenge at each test position in the outer zone;
- penetration to be no greater than 1% of the challenge at each test position in the inner zone;
- penetration to be no greater than 0·1% of the challenge at the centre of the test grid.

If a result is close to, or above the given limits, then a further reading must be obtained using a longer time base (1 minute) and the penetration must not exceed the given limit.

Basis of the test

8.155 Whyte W, Shaw BH, Freeman MAR. An evaluation of a partial-walled laminar-flow operating room. *J Hyg Camb* 1974 ; 73 : 61 – 75.

Whyte W, Lidwell OM, Lowbury EJL, Blowers R. Suggested bacteriological standards for air in ultraclean operating rooms. *J Hosp Infect* 1983 ; 4 : 133 – 139.

UCV visualisation

8.156 The use of smoke to gain an understanding of the overall performance of the system may prove useful at this stage in the validation process but cannot be relied on to produce a contractually definitive measure of performance.

UCV noise level

8.157 An industrial-grade sound-level meter to BSEN 61672 Type 2 fitted with a muff should be used to check the noise level. The instrument should be calibrated using a matched sound source prior to each set of readings.

Vertical systems

8.158 The noise level readings should be taken at typical normal listening positions 1·5m above floor level and at least 1m from any surface and not on any line of symmetry. Measurements should be taken under the centre of each quadrant of the UCV terminal and the four readings averaged.

Horizontal systems

8.159 The noise level readings are to be taken at typical normal listening positions 1·5m above floor level on the test line. The width of the unit should be divided

in two and a measurement taken in the centre of each half but avoiding any line of symmetry. The two readings should be averaged.

8.160 Measurements should also be taken in each room of the suite.

8.161 In the event of a contractual deficiency a Type 1 precision-grade sound-level meter complying with BS EN 61672 should be used. Readings should be taken at the positions specified above and in each case the logarithmic mean of the results should be calculated in order to determine the noise level. (Further information can be found in SHTM08-01, forthcoming).

8.162 For vertical or horizontal systems, the noise level shall not exceed:

- 50NR [55dB(A)] – for UCV operating rooms and spaces without doors that open directly on to it (for example the scrub);
- 40NR [45dB(A)] – for all other peripheral rooms of the suite.

UCV control system checks

Temperature

8.163 The readings of temperature taken under or in front of the UCV unit should be within ±1°K of each other and the read-out on the surgeon's panel.

Humidity

8.164 The readings of humidity taken under or in front of the UCV unit should be within ±5% of each other and the read-out on the surgeon's panel.

Direct-reading differential pressure gauges

8.165 The differential pressure across the terminal filter(s) should be measured to confirm the accuracy of the indicated reading of any gauge.

Control functions

8.166 The operation of all control functions provided on the surgeon's panel should be proved for conformity with the design specification.

8.167 If an auxiliary panel has been fitted then its interlocking with the main surgeon's panel control functions must be proved to conform to the design specification.

Panel indicator lights

8.168 The panel indicator lights should illuminate as appropriate when the control functions are selected or warning levels are reached

BEMS interface

8.169 The operation, monitoring and alarm functions must be proved to conform with those set out in the design specification.

UCV theatre microbiological tests

8.170 There is little value in performing microbiological sampling in a new theatre supplied with ultra-clean ventilation. The foregoing filter challenge tests, air velocity measurements and entrainment test should have proved that the system operates satisfactorily and achieves the contracted level of performance. The HEPA filters will remove bacteria-sized particles from the air supplied through the UCV terminal. Therefore there will be an insignificant number of bacterial and/or fungal CFUs present until the Theatre is actually used.

8.171 Once the theatre has been taken into use, microbial sampling during a surgical procedure should help to confirm the satisfactory performance of the system and discipline of the users. Before commencing bacteriological testing, the room and its ventilation system should have achieved a steady state condition: (see also paragraph 8.74)

8.172 The installation should be tested during surgical procedure at intervals between the time of the first incision and final closure of the wound. On average, the air sampled within 300mm of the wound should not contain more than 10 CFU/cubic metre.

UCV validation report

8.173 Following validation a full report detailing the findings should be produced. The report shall conclude with a clear statement as to whether the UCV theatre suite achieved or did not achieve the standard set out above.

8.174 A copy of the report should be lodged with the following groups:

- operating department;
- infection control;
- estates and facilities.

Health Facilities Scotland

NHS National Services Scotland

Appendix 1 – Table A1: Recommended air-change rates

Application	Ventilation	AC/Hour	Pressure (Pascals)	Supply Filter	Noise (NR)	Temp (oC)	Comments For further information see Section 6
General ward	S / N	6	-	G4	30	18-28	
Communal ward toilet	E	10	-ve	-	40	-	
Single room	S / E / N	6	0 or –ve	G4	30	18-28	
Single room WC	E	3	-ve	-	40	-	
Clean utility	S	6	+ve	G4	40	18-28	
Dirty utility	E	6	-ve	-	40	-	
Ward Isolation room	-	-	-	-	-	-	See HBN 4; Supplement 1
Infectious disease Iso room	E	10	-5	G4	30	18-28	Extract filtration may be required
Neutropeanic patient ward	S	10	+10	H12	30	18-28	
Critical Care Areas	S	10	+10	F7	30	*18-25*	Isolation room may be –ve press
Birthing Room	S & E	15	-ve	G4	40	*18-25*	Provide clean air-flow path
SCBU	S	6	+ve	F7	30	*18-25*	Isolation room may be –ve press
Preparation room (Lay-up)	S	>25	35	F7*	40	*18-25*	*H12 if a lay-up for a UCV Theatre
Preparation room / bay sterile pack store	S	10	25	F7	40	*18-25*	*50NR if a bay in a UCV Theatre
Operating theatre	S	25	25	F7	40	*18-25*	
UCV Operating theatre	S	25*	25	H12	40	*18-25*	Fresh air rate; excludes re-circulation
Anaesthetic room	S & E	15	>10	F7	40	*18-25*	Provide clean air-flow path
Theatre Sluice/dirty utility	E	>20	-5	-	40	-	
Recovery room	S & E	15	0	F7	35	*18-25*	Provide clean air-flow path
Cardiac catheterisation lab	S	15	+ve	F7	40	*18-22*	

Endoscopy room	S	15	+ve	F7	40	*18-25*	
Endoscopy cleaning	E	>10	-ve	-	40	-	
Day case theatre	S	15	+ve	F7	40	*18-25*	
Treatment room	S	10	+ve	F7	35	*18-25*	
Pharmacy aseptic suite	S	20	#	H14	-	*18-22*	# See EGGMP (Orange guide) a
Cat 3 or 4 containment room	#	>20	#	H14*	-	*18-22*	# See ACDP guide; *Filter in extract
Post mortem room	S & E	S = 10 E = 12	-ve	G4	35	18 –22	Provide clean air-flow path
Specimen store	E	-	-ve	-	-	-	Fan accessible from outside of store

Notes: (applicable to Table A1)

18-22°C indicates the range over which the temperature may float
18-22°C indicates the range over which the temperature should be capable of being controlled
S = supply N = natural ventilation
E = extract a – European guidelines on good manufacturing

Appendix 2 – Hierarchy of cleanliness

			Air-flow rate for bacterial contaminant dilution	
Class	**Room**	**Nominal pressure (Pa) a**	**Flow in or supply m^3/s**	**Flow out or extract m^3/s**
Sterile	Preparation room (a) lay-up (b) sterile pack store Operating room Scrub bay b	 35 25 25 25	See standard schemes in Appendix 3 for recommended design values	
Clean	Sterile pack bulk store Anaesthetic room c Scrub room	 +ve 14 c 14	6 AC/h The greater of 15 AC/hr or 0.15 -	- The greater of 15 AC/hr or 0.15 0.10
Transitional	Recovery room Clean corridor General access corridor Changing rooms Plaster room	3 0 0 3 3	15 AC/hr d e e 7 AC/hr 7 AC/hr	15 AC/hr d 7 AC/hr 7 AC/hr 7 AC/hr 7 AC/hr
Dirty	Service corridor Disposal room	0 -5 or 0	- -	f 0.41 or 0.10

Table A2

Notes: (applicable to Table A2)

a. Nominal room pressures are given to facilitate setting up of pressure relief dampers, the calculation process, and the sizing of transfer devices. In practice, the resultant pressures are not critical, provided the desired air-flow rates and movement are achieved.

b. An open or semi-open bay is considered to be part of the operating room; provided air movement is satisfactory, no specific extract is required. However if the layout means that air movement is poor, a local extract may be required to control local condensation on the building surfaces, which can result in mould growth.

c. For design purposes, anaesthetic should be assumed to be at 14Pa. When commissioning 10Pa is considered suitable.

d. 15 AC/hr is considered necessary for the control of anaesthetic gas pollution.

e. Supply air-flow rate necessary to make up 7 AC/hr after taking into account secondary air from cleaner areas.

f. No dilution requirement. Temperature control requirements only.

Type	Pressure difference - Pa						
	5	**10**	**15**	**20**	**25**	**30**	**40**
Single door (CDB Size 2.4.3.2.6.)	.03	.05	.06	.06	.07	.07	.08
Double door (CDB)	.04	.08	.10	.11	.12	.13	.14
High permanent length of 3mm gap	.004	.008	.010	.011	.012	.012	.013

Table A3 – Leakage flows in m^3/s through closed door gaps

Note: CDB = Component Data Base

It should be noted that many doors are now fitted with cold smoke seals as standard. These will significantly reduce the door leakage rate when new and undamaged. It is therefore recommended that provision for the design leakage be factored into the sizing of the appropriate transfer grille or pressure stabiliser. Failure to do this will result in air gap whistles and doors being held partially open by air pressure.

Factory-assembled door-sets with a steel frame and pre-hung leaves have become common. There is effectively no leakage across these doors when closed. Therefore, when this type of door assembly is fitted, the door leakage can be ignored and the design air-flow into the room reduced accordingly. The design air-flow would then become that required either (i) for open door

protection, or (ii) to achieve the specified air-change rate - whichever is the greater.

Room class		Dirty	Transitional	Clean	Sterile
Sterile	Hatch	0.3	0.24	0.18	
	Single door	0.47	0.39	0.28	0 or 0.28 a
	Double door	0.95	0.75	0.57	0 or 0.57 a
Clean	Single door	0.39	0.28	0 or 0.28 a	
	Double door	0.75	0.57	0 or 0.57 a	
Transitional	Single door	0.28	0 or 0.28 a		
	Double door	0.57	0 or 0.57 a		
Dirty	Single door	0	Open single door = 0.80m x 2.01m high		
	Double door	0	Open double door = 1.80m x 2.01m high		

Table A4 - Recommended air flow rates in m^3/s through a doorway between rooms of different cleanliness to control cross-contamination

Designer's Notes:

a The degree of protection required at an open doorway between rooms is dependent upon the degree of difference in cleanliness between them.

b Flow rate required between rooms within the same class tends to zero as class reduces.

c If two rooms are of equal cleanliness, no flow is required (in practice there will be an interchange in either direction) and the design of the air movement will assume zero air flow. In certain cases, however, interchange is not permitted and a protection air flow of 0.28 is assumed in the design, for example, in the case of a preparation room used as a "lay up".

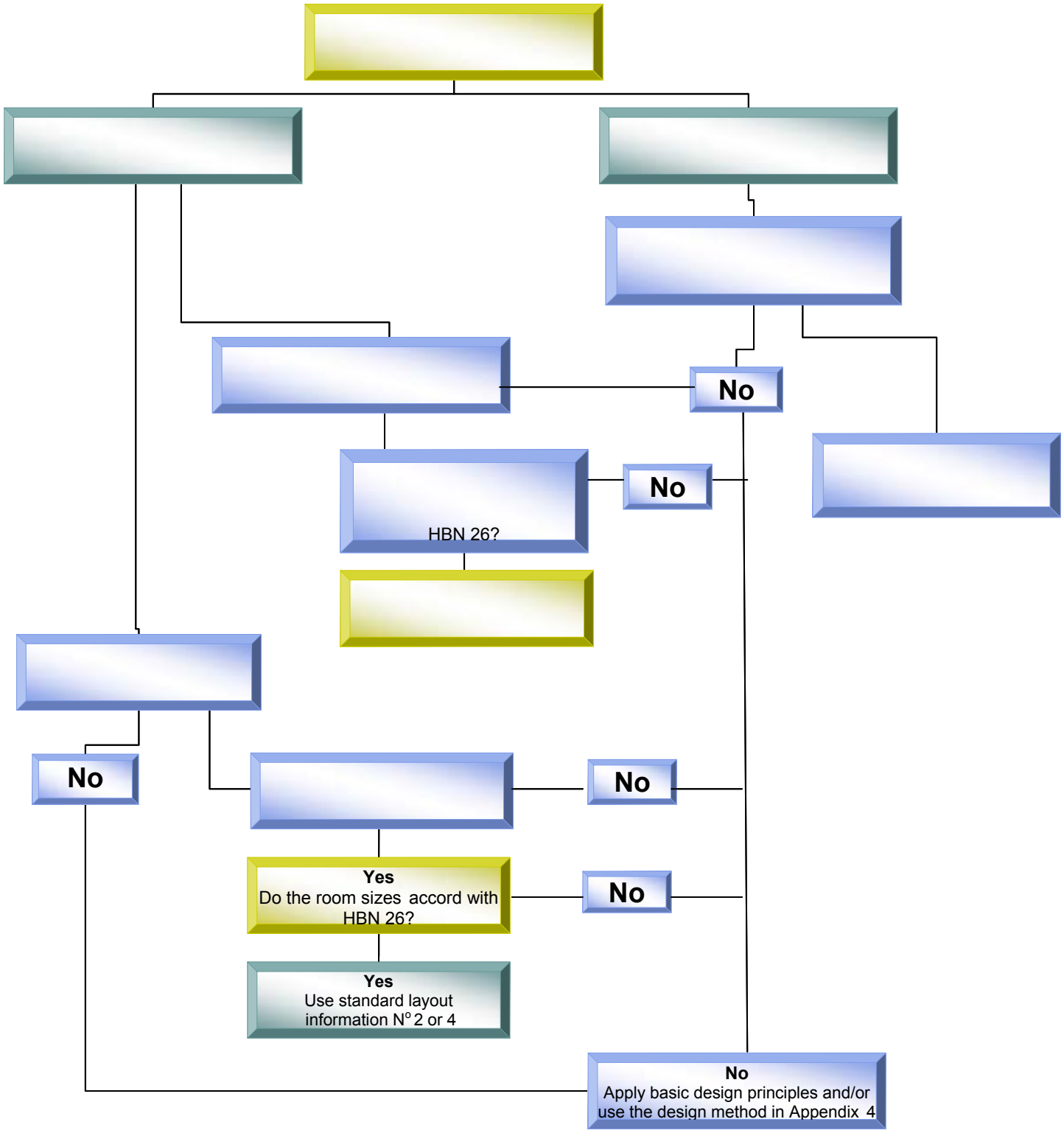
		Effect on other rooms	
Door open between	Resultant pressure in these rooms (Pa)	Room	Pressure (Pa)
Operating room and corridor or Scrub bay and corridor	0	Anaesthetic Preparation – lay up Disposal Preparation – sterile pack store	0 12 -6 5
Operating room and anaesthetic room (or other series room with double doors)	17	Preparation – lay up Disposal Preparation – sterile pack store	26 -9 22
Operating room and disposal room or Operating room and preparation room	25	No change	
Anaesthetic room and corridor (or other series room with double doors)	0	Preparation – lay-up Disposal Operating room Preparation – sterile pack store	30 -6 20 25
Preparation room – corridor Disposal room & corridor	0	No change	
Disposal room & outer corridor	0	No change	

Table A5 - Typical pressures in an operating suite when a given door is open

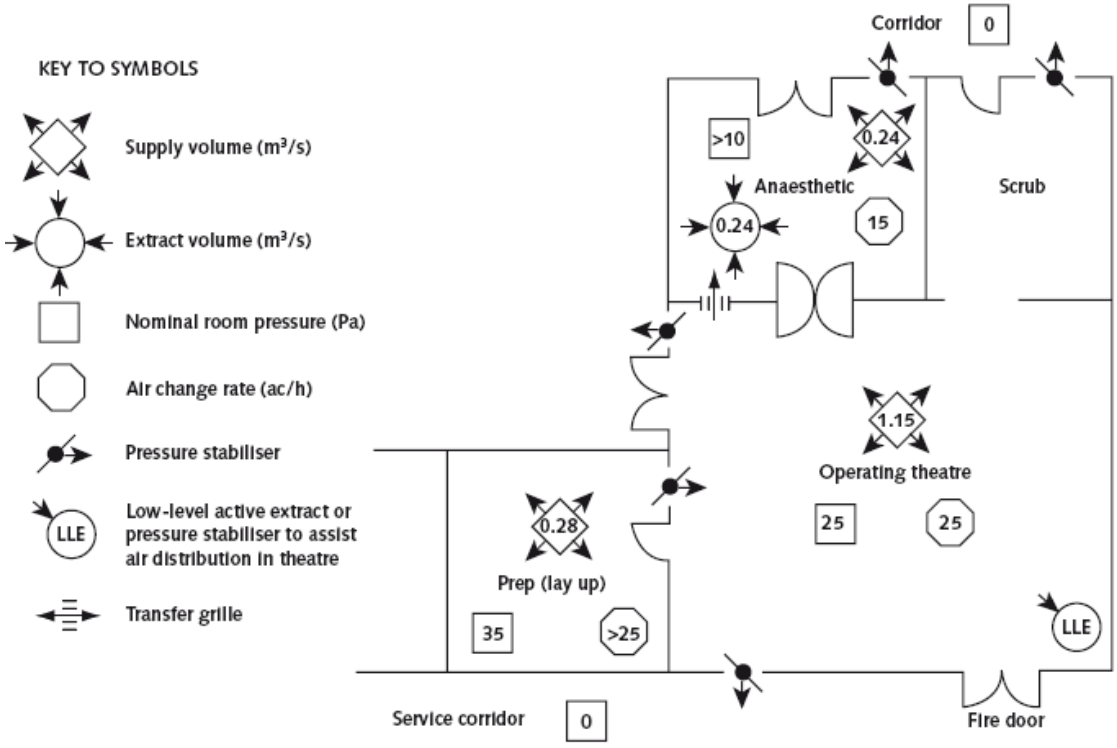
Notes:-

1. The room differential pressure protects against reverse flows when the door is closed.
2. The flow of air through a doorway protects against reverse air-flow when the door is open.
3. Pressure stabilisers control flow and ensure a known air-flow path between rooms when doors are closed and reduce back-flow between rooms when doors to other rooms are open.

Appendix 3 – Operating suite design logic



New Standard Layout N° 1 - Suitable for a typical conventional theatre suite (Room sizes as specified in HBN 26)



Room	Size m³ Derived from HBN26	Air-Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15
Anaesthetic	57	15	>10	0.24
Lay-Up-Prep	36	>25	35	0.28**
Scrub	*	-	25	-

*This is a separate scrub and is not considered as being part of the theatre volume.

**Interchange is not permitted between the theatre and lay-up prep; therefore an airflow protection of 0.28 + 0.06 closed-door airflow is required as a minimum.

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

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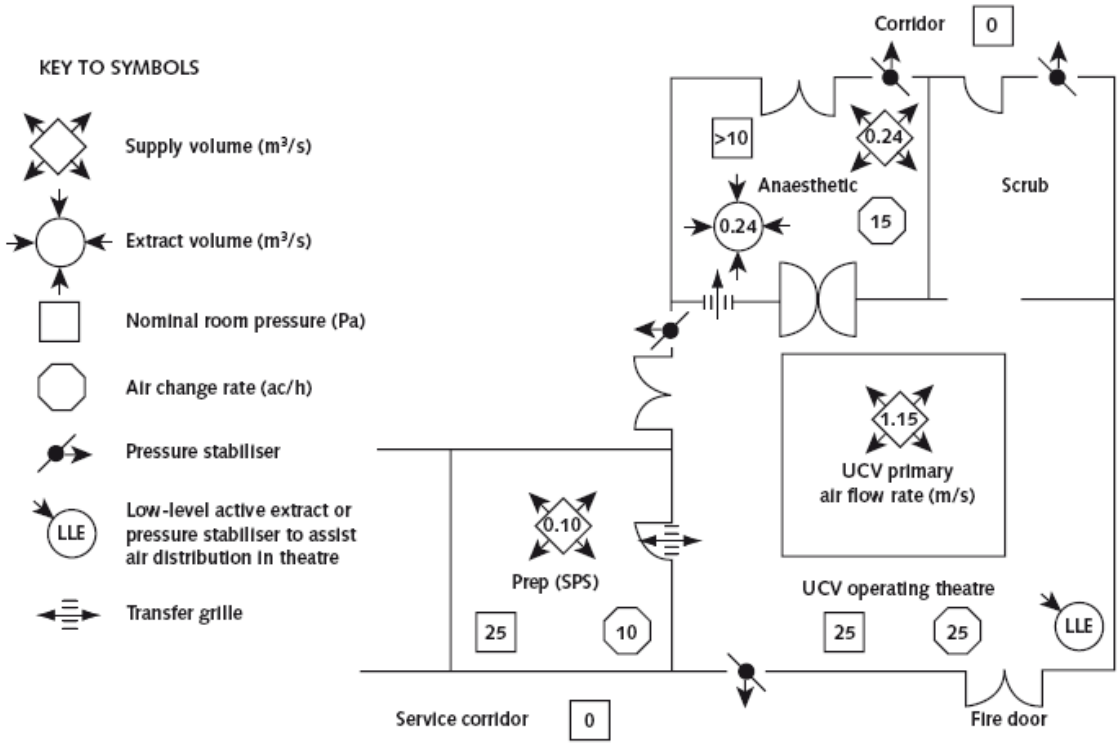
New standard layout N° 2 - Suitable for a typical UCV theatre suite (Room sizes as specified in HBN 26)



Room	Size m^3 Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	165	25	25	1.15**
Anaesthetic	57	15	>10	0.24
Sterile Prep	36	25	25	0.10
Scrub	*	-	25	-

*Separate scrub and not considered as part of theatre volume

**Primary Fresh air Volume Only

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

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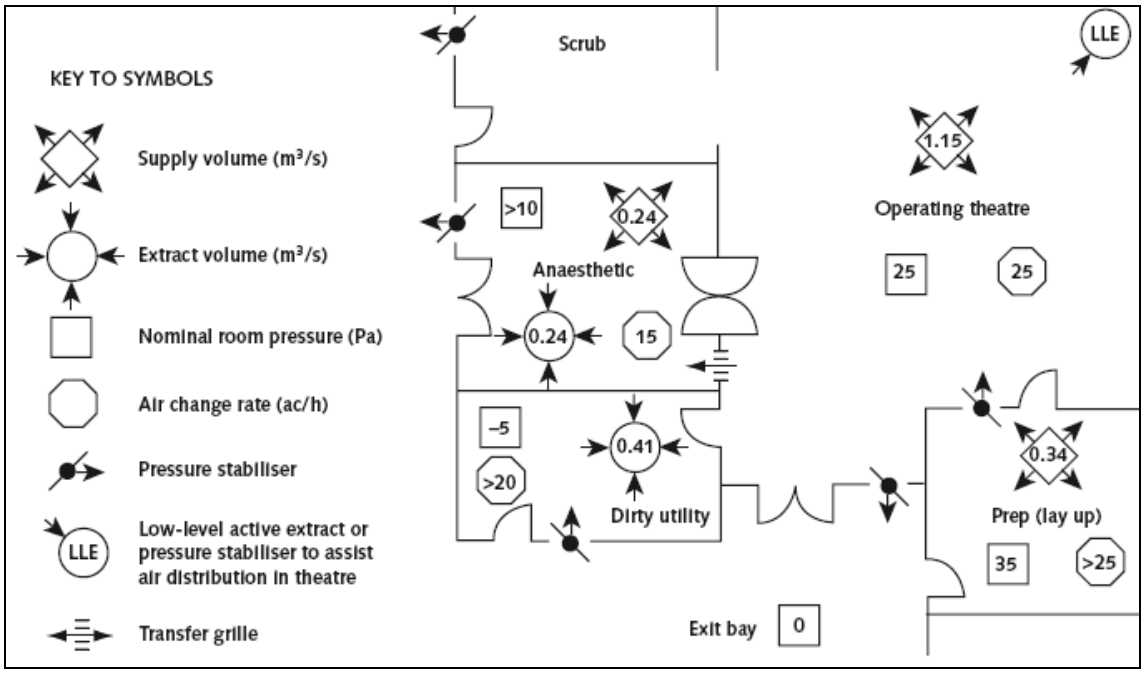
New standard layout N° 3 - Suitable for a typical Conventional theatre suite (Layout and room sizes are as illustrated in HBN 26)



Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15
Anaesthetic	57	15	14	0.24
Lay-Up Prep	36	>25	35	0.34**
Scrub	*	-	25	-
Dirty Utility	36	-	-5	0.41

*Separate scrub not considered part of theatre volume.

**Interchange is not permitted between the theatre and lay up prep therefore as table 4 an airflow protection of 0.28 + 0.06 closed door air flow is required as a minimum.

The volume of air to be extracted from the theatre should be determined by subtracting the airflow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

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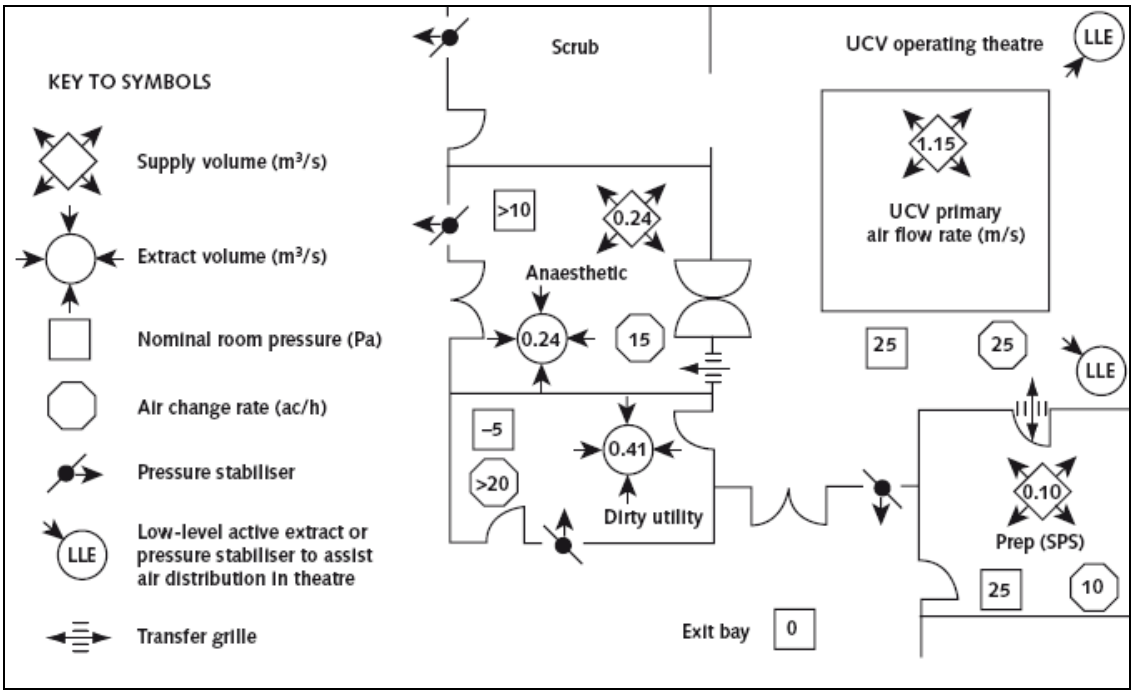
New standard layout N° 4 - Suitable for a typical UCV theatre suite (Layout and room sizes are as illustrated in HBN 26)



Room	Size m³ Derived from HBN26	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	165	25	25	1.15**
Anaesthetic	57	15	>10	0.24
Sterile Pack Prep	36	10	25	0.10
Scrub	*	-	25	-
Dirty Utility	36	-	-5	0.41

* Separate scrub not considered part of theatre volume

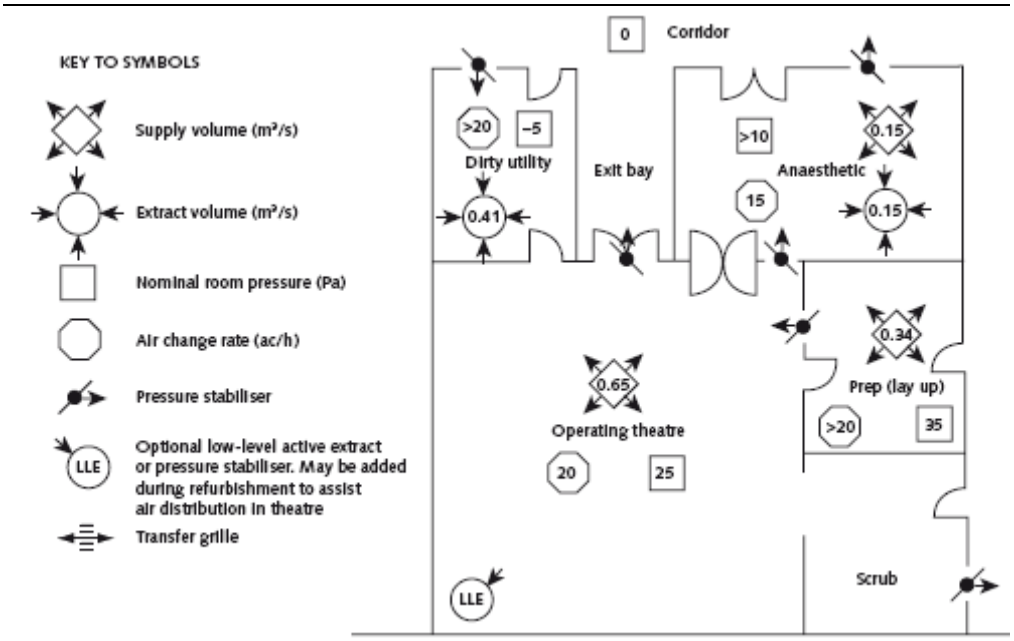
**Primary Fresh air Volume Only

The volume of air to be extracted from the theatre should be determined by subtracting the air-flow required for door protection at the exits from the total air entering the theatre space. The balance should be equally divided between the passive or active extract locations.

The extracts within the theatre may be either passive and fitted with pressure stabilizers or active and connected to the extract system. They should be located at low level and positioned to promote the ventilation of all areas of the space.

New standard layout N° 5 - SHTM 2025 Existing standard plan '1b' Typical layout for a conventional theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



Room	Size m³	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.65
Anaesthetic		15	14	0.15
Lay-Up Prep		-	35	0.34
Scrub		-	25	Included within theatre
Disposal		-	-5	0.41

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor.

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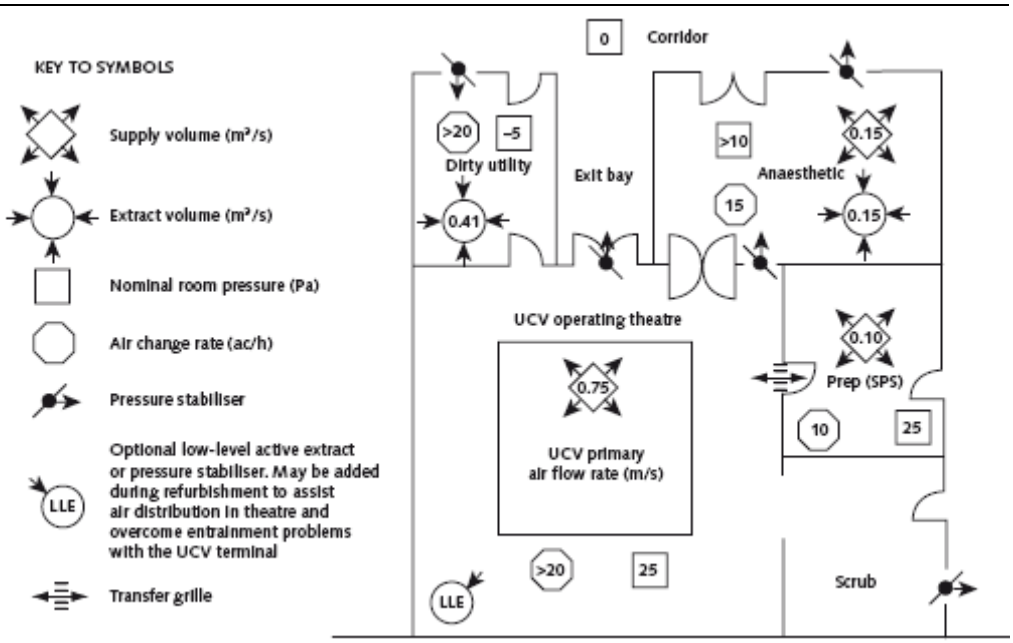
Standard layout N° 6 - SHTM 2025 Existing standard Plan '1a' Typical layout for a UCV theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



Room	Size m³	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.75*
Anaesthetic		15	>10	0.15
Sterile Pack Prep		10	25	0.1
Scrub		-	25	Included within theatre
Disposal		-	-5	0.41

*Primary fresh air-flow volume

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor.

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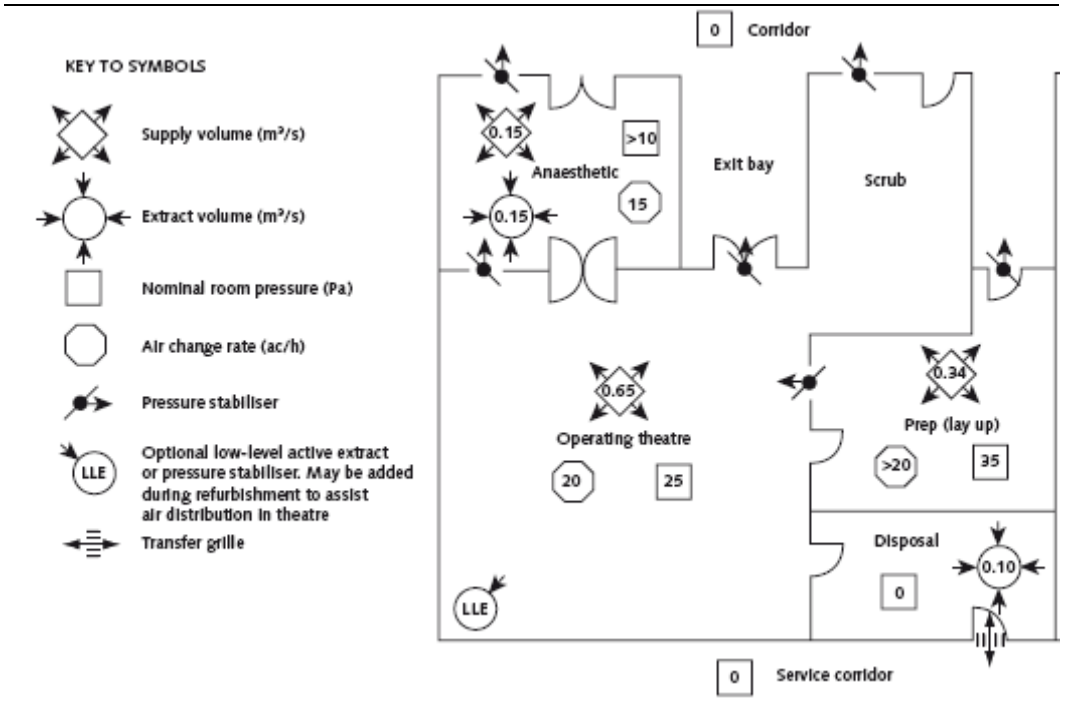
Standard layout N° 7 - SHTM 2025 Existing standard Plan '5b' Typical layout for a conventional theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



Room	Size m³	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m³/s
Theatre	Existing Theatre Suite to be Measured on site	20	25	0.65
Anaesthetic		15	>10	0.15
Lay-Up Prep		>20	35	0.34
Scrub		-	25	Included within theatre
Disposal		-	0	0.1

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor. Alternatively the disposal room could be omitted and replaced with a disposal hatch between the theatre and corridor.

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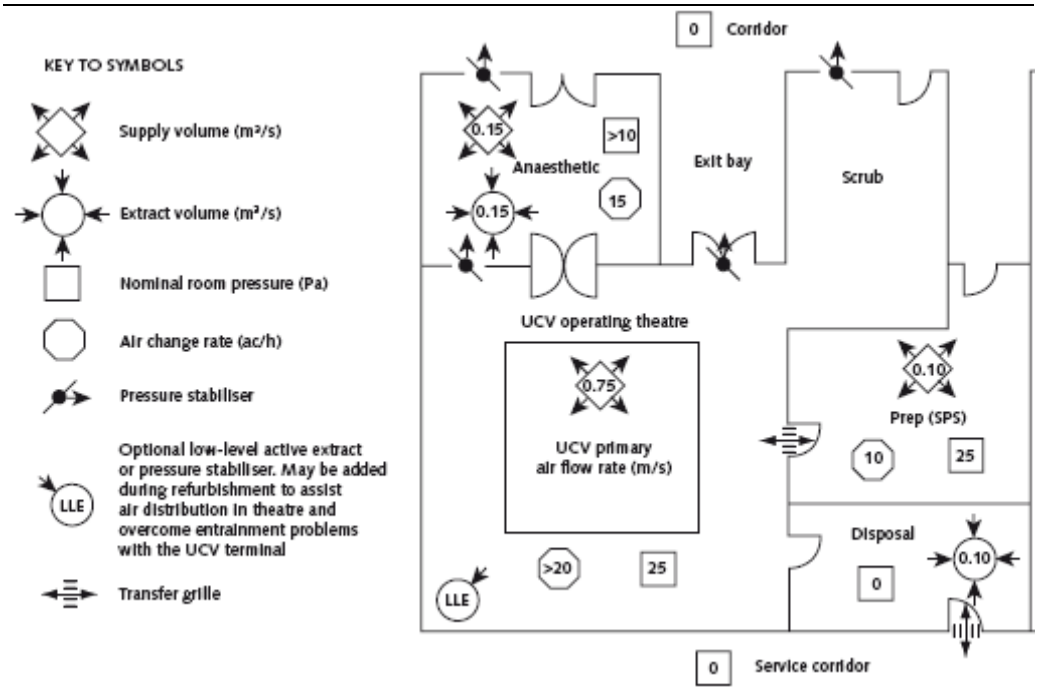
Standard layout N° 8 - SHTM 2025 Existing standard Plan '5a' Typical layout for a UCV theatre suite

This layout and data is for historical purposes only. The information is to be used for the evaluating of existing systems or rebalancing following ventilation system cleaning.



Room	Size m^3	Air Change Rate per hour	Nominal Pressure Pa	Flowrate m^3/s
Theatre	Existing Theatre Suite To Be Measured On Site	20	25	0.75*
Anaesthetic		15	>10	0.15
Sterile Prep		10	25	0.1
Scrub		-	25	Included within theatre
Disposal		-	0	0.1

*Primary fresh air-flow volume only

The disposal layout detailed will remain the same should a hatch be utilised instead of a door onto the outer corridor. Alternatively the disposal room could be omitted and replaced with a disposal hatch between the theatre and corridor.

Appendix 4 - Design of air-movement control schemes for operating theatres.

General

A4.1 Standard operating suite design solutions are given in Appendix 3. If these standard solutions cannot be used, the following procedure should be adopted, which will result in an acceptable design. Note that the method employed can equally be used to provide a design solution to a ventilated suite of rooms for any application.

A4.2 The method is concerned with the calculation of air-flow rates to ensure that correct air movement occurs between rooms when any one door is open. Under most circumstances, the air quantities required for air-movement control will approximate to those for either temperature control or bacterial contaminant dilution. This flow rate is sufficient to control the effects of any slight reverse flows occurring when a door is opened.

A4.3 The progression through the design procedure is shown in the air-flow design procedure chart (Figure A4/3) and is supported by worksheets WS1 to WS7 described in paragraph A4.4. It is recommended that a plan of the suite and an air-flow network be made (Figure A4/2) to collate all information. Flow rates, air-transfer devices etc should be entered as required. The remainder of this Appendix may be treated as reference data to assist in the various steps. The following symbols are used:

S_S – supply air-flow rate for summer temperature control;

S_W – supply air-flow rate for winter temperature control;

S_D – supply air-flow rate for dilution of bacterial contaminants;

S_L – supply air-flow rate for heat loss;

S_G – supply air-flow rate for heat gain;

E_D – extract air-flow rate for dilution of bacterial contaminants;

S_F – final supply air-flow rates;

E_F – final extract flow rates;

S_{AMC} – air-supply flow rate for air-movement control;

E_{AMC} – air-extract flow for air-movement control;

L_{OUT} – leakage air-flow rate outward;

L_{IN} – leakage air-flow rate inward;

$\sum_{OUT}$ – total air-flow rate outward;

$\sum_{IN}$ – total air-flow rate inward.

A4.4 To simplify the procedure, standard worksheets (WS1 to WS7) have been devised. For each operating suite, a set is required comprising one each of WS1, WS3, WS5, WS6a, WS6b and WS7, one WS4 for each corridor and one WS2 to cover each peripheral room. WS2 has five versions:

- WS2a single flow;
- WS2b parallel/series multi-flow;
- WS2c parallel multi-flow or series multi-flow (unbalanced);
- WS2d series multi-flow (balanced); and
- WS2e bay (semi-open).

Peripheral room type

A4.5 The rooms in the operating suite other than the operating room and corridor are referred to as peripheral rooms. Peripheral rooms have been classified according to the flows in and out. These room classifications are defined below in paragraphs A4.6 – A4.11.

Single flow

A4.6 This is a room with only one door and a net surplus of supply or extract air.

Parallel multi-flow

A4.7 This is a room with two or more doors through each of which the air flows either outwards (high pressure) or inwards (low pressure) (for example the Prep (lay-up) in standard layout 5 in Appendix 3).

Parallel/series multi-flow

A4.8 This is a room having a net surplus of supply or extract and with two or more doors. One or more doors will be to an area of equal cleanliness and need not be protected; hence, the flow may vary between inwards and outwards, the remaining door being to an area of greater or lesser cleanliness (for example the Prep (SPS) in standard layout 6 in Appendix 3).

Series multi-flow (unbalanced)

A4.9 This is a room having a net surplus of supply or extract and with two or more doors. Air flows inwards through one or more doors and outwards through one or more doors.

Series multi-flow (balanced)

A4.10 This is a room as in paragraph A4.9 above, but having either no mechanical ventilation or no net surplus of supply or extract. (for example an anaesthetic room).

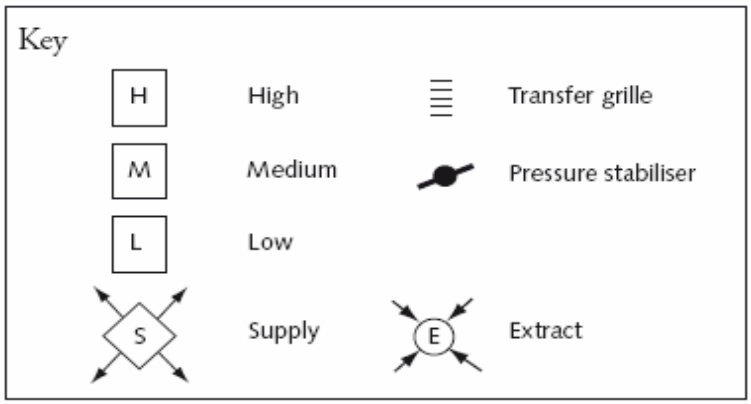
Bay

A4.11 A room which has a permanent opening to the operating room may be considered as a bay off the latter (for example a scrub). Two categories exist:

- open bay – the opening is larger than a normal single door opening. The bay may be considered as part of the main room;
- semi-open bay – the opening is no larger than a normal single door opening. In this case it is possible to protect the bay from the main room by provision of air supply or extract in the bay, or by passing air to or from another area.

Air-movement control in peripheral rooms

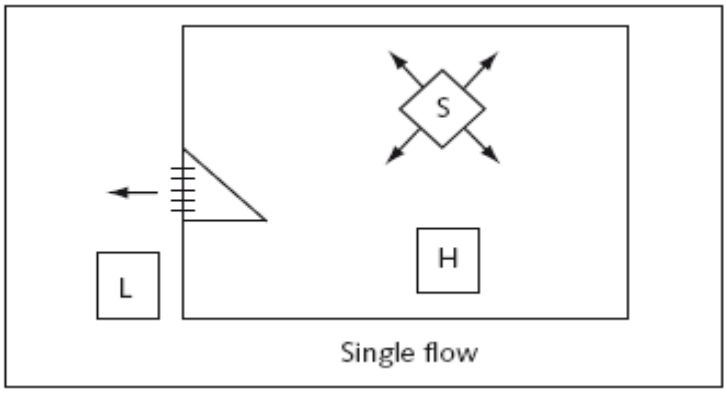
A4.12 For the design of air-movement control, two types of air-transfer device are considered. These are transfer grilles and pressure stabilisers. Each has a particular field of application within the design, as described in paragraphs A4.34 – A4.43. Air movement is controlled in each of the different room types described in paragraphs A4.13 – A4.31.



Note: This key applies to each diagram in 4.13 - 4.27.

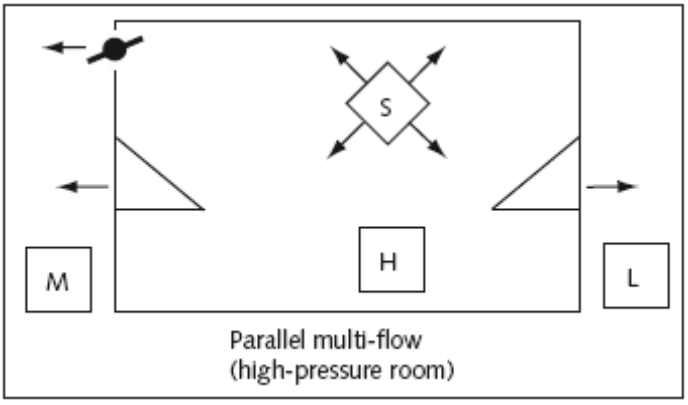
Single flow rooms

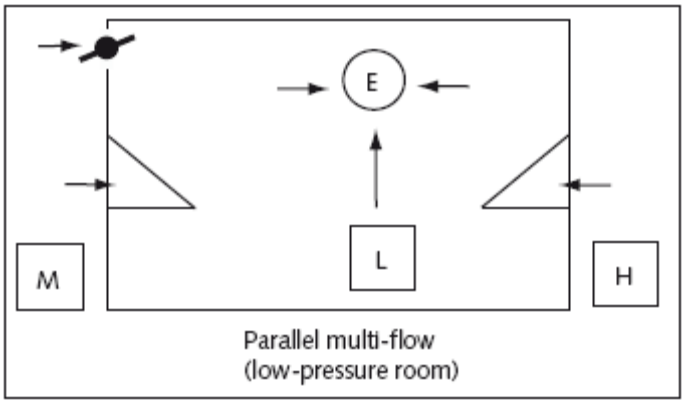
A4.13 An appropriately-sized transfer grille should be located in or adjacent to the door of each single flow room to relieve the pressure differences across the door when closed.



Parallel multi-flow rooms

A4.14 The pressure difference across the closed doors must be relieved, but transfer grilles are not appropriate where two doors lead to areas of different pressures, because reverse flow could occur when the other door is open. For this reason, pressure stabilisers are used.



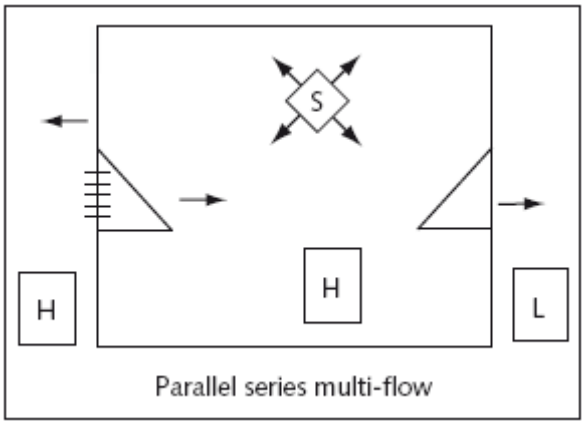


A4.15 These rooms will be either high-pressure or low-pressure with respect to the adjacent areas (see preparation lay-up room and disposal room, respectively, in standard layout 5 of Appendix 3). The pressure-relief damper is always situated between the room and area, which results in the smaller differential pressure to ensure best use of air.

A4.16 Just as reverse flow can occur if transfer grilles are used, it can similarly occur via door gaps when the other door is opened. It is not possible to avoid this, except by using air locks, but due to the low flow rates and short durations involved, this is not considered to be of importance.

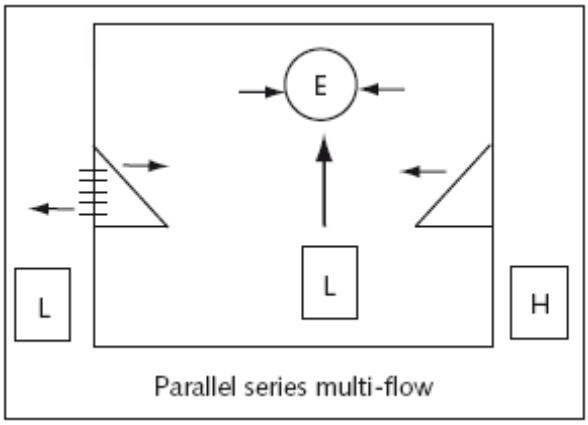
Parallel-series multi-flow rooms

A4.17 These rooms are similar to those in paragraph A4.14 above, but because the room is of equal cleanliness to one of the adjacent rooms the nominal pressures will be equal and air may flow through the adjoining doorway in either direction. (for example the Prep (SPS) in standard layout 6 of Appendix 3).



Parallel series multi-flow

A4.18 Where the nominal room pressure equals that of the higher-pressure adjacent room, the best use of air is by supplying air required for bacterial dilution only and allowing this to exhaust via a transfer grille to the area of equal cleanliness. The doorway to the lower pressure area is protected by the combination of the supply air and the air that will flow inwards through the transfer grille from the area of equal cleanliness.

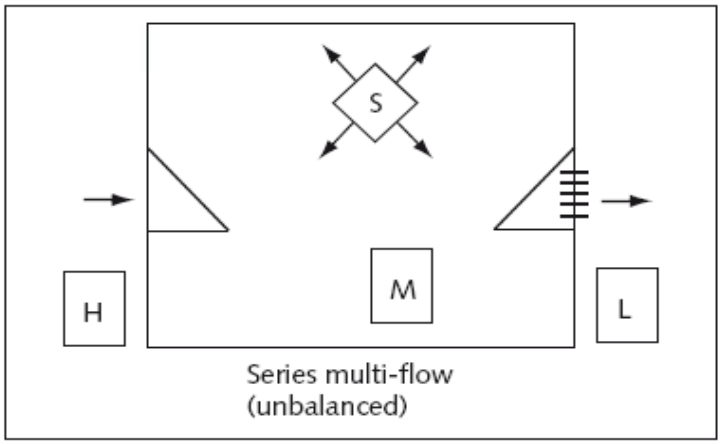


Parallel series multi-flow

A4.19 Conversely, where the nominal pressure equals that of the lower-pressure adjacent room, extract ventilation and a transfer grille to the lower pressure adjacent room should be provided. (for example the disposal room in standard layout 8 of Appendix 3).

Series multi-flow (unbalanced)

A4.20 These rooms are somewhat similar to those in paragraph A4.15 above, but because the pressure lies between that of the rooms on either side, the back-flow problem does not exist.



Series multi-flow (unbalanced)

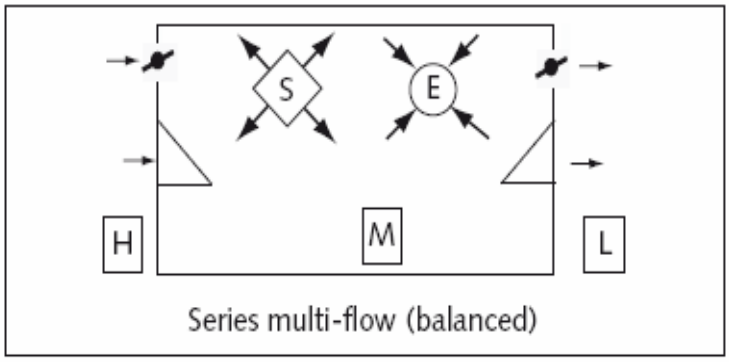
A4.21 Where the room has a net surplus of mechanical supply air, a transfer grille should be located in or adjacent to the door through which air flows outwards, and the mechanical supply flow rate to the room should be chosen to give protection when this door is open.

A4.22 Where the room has a net surplus of mechanical extract air, a transfer grille should be located adjacent to the door through which the air flows inwards, and the mechanical extract flow rate to the room should be chosen to give protection when this door is open.

A4.23 The grille must be sized for the protection requirement of the opposing door when open. When the room on the high-pressure side depressurises, there is a possibility of back-flow through gaps around the door, but this problem may be ignored.

Series multi-flow (balanced)

A4.24 In these rooms, a transfer device adjacent to each doorway is required in order to provide a flow path for the air required to protect the opposing door when opened.



Series multi-flow (balanced)

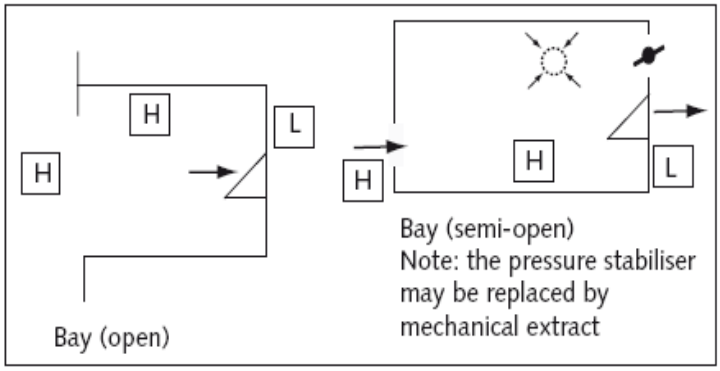
A4.25 These transfer devices will normally be pressure stabilisers, although transfer grilles may be used where a large amount of excess air is to be exhausted from the operating room when all doors are closed. (for example anaesthetic rooms).

A4.26 The calculation procedure is to assume that pressure stabilisers are being used; then (if there is sufficient excess air) change to transfer grilles as described in paragraph A4.50.

Bay

Open bay

A4.27 A bay of the open type (for example scrub-up) is considered to be part of the operating room. Provided air movement is satisfactory, no specific extract is required.



Semi-open bay

A4.28 In a bay of the semi-open type, protection of one area from the other is possible. (for example scrub-up).

A4.29 As stated previously, the need for protection between operating room and scrub-room is not very great. Better use of air can therefore be achieved in this case by installing a pressure stabiliser between the scrub-room and clean corridor. This will allow a flow of air through the scrub-room at all times, except when a door is opened elsewhere in the suite. The pressure stabiliser will then close and the air will be diverted to the other door. When it is considered necessary to protect the scrub-room at all times, either a transfer grille to the corridor or mechanical extract in the scrub-room should be provided.

Operating room

A4.30 Once the peripheral rooms have been considered, the operating room requirements may then be decided and the supply flow rate required for air-movement control calculated. This flow rate should be such that, with any one door open, the correct air movement directions are maintained. There will be one door in the suite that will require the largest supply flow rate to the

operating room for protection when open. This is called the "key door" and is discussed separately in paragraph A4.33. Use of this concept avoids repetitive calculations for each door in turn. Having established the required supply flow rate, a relief route must be provided to the clean corridor for any excess air when the doors are closed. This would be via transfer grilles or pressure stabilisers through a series-flow room or via pressure stabilisers to the clean corridor directly.

Corridors

A4.31 All surplus air from the suite, except that lost through structure leakage and any passing to the outer corridor, will arrive in the patient/staff corridor. Should this air be insufficient to achieve the required air-change rate (see Appendices 1&2), some additional air supply should be provided. (The air balance should take account of structural leakage.)

Door opening

A4.32 Whereas the resulting pressures are dependent on ductwork layout, room relationships and characteristics of the fan, the generalisations shown in Appendix 2 can be used to estimate the change in room pressure when a door is opened.

A4.33 The "key door" will be the open double door which leaves the operating room at the highest pressure, and/or requires the largest air flow. This should be determined using the procedure in worksheet WS3.

Transfer grilles

A4.34 These may be used to limit the pressure differences across the closed door of a single-flow room or, in some instances, for protection of a series-flow or parallel-series-flow room. They allow air flow in both directions and may not be suitable for all applications.

A4.35 The free area of a grille is calculated from the following equation:

$$A = \frac{Q}{0.84\sqrt{\Delta P}}$$

where:

A is free area (m^2)

Q is flow rate (m^3/s)

P is pressure difference (Pa).

A4.36 The flow through a grille at a different pressure may be found from the following equation:

$$Q_2 = Q_1\sqrt{\frac{\Delta P_1}{\Delta P_2}}$$

where:

Q_1 and P_1 are original flow and differential pressure

Q_2 and P_2 are new flow and differential pressure.

A4.37 The transfer grille may be replaced by carefully proportioned door undercuts of the equivalent free area.

A4.38 The function of the transfer grille is to provide a means of air-flow control by which the volume and pressure loss can be established. If a grille is used, it should have an easily removable core to facilitate cleaning.

Pressure-relief dampers

A4.39 The functions of a pressure-relief damper are now carried out by pressure stabilisers. Accordingly, all further mention of them has been removed from this document.

Pressure stabilisers

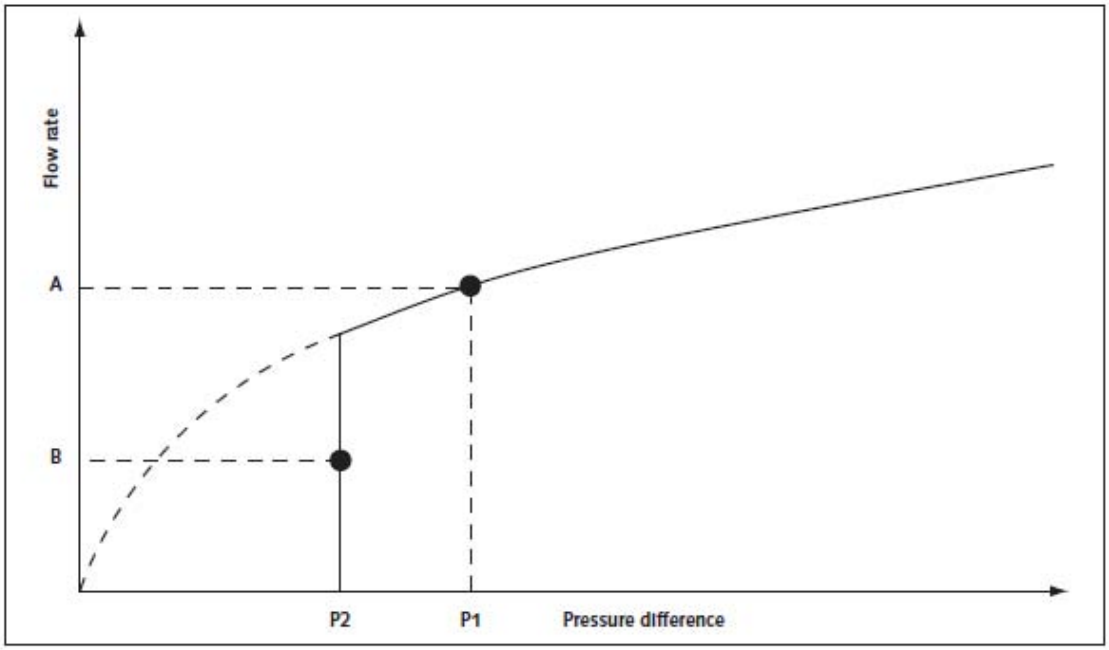
A4.40 Pressure stabilisers can be adjusted to hold the pressure constant over a wide range of flow rates. They are used where requirements exist for accurate room-pressure control or rapid shut-off on pressure fall.

A4.41 The installation of a grille or baffle in association with a stabiliser will alter the operating characteristics. It is recommended that a location be chosen to avoid the need for visual screening, for example, at high level. The location should be chosen to minimise the likelihood of damage.

A4.42 The stabilisers used should be virtually silent in operation, adjustable on site, maintenance-free and of a type which cannot be wrongly inserted. They should not be used in external walls or where the pressure difference is less than 5 Pa. The required size of a pressure stabiliser is dependent on the design pressure difference across it and flow rate through it. The manufacturer should provide data relating pressure difference to mean velocity (or flow rate per unit area). From this, the required area can be calculated and then rounded-up to the nearest size manufactured or nearest combination of smaller sizes.

A4.43 It is sometimes possible to arrange for a pressure stabiliser to perform two tasks. In an anaesthetic room, for example, the two pressure stabilisers may be made to pass the open door protection air, and also control the operating and anaesthetic room pressures with the door closed. To achieve this, the stabilisers are sized for the flow rate required with one of the doors open, but the pressure setting is adjusted to be the value required with the doors closed. This is shown in Figure A4/1.

Figure A4/1



Door leakage flows

A4.44 For an air-movement control scheme to work satisfactorily, it is essential that the estimates of door-gap leakage made at the design stage are closely related to those which are achieved in practice. The calculation of gap-flows is complicated by the fact that such flows generally fall into the transition region between laminar and turbulent flow and hence do not follow the normal flow equations. The gaps assumed are 4mm along the bottom, 3mm at the top and sides, and 2mm between double leaves. Doors should not have wider gaps than these. Tighter gaps would result in lower flow-rate requirements and hence lower fan power, but care should be taken to ensure that all doors in the suite have similar gap dimensions. It may be possible to ignore the door leakage and so reduce the air-flow requirement (see the notes in Appendix 3).

Room temperature estimation

A4.45 The air-flow rate required to prevent back-flow through an open door is dependent on the temperature difference across the door. The design figures shown in Appendix 3 are based on the temperature differences that will normally occur in practice, assuming heat gains and losses in accordance with Appendix 2.

A4.46 In accordance with the air-flow design process, the temperature differences across the doors of all rooms classed as “sterile” are calculated. Worksheet WS6 is recommended for the calculations, using the following criteria:

- assume that the operating room is being controlled at 20°C and calculate the incoming air-supply temperature as shown on worksheet WS6;

- the calculation should be repeated for both summer and winter conditions, with an operation in progress;
- assume all doors are closed;
- use the room supply flow rates from WS1;
- use the inward air flows through air-transfer devices and closed door leakages from WS2a to WS2e;
- the formula used in worksheet WS6 is as follows:

$$T = \frac{(t_1Q_1 + t_2Q_2 + \cdots + t_nQ_n) + 0.828H}{(Q_1 + Q_2 + \cdots Q_n)}$$

where:

Q = flow rate from source (m^3/s)

t = the temperature of source (°C)

H = the room heat gain (kW).

A4.47 If the evaluated temperature differences between rooms do not exceed 2°C, the solution is satisfactory; otherwise proceed as follows:

- check the assumption on which the heat gains are based;
- take steps to reduce the heat gains;
- if the door is to a corridor, the flow through the open door will be larger than the value given in Appendix 2. Calculate on WS3, assuming it is the "key door" with door-flow unknown, and the supply as known;
- if the door leads to a room with mechanical supply, install a trimmer heater in the supply to the room controlled by either a differential thermostat or a thermostat slaved to the operating room thermostat to ensure that T is minimized.
- If the door leads to a room with no mechanical supply, increase the door protection flow as follows:

$$Q_{new} = Q_{old}\left[\frac{\Delta T + 1}{2}\right]$$

A4.48 These options should be considered in this order, and (i), (ii) and (iii) should be investigated thoroughly before proceeding to (iv) or (v). The mechanical supply may need to be increased in order to achieve the desired air-change rates.

Relief of excess air from operating room when all doors are closed

A4.49 As the mechanical supply to the operating room is sized to provide an appropriate flow outward through any door which is opened, it follows that when

all doors are closed, there will be more air supplied to the operating room than can exit from it via leaks etc. This "excess" air can be relieved by either of the two methods described in paragraphs A4.50 - 4.54.

By transfer devices via the anaesthetic room

A4.50 For door protection, the transfer devices in the anaesthetic room are typically designed to pass 0.47 m^3/s at a differential pressure of 14 Pa. When the doors are closed, the differential pressure will change to 11 Pa between theatre and anaesthetic room, and 14 Pa between anaesthetic room and corridor; the volume of air passed by the transfer devices will be modified as shown in the following formula:

$$Q = Q_1\left(\frac{\Delta P_1}{\Delta P_2}\right)^{1/2}$$

$$= 0.47\left(\frac{11}{14}\right)^{1/2}$$

$$= 0.42\ m^3/s$$

where:

Q = "excess" air to be vented with doors closed;

Q_1 = air flow required for door protection through transfer device;

ΔP_1 = nominal differential pressure with door to operating room closed and door to corridor closed;

ΔP_2 = nominal differential pressure between either the anaesthetic room and corridor when the operating room door is open, or the anaesthetic room and operating room when the corridor is open. This differential pressure is used when selecting size of both devices.

A4.51 If the "excess" air is less than 0.42 m^3/s, a pressure stabiliser is required to ensure that the correct protection air-flow is available to pass through the door.

A4.52 If the "excess" air is greater than 0.42 m^3/s, a transfer grille is acceptable because at all times the air-flow will exceed the flow required for door protection.

By pressure stabilisers to the corridor

A4.53 If it is undesirable to pass operating room air through the anaesthetic room, it may be passed directly to a corridor via a separate pressure stabiliser.

A4.54 If there is sufficient "excess" air, the transfer grille solution at paragraph A4.52 should be adopted, as it provides the simplest solution and, once set up, will require no further maintenance. With less excess air, it is recommended that the

air be passed through the anaesthetic room via the pressure stabilisers as at paragraph A4.51, thus keeping the number of pressure stabilisers to a minimum. Both these solutions increase the air-change rate in the anaesthetic room, but care should be taken to avoid passing excessive amounts through that would cause discomfort to the occupants.

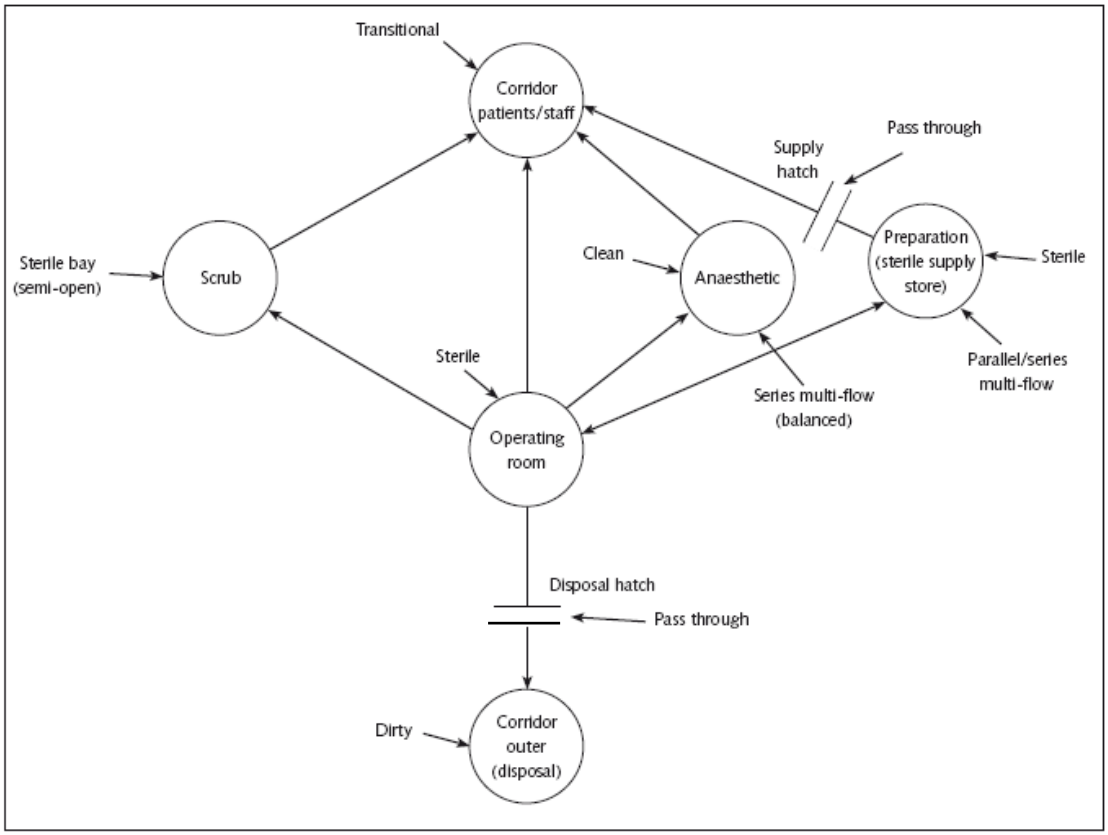


Figure A4/2. An example of an air-flow network

Step	Description	Worksheet
1	Show nominal room pressures and air flow directions on the plan of the theatre suite and WS!	WS1
2	Enter heat/loss/gain data and calculate supply air flow rates for temperature control only. Categorise room types, e.g sterile, clean etc	WS1
3	Enter air flows required for bacterial contamination control or air change rate whichever is the greater, add supply and extract volumes (S_D, E_D) on the plan.	WS1
4	Define peripheral room types, see paragraphs A4.5-A4.11, and select appropriate worksheets.	Select from WS2a to WS2e
5	Locate air transfer devices, enter details on worksheets and locate on the plan and Figure A4/2	Selected worksheets from WS2a to WS2e
6	For each peripheral room, determine air flows through doors when open and calculate mechanical supply or extract and transfer device flows	As above
7	Select "Key Door" and calculate air supply for operating room	WS3
	Does this door produce solution with greatest flow — NO	
	YES	
8	Transfer to WS1 and select final rate S_F and E_F	WS1, WS3
9	Make provision for relief of excess air with doors closed	Selected Worksheets and WS3
10	Calculate supply and extract flow rates for corridor(s)	WS4, WS5
11	Calculate room temperatures (all doors closed) and ΔT's	WS4, WS5
	Do any ΔT's across doors to sterile rooms exceed 1.0°C — YES → Rectify as in paragraph A4.47	
	NO	
12	Make summary of flows	WS6a and WS6b
13	Size transfer devices, size ductwork, central plant etc	WS7
14	Design ductwork layout, control plant etc	-

Figure A4/3 Air-flow design procedures

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Calculation sheet for						**Worksheet WS1** **Reference:**
Room Name:						
1. Summer Temperature Control Heat Gain	kW					
2. Acceptable Δt	°C					
3. Air flow rate (S_G) $= \frac{\text{Gain}}{\Delta t \times 1.2}$	m^3/s					
4. Winter Temperature Control Heat Loss	kW					
5. Acceptable Δt	°C					
6. Air flow rate (S_L) $= \frac{\text{Loss}}{\Delta t \times 1.2}$	m^3/s					
7. Dilution of bacterial contaminations Air flow rate	m^3/s					
S_D or E_D						
8. Desired air change rate	AC/hr					
$\frac{\text{AC/hr x room volume } (m^3)}{3600}$	m^3/s					
9. Maximum of S_G, S_L, S_D or E_D or air change rate from Step 8	m^3/s					
10. Air movement control	S m^3/s					
Air flow for air movement control S_{AMC} or E_{AMC} (from WS2, WS3, or WS4)	E m^3/s					
11. Final Supply Flow Rate (S_F)	m^3/s					
12. Final Extract	m^3/s					
13. Total Supply	m^3/s					
14. Total Extract	m^3/s					

Surveyor (AP(V)/CP(V))…… **Date**……

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Air Movement Control **Peripheral Room ..... type, single flow**			**Worksheet WS2a** **Reference:** **Nominal Pressure: ..... Pa**		
Consider door to ..... open					
			Air flow, m^3/s		
Flow required through doorway to give protection	Pa	Δt	Out	In	Remarks
Total					
S_{AMC} $(\sum_{OUT} - \sum_{IN})$ ____ m^3/s or E_{AMC} $(\sum_{OUT} - \sum_{IN})$ ____ m^3/s Transfer S_{AMC} or E_{AMC} to WS1					
Consider door to .....closed					
	Pa	Δt	Out	In	Remarks
Closed door leakage					
Total					
Return S_F and E_F to WS1 ____ ____ Flow through transfer grille outward ($S_F - E_F - L_{OUT}$ ____ or Flow through transfer grille inward ($E_F - S_F - L_{IN}$) ____					

Surveyor (AP(V)/CP(V))..... Date.....

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Air movement control **Peripheral Room ..... type, paralle l/series m ulti-flow**	**Worksheet WS2b** **References:** **Nominal Pressure: Pa**

Door from this room to ..... (room of equal cleanliness) is not to be protected.
A transfer grille is located in, or adjacent to, this door.

Consider door to ..... open

Room pressure now becomes [ ] or [ ] or [ ] Pa (see Appendix 6)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
Mechanical supply or extract (S_F/E_F)					
		Total			

X ($\sum_{OUT} - \sum_{IN}$) [ ] Or Y ($\sum_{IN} - \sum_{OUT}$) [ ]

Transfer grille required:

from high-pressure zone Flow = *X*

or [ ] at [ ] ΔPa

to low-pressure zone Flow = *Y*

Size of transfer grille (free area) A1 [ ]

Consider doors and hatch closed – room pressure becomes [ ] Pa (nominal)

Closed door leakage from Appendix 4 (assuming no transfer grille)	Pa	ΔP	Out	In	Remarks
Mechanical supply or extract					
		Total			

Air flow required through transfer grille = IN – OUT = Z' [ ]

or OUT – IN = Z'' [ ]

Transfer grille required flow *Z' or Z''* [ ] @ [ ] ΔP

Size of transfer grille (free area) A2 = [ ]

Select larger of A1 or A2 [ ]

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Air movement control **Peripheral Room ..... type, p arallel m ulti-flow high/low or series multi-flow (unbalanced)**	**Worksheet WS2c** **References:** **Nominal Pressure: Pa**

Consider door from this room to ..... open.

Room pressure now becomes [ ] or [ ] or [ ] Pa (see Appendix 6)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
		Total			

$S_1 (\sum_{OUT} - \sum_{IN})$ [ ] Or $E_1 (\sum_{IN} - \sum_{OUT})$ [ ]

Consider door from this room to ..... open

Room pressure then becomes [ ] or [ ] or [ ] Pa

			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
		Total			

$S_2 (\sum_{OUT} - \sum_{IN})$ [ ] Or $E_2 (\sum_{IN} - \sum_{OUT})$ [ ]

Consider doors closed. Closed doors leakage from Appendix 4

Door to:	Pa	ΔP	Out	In	Remarks
		Total			

Return S_F and E_F to WS1 [ ] [ ]

Flow through transfer grille outward ($S_F - L_{OUT}$) [ ] to .....

or

Flow through transfer grille inward ($E_F - L_{IN}$) [ ] from.....

Transfer grille [ ] Pressure relief damper [ ]

Surveyor (AP(V)/CP(V))..... Date.....

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Air movement control **Peripheral Room ..... type, parallel/series multi-flow**	**Worksheet WS2d** **References:** **Nominal Pressure:** **Pa**

Note: In this type of room the supply and extract air flow rates are equal and take no part in the air movement control (AMC)

First, open door to higher pressure area.

Room pressure then becomes [ ] or [ ] or [ ] Pa (see Appendix 2)

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
Total					

Q_1 ($\sum_{IN} - \sum_{OUT}$) [ ] (+ve inwards)

Next, open door to lower pressure area.

Room pressure then becomes [ ] or [ ] or [ ] Pa

			Out	In	Remarks
Flow required through open doorway to give protection					
At above pressures leaks through closed doors are:	Pa	ΔP			
Total					

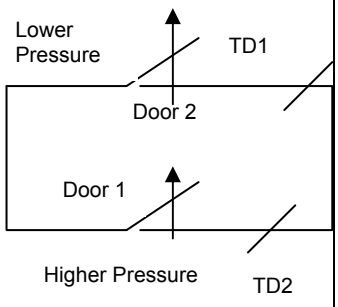
Q_1 ($\sum_{IN} - \sum_{OUT}$) [ ] (+ve inwards)

Flow through transfer device (TD1) to protect Door 1 = Q1 [ ] at resultant

ΔP .....

Flow through transfer device (TD2) to protect Door 2 = Q2 [ ] at resultant

ΔP .....



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Air movement control **Peripheral Room ..... type bay (semi-open)**	**Worksheet WS2e** **References:** **Nominal Pressure:** **Pa**

Note: If the room is of the open bay type (i.e. opening is larger than normal single doorway), then room should be considered part of the main room. No air movement control considerations need then be made, and this sheet can be discarded. Supply and/or extract flow ill be based on air distribution considerations.

Consider permanent opening

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
At above pressures leaks through closed doors	Pa	ΔP			
		Total			

E_{AMC} _____ or flow outward through transfer ($\sum_{IN} - \sum_{OUT}$) _____

Transfer S_{AMC} or E_{AMC} to WS1

Transfer device – transfer grille _____

– pressure stabiliser _____

Size select transfer device for flow rate _____ @ ΔP _____

Note: A door from the bay is considered with the peripheral room to which it leads or, if it leads to the corridor, it is considered with the main room.

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Air movement control **Operating Room**	**Worksheet WS3** **References:** **Nominal Pressure:** **Pa**

Note: To avoid considering each door open in turn, the "key door" concept is introduced. This is the door which requires the greatest mechanical flow when open. See paragraph A4.33

Select "key door" (see above).

Consider this door open – room pressure now becomes _____ Pa (See Appendix 2)

See Appendix 3 for room pressures

			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Air flow "out" or "in" via doors, transfer devices etc.	Pa	ΔP			
Mechanical extract					
Total					

S_{AMC} $(\sum_{OUT} - \sum_{IN})$ _____ Transfer S_{AMC} to WS1

Consider all doors closed.

Return S_F and E_F to WS1 _____ Room pressure now _____ Pa (nominal)

Air flow "out" or "in" via door leakage, transfer devices etc	Pa	Δt	Out	In	Remarks
Mechanical extract					
Total					

Flow $(\sum_{IN} - \sum_{OUT})$ through transfer device _____ @ ΔP _____ to……

For final selection of transfer device see paragraphs A4.50 – A4.54

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Air movement control **Corridor**			**Worksheet WS4** **References:**		
			Nominal Pressure:		**Pa**
Consider all doors closed					
			Air flow, m^3/s		
			Out	In	Remarks
Flow required through doorway to give protection					
Leaks through closed doors, transfer devices, permanent openings etc.	Pa	ΔP			
Total flow inwards (S_1)					
Add mechanical input (S_2) if necessary to increase S_1 to give 7 AC/hr					
Total Flow Outwards and Inwards					
$S_{AMC} = (\sum_{OUT} - \sum_{IN} + S_2)$		Transfer to WS5			
or $E_{AMC} = (\sum_{IN} - \sum_{OUT} + S_2)$		Transfer to WS5			

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Air movement control **Corridor**	**Worksheet WS5** **References:**

Summary of Air Supply and extract for an Operating Suite		
Consider all doors closed		
Air Flow to Corridor	All Doors Closed	Anaesthetic (key door open)
	m^3/s	m^3/s
From Preparation		
From Operating Room		
From Scrub		
From Anaesthetic		
Total (a)		
Air Flow to Corridor from Disposal		
From other source		
Total (b)		
Other Room Supplies.....Total (c)		
Total Air Supply (a) + (b) + (c)		

Consider corridor ventilation (see Appendix 2) and calculate air volume required, based on 7 AC/hr (see Note 1)	
	m^3/s
Additional Air to Ventilate Corridor	
Additional Air to Ventilate Service Corridor (see Note 2)	
Air Extract The size of the extract plant should be of the order of 10% below the supply to assist in maintaining the department under positive pressure relative to the outside departments.	
	m^3/s
Extract Plant = Supply less Leakage	
Less 10% of Supply	
Total Extract (see Note 3)	

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Room Temperature - Summer

Worksheet WS6a

References:

Find summer supply temperature T_{SS} = 20 – 0.828 H/(O/R) _____ = T_{SS} _____ °C

Q(O/R) _____

Note: The temperature of a space may be calculated from

$$T = \frac{t_1 Q_1 + t_2 Q_2 + \ldots\ldots\ldots\ldots + t_n Q_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source (1°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Summary of Air Supply and extract for an Operating Suite

Consider all doors closed

Room	Heat Gain kWh	Supply		Flows Inwards										Temperature °C T
		Q	T_{SS}	From		From		From		From		From		
				Q	t	Q	t	Q	t	Q	t	Q	t	

Check Doors to Sterile Areas

Door Between	Calculated Room ΔT (°C)	Maximum ΔT *Permitted*	Remarks

Surveyor (AP(V)/CP(V))…… **Date**……

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Room Temperature - Winter	**Worksheet WS6b** **References:**

Find winter supply temperature T_{SW} = 20 – 0.828 H/(O/R) _____ = T_{SW} _____ °C

Q(O/R) _____

Note: The temperature of a space may be calculated from

$$T = \frac{t_1 Q_1 + t_2 Q_2 + \ldots\ldots\ldots\ldots + t_n Q_n + (0.828H)}{Q_1 + Q_2 + \ldots Q_n}$$

Where t_1 is temperature of source (1°C)
Q_1 is flow from source 1 when all doors are closed (m^3/s)
H is heat gain in space (kW)

Summary of Air Supply and extract for an Operating Suite

Consider all doors closed

Room	Heat Gain kWh	Supply		Flows Inwards										Temperature °C T
		Q	T_{SW}	From		From		From		From		From		
				Q	t	Q	t	Q	t	Q	t	Q	t	

Check Doors to Sterile Areas

Door Between	Calculated Room ΔT (°C)	Maximum ΔT *Permitted*	Remarks

Surveyor (AP(V)/CP(V))…… **Date**……

Transfer Grilles, Pressure Relief Dampers and Pressure Stabilisers	**Worksheet WS7** **Reference:**

Transfer Grilles – see paragraphs A4.34 – A4.38

Check Doors to Sterile Areas

No	Location	Pressure Difference Pa	Flow Rate m^3/s	Free Area m^2	Model	Resultant Δp Pa	Remarks

Pressure Relief Dampers – see paragraph A4.39

No	Location	Pressure Difference Pa	Flow Rate m^3/s	Free Area m^2	Pressure Setting Pa	Remarks

Pressure Stabilisers –see paragraphs A4.40 – A4.43

Note: where a stabiliser is acting both as series room door protection and operating pressure control, "pressure difference" and "flow rate" are from WS2d; "pressure setting" is from WS3

No	Location	Pressure Difference Pa	Flow Rate m^3/s	Free Area m^2	Pressure Setting Pa	Remarks

Surveyor (AP(V)/CP(V))…… Date……

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Comments on consultation

Name: Date:
Document Title: SHTM 03-01 Part B: Please return comments to [redacted] before 1st March 2010

[1]**T= Technical; G= General; E=Editorial**

Paragraph No.	Page	Type[1]	Comment

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Scottish Health Technical Memorandum 03-01: Ventilation for healthcare premises

Part B: Operational management and performance verification

Health Facilities Scotland
Engineering and Environment

January 2010

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Preface

About Scottish Health Technical Memoranda

Scottish Engineering Health Technical Memoranda (SHTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Scottish Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle.

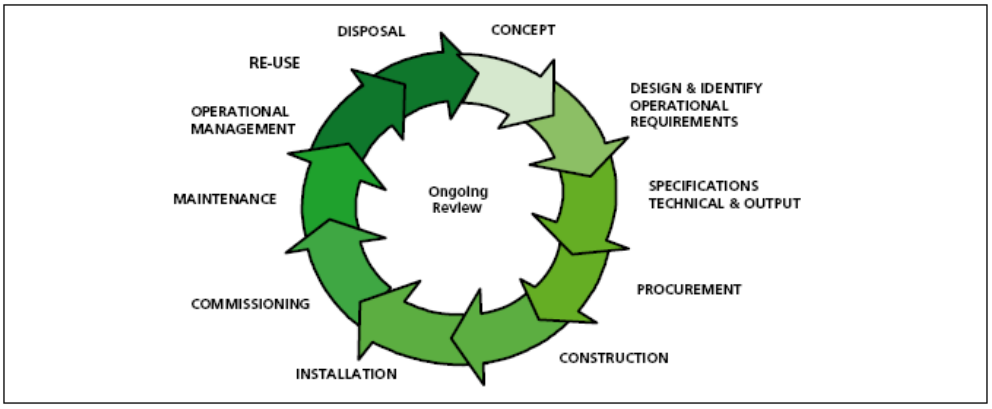

Figure 1: Healthcare building life-cycle

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

It is not the intention within this suite of documents to repeat unnecessarily international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of eight subject areas provides access to guidance which:

- is more streamlined and accessible;

- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.

Structure of the Scottish Health Technical Memorandum suite

The series of engineering-specific guidance will ultimately contain a suite of eight core subjects pending a re-assessment of Firecode SHTMs 81-66.

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water systems

Scottish Health Technical Memorandum 05: Reserved for future use.

Scottish Health Technical Memorandum 06: Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Scottish Health Technical Memorandum 06-02 Part A will represent Electrical Services – Electrical safety guidance for low voltage systems.

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent Environment and Sustainability - EnCO_2de.

All Scottish Health Technical Memoranda are supported by the initial document Scottish Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

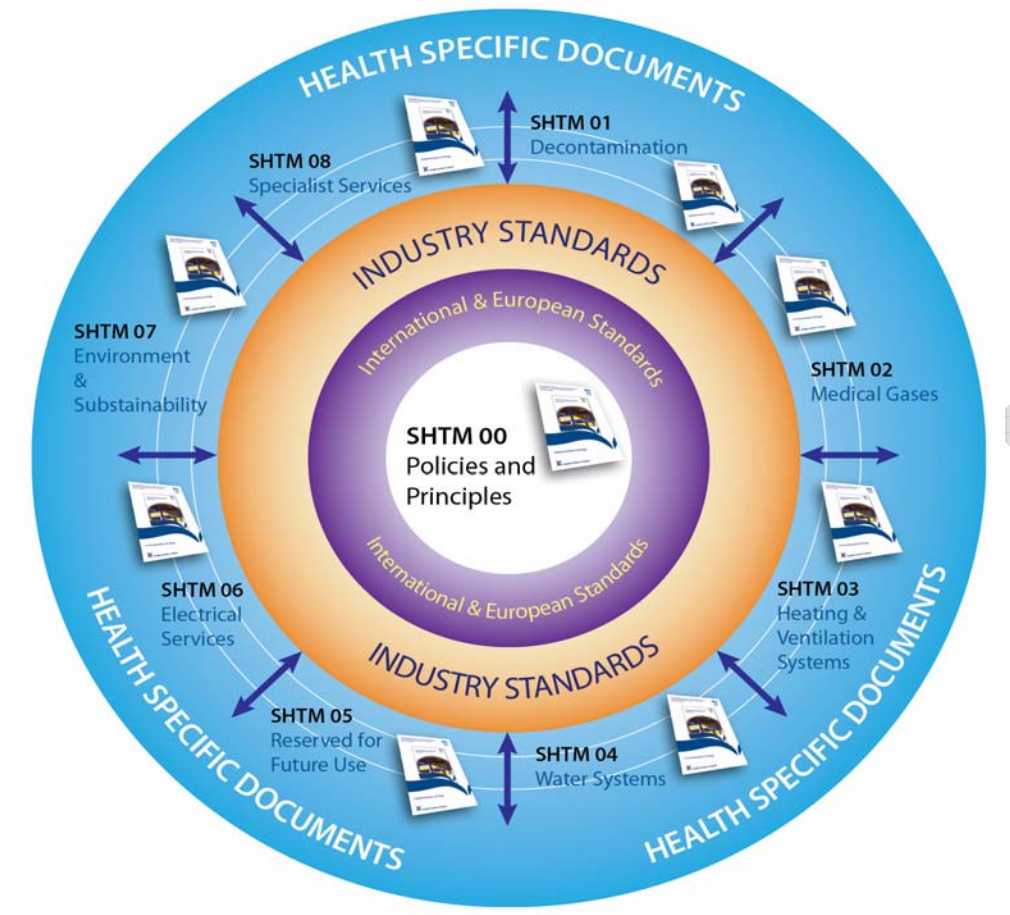

Figure 2: Engineering guidance

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Executive summary

Scottish Health Technical Memorandum 03-01: 'Ventilation in healthcare premises' is published in two parts. Part A deals with the design and installation of ventilation systems; Part B covers operational management.

The document gives comprehensive advice and guidance on the legal requirements, design implications, maintenance and operation of specialised ventilation in all types of healthcare premises.

The guidance contained in this Scottish Health Technical Memorandum applies to new installations and major refurbishments of existing installations.

Scottish Health Technical Memorandum 03-01 supersedes all previous versions of Scottish Health Technical Memorandum 2025: 'Ventilation in healthcare premises'.

Who should use this guidance?

This document is aimed at healthcare management, estates managers and operations managers.

Main recommendations

- all ventilation plant should meet a minimum requirement in terms of the control of *Legionella* and safe access for inspection and maintenance;
- all ventilation plant should be inspected annually;
- the performance of all critical ventilation systems (such as those servicing operating suites) should be verified annually.

1. Introduction

1.1 Scottish Health Technical Memorandum 03-01: 'Specialised ventilation in healthcare premises' is published in two parts. Part A deals with operation of general and specialised ventilation; Part B covers operational management.

1.2 The document gives comprehensive advice and guidance to healthcare management, design engineers, estates managers and operations managers on the legal requirements, design implications, maintenance and operation of specialised ventilation in all types of healthcare premises.

1.3 The guidance contained in this Scottish Health Technical Memorandum applies to new installations and major refurbishments of existing installations.

1.4 Scottish Health Technical Memorandum 03-01 supersedes all previous versions of Scottish Health Technical Memorandum 2025: 'Ventilation in healthcare premises'.

Ventilation in healthcare premises

1.5 Ventilation is used extensively in all types of healthcare premises to provide a safe and comfortable environment for patients and staff. More specialised ventilation is provided in areas such as operating departments, critical care areas and isolation facilities for primary patient treatment.

1.6 It is also installed:

- to ensure compliance with the quality assurance requirements of items processed in pharmacies and sterile services departments;
- to protect staff from harmful organisms and toxic substances (for example in laboratories).

Statutory requirements

1.7 Increased health risks to patients will occur if ventilation systems do not achieve and maintain the required standards. The link between surgical site infection and theatre air quality has been well established.

If the ventilation plant has been installed to dilute or contain harmful substances, its failure may expose people to unacceptable levels of contamination. Proven breaches of the statutory requirements can result in prosecution and may also give rise to a civil suit against the operators.

Health and Safety at Work etc Act 1974

1.8 The Health and Safety at Work etc Act 1974 is the core legislation that applies to ventilation installations. As these installations are intended to prevent

contamination, closely control the environment, dilute contaminants or contain hazards, their very presence indicates that potential risks to health have been identified.

COSHH

1.9 The Control of Substances Hazardous to Health (COSHH) Regulations 2002 place upon management an obligation to ensure that suitable measures are in place to protect their staff and others affected by the work activity. These methods may include both safe systems of work and the provision of a specialised ventilation system. In laboratories the requirements are often met by the provision of fume cupboards and microbiological safety cabinets.

1.10 Where specialised ventilation plant is provided as part of the protection measures, there is a statutory requirement that it be correctly designed, installed, commissioned, operated and maintained. The local exhaust ventilation (LEV) section of COSHH requires that the system be examined and tested at least every 14 months by a competent person and that management maintain comprehensive records of its performance, repair and maintenance.

1.11 Certain substances have workplace exposure limits (WELs) set out in the Health and Safety Executive's Guidance Note EH40 – 'Workplace exposure limits: containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended)'. If specialised ventilation systems are provided in order to achieve these standards, they will be subject to the COSHH Regulations as above.

Fire regulations

1.12 The Fire Regulations require that if ventilation ductwork penetrates the fabric of a building, it should be designed and installed so as to contain the spread of fire (see Firecode: SHTM 81: 'Fire Precautions in New Hospitals, Version 3' and the requirements of the Scottish Technical Handbooks, Non-Domestic, Section 2: Fire).

1.13 It is management's responsibility to ensure that the standards applied during the design and installation are not reduced during the subsequent operation and maintenance of the equipment.

Plants installed in units manufacturing medicinal products

1.14 Plants installed in units manufacturing medicinal products to the standards set out in the current European guide to good manufacturing practice (http://ec.europa.eu/enterprise/pharmaceuticals/ eudralex/homev4.htm) may also be subject to particular legislation with regard to their operation and maintenance.

1.15 There are specific requirements under the Medicines Act 1968 to maintain accurate records of plant performance, room conditions and maintenance events.

Such records would need to be preserved for up to 35 years as part of a quality assurance audit trail.

Plants installed in laboratories

1.16 Specialised ventilation plants installed in laboratories dealing with research, development or testing, whether involving drugs, animals or genetically modified organisms, may be subject to particular legislation with regard to their operation in addition to that mentioned above.

Codes of practice and guidance

1.17 All ventilation systems should conform to the principles set out in the Health and Safety Commission's Approved Code of Practice and guidance document 'Legionnaires' disease: the control of *Legionella* bacteria in water systems' (commonly known as L8), and Scottish Health Technical Memorandum 04-01: 'The control of *Legionella*, hygiene, 'safe' hot water, cold water and drinking water systems'.

1.18 Scottish Health Facilities Note 30: 'Infection Control in the Built Environment, Design and planning' guides and stimulates thinking on the planning of and execution of new construction and refurbishment works in all types of healthcare facilities. Ventilation systems (covered in this guidance) play an important role in reducing the risk of Healthcare Associated Infection.

Management responsibilities – general

1.19 It is a management responsibility to ensure that inspection, service and maintenance activities are carried out safely without hazard to staff, patients or members of the public.

1.20 Those required to monitor and/or maintain ventilation equipment will need to show that they are competent to do so (see Section 2).

1.21 Maintenance procedures should be reviewed periodically to ensure that they remain appropriate.

System information

1.22 When new ventilation systems are accepted for use, full information as to their designed mode of operation together with recommended maintenance procedures should be provided as part of the handover procedure.

1.23 In many existing systems, original design and commissioning information will not be available. It will therefore be necessary to determine a suitable level of system performance based on the function, purpose and age of the installation.

1.24 Part A of this Scottish Health Technical Memorandum gives design parameters for new installations.

1.25 Section 3 of this document sets out the minimum standards for all air-handling units (AHUs) and their air distribution systems.

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

Note 1: In the event of a reportable incident connected with ventilation equipment or the area that it serves; all records and plant logbooks will need to be collected as evidence.

1.27 A set of specimen maintenance checklists is given in Appendix 1.

Frequency of inspections and verifications

1.28 All ventilation systems should be subject to, at least, a simple visual inspection annually.

1.29 Ventilation systems serving critical care areas should be inspected quarterly and their performance measured and verified annually. The quarterly inspection should be a simple visual check; the annual verification will be a more detailed inspection of the system together with the measurement of its actual performance.

1.30 The LEV section of the COSHH regulations contains a statutory requirement that systems installed to contain or control hazardous substances be examined and tested at least every 14 months by a competent person.

1.31 Regular tests, at intervals agreed with the local fire prevention officer, will need to be carried out in order to demonstrate the continuing efficiency of the fire detection and containment systems. These may be in addition to the inspections detailed above. Records of these tests should be kept.

Implications of PPP/PFI Procurement

1.32 While the ultimate responsibilities as set out in this SHTM in terms of overall management remain with Health Boards, when a new or recent hospital has been procured via the Public-Private Partnership (PPP) or Private Finance Initiative (PFI) routes, there are changes in the chain of responsibilities.

1.33 More often than not, the operator of the facility will subcontract or enter into partnership with a Facilities Management (FM) Provider who will maintain and operate mechanical and electrical installations, including ventilation systems. It is

not unknown for the FM provider to be the Health Board's own estates staff. Whichever organisation carries out the functions set out in this SHTM, it will be necessary for the same practice and procedures to be carried out, records maintained and reports prepared to maintain an audit trail. These have to be submitted to the Health Board for which the hospital has been established. The Health Board will retain in-house estates staff and/or technical advisers to monitor these records and reports, having the right to comment where performance standards are not being achieved, inspect installations, and seek to ensure that remedial measures are put in hand and monitored as to their effect.

In the event that a civil suit is served on a Health Board, they would seek redress from the operator of the Hospital, where appropriate.

1.34 Issues related to control of infection where mechanical ventilation systems are implicated will be the remit of the Health Board's control of teams set up for the purpose and representation should be arranged for estates staff or the FM Provider so that any remedial action agreed can be can be set in motion without delay.

2. Functional responsibilities

Management responsibilities

2.1 Clear lines of managerial responsibility should be in place so that no doubt exists as to who is responsible for the safe operation and maintenance of the equipment.

2.2 A periodic review of management systems should take place in order to ensure that the agreed standards are being maintained.

2.3 Those required to inspect, verify or maintain ventilation equipment will need to show that they are competent to do so. As a minimum they should have sufficient knowledge of its correct operation to be able to recognise faults.

2.4 It is anticipated that training in the validation and verification of specialised healthcare ventilation systems for Authorised Persons and Competent Persons will become available during the life of this Scottish Health Technical Memorandum.

Designated staff functions

2.5 A person intending to fulfil any of the staff functions specified below should be able to prove that they possess sufficient skills, knowledge and experience to be able to perform safely the designated tasks.

Management

2.6 Management is defined as the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable for the safe operation of premises.

Designated Person

2.7 This person provides the essential senior management link between the organisation and professional support. The Designated Person should also provide an informed position at board level.

Authorising Engineer (Ventilation) (AE(V))

2.8 The AE(V) is defined as a person designated by Management to provide independent auditing and advice on ventilation systems and to review and witness documentation on validation.

Authorised Person (Ventilation) (AP(V))

2.9 The AP(V) will be an individual possessing adequate technical knowledge and having received appropriate training, appointed in writing by the Designated Person (in conjunction with the advice provided by the AE(V)), who is responsible for the practical implementation and operation of Management's safety policy and procedures relating to the engineering aspects of ventilation systems.

Competent Person (Ventilation) (CP(V))

2.10 The CP(V) is defined as a person designated by Management to carry out maintenance, validation and periodic testing of ventilation systems.

Infection Control Officer

2.11 The Infection Control Officer (or consultant microbiologist if not the same person) is the person nominated by management to advise on monitoring the infection control policy and microbiological performance of the systems.

2.12 Major policy decisions should be made through an infection control committee. The infection control committee should include representatives of the user department and estates and facilities or their nominated representative (that is, the Authorised Person).

Plant Operator

2.13 The Plant Operator is any person who operates a ventilation installation.

User

2.14 The User is the person responsible for the management of the unit in which the ventilation system is installed (for example head of department, operating theatre manager, head of laboratory, production pharmacist, head of research or other responsible person).

Contractor

2.15 The Contractor is the person or organisation responsible for the supply of the ventilation equipment, its installation, commissioning or validation. This person may be a representative of a specialist ventilation organisation or a member of the general manager/chief executive's staff.

Records

2.16 A record should be kept of those appointed to carry out the functions listed above. The record should clearly state the extent of the postholder's duties and responsibilities, and to whom they are to report.

2.17 Substitute or replacement staff should be designated in order to cover for sickness, holidays and staff transfers.

Training

2.18 Routine inspection and maintenance procedures can cause risks to the health of staff carrying out the work and those receiving air from the plant. All those involved should be made aware of the risks, and safe systems of work should be agreed. Suitable safety equipment should be provided as necessary, and training in its use should be given.

2.19 Any training given should be recorded, together with the date of delivery and topics covered.

2.20 Training in the use of safety equipment and a safe system of work will need to be repeated periodically in order to cater for changes in staff.

Specific health and safety aspects

2.21 Staff engaged in the service and maintenance of extract ventilation systems from pathology departments, mortuaries, laboratories, source- protective isolation facilities and other areas containing a chemical, biological or radiation hazard may be particularly at risk. In these cases, the risk should be identified and assessed.

2.22 The means by which the system can be rendered safe to work on should be determined, and a permit-to-work on the system implemented.

2.23 Training in the exact procedures should be given to all staff involved.

2.24 Some healthcare facilities may contain specialised units that are subject to access restrictions (for example pharmacy aseptic suites). Estates or contract staff requiring access may need additional training or to be accompanied when entering the unit.

Note 2: See also the following guidance published by the Health and Safety Commission's Health Services Advisory Committee:

- 'Safe working and the prevention of infection in clinical laboratories and similar facilities';
- 'The management, design and operation of microbiological containment laboratories';
- 'Safe working and prevention of infection in the mortuary and post-mortem room'.

3. Ventilation systems – minimum requirements

General requirements

3.1 All ventilation systems should be inspected annually to ensure conformity with minimum requirements, which are designed to:

- ensure safe access when carrying out routine service and maintenance activities;
- prevent or control risks associated with *Legionella* and other potential hazardous organisms;
- check that the system remains fit for purpose;
- maintain records of outcomes.

3.2 Every effort should be made to ensure that all AHUs achieve the minimum requirement set out below.

Location and access

3.3 AHUs should be secured from unauthorised access.

3.4 Units located on roofs must have a safe and permanent means of access. Suitable precautions must be in place to prevent personnel or equipment from falling during maintenance activities.

3.5 Units located outside at ground level should be secured within a compound to prevent unauthorised access. Vehicles should be excluded from the vicinity to ensure that exhaust fumes will not be drawn into intakes.

3.6 All parts of the AHU should be easily and safely accessible for routine inspection and service.

3.7 The area around an AHU within a building should be tanked to prevent water penetration to adjacent areas, and should be adequately drained.

3.8 Fire precautions should be in accordance with Firecode.

3.9 Combustion equipment must not be located in a fire compartment that houses air-handling equipment.

3.10 Plantrooms that house AHUs must not be used for general storage. Care should be taken to ensure that combustible material is not kept in the plantroom.

Basic requirements

3.11 The plant must not contain any material or substance that could support the growth of microorganisms.

3.12 The plant must not contain any material or substance that could cause or support combustion.

3.13 Access to items that require routine service, such as filters, coils and chiller batteries, should be via hinged doors.

3.14 Items requiring infrequent access such as attenuators may be via clipped or bolted-on lift-off panels.

3.15 All doors and panels should be close-fitting and without leaks.

3.16 Every effort should be made to ensure that access is via fixed ladders and platforms or pulpit-style movable steps.

3.17 Electrical and mechanical services should not restrict or impede access to those parts of the AHU that require inspection.

3.18 Viewing ports and internal illumination should be fitted in order to inspect filters and drainage trays.

3.19 Internal illumination should be provided by fittings to at least IP55 rating. Fittings should be positioned so that they provide both illumination for inspection and task lighting.

3.20 A single switch should operate all of the lights in a unit.

AHU intakes and discharges

3.21 Intake and discharge points should not be situated where they will cause vitiated air to be drawn into a system (see paragraphs 3.61-3.71) in Part A, which give detailed information). In existing systems, it may be necessary to extend the intake or discharge point to a suitable position.

3.22 Each intake and discharge point should be fitted with corrosion-resistant weatherproof louvres or cowls to protect the system from driving rain. The inside of the louvres should be fitted with a mesh of not less than 6mm and not more than 12mm to prevent infestation by vermin and prevent leaves being drawn in.

3.23 The duct behind a louvre should be self-draining. If this is not practicable, it should be tanked and provided with a drainage system. Cleaning access must be provided either from the outside via hinged louvres or by access doors in the plenum behind the louvre. Where a common plenum is provided, cleaning access should be via a walk-in door.

AHU drainage system

3.24 All items of plant that could produce moisture must be provided with a drainage system. The system will comprise a drip-tray, glass trap, air break and associated drainage pipework.

3.25 Some existing units may not have been mounted far enough above the floor to permit the correct installation of a drainage system. If the AHU cannot be raised to an adequate height, an alternative arrangement (such as a pump-out system) must be provided.

3.26 The drip-tray should be constructed of a corrosion-resistant material (stainless steel is preferred) and be so arranged that it will completely drain. To prevent 'pooling', it is essential that the drain connection should not have an up-stand and that a slope of approximately 1 in 20 in all directions should be incorporated to the drain outlet position. The tray must be completely accessible or, for smaller units, easily removable for inspection and cleaning.

3.27 Each drip-tray should be provided with its own drain trap. The drain trap should be of the clear (borosilicate) glass type. This permits the colour of the water seal to be observed, thus giving an early indication of corrosion, biological activity or contamination within the duct (Part A, Section 4, paragraphs 4.20-4.25 refer and paragraph 3.29 of this Part B).

3.28 The trap should have a means for filling and should incorporate couplings to facilitate removal for cleaning. It should be located in an easily visible position where it will not be subject to casual knocks. The pipework connecting it to the drainage tray should have a continuous fall of not less than 1 in 20.

3.29 Traps fitted to plant located outside or in unheated plantrooms may need to be trace-heated in winter. The trace heating should be checked for operation and must not raise the temperature of water in the trap above 5°C.

3.30 Water from each trap must discharge via a clear air gap of at least 15mm above the unrestricted spill-over level of either an open tundish connected to a drainage stack via a second trap, or a floor gully (or channel). A support should be provided to ensure that the air gap cannot be reduced. More than one drain trap may discharge into the tundish, providing each has its own air break.

3.31 Drainage pipework may be thermoplastic, copper or stainless steel. Glass should not be used. The pipework should be a minimum diameter of 22mm and have a fall of at least 1 in 60 in the direction of flow. It should be well supported, and located so as not to inhibit access to the AHU.

Dampers

3.32 AHUs serving critical areas and those areas that are shut down out of hours should be fitted with motorised low-leak shut-off dampers located immediately behind the intake and discharge of each supply and extract system.

Fan drives

3.33 Fan-drive trains, whether supply or extract, should be easily visible without the need to remove access covers. Protecting the drive train with a mesh guard is the preferred option. For weatherproof units designed to be located outside, the fan drive should be enclosed. It should be easily visible through a viewing port with internal illumination and be accessed via a lockable, hinged door.

3.34 The motor windings of induction-drive 'plug' motor arrangements and in-line axial fans having a pod motor within the air stream must be protected from over-temperature by a thermistor and lock-out relay.

3.35 It is necessary to ensure that – should the computer control system or its software develop a fault – the fan can be switched to a direct start with fixed speed and manual operation. This is particularly important for critical care systems serving operating suites, high dependency care units of any type, isolation facilities, laboratories and pharmaceutical production suites.

Heater & Frost batteries

3.36 Access for cleaning must be provided to both sides of frost batteries and heater-batteries.

3.37 Where auxiliary wet heater-batteries are located in false ceilings, they should be fitted with a catch tray and leak alarm. The catch tray should be installed under both the battery and the control valve assembly to protect the ceiling from leaks. A moisture sensor and alarm should be fitted in the tray. Placing wet heater batteries in ceiling voids should be avoided if at all possible.

Cooling coils

3.38 All cooling coils – whether within the AHU or within a branch duct – must be fitted with their own independent drainage system as specified above. A baffle or similar device must be provided in the drip-tray to prevent air bypassing the coil, and the tray should be large enough to capture the moisture from the eliminator, bends and headers.

3.39 The cooling-coil control valve should close upon selection of low speed, system shut-down, low air-flow or fan failure.

3.40 Where auxiliary wet-cooling coils are located in false ceilings, they should be fitted with a catch tray and leak alarm. The catch tray should be installed under both the battery and the control valve assembly to protect the ceiling from leaks. A moisture sensor and alarm should be fitted in the tray.

Humidifiers

3.41 Humidifiers are not generally required. Where they are fitted, but have been out of use for a significant period of time, they should be removed. All associated pipework should also be removed back to its junction with the running main.

3.42 Where humidifiers are fitted and their use is still required, they should fully conform to the installation standard set out in Section 4 of Part A.

3.43 The section of ductwork containing the humidifier may need to be periodically decontaminated. Hinged access doors with viewing ports and internal illumination should be provided.

3.44 All humidifiers must be fitted with their own independent drainage system as detailed above.

3.45 Only steam-injection humidifiers, whether mains fed or locally generated, are suitable for use in air-conditioning systems within healthcare facilities. Water humidifiers, if fitted, should be removed.

3.46 Self- and locally-generated steam humidifiers must be supplied with potable water. The installation should be capable of being isolated, drained and cleaned. Section 4 in Part A of this Scottish Health Technical Memorandum gives further details.

3.47 Some steam generators are of a type that requires regular cleaning and descaling. The installation should enable them to be physically isolated from the air duct in order to prevent contamination of the air supply by cleaning agents.

3.48 The humidifier control system should fully conform to the standard set out in Sections 4 and 6 of Part A.

Filtration

3.49 Filters must be securely housed and sealed in well-fitting frames that minimise air bypass. Air bypass significantly reduces filter efficiency; the higher the filter grade, the greater the effect. Mounting frames should be designed so that the air flow pushes the filter into its housing to help minimise air bypass.

3.50 All filters should be of the dry type. Panel filters are generally used as prefilters and should be positioned on the inlet side of the supply fan, downstream of the frost battery. Where required, secondary filters (these will be bags or pleated paper) should be on the positive-pressure side of the fan.

3.51 The filter installation should provide easy access to filter media for cleaning, removal or replacement; therefore, a hinged access door should be provided. The upstream side of the filter should be visible for inspection through a viewing port with internal illumination.

3.52 All filters should be provided with a means of checking the differential pressure across them. Direct-reading dial-type gauges marked with clean and dirty sectors are preferred.

High-efficiency filters – HEPA and ULPA

3.53 Where fitted, HEPA filters should be of the replaceable-panel type with leak-proof seals. Their installation should permit the validation of the filter and its housing.

3.54 HEPA filters are sometimes used in extract systems for the containment of hazardous substances or organisms. They may be fitted with prefilters to extend their service life.

3.55 When used for the containment of hazardous substances, the installation should incorporate design provision for the subsequent safe removal and handling of contaminated filters by maintenance staff.

Energy recovery

3.56 Energy recovery, where fitted, will require cleaning access to both sides of the device.

3.57 Whichever type of energy recovery device is fitted, the extract side should be protected by a G3 filter and provided with a drainage system to remove condensate.

3.58 The heat-recovery device should be controlled in sequence with the main heater-battery, and may need to incorporate a control to prevent the transfer of unwanted heat when the air-on condition rises above the plant's required set-point.

Attenuation

3.59 Cleaning access should be provided at both ends of any attenuator unit.

Identification and labelling

3.60 All supply and extract ventilation systems should be clearly labelled. The label should identify both the AHU and the area that it serves. The lettering should be at least 50mm high and be mounted in an easily visible place near the fan of the unit. Any subsystems and the principal branch ducts should be similarly labelled.

3.61 The direction of air-flow should be clearly marked on all main and branch ducts.

3.62 All air-flow test-points should be clearly identified, and the size of the duct given.

Pressure stabilisers

3.63 Pressure stabilisers should be unobstructed and silent in operation.

4. Annual inspection and verification requirements

Ventilation systems inspection

4.1 All ventilation systems should be subject to at least a simple visual inspection annually.

4.2 The purpose of the inspection is to establish that:

- the system is still required;
- the AHU conforms to the minimum standard (see Section 3);
- the fire containment has not been breached;
- the general condition of the system is adequate for purpose;
- the system overall is operating in a satisfactory manner.

4.3 It is recommended that a simple check sheet be used to record the result of the inspection. Examples are given in Appendices 1 and 2.

Critical ventilation systems

4.4 All critical ventilation systems should be inspected quarterly and verified at least annually. In some circumstances the verification may need to be carried out more frequently.

4.5 The quarterly inspection should be as detailed in paragraphs 4.1 – 4.3.

4.6 The purpose of the annual verification will be to ensure additionally that the system:

- achieves minimum standards specific to the application;
- is operating to an acceptable performance level;
- remains fit for purpose.

Definition of a critical system

4.7 Ventilation systems serving the following are considered critical:

- operating theatres of any type, including rooms used for investigations (for example catheter laboratories);
- patient isolation facility of any type;
- critical care, intensive treatment or high-dependency unit;
- neonatal unit;
- category 3 or 4 laboratory or room;

- pharmacy aseptic suite;
- inspection and packing room in a sterile services department;
- MRI, CAT and other types of emerging imaging technologies that require particularly stable environmental conditions to remain within calibration;
- any system classified as an LEV system under the COSHH Regulations;
- any other system that clearly meets the definition.

4.8 The loss of service from such a system would seriously degrade the ability of the premises to deliver optimal healthcare.

Annual verification

4.9 The annual verification is intended to establish that:

- the system is still required;
- the AHU conforms to the minimum standard (see Section 3);
- the fire containment has not been breached;
- the general condition of the ventilation system is adequate;
- the fabric of the area served is satisfactory;
- the system performance is adequate with respect to the functional requirement – this will require:

  - a full measure of the supply and extract air-flow rates;
  - the calculation of room air-change rates if applicable;
  - the measurement of room differential pressures if applicable;
  - the measurement of room noise levels;
  - air-quality checks if appropriate;
  - a check on the control functions.

4.10 An assessment should then be made as to whether the system overall is fit for purpose and operating in a satisfactory manner.

Fabric of the area served

4.11 The building elements in the room or rooms served by a critical ventilation system should also be suitable for the function. As an example, in a suite of rooms comprising an operating theatre complex, the following elements should be checked:

- the ceiling should be complete and, if tiled, all tiles should be clipped down and sealed;

- the walls and floors should be free from significant construction and finish defects;
- windows and their trickle vents should be sealed and locked shut;
- the doors should close completely and the door closers should be correctly adjusted to hold them against the room pressure;
- all service penetrations and access panels should be sealed to prevent uncontrolled air flow between rooms and service voids;
- steps should have been taken (if necessary) to prevent portable equipment and stock items from obstructing low-level supply, transfer or extract air-flow paths.

4.12 Failure to achieve a suitable standard will render even the most sophisticated ventilation system ineffective.

4.13 All fire dampers should be tested as part of the annual verification.

4.14 LEV systems will be subject to an examination and test by a competent person at least every 14 months.

4.15 Table 1 below provides a model for the verification of critical ventilation systems.

Critical ventilation systems – verification standards

4.16 Unless otherwise specified below, the ventilation system should achieve not less than 75% of the design air-change rate given in Appendix 1 of Part A, or its original design parameters.

4.17 The pressure regime should achieve not less than 75% of the design value given in Appendix 1 of Part A, or its original design parameters; and the pressure gradient relationships with regards to surrounding areas must be maintained.

4.18 The sound levels given in Table 2 below are maximum permissible levels and should not be exceeded. Measurements should be made using at least a Type 2 sound meter fitted with a muff. Its accuracy should be checked using a calibration sound source before use.

Table 1: Operational management and routine verification process model

Step	Question	Information/standard required	Comment
1	Is the system still required?	Why was it installed?	Is that function still required?
2	Does the AHU achieve the minimum standard?	Health and safety aspects Intake/discharge positions Inspection access *Legionella* control and drainage Fire and electrical safety Leaks, cleanliness and insulation Filtration	Inspect to ascertain compliance with minimum standards set out in Section 3 Part B of this SHTM
3	Is the air distribution system satisfactory?	Access Fire dampers Cleanliness Insulation Identification Room terminals Pressure stabilisers	Inspect to ascertain continued fitness for purpose
4	Does the measured system performance still accord with the design intent and achieve a minimum acceptable standard?	Design air velocities Design air-flow rates Room air-change rates Pressure differentials Noise levels Air quality	Establish the design values Measure the system output to verify its performance
5	Does the control system function correctly?	Desired environmental conditions Control sequence logic Run; set back, off philosophy	Establish the design requirement Inspect/test to verify performance
6	Having regard to the foregoing, is the system 'fit for purpose' and will it only require routine maintenance in order to remain so until the next scheduled verification?		Yes or No
7	What routine service and maintenance will be required for the system to remain fit for purpose and function correctly until the next scheduled verification?	Filter changes System cleaning Performance indication Performance monitoring Performance measurement	Decide inspection frequency and maintenance schedule

Table 2: Maximum sound levels (service noise only)

Location	Design sound level (NR)	Measured sound level (dB(A))
Ultra-clean operating room	50	55
Conventional operating room	40	45
All other non-specified rooms	40	45
Corridors	40	45
Recovery room	35	40
Ward areas, sleeping areas	30	35

Vertical ultra-clean operating theatres

4.19 The following additional measurements should be taken:

- the average air velocity at the 2m level under the canopy: it should achieve a minimum average of 0.38m/s for a partial wall system and 0.3m/s for a full wall system;
- the air velocity within the inner zone at the 1m level: every reading should achieve a minimum velocity of 0.2m/s.

4.20 The air velocity measurements are to be taken using the equipment, test grid and method set out in Section 8 of Part A.

Note 3: There is no requirement to carry out filter scanning or entrainment tests at the annual verification unless the HEPA filters or recirculating air fans are changed, or the system is in some other significant way disturbed or altered. Changing the filters in the AHU or recirculating air filters does not constitute a significant disturbance to the ultra-clean ventilation (UCV) unit.

4.21 Should the UCV terminal fail to achieve a suitable standard, resulting in the need to disturb or replace the HEPA filters or recirculating air fans, the unit should be revalidated using the procedure given in Section 8 of Part A.

Note 4: Scottish Health Technical Memorandum 08-01 gives detailed guidance on acoustics and the measurement of sound

Horizontal ultra-clean operating theatres

4.22 The following additional measurements should be taken:

- the discharge velocity test at 1m, 1.5m and 2m in front of the terminal: the average velocity should be not less than 0.4m/s.

4.23 The measurements are to be taken using the equipment, test grid and method set out in Section 8 of Part A.

Note 5: There is no requirement to carry out filter scanning at the annual verification unless the HEPA filters or recirculating air fans are changed; or the system is in some other significant way disturbed or altered. Changing the filters in the AHU or recirculating air filters does not constitute a significant disturbance to the UCV unit.

4.24 Should the UCV terminal fail to achieve a suitable standard, resulting in the need to disturb or replace the HEPA filters or recirculating air fans, the unit should be revalidated using the procedure given in Section 8 of Part A.

Category 3 and 4 laboratories and rooms

4.25 These areas should conform to the requirements of current information published by the Advisory Committee on Dangerous Pathogens and the Health and Safety Executive:

- 'The management, design and operation of microbiological containment laboratories';
- 'Biological agents: managing the risks in laboratories and healthcare premises'; and
- 'Biological agents: the principles, design and operation of Containment Level 4 facilities'.

Pharmacy aseptic suites

4.26 Pharmacy aseptic suites should conform to the requirements of the European guide to good manufacturing practice (http://ec.europa.eu/enterprise/pharmaceuticals/eudralex/homev4.htm) and the requirements of the Medicine Inspectorate if a licensed manufacturing unit.

Sterile services department – inspection and packing rooms

4.27 Inspection and packing rooms should conform to the requirements of BS EN ISO 14644 and any additional requirements for the processing of medical devices, if applicable (see also Scottish Health Planning Note 13 – 'Sterile services department').

LEV systems

4.28 LEV systems should conform to the Health and Safety Executive's 'The maintenance, examination and testing of local exhaust ventilation'.

Critical system verification failure

4.29 Should a critical system be unable to achieve the standard set out above, it should be taken out of service. If healthcare provision needs prevent the system being taken out of service, the senior manager of the user department should be informed in writing that the system performance is suboptimal. A copy of the notice should be sent to the infection control committee.

4.30 If a critical system is refurbished in order to bring it to a suitable standard, it should be subject to the full validation procedure set out in Section 8 of Part A or other application-specific guidance as appropriate.

5. Inspection and maintenance

General

5.1 Inspection and maintenance activities should be assessed to ensure that they do not create a hazard for those who undertake the work or for those who could be affected by it.

5.2 The degree and frequency of maintenance should relate to the function of the system, its location, its general condition and the consequence of failure.

5.3 Specimen inspection and maintenance checklists are given in Appendices 1 & 2.

Inspection and maintenance of critical systems

5.4 The loss of service of these systems would seriously degrade the ability of the premises to deliver optimal healthcare. In order to ensure reliable service provision, it is essential to inspect, verify and maintain these systems at appropriate intervals.

5.5 For many of these systems a permit-to-work will need to be completed to ensure that taking the ventilation system out of service does not compromise the activities of the user department. In any event, it will be necessary to liaise with the user department when switching the system off to carry out routine inspection and maintenance.

AHU drainage

5.6 AHU drainage systems comprise a drainage tray, glass trap, connecting pipework and an air break. The system should be inspected to ensure that it is clean and operating correctly. The cleanliness of the drainage tray and colour of the water in the trap will give an indication of a fault condition (see Table 3 below).

Table 3: Colour of water in glass trap

Colour of water	Probable cause and comment
Normal	Satisfactory.
Green	Copper corrosion of pipework Possible leak in battery tubing.
White	Aluminium corrosion of battery fins.
Black	General dirt Filter faulty allowing air bypass System is overdue for a thorough clean Urgent action required.
Brown/red	Iron corrosion (rust) within the duct May indicate a specific *Legionella* hazard Immediate action required.
Bubbly/slimy	Microbiological activity within the duct May indicate a specific *Legionella* hazard Immediate action required.

Filter changing

5.7 Dirty supply air filters may pose a general dust hazard when being changed.

5.8 Dirty extract- and return-air filters may pose an increased level of hazard. This will relate to the particular contamination within the air that they have filtered. Filters handling extract air from general areas are unlikely to present a significantly greater hazard than that posed by dirty supply air filters.

5.9 Care should be taken to protect staff from inhaling the dust. If there is a need to enter the duct when changing filters, a dust mask should be worn.

5.10 Dirty filters should be carefully removed and placed in the box that contained the replacement filters or in a plastic bag. On completion of the work, the dirty filters should be removed from the plantroom and disposed of appropriately.

5.11 The duct in the area of the filter housing should be carefully vacuumed before fitting the replacement filters. This will prevent particles (that is, those that are shed when the dirty filters are disturbed) being blown into the system downstream.

5.12 It is important to ensure that replacement filters are fitted the right way round. Most panel filters are manufactured with a membrane or wire support mesh on their downstream side. Alternatively they may be colour-coded. The manufacturer's instructions regarding fitting should be followed.

5.13 Bag filters should be fitted with the pockets vertical. Care should be taken to remove any transit tapes and to ensure that the individual pockets are separate and free to inflate.

Changing extract filters containing hazardous substances

5.14 Filters handling extract air from an LEV system will obviously present a hazard and should be subject to a safe system of work.

5.15 Filters used in an extract system for the containment of hazardous substances or organisms should incorporate design provision for their safe removal when so contaminated. This may be achieved by:

- sealing the hazardous substance into the filter before it is removed;
- a system to fumigate the filter to kill any organisms;
- housing it in a 'safe change' unit that permits the filter to be ejected into a bag and sealed without staff having to come into direct contact with it.

5.16 The method chosen should reflect the nature of the hazard.

5.17 Filters fitted to remove hazardous substances from extract air are classed as hazardous waste and should be handled and disposed of accordingly.

Ventilation system cleaning

5.18 The intake section of a ventilation system should be vacuumed-out as necessary to remove visible particles.

5.19 AHUs should be vacuumed-out and/or washed down internally as necessary to remove obvious dust and dirt.

5.20 Chiller batteries, humidifier units, energy-recovery batteries or plates and their drainage systems should be washed down with hot water annually to remove visible contamination.

5.21 Supply air distribution ductwork conveys air that has been filtered. It will require internal cleaning only when it becomes contaminated with visible dirt. The frequency of cleaning will depend on the age of the system and grade of the AHU final filter but will typically be in excess of ten years. There is no requirement to clean ductwork annually. A rapid build-up of visible dirt within a supply duct is an indication of a failure of the filtration or its housing.

5.22 Extract air systems handle unfiltered air. They should be cleaned as frequently as necessary in order to maintain their operating efficiency. Room extract terminals, particularly those sited at low level in critical care areas, will need regular cleaning.

5.23 On completion of cleaning, the ductwork should not be 'fogged' with chemicals. This treatment has no lasting biocidal effect and is responsible for initiating the breakdown of the galvanised coating of ductwork. This will result in accelerated corrosion of the inside of the duct, with the products of corrosion being shed into the air stream. It will also significantly shorten service life.

5.24 Following duct cleaning, all service hatches should be checked to ensure that they have been correctly replaced and do not leak.

5.25 Duct-cleaning equipment that uses rotating brushes or a vacuum unit can easily damage flexible sections of ductwork. On completion of cleaning, all flexible duct sections should be checked for rips and tears. The straps that secure them to rigid duct sections and air terminals should also be checked to ensure that there is no air leakage.

Chilled beams

5.26 The efficiency of these units will rapidly decline if they become blocked with fluff/lint. They should be inspected every six months and cleaned as appropriate.

Split and cassette cooling units

5.27 These units incorporate internal recirculation air filters and a drainage system to remove condensate from the cooling coil. The systems should be inspected and cleaned every three months.

Portable room cooling units

5.28 Portable units are sometimes kept in-store or hired-in to cope with temporary local situations giving rise to excessive temperatures. They typically incorporate internal recirculation air filters and a drainage system to remove condensate from the cooling coil. Units employing an internal water reservoir and wick to promote evaporative cooling must not be used in healthcare premises.

5.29 The infection control team must be consulted before these types of unit are deployed.

5.30 The units should be inspected and thoroughly cleaned before being taken into use. Units that are to be used in areas containing immunocompromised patients will, unless new, need to be fumigated before use.

5.31 All portable units should be inspected and cleaned every week that they remain in use.

Self-contained mobile filter and/or ultraviolet (UV) light units

5.32 The efficacy of these units is directly related to their cleanliness. In this respect, the manufacturer's instructions regarding service/maintenance and lamp and filter replacement should be closely followed.

5.33 Units that have been used in isolation rooms or areas containing infective patients will need to be fumigated before being used in other locations, or returned to store or to the hirer.

5.34 Filters fitted to remove hazardous substances from the recirculated room air are classed as hazardous waste and should be handled and disposed of accordingly (see also Scottish Health Technical Memorandum 07-01 – 'Safe management of healthcare waste').

Inspection and maintenance records

5.35 Records of inspection and maintenance activities should be kept for at least five years.

Appendix 1: Annual inspection of critical ventilation systems – AHU and plantroom equipment

Definition of terms used on survey form

General condition

End of useful life
This should be clear from the condition of the AHU and its associated services and plant. The main indicators will be: • extensive internal and/or external corrosion of the AHU casing; • failure of filter housings to prevent air bypass; • general corrosion of heater and cooling battery fins, attenuator surfaces etc; • significant failure to meet minimum standards; • associated plant services and control elements in a poor condition or not able to fulfil their purpose; • AHU aged 20 years or more.
Action: Urgent replacement indicated.

Poor
Should be fairly apparent but should include an assessment of the degree of corrosion; • cleanliness of coils and batteries; • quality of filter mountings and their ability to prevent air bypass; • fan and drive train condition; • the control system elements' ability to fulfil their function; • condition of the access doors and inspection covers. The age of the AHU is generally less important.
Action: Extensive refurbishment or prolonged replacement indicated.

Average
Some faults but generally free of significant corrosion, clean internally and conforming to minimum standards.
Action: Faults capable of correction at next maintenance period.

Good
Conforming to the minimum standards, obviously cared for and subject to routine maintenance.
Action: Routine maintenance will preserve standard of equipment.

Compliance with minimum standards (questions 2 to 23, 32 and 33)

Poor
More than three answers are negative.
Action: Management action require by estates/facilities department.

Average
No more than 3 answers are negative.
Action: Maintenance action required.

Good
No answers are negative, full compliance.
Action: None.

Maintenance quality (questions 5, 12, 26 to 31 and 34 to 40)

Poor
More than three answers are negative.
Action: Management action required by estates/facilities department.

Average
No more than three answers are negative.
Action: Maintenance action required.

Good
No answers are negative.
Action: None.

Annual inspection of critical ventilation systems – AHU and plantroom equipment

Hospital _____

Plantroom _____

Air-handling unit _____ **Age of unit** _____

Area served by unit _____

Date of survey _____ **Name** _____

General condition: End useful life ☐ **Poor** ☐ **Average** ☐ **Good** ☐

Compliance with minimum standards **Poor** ☐ **Average** ☐ **Good** ☐

(Questions 2 to 23; 32 and 33)

Maintenance quality **Poor** ☐ **Average** ☐ **Good** ☐

(Questions 5, 12, 26 to 31, 34 to 40)

No	Survey question	Yes	No	Comments
1	Plant running?			
2	Are the unit and its associate plant secure from unauthorised access?			
3	Is the unit safely accessible for inspection and maintenance?			
4	Is the air intake positioned to avoid short circuiting with extract or foul air from other sources such as gas scavenging outlets?			
5	Are all inspection lights operating?			
6	Are motorised dampers fitted to the intake and discharge?			
7	Are the fan motor(s) outside of the air stream?			

8	Is the fan drive train visible without removing covers?			
9	Is the cooling coil located on the discharge side of the fan?			
10	Is an energy-recovery system fitted (state type)?			
11	Are condensate drainage systems fitted to all energy recovery systems, cooling coils and humidifiers in accordance of Section 3 of Scottish Health Technical Memorandum 03-01, Part B?			
12	Are drainage traps clean and filled with water? (see Table 3 in SHTM 03-01, Part B)			
13	Is the drain trap air break at least 15mm?			
14	If a humidifier is fitted, state the type			
15	Is the humidifier capable of operation?			
16	Is there space to safely change the filters safely?			
17	Are there test holes in the principal ducts?			
18	Are the test holes capped?			
19	What is the general condition of the exterior of the AHU?			
20	Are the principal ducts lagged?			
21	What is the general condition of the associated control valves and pipework?			
22	Is the pipework adequately lagged?			
23	Is the system clearly labelled?			
24	Record prefilter differential pressure.			
25	Record main filter differential pressure.			
Switch plant off. Fit padlock to isolator.				

26	Did the motorised dampers close on plant shut-down?			
27	Is the vermin/insect screen clean?			
28	Is the intake section including the fog coil clean?			
29	Are the prefilters correctly fitted with no air by-pass?			
30	Are all drive belts correctly aligned and tensioned?			
31	Is the cooling-coil matrix cleaned?			
32	Are all drip trays fully accessible or capable of being removed for cleaning and have a fall to drain?			
33	Are the drainage trays stainless?			
34	Are the drainage trays clean?			
35	Are the drainage traps free of water?			
36	Is the matrix clean for each heater-battery?			
37	Have the main filters been correctly fitted with no air by-pass?			
38	Is AHU and its associated main ductwork clean internally?			
Remove padlock and Re-start plant.				
39	Did unit restart satisfactorily?			
Test automatic fan-motor change-over, if fitted				
40	Did automatic change-over operate satisfactorily?			

Additional comments
(For example: air leaks from access doors; control valves leaking or passing; general cleanliness of the area around the unit; or any other items of concern.)

Competent person/Authorised person……

Appendix 2: Operating suite annual verification

Definition of terms used on survey form

Assessment of compliance with Scottish Health Technical Memorandum 03-01 (all questions relevant to the type of theatre)

Poor
• Air volumes and hence air-change rates is less than 75% of the design; • room pressure differentials do not ensure a flow from clean to less clean areas; • supply or extract air diffusers are not clean; • pressure stabilisers not clean and/or not operating correctly; • significant faults or failures of indicators on surgeon's panel; • visible faults in the fabric of the suite; • doors unable to close completely; • general air of neglect.
Action: Urgent management action required

Average
• Air pressure and room pressure differentials approximate to the original design values; • supply air diffusers clean but extracts visibly fouled; • most pressure stabilisers clean and operating correctly; • some of the indicators on the surgeon's panel not working; • minor faults in the fabric and décor of the suite.
Action: Maintenance action required

Good
Better than average
Action: None

Maintenance quality (all questions relevant to the type of theatre)

Poor
More than three answers are negative
Action: Management action required by estates/facilities department

Average
No more than three answers are negative
Action: Maintenance action required

Good

No answers are negative
Action: None

Annual verification of theatre ventilation systems - Theatre suite information

Hospital _____

Theatre name/no. _____ **Type of Theatre** _____

Date of survey _____ **AHU location & ID** _____

Name _____

Compliance with SHPN & SHTM **Poor** ☐ **Average** ☐ **Good** ☐

Maintenance quality **Poor** ☐ **Average** ☐ **Good** ☐

No	Survey question	Yes	No	Comments
1	Has the annual verification of the AHU been carried out?			
2	Are windows hermetically sealed?			
3	Is the theatre /are the theatre and prep room complete and sealed?			
4	Are there any significant faults in the fabric of the rooms in the suite?			
5	Are room light fittings correctly sealed?			
6	Do all doors close completely and hold against the room pressure?			
7	Are the pressure stabilisers operating correctly and silently?			
8	Are the supply and extract air terminals and pressure stabilisers visibly clean?			
9	Measure and record the operating room temperature			
10	Does this accord with that displayed on the surgeon's panel?			

No	Survey question	Yes	No	Comments
11	Measure and record the operating room relative humidity.			
12	Does this accord with that displayed on the surgeon's panel?			
13	Measure and record the supply and extract air flow in the principal ducts.			
14	Measure and record the air flow at all supply and extract terminals.			
15	Does the derived air-change rate achieve at least 75% of the design?			
16	For UCV units, also measure and record the air velocities within the canopy using the method set out in Section 8 of Scottish Health Technical Memorandum 03-01 (Part A)			
17	Do the air velocities achieve the standard appropriate for the type of canopy?			
18	Measure and record the room differential pressures			
19	Do the room differential pressures ensure a flow of air from the clean to the less clean areas?			
20	Measure and record the noise levels in the principal rooms of the suite.			
21	Do the noise levels fall below the limits set out in Table 2 of SHTM 03-01 Part B			
22	Check the operation of all ventilation control functions represented on the surgeon's panel.			
23	Do the indicators accurately represent the operational state of the ventilation system(s)?			

No	Survey question	Yes	No	Comments
24	For UCV systems: are the UCV and AHU interlocked to ensure that the AHU runs at full speed when the UCV is at operating speed or at set-back? (see Table 7 in Scottish Health Technical Memorandum 03-01, Part A)			
25	With the UCV running at set-back, does the system maintain the standard of a conventional operating room?			
26	For all theatres: with the system running at set-back, does it maintain a flow of air from the clean to the less clean areas?			

Additional comments
(For example: the general décor; are the suite and its ventilation systems suitable for their designated functions?)

Competent person/Authorised person……

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From: Macleod, Mairi
To: Hughes, Janis
Bcc: "Rose, Carol"
Subject: RE: Schiehallion Operational Policy
Date: 01 July 2014 15:08:00

Janis

Technical viewpoint:

"Barrier" is created by hepa filtered supply to lobby with extract from isolation room/en suite therefore no cross infection between room and corridor in either direction. Reversal to create – ve lobby is not possible as no extract in lobby and no supply in isolation room/en suite

Mairi

From: Hughes, Janis [redacted]
Sent: 01 July 2014 12:07
To: Macleod, Mairi
Subject: RE: Schiehallion Operational Policy

I've spoken to the SCN and the issue is that sometimes if BMT patients are in a +ve pressure room currently but need a negative pressure room, they have to be moved out of the room with lobby and into a single cubicle to be reverse barrier nursed as it's not possibly to change the pressure in the RHSC rooms. They are asking if the pressure could be changed, if required, while patient is still in the room if their clinical condition dictates it.
Could we get a technical opinion?
Ta
J

From: Macleod, Mairi
Sent: 01 July 2014 09:43
To: Hughes, Janis
Subject: RE: Schiehallion Operational Policy

Janis

My understanding is that it is possible – but it is through the Building Management system- not sure why you would want to

The lobby is +ve and therefore ensuring that both the bedroom and the corridor are protected with the air being vented through the lobby's air handling unit

Mairi

From: Hughes, Janis [redacted]
Sent: 01 July 2014 09:15
To: Macleod, Mairi
Subject: FW: Schiehallion Operational Policy

See below, following last night's discussions. Think we talked about this before and that it is possible but not easy? Can you clarify?

Thanks
Janis

From: Kirkwood, Jean
Sent: 01 July 2014 09:12
To: Hughes, Janis
Cc: McVeigh, Alanna; Gibson, Brenda
Subject: RE: Schiehallion Operational Policy

Hi Janis,
Is it possible to have any of these rooms dual purpose? Changeable to negative pressure, to source isolate BMT patients?
Many thanks
Jean

From: McVeigh, Alanna
Sent: 30 June 2014 17:45
To: Gibson, Brenda; Kirkwood, Jean
Subject: FW: Schiehallion Operational Policy

Do you want to ask if its possible to have any neg pressure rooms for source isolation?

From: Hughes, Janis
Sent: 30 June 2014 17:28
To: McVeigh, Alanna
Cc: Gibson, Brenda; Brady, Coral; Redfern, Jamie
Subject: FW: Schiehallion Operational Policy

Alanna
In answer to a query in your operational policy, please see below from the Project Team
Let me know if you need anything else.
Regards
Janis

From: Macleod, Mairi
Sent: 19 June 2014 15:20
To: Hughes, Janis
Subject: RE: Schiehallion Operational Policy

Janis

There are 8 Hepa filtered isolation rooms within the Unit:

Bedroom	SCH-010	SCH-011	SCH-017	SCH-020	SCH-074	SCH-072	SCH-067	06 SCH-6
Lobby	SCH-009	SCH-013	SCH-018	SCH-019	SCH-075	SCH-071	SCH-068	SCH-064
En suite	SCH-007	SCH-015	SCH-016	SCH-023	SCH-076	SCH-070	SCH-069	SCH-065

And these are +ve pressure with separate air handing units for each individual room

Hope this is helpful

Mairi

From: Hughes, Janis [redacted]
Sent: 19 June 2014 14:24
To: Macleod, Mairi
Subject: Schiehallion Operational Policy

Mairi

Room number	Description	Notes including No. of People
SCH-027 / 022	Single cubicle rooms & en-suites	
SCH-020 / 019 / 023 SCH-017 / 018 / 016 SCH-074 / 075 / 076 SCH-072 / 071 / 070 SCH-067 / 068 / 069 SCH-066 / 064 / 065 SCH-015 next slide	Double-door rooms with en-suite & ante room	We have not yet had a response to our question whether these are the rooms which should be used for stem cell transplant and their specification - positive pressure, monitoring and HEPA filtration.
SCH-014	Dirty Utility	
SCH-021	Chemo room	Drug preparation and storage (medicine management)
SCH-024	General Store	
SCH-025	Resus Trolley	
SCH-062	Play / Dining Area	
SCH-063	Treatment Room	
SCH-073	Corridor	

As discussed - can you clarify query over isolation rooms, please.

Kind regards

Janis

Janis Hughes
Planning Manager - Women and Children's Directorate
☎ [redacted]
Secretary: [redacted]

From: Brady, Coral
To: Macleod, Mairi
Cc: McCormack, Bill
Subject: FW: Haemato Oncology Air Filtration System
Date: 21 February 2013 13:56:50

Hi Mairi,

You may recall this email trail from a couple of years ago.

At this mornings SCT Meeting, we were discussing the Hepa-filtration of the NCH transplant rooms as we've had some issues with the ones on site here recently. I understand that as part of a conversation around the room maintenance, it was tentatively mentioned that the estates team that look after the HTA regulated duct systems, room pressures etc. on this site had not yet been asked to advise on NCH.

I'm sure this is all in hand, but thought it worth while getting an update if there was one available.

Thanks very much

Coral

Coral Brady | Business & Administration Manager | NHS Greater Glasgow and Clyde (Yorkhill Hospital) | RHSC Glasgow | Dalnair Street | Glasgow G3 8SJ
t. [redacted] | x [redacted] | e. [redacted]

From: Macleod, Mairi
Sent: 19 September 2011 14:59
To: Brady, Coral; Gibson, Brenda
Subject: RE: Haemato Oncology Air Filtration System

Coral

There are 8 isolation rooms planned for the new unit

Mairi

From: Brady, Coral
Sent: 16 September 2011 13:45
To: Gibson, Brenda; Macleod, Mairi
Subject: RE: Haemato Oncology Air Filtration System

Hi Mairi,

I fed back at yesterdays SCT meeting the news regarding the hepa filter and pressure, and was reassured regarding that, although surprise was expressed that the person who had been so heavily involved from an accreditation perspective (and therefore knows the

specification probably better than anyone else) wasn't involved - however, they accepted that this was in hand. One of the questions that was raised was regarding the number of rooms to have the HF and Pressure - and I couldn't recollect from previous discussions. Please can you ask someone from the tech team to remind us?

Thanks so much and best wishes

Coral

From: Brady, Coral
Sent: 31 August 2011 08:06
To: Gibson, Brenda
Subject: FW: Haemato Oncology Air Filtration System

fyi

From: Macleod, Mairi
Sent: 29 August 2011 16:34
To: Brady, Coral
Cc: McCormack, Bill
Subject: RE: Haemato Oncology Air Filtration System

Coral

Hi I'm fine – hope this finds you well

The plans for the Haemato-oncology area in the NCH include Hepa filter and pressure as necessary. When we are further in the design we will contact staff as and when required. We do however have a full NHS technical team supported by external Technical advisers who are aware of the building requirements for the unit

Thanks for your email though – it is helpful if people keep us advised of any concerns that they have to avoid costly mistakes

Kind regards

Mairi

From: Brady, Coral
Sent: 25 August 2011 12:55
To: Macleod, Mairi
Cc: McCormack, Bill
Subject: Haemato Oncology Air Filtration System

Hi Mairi,

How are you? Hope alls well with you!

Can I check with you what plans have been made (or are going to be made) for the consideration of the air filter system in the haemato-oncology unit at NCH?

Bill McCormack is the gentleman who currently maintains the existing system, changes the

filters and keeps it up to spec, and he is fully aware of the minimum standard requirements for transplant and non-transplant patients.

To date, no-one's quite sure who has been discussing this, and thought it would be useful to clarify.

Look forward to hearing from you.

best wishes

Coral

From: Macleod, Mairi
To: "eddie.mclaughlan[redacted]
Cc: Griffin, Heather; Moir, Peter
Subject: Isolation rooms
Date: 26 March 2013 14:40:00

Eddie

In response to your email of 19 March 2013 to Peter Moir, please find below the process followed for the adult and new children's hospitals on the Southern campus:

Infection control have been involved throughout the project, with a full time Senior Infection Control Nurse seconded onto the project team who has linked back to the Board's Infection Control Team. She was fully involved in the Competitive Dialogue process with the three bidders who bid to build the new hospitals, and participated in all of the User Group meetings where the schedules of accommodations, the 1:200 departmental layout drawings and the 1:50 room layouts were agreed.

Adult Hospital

The new South Glasgow Hospital (Adult Hospital) has 1109 bedrooms, there are 100 % single rooms with the exception of Critical Care which, for clinical and patient safety reasons, is open plan with the exception of the isolation rooms.

The seconded infection control nurse and the Board's Infection Control Team had a series of meetings to discuss and debate the isolation room provision, and took into account the single rooms.

The Adult hospital has 15 isolation rooms distributed as follows:

- 10 isolation rooms in Critical Care Unit (which has a total of 59 beds and 20 CCU beds which are in single rooms)
- 2 isolation rooms in the renal ward.
- 3 isolation rooms in the respiratory ward
- There is a also a Haemato-oncology ward planned for the new hospital with hepa filtration positive to the rest of the hospital with highly filtered air to H13 ie 99.95%

This distribution gives flexibility in the ward stack and specialty areas.

It should be noted that there is an Infectious Diseases facility on the Gartnavel General site and any adult patient requiring specialist isolation facility would be admitted there e.g. drug resistant TB.

New Children's Hospital

The New Children's Hospital (NCH) has 256 beds and there are a mixture of single and 4 bedded areas. There are 24 isolation rooms in the NCH, the breakdown of how these are distributed is below:

- Observation ward (beside ED- a decision making ward) - 2 rooms
- Cardiology ward - 2 rooms
- PICU- 4 rooms
- Acute Receiving ward – 2 rooms
- Schiehallion (cancer/haematology ward) 8 rooms
- Generic ward – 6 (2 in each 24 bedded ward)

The decision on the number and location of these beds was made in again in consultation with Infection Control colleagues. As the NCH will admit children with varying symptoms it was agreed that it was best to have the beds spread throughout the hospital in order to offer flexibility whilst allowing the patients to be co-located with the specialty of their main presenting condition.

I trust that this information is helpful to you

Mairi

Mairi Macleod
Project Manager New Children's Hospital
Brookfield Site Offices
Hardgate road
Govan

[redacted]

From: Macleod, Mairi
To: Beattie, Jim; Hughes, Janis; Redfern, Jamie
Cc: Hill, Kevin
Subject: RE: Staff Open Sessions - New Children"s Hospital Update
Date: 07 August 2013 17:27:00

Janis

I've just spoken to our technical advisor who advises that the demolition of the surgical block is 150 m from the air handling unit for Schiehallion which should be sufficient in itself. However, it should be stressed that the NCH is sealed building, ie there are no windows, and all air handling units will be filtered. Over and above that the bone marrow transplant rooms will have hepa filters

I trust that this will give comfort to the Users

Mairi

From: Hughes, Janis [redacted]
Sent: 07 August 2013 13:53
To: Macleod, Mairi
Subject: FW: Staff Open Sessions - New Children's Hospital Update

Hi Mairi
Not sure if you've given us any feedback on this and I've missed it?
Thanks
Janis

From: Macleod, Mairi
Sent: 15 July 2013 16:04
To: Beattie, Jim; Hughes, Janis; Redfern, Jamie
Cc: Hill, Kevin
Subject: RE: Staff Open Sessions - New Children's Hospital Update

Jim

We looked at this earlier in the process and the demolitions were far enough away – I will however, get our guys to look at the actual distances and feedback to you in due course

Mairi

From: Beattie, Jim [redacted]
Sent: 11 July 2013 17:43
To: Hughes, Janis; Redfern, Jamie
Cc: Hill, Kevin; Macleod, Mairi
Subject: RE: Staff Open Sessions - New Children's Hospital Update

I will pass this onto Mairi for comment. To my mind there will be little in the way of immediate adjacency of the new build to the surgical block. My understanding that elsewhere the demolition was pretty close to the SCT units.
Jim

From: Hughes, Janis
Sent: 11 July 2013 14:59
To: Beattie, Jim; Redfern, Jamie
Cc: Hill, Kevin
Subject: FW: Staff Open Sessions - New Children's Hospital Update

Jim/Jamie
See below - grateful for comments. Are you aware of any previous discussions? Is this an issue for our Risk Register?
Janis

From: Robertson, Lynne
Sent: 11 July 2013 14:55
To: Ewins, Anna-Maria
Cc: Gibson, Brenda; MacKinnon, Yvonne; Hughes, Janis
Subject: RE: Staff Open Sessions - New Children's Hospital Update

Anna Marie
Probably not, if accurate about of demolition and timing. I am aware of impact due to work we done for our BMT area and presentations made from London based hospitals regarding impact and their experience. I will copy Janis Hughes in to raise as an issue and to clarify at our OTM steering group. Need to find out if factually accurate before consulting with Prof Craig Williams.

Regards Lynne

Lynne Robertson
Clinical Service Manager
Hospital Paediatrics
Women and Children's Directorate
[redacted]

From: Ewins, Anna-Maria
Sent: 11 July 2013 14:44
To: Robertson, Lynne
Cc: Gibson, Brenda; MacKinnon, Yvonne
Subject: RE: Staff Open Sessions - New Children's Hospital Update

Dear Lynne,
I read in one of the GGC newsletters that the old surgical buildings will be demolished one year after (2016) the move into the New Childrens' hospital.
Has the Board considered the impact on the Haematopoietic Stem Cell transplant programme , as well as the increased risk to solid organ transplant recipients and other immunocomprised patients.?We would anticipate a significant increase in the number of mould infections amongst these patients if adjacent buildings are undergoing demoltion.

AnnaMaria Ewins
Associate Specialist Paediatric Bone Marrow Transplantation
Schiehallion Unit,
RHSC
Glasgow G3 8SJ
Telephone [redacted]
Page [redacted]

From: Robertson, Lynne

Sent: 11 July 2013 14:30
To: Callander, Elizabeth; Johnston, Elaine; Taylor, Judy; Taylor, Maureen; Buchanan, Irene; Court, Irene; Dixon, Melville; Fraser, Dougie; Gallagher, Judith; Grant, Alison; Harper, Lorraine; Harrigan, Jim; Johnson, Elinor; King, Caroline; Lawson, Lynda; Maclean, Anne; Mccrossan, Elaine (NHSmail); Murtagh, Eamon; Pirie, Mary; Reidpath, Hilary; Robertson, Karyn; Shepherd, Sheila (NHSmail); Conetta, Hilary; Faltaous, Amgaad; Gibson, Helen; Houston, James (NHSmail); Hunt, Greg; Kelly, Brian; Kurian, Oommen; McKie, Allison; Nairn, Lesley; Narkhede, Mangala; Qayyum, Nadia; Ray, Mary; Russell, Shiuli; Sharma, Amita; Singh, Harcharan (NHSmail); Stewart, Graham; Whyte, Karen; ahmed, faisal; Anand, Dhullipala; Baig, Hafeez; Barclay, Andrew; Beattie, Jim; Beattie, Paula; Bland, Ruth; Campbell, Morag; Chalmers, Elizabeth; Choudhery, Vincent; Cochran, Dominic; Coutts, Jonathan; Craigie, Ian; Davidson, Joyce; Davidson, Mark; Davies, Philip; De zeeuw, Fiona (NHSmail); Devenny, Anne; Doherty, Conor; Dygas, Tomasz; Ewins, Anna-Maria; Flynn, Diana; Gallacher, Christine; Gibson, Brenda; Gibson, Neil; Gulati, Ram Kumar; Hague, Rosie; Halliday, Susan; Heaney, Nicholas; Hendry, Scott; Heuchan, Anne Marie; Hill, Sarah; Horrocks, Iain; Hughes, David; Jackson, Allan; Jackson, Lesley; Kasem, Kerry; Kenneth Robertson; Kidson, Chris; Levin, Richard; Lilley, Chris; MacDonald, Peter; MacLeod, Stewart; Mactier, Helen; Martin, Neil; Matta, Nashwa; Maxwell, Heather; McGrogan, Paraic; Milne, Clare; Mora, Juan; Murphy, Dermot; O'Regan, Mary; O'Reilly, Kathleen; Peters, Colin; Powls, Andrew; Quine, David; Ramage, Ian; Robinson, Peter; Ronghe, Milind; Russell, Richard (NHSmail); Russell, Fiona; Sastry, Jairam; Schwahn, Bernd; Shaheen, Ihab; Shaikh, Guftar; Shujaat, Rosina; Simpson, Judith; Skeoch, Charles; Smith, Ben; Spenceley, Neil; Spiers, Marie; Stirling, Joanne; Storie, Lynda; Sweeney, Siobhan; Thomson, Louise; Wilkinson, Jane; Yadavali, Sasi; Yeo, Tong Hong; Zuberi, Sameer; Basith Amjad; Bell, Graham; Best, Crispin; Bolton, Philip; Brindley, Nicola; Brown, Jennifer; Campbell, Emer; Cascio, Salvatore; Clement, William (NHSmail); Cupples, Pamela; Danton, Mark; Davis, Carl; Devlin, Mark; Duncan, Roderick (NHSmail); Fairgrieve, Ross; Flett, Martyn; Ghent, Robert; Haddock, Graham (Uni); hajivassiliou, constantinos; Hammond, Phil; Huntley, Jim; Knight, Brodie; Koppel, David (NHSmail); Kubba, Haytham; Lavy, Tim; Lawson, Ros; MacArthur, Kenny; McIlveney, Susan; McIntyre, Andrew; McKee, Lesley; McLean, Andrew; Mclean, Andrew (NHSmail); McLeod, Karen; Moores, Tony; Morrissey, Simon; Murnaghan, Claire; O'Toole, Stuart; Ray, Arup; Read, Heather; Robert Carachi; Rowland, David; Sabharwal, Atul; Sangra, Meharpal (NHSmail); Scarth, Jennifer; Sinclair, John; Walker, Gregor; Wallace, Ewan; Wilson, Neil; Wynne, David
Cc: Hackett, Janice; Bruce, Jacquie; Dawes, Heather; Hughes, Janis
Subject: FW: Staff Open Sessions - New Children's Hospital Update

FYI /action

Regards Lynne

Lynne Robertson
Clinical Service Manager
Hospital Paediatrics
Women and Children's Directorate
[redacted]

Dear All

Please find attached a flyer outlining a series of open drop in sessions being held on **15, 16 and 19th July** in the **Conference Room, QMH** from **12 noon - 2pm**, hosted by Kevin Hill, Director, Women and Children's Services.

These sessions will provide the latest information on the progress of the New Children's Hospital and New South Glasgow Hospital projects, showing the latest images of the hospital and plans for office accommodation.

All staff are very welcome to attend and presentations will be run throughout the 2 hour period, enabling staff to drop in when convenient.
Kind regards
Janis

Janis Hughes
Planning Manager - Women and Children's Directorate

NEW SOUTH GLASGOW HOSPITALS

PROJECT MANAGERS INSTRUCTION No. 231

The Employers' Requirements state the following in relation to commissioning and handover:

6.8.1 It is envisaged that the contractor will appoint an Independent Commissioning Engineer to manage/programme/collate all M&E Testing & Commissioning processes, all as detailed in Appendix M, M&E3 Section 5 of the Employers Requirements.

M&E3 5.2 Commissioning Engineer

An Independent Commissioning Engineer shall be appointed by the contractor.

The commissioning Engineer shall be responsible for fully managing the commissioning process for the electrical and mechanical, public health, medical gases, life safety and communications installations and shall carry out all necessary liaison with other contractors and specialist installers and compile the operation and maintenance manuals.

Brookfield have intimated that the commissioning engineer role will be undertaken by a BMCE member of staff, rather than an independent commissioning engineer. The Board acknowledge the request for a change to the ER requirement in relation the "independence" of the engineer on the basis that the current BMCE staff have a detailed knowledge of the complex installations and are best placed to undertake the role.

The scope of the role, as outlined in M&E3 Section 5.0 remains unaltered and any change to the proposed individual, David Wilson, should be agreed in advance with the Board's Project Manager.

8th July 2013.

From: Hirst, Allyson
To: Powrie, Ian
Subject: Risk Register
Date: 04 March 2014 16:17:04
Attachments: Project Risk Register - Feb 2014.xls

Updated as per the comments on Friday – I have highlighted the two areas that you were to give further detail/comment on.

Can you update and return to me so that it is ready for DL review before On the Move Group

Thanks

Allyson Hirst
PA to the Project Director
New South Glasgow Hospital Development
Construction Offices
Hardgate Road
Govan
G51 4SX

Tele - [redacted]

NHS Greater Glasgow and Clyde *Project Risk*

Risk is the chance of something happening which will cause harm or detriment to the organisation, staff or patients.

Risk is assessed in terms of likelihood of an event occurring and the severity of its impact upon the organisation, staff or patients.

NHS Greater Glasgow and Clyde has adopted, as standard, a “1 - 5” scoring system which enables the risks to be prioritised. This is illustrated in the following table.

Likelihood (L)		Consequence (C)		Risk (LxC) = Priority		
Almost certain	5	Extreme	5	20 - 25	=	Priority 1 = VERY HIGH
Likely	4	Major	4	12 - 19	=	Priority 2 = HIGH
Possible	3	Moderate	3	6 - 11	=	Priority 3 = MEDIUM
Unlikely	2	Minor	2	1 - 5	=	Priority 4 = LOW
Rare	1	Negligible	1			

NHS Greater Glasgow and Clyde

Project Risk Register

Completed by New South Glasgow Hospitals Project Team

Date Reviewed by Joint Project Team 28th February2014

Date to be reviewed by the On The Move Programme Board 20th March 2014

Date to be reviewed by ASSB May-14

Date to be reviewed by Joint Project Team 01 April 2014

LEGEND (RISK OWNERSHIP)
DL - David Loudon
HG - Heather Griffin
HMcD - Hugh McDerment
MM - Mairi Macleod
MMc - Mark McAllister
PM - Peter Moir
KC-Karen Connelly
DH - David Hall
DR - Douglas Ross
EM - Eleanor McColl

Risk = the chance of something happening which will cause harm
Levels of risk = assessed in terms of likelihood and consequence (LxC)

Likelihood (L)	Consequence (C)		Risk Ranking Priority	
5	Extreme	5	20 - 25	= Priority 1 - **VERY HIGH**
4	Major	4	12 - 19	= Priority 2 - **HIGH**
3	Moderate	3	6 - 11	= Priority 3 - **MEDIUM**
2	Minor	2	1 - 5	= Priority 4 - **LOW**
1	Negligible	1		

Ref	THE RISK - what can happen and how it can impact	CONTROLS IN PLACE	RISK EXPOSURE Likelihood (L)	RISK EXPOSURE Consequence (C)	RISK RATING (LxC)	RISK RANKING PRIORITY	FURTHER ACTION REQUIRED	OWNER
1	Appropriate Design Quality not being Achieved. (Building and Services)	Detailed Employer's requirements set out Quality Standards. A&DS supporting project with enabler input. Evaluation criteria has quality as a key element and priority. Design Action considered in specifications BREEAM Consultant Input to Planning process Project Supervisor contracted from 1st June 2010 (Capita) Project Supervisors quality checking construction and engineering	1	5	**5**	**4**	Design checks on appendix K agreed for FBC approval Supervisors on site from June 2010 - Monthly reporting Ongoing monitoring RDD process will continue to be maintained. 2 Stage review process - 1st stage review undertaken in July 2010. 1:200 review concluded minimum scope change 1:50 process finalised - minimum scope change Project Team involved in product workshops to input services/finshes selection 1:50 "sweep-up" exercise concluded	PM
2	HOSPITALS - Capital costs outwith affordable level	Formal change control process in place to control scope change Review contingency at ASSB Review at Commercial Group meeting	1	5	**5**	**4**	Ongoing monitoring. Regular reporting to the Exec Group Final stage of 1:50 process in place. 98% of contract let Hospitals outturn cost forecasted within budget. Continually review and report on contingency Ongoing assessment of risks through Early Warning meeting with Brookfield	DL
3	Lack of adequate resources and skills for next stage of the project (Stages 2&3) are in place and for commissioning	Realign project team and technical team to meet new project challenge. Review and change technical advisor input. Identified requirement to commission quality regime for construction phases of the project (supervisors) Restructured Project team and allocated responsibilities	2	2	**4**	**4**	Obtained support from Procurement and Medical Physics, IT and Pharmacy Continuous Review Assign each team member with special responsibilities. Out sourcing specialist staff for testing and commissioning	DL

Ref	THE RISK - what can happen and how it can impact	CONTROLS IN PLACE	RISK EXPOSURE Likelihood (L)	RISK EXPOSURE Consequence (C)	RISK RATING (LxC)	RISK RANKING PRIORITY	FURTHER ACTION REQUIRED	OWNER
4	Major Hospitals works starting on site from March 2011 and potential risk to current site operation	Construction Interface Group established to manage, control and monitor all activities and liaise with Contractor, SGH Facilities and SGH Estates Depts. Group undertakes a weekly "look-ahead" of programme to identify any potential disruption. Site and/or specific department notified in advance of any potential disruption. Other site projects also members of this group Complaints Register instigated to log any complaints and actions taken Ongoing liaison with local residents during link bridge install and VIE construction	2	3	6	3	Continuous monitoring and evaluation of processes and outcomes by Project Team and PMG Ground scanned for services check Users involved where there is potential for the works to impact on their services Ground scan for services check repeated (March 2012). Prior to any works continuing to liaise with Directorate Lead Current focus is on the link bridge installations and associated works	DL
5	Appropriate communications not being provided to all stakeholders	Since Ministerial announcement with role out communication plan to all stakeholders Communications Plan in force	3	4	12	2	Project team continue to review communications Boards website updated monthly with webcam images A project web-portal has been set-up Project Community Engagment Manager working closely with BCL to take forward joint communications Community Engagement events for local residents commenced formally 19th July 2010. Presentation to South Glasgow Area committees x 6 ASR Comminucations Group established Neighbourhood Liaison Group established	MM/Project Team
6	Detrimental environmental impacts i.e. Noise disruption and pollution	All works to be assessed for noise disruption and/or pollution consequences Ecology report undertaken Contractors environmental policy implemented WRAP initiative implemented . Brookfield monitor vibration and noise automatically. Disruption to local residents during VIE construction, removal of tower cranes. Continue local liaison with residents	4	3	12	2	Ongoing review by PMG Regular meetings with local residents to discuss a series of environmental issues pre construction of the hospitals BCL WRAP on site Dust monitors installed around BMCL site to gather information - weekly report provided to NHS Team Dust screens erected in specific locations Acoustic barriers erected to minimise potential noise disruption Project Director reinforced that Brookfield must comply with GCC conditions.	PM
7	Inadequate LAN Infrastructure costs allowed for in Project	There is a risk that there is insufficient budget allocated for LAN Instrastructure costs in Project budget. This could result in their being insufficient available budget to cover any LAN design changes that need to be made.	1	4	4	4	Contractor appointed to install LAN and switches. IT active equipment install programmed to commence October 2013. NHS liaising closely with BMCL. Implementation plan has been developed in line with BMCL commissioning plan.	EM
8	Failure to meet requirements of fire guidance documents - programme impact (design process)	Fire strategy developed in conjunction with NHS personnel including Fire Officer Progress monitored at Project Management Group and Project Team Regular specific fire meetings scheduled with Project Team and Users. All information sent to building control. Only cause and effect matrix to be concluded	1	3	3	4	Building Warrant application submitted to GCC Building Control Dept Workshops arranged to discuss fire strategy with Architects, Project Team, Technical Advisers, Contractor and Strathclyde Fire & Rescue Ongoing discussions TA Fire Advisers prepared report for submission to Building Control - indicating BCL design fully compliant with Fire Regulations Recent guidance released setting out new complaince standards for the prevention of fire in the atria of healthcare buildings. NHS Project Team and designers determining whether any changes to the design is required. Ongoing liaison with GCC Building warrant for Stage 8 (Fire Strategy) now received by BMCL Project Team met with HFS who are satisfied the atrium design meets new regulations.	DH

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9	Data share with Contractor not adequate	Process in place (Aconex) to ensure contractor correspondence widely circulated and requests actioned	2	2	4	4	Standing agenda item for weekly project team Further aconex training provided to project team members Request For Information (RFI) tracker developed and being actively managed to ensure responses provided to contractor within appropriate timescales. RFI tracker is standing agenda item on site progress and design groups.	DL
10	A&C - Group 2,3,4 & 5 Equipment Non-compliance of group 5 equipment with BMCL Construction programme	Project Team have agreed a methodology to respond to BMCL plan/construction programme. Resource to assist maintaining the programme being provided to the project Team from Medical Physics (Secondment) Cost estimate prepared and reviewed for each equipment category. Tenders issues and returned. Tender assessment process is underway	3	4	12	2	Project Team receives regular progress updates from Equipment Group lead to ensure no impact on programme. Work underway to identify 'new' versus 'transfer' equipment Full detailed equipment installation process being developed Regular meetings between BMCL and NHS to discuss and agree way forward re group 5 equipment install in those areas to be completed first. Deliveries of Group 2 (Board supply) equipment to BMCL ongoing and methodology for the delivery and storage of Group 2 equipment to/by BMCL concluded. Group 3 & 4 - Project team meeting users to start process of determining old versus new Group 5 - detail plan agreed to procure and install equipment - still to agree purchase/transfer	MM
11	Specialist Departments Failure to identify early those reps who need to be involved in the final sign-off of specialist departments i.e. external validators, external testers, etc	Project Team have identified a list of departments that will require specialist input to the design/sign-off process.	2	4	8	3	Project Team to liaise with the leads of the specialist departments to seek details of validators/testers that will be required for final sign-off of a room/area/dept. BMCL are organising to present their proposals to commission the hospitals to the NHS Team. Final system commissioning programme required from BMCL to allow planning of the test and commissioning of systems. Information required by April/May 2014 to progress within timelines	PM
12	Construction Quality requirement not being achieved	Capita Symonds appointed independent testers. Additional NHS support/resource provided on project (July 2012)	2	3	6	3	Provide regular reports on all aspects of construction activities. Provide weekly quality report to Project Team Both reports discussed at monthly meetings and information shared with contractor. Daily site visits undertaken by NHS Reps to monitor works on the site. NHS Reps linking with Capita to raise any concerns in order that formal communications are provided to BMCL. Exemplar areas have been signed off which sets the precedent going forward for the rest of the building.	PM
13	The detrimental effect of any of the demolitions works -post 2015- on the hepa filtered wards in both the adult and children's hospitals	Distance from air intake point. Environmental control covered within contract	3	3	9	3	Discussions to be instigated with BMCL Dustscan in place to monitor dust levels. Dust suppression system used onsite Understanding dust filter implications. Risk assess this aspect as part of demolition contract, may require additional filters.	PM

Ref	THE RISK - what can happen and how it can impact	CONTROLS IN PLACE	RISK EXPOSURE Likelihood (L)	RISK EXPOSURE Consequence (C)	RISK RATING (LxC)	RISK RANKING PRIORITY	FURTHER ACTION REQUIRED	OWNER
14	PPC Permits - Change to legislation Requirement to obtain permit to operate large scale combustion plant for purposes of commissioning. Not obtaining permit will delay BMCL commissioning	NHS GG&C are designated operators of the proposed energy centre & existing retained estate combustion plant and are therefore responsible to for the submission of permit application. A specialist Environmental consultant has been appointed to support the preparation submission of this complex application'	3	5	**15**	**2**	Retained Estates, Site assessment meetings on-going with SEPA to establish benchmark environmental impact testing requirements. Consultant appointed to prepare application. 6 month process anticipated.	IP
15	Inadequate Commissioning of Buildings	Commissioning Plan and Completion Criteria. NHS Resource Plan Focussed meetings with BMCL	2	4	**8**	**3**	Completion criteria to be circulated to the group.Breaking down by areas would be useful to take forward	PM
16	Building Control - Delayed Statutory approval	Project programme Project meetings with BMCL	2	4	**8**	**3**	Completion criteria to be circulated to the group. Accoustic testing being planned. Temporary occupancy certification will be issued until Stage 3 completed. Temporary partitions may require to be set up in retails spaces to satisfy fire regulations	PM
17	Non-compliance of completion criteria by BMCL	Meetings to be arranged. Criteria to be circulated	3	4	**12**	**2**	Completion criteria to be circulated to the group. Continue to monitor progress	PM
18	Helipad flight acceptance test not being granted	Method statement from BMCL	2	2	**4**	**4**	Alternative landing and transport in place, Contact with relevant external - including SAS/GCC/Military/Private Sector suppliers to be involved	PM
19	Uable to recruit and train staff to manage the helipad for test flight after commissioning	Discussions underway with relevant NHS colleagues to plan and prepare	3	5	**15**	**2**	Meeting arranged with BMCL and Helicopter Advisor to confirm requirements. Training provider identified at Glasgow Airport. Job Description and person spec in development	DL
20	Specialist Witness Testing - lack of availability of appropriate resources	Make arrangements with relevant specialist staff groups to prepare for work load	3	4	**12**	**2**	Commissioning programme required from BMCL to prepare and plan for this part of the process	PM

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21	Non-completion by 26th January 2015 - impact on migration, procurement	Monthly monitoring and weekly walkthrough to monitor situation	3	4	12	2	Continue regular monitoring	DL
22	Compression of commissioning programme	Existing commissioning programmes are in place for plant rooms and energy centre	2	4	8	3	Request issue of commissioning programme on a quarterly basis. October/Jan/April and July to keep under review	PM/DH
23	Financial/Commercial - impact of failure to budget appropriately for remaining packages	Monitor on a regular basis procurement and financials of BMCL	2	2	4	4	Regular monitoring of the financial spending of the contractor	DR
24	Sub-contractor liquidated/cease to trade	Financial checks continue to be carried out - guarantee bonds in place and warranties in place via BMCL	1	3	3	4	Continue to check financials on a regular basis	DR
25	Non-completion of project - £1/4M per week costs to BMCL, impact on migration, procurement, commissioning and Board being unable to clear areas of the campus scheduled for demolition to complete stage 3 works	Continual monitoring of programmes, work on site and financial status of main contractor and their sub-contractors	2	5	10	3	Include this issues within programme risk and continue liaison with BMCL	DL/PM/DH
26	Cashflow - possible issues for 2014/2015	Project Director working with Finance colleagues to ensure funds are allocated appropriately throughout the contract	2	5	10	3	Review of cashflow predictions with AMcCubbin	DL
27	Staff - lack of familiarisation with new areas Lack of familiarisation with new technologies Inadequate plan with FM colleagues to take forward best ways of familiarising buildings and campus	Communications group to review ways of providing familiarisation with focus on relevant areas initially. Authorised persons for HV, Medical Gases etc to be incorporated in training Additional costs for additional training - contractually BMCL will provide commissioning training but clarity on what this incorporates and level of training provided. Board requires clear understanding in order to develop plans	2	5	10	3	Project Manager to liaise with colleagues in Communications and FM on the best way forward - target to complete discussion by end of 2013	MMcA/MM/HG/KC

Ref	THE RISK - what can happen and how it can impact	CONTROLS IN PLACE	RISK EXPOSURE Likelihood (L)	Consequence (C)	RISK RATING (LxC)	RISK RANKING PRIORITY	FURTHER ACTION REQUIRED	OWNER
28	Loss of Key Resources (NHS)	Sharing of knowledge, roles and responsibilities	2	3	6	3	Buddy up staff to lessen impact	DL
29	Loss of Key Resources (BMCL) - key staff moving onto new contracts	BMCL to confirm	4	4	16	2	Check BMCL position in relation to staff retention until job is completed	DL
30	Lack of early communication with external stakeholders	Split responsibility with project team and other NHS colleagues	3	4	12	2	Police, SAS, GCC, Community Engagement and Board level discussions along with tours for staff, familiarisation, equipment training, video training? Supplier training built into procurement tenders	MMcA/MM/HG
31	On the Move Risks	Any further changes to national services will impact on migration planning. Colleagues informed of financial implication of any changes to programme at this stage	2	4	8	3	Continue liaison with stakeholders to ensure this message is understood	DL
32	Access to new hospitals - transport/car parking, Section 75 not being fully implemented. GCC not completing Fastlink to ensure use for hospitals opening, costs being too high to make public transport attractive or timing being inappropriate for shifts and appointments. Under provision of car parking a concern, inappropriate signage and directions	Work with colleagues at GGC to ensure that planning of Fastlink is progressed within timeframe. Working with transport providers to ensure that transport is appropriate for requirements. Project team progressing and planning the car parking provision and understanding pinch points of the project	2	2	4	4	Community Engagement working with GCC, car parking policy being implemented and community engagement sub-group to take forward ideas for communication with users and staff. Noted reputation of Board at risk if not fully thought through	MMcA
33	Demolition planning - non compliance and service disruption	Policies adhered to and understood	2	4	8	3	Preventative - compliy with Board policy. Training support for resaponsible staff	HMcD
34	Over development of SGH - concurrent activities, disruption to hopsital project delivery. Lack of co-ordination of works		4	4	16	2		DL

From: Stewart Ian (NATIONAL SERVICES SCOTLAND)
To: Bryden Ian (NHS DUMFRIES & GALLOWAY); Bennett David (NHS TAYSIDE); Valentine Mark (NHS FIFE); Hogg Paul (NHS NATIONAL WAITING TIMES BOARD); Fyffe Ronald (NHS TAYSIDE); Chalmers, Jack; Dunn, Keith; Stirton Trevor (NHS GRAMPIAN); Phil.Christie[redacted]; Martin Graham (NHS HIGHLAND)
Cc: Powrie, Ian; McLaughlan Edward (NATIONAL SERVICES SCOTLAND)
Subject: Contractor"s handover checklist - ventilation
Date: 24 March 2014 14:18:22
Attachments: Handover checklist.docx

Good afternoon all,

At the most recent SETAG meeting Iain McInally (NHS Ayrshire & Arran) issued a request that a contractor's handover checklist should be compiled for domestic water services as there was evident ignorance as to what was expected. It is true that the requirements are set out in SHTM 04-01 Part A but scattered throughout the document, hence the need for these to be assembled together as a potential addendum. A document has been prepared for this purpose. It has yet to be endorsed by the Advisory Group and SETAG but already one NHS Board is keen to have it available in the data room for a forthcoming project.

Following similar lines, there appears to be a similar need for a document covering ventilation installations. I have compiled a checklist – again drawing from the SHTM (03-01) to avoid accusations that contractors are being asked to do something new that would carry additional costs. A draft copy is attached for your consideration and I will place this on the agenda for the next Ventilation Group meeting in May. Having given the Chairman prior sight of it he feels that this will be a useful addendum to the SHTM but has suggested that we need to avoid contractors assuming that it will supersede all other guidance for commissioning and handover of systems. Without wanting to repeat information from other sources, it would be possible to refer to it and if you have views on this, please let me have them at or before the next Advisory Group meeting as I would like them to be included prior to circulating the checklist to SETAG.

The next ventilation Group meeting takes place on Wednesday 14th May at 10.00am.

Kind regards,

Ian Stewart
Project Manager
Engineering & Environment
Health Facilities Scotland
NHS National Services Scotland

3rd Floor
Meridian Court
5 Cadogan Street
Glasgow
G2 6QE
Telephone: Direct Dial:[redacted]
Reception:[redacted]
www.hfs.scot.nhs.uk

Activity	Yes	No	N/A	Remarks
Design				
Balancing & commissioning dampers provided in adequate numbers?				
Are balancing & commissioning dampers arranged to be accessible?				
Are all fire/smoke dampers accessible for inspection?				
Are test positions accessible?				
Are sufficient duct access panels provided for internal cleaning?				
Are duct access panels capable of being removed?				
Has the commissioning specialist been provided with information as set out in SHTM 03-01 Part A?				
Pre-commissioning activities				
Visual inspection carried out?				
Installation accords with specification and drawings?				
Approved sealants employed?				
All components functioning correctly?				
Access doors and viewing ports sealed satisfactorily?				
Air leakage tests completed prior to insulation being applied?				
Air leakage tests records provided?				
Test holes sealed with grommets?				
Control damper quadrants fitted correctly?				
Interlocks operating as specified?				
All electrical circuitry complete, tested and energised?				
Rotation of motors checked?				
Did the designer provide the commissioning specialist with full commissioning data (SHTM 03-01 Part A?) (Specification, Schematics, Equipment schedules & control devices, fan curves, wiring diagrams and user brief)				
AHU components & controls functioning correctly?				
AHU interlocks & safety controls functioning correctly?				
Plant and ductwork physically complete and identified?				
Access to all plant safe & satisfactory?				
All ventilation ducting internally clean?				

Activity	Yes	No	N/A	Remarks
Have filters been installed correctly?				
Have filter seals been fitted and in good condition?				
Have primary & secondary filters' test certificates been provided?				
Have builderwork duct surfaces been sealed to prevent dust?				
Have HEPA filters test certificates been provided?				
Have HEPA filters been correctly sealed in purpose-made housings?				
Have air intakes been cleared of vegetation, waste and rubbish?				
Have fan performance test certificates been provided?				
Have coils test certificates been provided?				
Have attenuators test certificates been provided?				
Can drain trays be easily removed?				
Can drain traps be easily removed?				
Have drain traps been fitted correctly with 15mm air gap?				
Is connecting pipework adequately supported?				
Commissioning				
Have test instruments' calibration certificates been provided?				
Have filter manometers been checked and certified for accuracy?				
Heater batteries connections have correct temperatures, pressures and volume flows?				
Cooling coils connections have correct temperatures, pressures and volume flows?				
Were commissioning activities carried out in clean conditions?				
Were summer / winter design conditions simulated as part of the commissioning process?				
Were thermo-hygrograph monitoring devices installed?				
Has independent validation of critical systems been carried out (e.g. UCV plant)?				
Has all commissioning data been provided including direct comparisons between performance and design?				

Activity	Yes	No	N/A	Remarks
Were the required standards achieved?				
Has commissioning of automatic controls / BMS been completed by specialist supplier?				
Was automatic controls / BMS commissioning witnessed?				
Were control and monitoring sensors checked for accuracy?				
Was monitoring the functions of remote panels completed satisfactorily?				
Were correct airflow patterns in theatre suites achieved?				
Have all risk assessments been completed with no residual risks remaining?				

From: Powrie, Ian
To: Hamilton, Pauline
Subject: FW: NSGH Pseudomonas Risk Assessment
Date: 05 August 2014 12:35:00
Attachments: NSGH Psudomonas Risk Assessment Water Safety July 2014 draft 1a.doc
SGH mtg 050614 V2.docx
Differences in 2014 guidance.pdf

FYI

Ian

I. Powrie
Sector Estates Manager (NSGH)
Project Team, New South Glasgow Hospitals,
Southern General Hospitals Construction Site,
2nd Floor, Modular Building, Off Hardgate Road, Glasgow,G51 4SX
[redacted]
Tel: [redacted]
Reception: [redacted]
Mob: [redacted]

From: Powrie, Ian
Sent: 04 August 2014 11:50
To: McCluskey, Fiona
Cc: Green, John
Subject: NSGH Pseudomonas Risk Assessment

Fiona

I would be grateful if you could rearrange for the risk assessment review meeting with a suitable representative from the ICT to review and finalise the RA recommended by HPS\HFS in their conclusion of the NSGH status with regards to implementing the recommendations of

I have attached for reference the supporting information and outcome from the recent meeting with HPS & the HFS water management group regarding the technical issues concerning the NSGH installation and it status pertaining to retrospective application of new guidance post contract. I have also attached the noted difference in the impending revised Pseudomonas guidance from HPS\HFS (Circa July\Aug 2014), the new text on page 10references the situation on the NSGH project.

John Green & I are available on the following dates:

Monday 11th Aug - am only.
Tuesday 12th Aug – am only.

Regards

Ian

I. Powrie

Sector Estates Manager (NSGH)
Project Team, New South Glasgow Hospitals,
Southern General Hospitals Construction Site,
2nd Floor, Modular Building, Off Hardgate Road, Glasgow,G51 4SX
[redacted]
Tel: [redacted]
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Mob: [redacted]

ID:

Risk Assessment Form

Use this form for any detailed risk assessment unless a specific form is provided. Refer to your Summary of Hazards/Risks and complete forms as required, including those that are adequately controlled but could be serious in the absence of active management. The Action Plan and reply section is to help you pursue those requiring action.

Name of Assessor:	Ian Powrie, John Green	**Post Held:**	
Department:	**Estates**	**Date:**	July 2014

Subject of Assessment: E.g.: hazard, task, equipment, location, people

Assess residual risk to patients in designated high risk areas of the NSGH development, of not implementing the removal flow control regulators from water outlets where patients may be at a higher risk of from pseudomonas and related infections.

Hazards (Describe the harmful agent(s) and the adverse consequences they could cause)

Pseudomonas aeruginosa from water outlets

Description of Risk
Describe the work that causes exposure to the hazard, and the relevant circumstances. Who is at risk? Highlight significant factors: what makes the risk more or less serious – e.g.: the time taken, how often the work is done, who does it, the work environment, anything else relevant.

Pseudomonas aeruginosa (Pa), and other similar opportunistic pathogens, are micro-organisms that can cause outbreaks in any healthcare setting where patients are immunocompromised through drugs, disease, invasive device use or the presence of wounds. There have been serious healthcare associated outbreaks mainly in NNUs and ICUs (adult and paediatric) attributed to Pa where the source of the organism was thought to be tap water A review of all blood cultures for *Pseudomonas aeruginosa* was undertaken in period between 2010 – 2012 to identify areas with significant number of PA isolates. Other than receiving units, the main areas identified were intensive care areas across all NHS GGC sites and the Beatson Oncology Unit (wards 7,8 and 9). Table 1 shows areas within the NSGH which have been identified as falling in to this category and actions required following risk assessment.

Existing Precautions

Summarise current controls In place	**Describe how they might fail to prevent adverse outcomes.**
• New compliant designed water supply & distribution system. • Well engineered & installed distribution system. • Raw Water supply filtration to 0.2μm. • System commissioned in line with current best practice guidance. • Water Safety Systems Policy • Infection Prevention and Control Environmental Audit • Annual review of epidemiology of pseudomonas in blood culture	Failure to follow Policy and Written Scheme.

Level of Risk - Is the control of this risk adequate?
Give more than one risk level if the assessment covers a range of circumstances. You can use the 'matrix' to show how 'likelihood' and 'consequences' combine to give a conclusion. Also, be critical of existing measures: if you can think how they might fail, or how they could be improved, these are indications of a red or orange risk.

Risk Matrix

Likelihood	**Impact/Consequences**				
	Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
Almost Certain	**Medium**	**High**	**High**	**V High**	**V High**
Likely	**Medium**	**Medium**	**High**	**High**	**V High**
Possible	**Low**	**Medium**	**Medium**	**High**	**High**
Unlikely	**Low**	**Medium**	**Medium**	**Medium**	**High**

Rare	Low	Low	Low	Medium	Medium

Very High High Medium Low

Current risk level

Given the current precautions, and how effective and reliable they are, what is the current level of risk? **Green** is the target – you have thought it through critically and you have no serious worries. Devise ways of making the risk green wherever you can. **Yellow** is acceptable but with some reservations. You can achieve these levels by reducing the inherent risk and or by effective and reliable precautions.
High (Orange) or Very High (Red) risks are unacceptable and must be acted on: use the Action Plan section to summarise and communicate the problems and actions required.

Action Plan (if risk level is **High (Orange) or Very High (Red)**

Use this part of the form for risks that require action. Use it to communicate, with your Line Manager or Risk Coordinator or others if required. If using a copy of this form to notify others, they should reply on the form and return to you. Check that you do receive replies.

Describe the measures required to make the work safe. Include hardware – engineering controls, and procedures. Say what you intend to change. If proposed actions are out with your remit, identify them on the plan below but do not say who or by when; leave this to the manager with the authority to decide this and allocate the resources required.

Proposed actions to control the problem List the actions required. If action by others is required, you must send them a copy	**By Whom**	**Start date**	**Action due date**
Routine maintenance measures In line with Boards water safety system policy site specific written scheme:			
• Develop site specific written scheme	Estates	Sept 2014	Dec 2014
• 3 Monthly: Carry out TMT operation test & visual inspection of outlet flow control device.	Estates	May 2015	May 2015

• 6 Monthly: Service exchange TMT maintenance procedure including:
  ○ Visual inspection and manual clean of components.
  ○ Full mechanical service & inspection.
  ○ Functional testing.
  ○ Thermal sanitisation.
	Estates	Sept 2015	Sept 2015

• Thermal Sanitisation frequency to be verified by sampling\swabbing representative sample from each high risk area and compared with representative samples from Non high risk areas. (Note this control measure to be confirmed by ICT)			

Action by Others Required - Complete as appropriate: (please tick or enter YES, name and date where appropriate)

Report up management chain for action	Yes, Water safety Group
Report to Estates for action	Yes, Site Estates Manager
Contact advisers/specialists	Yes, Authorising Engineer (water systems) TBC
Alert your staff to problem, new working practice, interim solutions, etc	Yes, Include within new Written Scheme

Reply

If you receive this form as a manager from someone in your department, you must decide how the risk is to be managed. Update the action plan and reply with a copy to others who need to know. If appropriate, you should note additions to the Directorate / Service Risk Register.

If you receive this as an adviser or other specialist, reply to the sender and investigate further as required.

Table 1: Areas where action required to prevent *Pseudomonas aeruginosa* infection in healthcare settings

Site	Hospital	Ward	Assessment
SGH	NCH	Ward 1D (Paediatric Critical Care)	Water Safety Written Scheme
SGH	NCH	Ward 1E (Cardiology)	Water Safety Written Scheme
SGH	NCH	Ward 2A (Schiehallion)	Water Safety Written Scheme
SGH	NSGH	Adult Critical Care Unit	Water Safety Written Scheme
SGH	NSGH	Coronary Care Unit	Water Safety Written Scheme
SGH	NSGH	Ward 4B (Haemato-Oncology)	Water Safety Written Scheme

Assessment completed - date:	Ian Powrie, John Green, Sandra McNamee.	**Review date:**	Jan 2016

From: David Hall
To: Powrie, Ian
Subject: Horne Tap - HFS/HPS Meeting
Date: 24 June 2014 08:48:15

Ian,

I have been asked to confirm that we have something, in writing, from HFS re the "agreement" to retain Horne taps in "high risk" areas which was reached at the recent meeting with the manufacturer. Do we have anything, even minutes or notes from the meeting?

David

David Hall
FCIOB/MAPM
Director
Currie & Brown
Email: [redacted]
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Lanarkshire ML1 4WQ
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From: Powrie, Ian
To: "Angus Horne"
Subject: RE: Thermal disinfection parts 4
Date: 17 July 2014 10:14:00

Angus

Thanks for this its looks interesting however I have a couple of initial questions with respect to this return connection device.

- Does the flow reg device need to be removed to fit the test rig return connection device? If so does that mean the flow reg must be removed & sanitised separately?
- Assuming that there is bacterial load contamination in the tap assembly, would sanitisation on a closed loop process give rise to the potential for contamination of the loop or part therein including other connected tap assemblies?
- Do the flexible hoses meet current guidance standards? Or would this introduce another potential risk? (albeit manageable)

I look forward to meeting to discuss this further.

Many thanks

Regards

Ian

I. Powrie
Sector Estates Manager (NSGH)
Project Team, New South Glasgow Hospitals,
Southern General Hospitals Construction Site,
2nd Floor, Modular Building, Off Hardgate Road, Glasgow,G51 4SX
[redacted]
Tel: [redacted]
Reception: [redacted]
Mob: [redacted]

From: Angus Horne [[redacted]]
Sent: 17 July 2014 10:03
To: Powrie, Ian
Subject: Thermal disinfection parts 4

Dear Ian,

This shows the general arrangement of the parts and you can see how this could be scaled up quite easily. We have just used painted plywood and some MDF to mock this up which would not really be any good in practice but there are lots of options such as laminates for the structure but something very durable and water proof would obviously be best.

We have had an idea about shower hose connectors to join multiple hoses together which would involve a captive seals since I think it could be a bit fiddly to make up the connections with a separate washer and if these were dropped on the floor say, then that is contra to our objectives, it's also important that there are no leaks and a captive seal would make everything quicker and safer. We will make up the shower hose connectors early next week and once we have those we can arrange to meet to decide best way forward.

This is the last picture.

Best regards,

Angus

From:	Stewart Ian (NATIONAL SERVICES SCOTLAND)
To:	Bryden Ian (NHS DUMFRIES & GALLOWAY); Phil.Christie[redacted]; Stirton Trevor (NHS GRAMPIAN); Bennett David (NHS TAYSIDE); MacLeod Torquil (NHS HIGHLAND); Wilson Alan (NHS FIFE); Hogg Paul (NHS NATIONAL WAITING TIMES BOARD); Fyffe Ronald (NHS TAYSIDE); Chalmers, Jack; Dunn, Keith
Cc:	McLaughlan Edward (NATIONAL SERVICES SCOTLAND); Powrie, Ian; Storrar Ian (NATIONAL SERVICES SCOTLAND); Barr Bruce (NHS HIGHLAND); Bisset Lawson (NHS SHETLAND)
Subject:	National H&V Advisory Group
Date:	19 August 2014 15:06:20
Attachments:	Handover checklist ventilation.(rev).doc

Good afternoon all,

Further to last week's meeting of the Group I now attach the Handover Checklist for Ventilation incorporating the agreed modifications. I have left the track changes feature active so that you can see what was done.

If it is agreed with SETAG, on 21st August, that this is acceptable, I will ensure that steps are taken to incorporate this information as a further Appendix to SHTM 03-01 as discussed at our meeting.

Kind regards,

Ian Stewart
Project Manager
Engineering & Environment
Health Facilities Scotland
NHS National Services Scotland

3rd Floor
Meridian Court
5 Cadogan Street
Glasgow
G2 6QE
Telephone: Direct Dial:[redacted]
Reception:[redacted]
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Activity	Yes	No	N/A	Remarks
Design				
Balancing & commissioning dampers provided in adequate numbers? aAnd correctly positioned in relation oft ductwork fittings etc?				Before this stage should there not be a check on design team competence at interview prior to appointment?
Are balancing & commissioning dampers arranged to be accessible?				
Are all fire/smoke dampers accessible for inspection and replacement?? (i.e. without having to remove adjacent services)				Access for maintenance to damper actuators, can dampers be removed and replaced without having to remove adjacent services e.g. access fouled by pipework
Are test positions accessible?				
Are sufficient duct access panels provided for internal cleaning?				
Are duct access panels for inspection and cleaning capable of being removed?				Can cleaning devices be easily used; Drain trays for duct mounted coils?
Can cleaning devices be easily used?				
Have drain trays been provided for duct-mounted coils?				
Has the commissioning specialist been provided with information as set out in SHTM 03-01 Part A?				What about control systems, pressure cascades. Filtration levels appropriate for areas served, departments served theatres very different from ward areas
Pre-commissioning activities				
Visual inspection carried out?				Duct cleanliness in line with standards, date stamped video record
Installation accords with specification and drawings? For example: drain traps installed, correct materials used, traps of adequate depth on both suction and discharge side.				Drain traps installed, correct materials used traps of adequate depth on both suction and discharge side
Approved sealants employed?				
All components functioning correctly?				
Access doors and viewing ports sealed satisfactorily?				
Air leakage tests completed prior to insulation being applied?				
Air leakage tests records provided?				
Test holes sealed with grommets?				
Control damper quadrants fitted correctly and commissioned position marked?				Commissioned position marked

Style Definition: Table text

Interlocks operating as specified?				
All electrical circuitry complete, tested and energised? (including AHU internal lighting functioning).				~~Internal lighting to AHUS functioning~~
Rotation of motors checked?				
Did the designer provide the commissioning specialist with full commissioning data (SHTM 03-01 Part A?) (Specification, Schematics, Equipment schedules & control devices, fan curves, wiring diagrams and user brief)				
AHU components & controls functioning correctly?				
AHU interlocks & safety controls functioning correctly? (For example: connection to fire system proved, fire/smoke dampers functioning as per cause and effect schedule).				~~Connection to fire system proved; fire / smoke dampers functioning as cause and effect schedule~~
Plant and ductwork physically complete and identified?				
Access to all plant safe & satisfactory?				
All ventilation ducting internally clean?				
Activity	Yes	No	N/A	Remarks
Have filters been installed correctly?				
Have filter seals been fitted and in good condition?				
Have primary & secondary filters' test certificates been provided?				
Have builderwork duct surfaces been sealed to prevent dust?				
Have HEPA filters test certificates been provided?				
Have HEPA filters been correctly sealed in purpose-made housings?				
Have air intakes been cleared of vegetation, waste and rubbish?				
Have fan performance test certificates been provided?				
Have coils test certificates been provided?				
Have attenuators test certificates been provided?				
Can drain trays be easily removed?				
Can drain traps be easily removed?				
Have drain traps been fitted correctly with 15mm air gap?				
Is connecting pipework adequately supported?				

Commissioning				
Have test instruments' calibration certificates been provided?				
Have filter manometers been checked and certified for accuracy?				
Heater batteries connections have correct temperatures, pressures and volume flows?				
Cooling coils connections have correct temperatures, pressures and volume flows?				
Were commissioning activities carried out in clean conditions?				
Were summer / winter design conditions simulated as part of the commissioning process?				~~functional load tests to be carried out as part of the project specifcationspecification~~
Were thermo-hygrograph monitoring devices installed?				
Has independent validation of critical systems been carried out (e.g. UCV plant)?				
Has all commissioning data been provided including direct comparisons between performance and design, including acoustic tests?				~~Acoustic tests~~
Activity	Yes	No	N/A	Remarks
Were the required standards achieved?				
Has commissioning of automatic controls / BMS been completed by specialist supplier?				
Was automatic controls / BMS commissioning witnessed? (Invertors not to exceed 50Hz).				~~Invertors not to exceed 50Hz~~
Were control and monitoring sensors checked for accuracy?				
Was monitoring the functions of remote panels completed satisfactorily? (Graphics proved to reflect what is happening: existing graphics updated).				~~Graphics proved to reflect what is happening: existing graphics updated~~
Were correct airflow patterns in theatre suites achieved with satisfactory results related to pressure cascades in line with design?				~~Slit plate tests carried out , micro-bacterial checks carried out and results satisfactory pressure cascades in line with design~~
Have all risk assessments been completed with no residual risks remaining?				

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From: Loudon, David
To: Kane, Mary Anne; Curran, Anthony
Subject: FW: HAI-SCRIBE New Publications
Date: 02 December 2014 11:55:00
Attachments: V4 0 Manual final.pdf
V3 0 Imp Strategy final.pdf
Importance: High

Mary Anne and Tony

Please see the message below and related attachments. You may have already received the message directly.

Please ensure that the message and attachments are widely circulated to your relevant staff and where appropriate, support consultants and contractors.

David

David W. Loudon, MCIOB, CBIFM, MBA
Project Director - South Glasgow Hospitals Development / Director of Facilities and Capital Planning - Designate
NHS Greater Glasgow & Clyde
New South Glasgow Hospital Site Offices
Top Floor, NHS Offices
Hardgate Road
Glasgow
G51 4SX

Direct Line: [redacted]
Mobile Phone: [redacted]
E mail: [redacted]

From: Stewart Ian (NATIONAL SERVICES SCOTLAND) [redacted]
Sent: 02 December 2014 11:42
To: Atkinson Ailsa (NATIONAL SERVICES SCOTLAND); Gardner, Andrew; Armour Doris (NHS FIFE); Armstrong Kenneth (NHS TAYSIDE); Bisset Lawson (NHS SHETLAND); Brown Ronni (NATIONAL SERVICES SCOTLAND); Browning David (NATIONAL SERVICES SCOTLAND); Bryson David (NHS DUMFRIES & GALLOWAY); Cavanagh Susan (NATIONAL SERVICES SCOTLAND); Colquhoun Malcolm (NHS ORKNEY); Connolly John (NATIONAL SERVICES SCOTLAND); Cullen Derek (NHS 24); Bedwell David (NATIONAL SERVICES SCOTLAND); Loudon, David; Donald Gerry (NHS GRAMPIAN); McLaughlan Edward (NATIONAL SERVICES SCOTLAND); Brown Elizabeth (NATIONAL SERVICES SCOTLAND); George Curley; Gerry Cox; gillian.mccallum[redacted]; Strang Gillian (NHS FORTH VALLEY); Green Eric (NHS HIGHLAND); Henry Martin (NATIONAL SERVICES SCOTLAND); Hirst, Allyson (NHSmail); Irwin Doug (STATE HOSPITALS BOARD FOR SCOTLAND); john.paterson[redacted]; john.wright[redacted]; Kane, Mary Anne; Karen.Slater[redacted]; Leiper James (NHS FIFE); Leishman Kate (NHS HIGHLAND); MacKenzie Douglas (NHS WESTERN ISLES); Mariane.McGowan[redacted]; Mair Marlene (NHS AYRSHIRE & ARRAN); Marsden Anne (NHS LOTHIAN); Martin David (STATE HOSPITALS BOARD FOR SCOTLAND); Marwick Teresa (NHS ORKNEY); McBirnie Gillian (SCOTTISH AMBULANCE SERVICE); McLauchlan Pamela (SCOTTISH AMBULANCE SERVICE); Mcluckie David (NHS BORDERS); McMurray Kirsten (NATIONAL SERVICES SCOTLAND); michael.baxter[redacted]; Montgomery Fiona (NHS DUMFRIES & GALLOWAY); Mortimer Gary (NHS GRAMPIAN); Parker Linda (NHS LANARKSHIRE); Haggarty Peter (NATIONAL SERVICES SCOTLAND); Renwick Margaret (NHS BORDERS); Seago Douglas (NHS HIGHLAND); Sim Avril (NHS TAYSIDE); Steele Tom (NHS FORTH VALLEY); Swanson Brian (NHS HEALTH SCOTLAND); Taylor Stephen (NATIONAL SERVICES SCOTLAND); Trayner Connie (NHS TAYSIDE); Watson Keri (NHS HIGHLAND)
Cc: O'Brien Geraldine (NATIONAL SERVICES SCOTLAND)
Subject: HAI-SCRIBE New Publications

We would take this opportunity to update the situation regarding the above since issuing our email dated 4th June.

Health Facilities Scotland (HFS) have now published the two revised SHFN 30 documents, as follows:

- **SHFN 30 Part A**: Manual Information for Design Teams, Construction Teams, Estates & Facilities and Infection Prevention & Control Teams
- **SHFN 30 Part B:** HAI-SCRIBE Implementation strategy and assessment process

These replace:

- Scottish Health Facilities Note (SHFN) 30 'Infection control in the Built Environment: Design and planning' Version 3, and;
- HAI-SCRIBE (Healthcare Associated Infection System for the Control of Risk of Infection in the Built Environment) Version 2.

Both documents provide information for those responsible for planning, design, construction, refurbishment & maintenance of Healthcare Facilities to help identify, prevent and control Built Environment HAI risks in a collaborative process. Implementation of the updated guidance should be the responsibility of an appropriately skilled specialist multi-disciplinary professional staff team. The documentation has both been through review and testing processes and feedback received from the latter has been incorporated.

If any NHS Board sees a need for advice, assistance or training workshops, HFS is willing to assist. Contact [redacted]

Hard copies of the documents have been received from the printers and are available on request also to [redacted]

It should be noted that use of the documents is a mandatory requirement for all NHSScotland Capital Projects and Maintenance/Refurbishment projects.

Kind regards,

Ian Stewart
Consultant
Engineering & Environment
Health Facilities Scotland
NHS National Services Scotland

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NHS National Services Scotland

SHFN 30
Part A: Manual

Information for Design Teams, Construction Teams, Estates & Facilities and Infection Prevention & Control Teams

Health Facilities Scotland
Engineering and Environment

October 2014

A52859616

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Acknowledgements

Health Facilities Scotland would like to thank the SHFN30/HAI-SCRIBE Steering Group for their efforts in producing Part A of SHFN 30. Their input has been gratefully appreciated.

Thanks are also due to the Pilot Study Group for their assistance with trialling the process.

Finally, HFS would take this opportunity to express gratitude to everyone who contributed to the consultation phase of completing this document.

1. Introduction and scope

Note: The Project Team referred to throughout the document is the team of NHS staff assembled to fulfil the role of 'The Client' and to manage the delivery of the project. Through the various stages of the project it may include NHS Project Managers, Clinicians, Estates staff and Infection Prevention and Control specialists.

1.1 This guidance consists of two parts:

- **SHFN 30 Part A: Manual**: This provides Built Environment Infection Prevention and Control information for Design Teams, Construction Teams, Infection Prevention and Control Teams and Estates & Facilities Teams;
- **SHFN 30 Part B: HAI-SCRIBE:** comprises the Implementation and Assessment Process which describes the process for identifying, eliminating or managing built environment infection control risks. It also describes the key personnel involved in this process together with their roles and responsibilities and the fact that collaboration among all those involved in the process is pivotal to its success.

It is envisaged that participants will use the HAI-SCRIBE document (SHFN 30 Part B) to help them identify, manage and record built environment infection control risks. The same Group will use the Manual document (SHFN 30 Part A) for sourcing information to help in the decision making process so that identified risks can either be eliminated or successfully managed.

Questionsets and Pro-formas

1.2 Arrangements have been made to make available on the HFS Website, separately, the portfolio of Questionsets and Pro-formas for each stage of project development suitable for photocopying and application to individual projects as appropriate.

1.3 Additionally, compliance with these guidance documents can ensure that there are facilities in place to help fulfil the mandatory requirements outlined in the National Infection Prevention and Control Manual produced by Health Protection Scotland.

1.4 The Project Team members and contributors from various disciplines will take different advice from the guidance and it is the ensuing debate and analysis which will improve the quality of the delivered facility.

1.5 This Manual is intended to provide an insight to the key factors within the built environment which can impact on the prevention and control of infection and will also be useful as a guide for best practice in existing healthcare facilities.

1.6 In the future due to changing patient populations and changing healthcare needs there may be different factors to be considered when planning accommodation. These include the increase in the ageing population, caring for Bariatric patients, and more focus on community-based care.

1.7 The design of the built healthcare environment plays a fundamental role in infection prevention and control. The increasing threat of antimicrobial resistant organisms and other emerging pathogens in healthcare may present new and more difficult challenges in future healthcare facility design and planning efforts.

1.8 A system of recording projects, signing-off plans and meeting notes by all participating parties will be needed. The completion of questionsets in the 'Implementation strategy and assessment process' part of this guidance will fulfil most of this requirement. It is important that the Project Team sign-off each stage of the project having taken advice from Estates & Facilities, Infection Prevention & Control representatives and other appropriate disciplines.

Note: To manage or mitigate infection risks requires knowledge from many sources. Input from the Project Team will not only include Infection Prevention and Control Teams (IPCT). Estates and Facilities Teams and Design and Construction Teams also have important roles to play in managing or mitigating these risks. However, it is not expected that any single group will possess full knowledge or experience of another's discipline. It is expected, therefore, that there will be an ongoing liaison during each stage of development where appropriate specialist knowledge from all sources of relevant expertise can be derived and incorporated into the design team appointments, project briefing, contract conditions, specification and quality control of construction and maintenance.

2. Risk assessment

Identifying risk

2.1 The time taken to plan or refurbish a healthcare facility can vary from a relatively short period in the case of urgent renovation, to as long as three or four years for a major capital build project. It is therefore important that all members of the Project Team are notified of capital bids at the earliest opportunity. The Infection Prevention and Control Team need to be involved in the first planning meetings. Most meetings thereafter will require some input from them.

2.2 To avoid mistakes and pitfalls the Project Team must consider issues including:

- how will the product, equipment, room or premises be used?
- what possible solutions are available?
- what are the budgetary limitations?
- which prevention and control of infection principles apply?
- which external regulations apply?
- what does the evidence suggest in relation to the specific context?
- what are the laws governing the project?
- what standards and guidelines apply from architectural and engineering bodies, Health Facilities Scotland, local and national government departments and accrediting agencies?
- which product or design best balances the infection prevention and control requirements with employee and patient safety and satisfaction, and cost constraints?
- what legal requirements are required under Health & Safety law?

Common pitfalls

2.3 Common pitfalls arise from a number of pressures, for example, the pressure to choose the cheapest products or design.

Note: The best products or designs may be more expensive initially but in the long term they will probably realise cost benefits as they may prevent outbreaks, or they may last longer and require less maintenance and be more durable.

Assessing risk

2.4 Designing premises that prevent the transmission of infectious agents to patients, healthcare workers and visitors is an important component of prevention and control of infection programme or plan.
Outbreaks of infection have been related to the design, plan, layout, function and/or finish of the built environment. Thus, risk assessment is a fundamental imperative in the planning and design stages of a healthcare facility. It is often overlooked or compromised throughout the lifecycle of the project. It has not been unknown for the clinical outcome of a well-intentioned risk assessment to create other problems. There is therefore a need to verify that these outcomes are themselves risk assessed.
Disseminating good specialist advice relating to Infection Prevention and Control throughout all phases of construction and renovation projects will reduce risks. There will be instances when it is not possible to achieve the ideal. This applies particularly to refurbishment projects within existing accommodation and is often related to spatial issues. In these circumstances the aim should be to make the best use of available facilities.

Note: Failure to assess properly risks affecting prevention and control of infection can lead to expensive redesign later and expose the patient and healthcare worker to unnecessary risks. It is important to bear in mind that any control measures put in place to prevent the spread of infection during a building stage and subsequent maintenance of any project take into account the effect that they would have on patients and staff in the surrounding areas.

Source

2.5 Building professionals must be aware of the risks associated with construction projects and that the environment can be a reservoir for potentially infectious agents. The source is the person, animal, object or substance from which an infectious agent is transmitted to a host. The immediate healthcare environment can be a potential reservoir of micro-organisms and source of infection or contamination, therefore, Designers and Planners need to consider eliminating potential sources of infection by practising good design, for example:

- adequate storage facilities;
- choice of materials, avoiding unnecessary surfaces that may become reservoirs for infectious agents;
- ensuring materials and surfaces can be cleaned and maintained.

3. Procurement and construction process

Overview

3.1 The procurement and construction of a healthcare facility are highly complex processes and require input from a wide variety of sources.

3.2 Infection Prevention and Control advice is essential in relation to procurement at the design and planning stage of a project. There is a case for stipulating that Designers for healthcare projects should be able to demonstrate their knowledge and understanding of prevention and control of infection in relation to current guidance. The NHS Project Team needs to confirm this in the course of interviewing Design Teams *prior to their appointment*.

3.3 The specification of building materials, especially surface finishes, healthcare facility equipment etc. should take account of the input from the Project Team who are best placed to ensure that requirements are met, based on risk assessment.

Securing appropriate skills

3.4 HAI-SCRIBE aims to manage infection risks through the use of a prevention and control of infection questionnaire, as set out in the Implementation Strategy and Assessment Process section of this guidance. The system highlights the need for a multi-disciplinary team of specialists with appropriate skills to ensure its implementation. This is an essential requirement in terms of the evaluation of the site for development. Where issues such as contaminated land or suspected geological faults arise, specialist advice should be obtained.

4. The Planning Process

General overview

4.1 In general the stages of a typical healthcare building project are:

- establishing the 'need to build' and obtaining agreement from Scottish Government Health and Social Care Department (SGHSCD) where required;
- appointment of a design team;
- preparing a project brief and carrying out feasibility studies;
- preparing a business case and securing funding;
- developing the design;
- appointment of a contractor;
- construction of the building works;
- handover;
- NHS commissioning of the building i.e. installing loose furnishings and equipment and training staff;
- occupation.

Business Case process

4.2 The preparation of a business case is the process that supports NHS Board submissions for funding of new projects. A business case must convincingly demonstrate that there is a need for a new building, alteration or refurbishment to improve the delivery of healthcare services and that the project is economically sound, financially viable and will be properly managed by the NHS Board.

4.3 Details of the business case process can be found in the Scottish Capital Investment Manual which can be found on the Scottish Government Health and Social Care Directorate website at: www.scim.scot.nhs.uk/.

4.4 It is important at this stage to identify and involve key people who have a direct interest in the end product including members of the Project Team along with other specialists or departmental heads as required. Specifically at this stage, they need to:

- establish the goals of prevention and control of infection;
- agree the agenda for prevention and control of infection design and planning;
- communicate prevention and control of infection imperatives throughout the course of the project, but especially at the initial stages;
- work through conflicting issues to reach an optimum compromise;

- determine available resources that can be used and recognise the cost benefits of not cutting corners on prevention and control of infection issues.

The brief/concept/feasibility study

4.5 The planning process starts with the identification of a 'need' by the users. The development of this need will involve feasibility studies to enable a design brief or output specification to be developed with consideration given to the following:

- the effect additional beds or departments will have on policies such as waste management, linen and catering, etc.;
- the effect of extra theatres would have on decontamination services, workflow, etc.;
- additional specialised areas that will probably require extra infection prevention and control and laboratory input as well as specialist advice which may not be available in-house e.g. bed space and size of departments, etc., plus engineering services needs such as ultra-clean ventilation, showers, baths, etc.

Space planning

4.6 The planning of the building can contribute to reducing the risk of transmission of micro organisms. For example internal and external routes identified for removal of dirty laundry, segregated recyclates and residual wastes, need to be carefully planned.

4.7 The location of departments, theatres, wards and rooms needs to take account of good prevention and control of infection practice and ensure that workflows are designed to inhibit infection spread.

4.8 Similarly, the detailed design of the building elements can contribute to reducing the risk of transmission of micro organisms e.g. selection of finishing materials for floors, walls and ceilings; designing the ventilation system to inhibit the spread of contamination.

4.9 A number of design and layout issues could contribute to the risk of transmission of micro-organisms. For example, the ventilation system needs to inhibit contamination spread rather than contribute to it. Internal and external routes identified for removal of dirty laundry, waste food, healthcare waste, similarly need to be carefully planned.

Concept Design/ Developed Design

4.10 Drawings at a scale 1:200 will be available at this stage. They will assist the Project Team in determining clean and dirty traffic flow patterns and confirming room relationships and adjacencies. In addition to verifying compliance with the appropriate Scottish Health Planning Notes (SHPN) or Health Building Notes (HBN), the Project Team should be asked review

these plans to comment where their specialist knowledge may assist in the decision-taking process regarding issues such as:

- confirming operational procedures;
- setting out traffic flow patterns;
- establishing baseline and future staffing profiles;
- establishing baseline and future revenue budgets;
- establishing equipment requirements;
- providing equipment bays;
- strategy for equipping;
- procurement and selection of furnishings and equipment;
- missing rooms;
- appropriate placing and accessibility of hand hygiene facilities;
- ventilation systems including the level of filtration where specialised ventilation is required;
- water supply, heating and plumbing;
- surface finishes: ceilings, walls, work surfaces, floor coverings and furnishings;
- storage (including waste collection points and delivery areas) and DSRs equipment cleaning areas;
- ancillary areas;
- single rooms;
- isolation rooms;
- changing facilities;
- providing flexibility of space: e.g. to allow for cohort nursing (a full glossary of terms can be found in Appendix 2);
- lifts;
- pneumatic delivery systems.

Particular issues to be addressed by the Project Team

4.11 The Project Team must ensure that prevention and control of infection implications are not compromised by reducing standards set by NHS guidance or by overcrowding in clinical areas and they should communicate their views to the Project Manager for further action.

Technical design

4.12 Drawings at a scale of 1:50 will be available at this stage confirming more precise detail such as the number and location of sanitary fittings, equipment, furnishings, etc.

4.13 The Project Manager, with advice from the Project Team, will also need to consider the prevention and control of infection issues around:

- workflow;
- wash-hand basins: types, numbers and location;
- fixtures/fittings/flooring;
- waste water and sewage/body fluid disposal;
- ventilation;
- heating and lighting;
- water systems;
- suction/medical gases;
- storage systems;
- ward kitchens/pantry.

NHS guidance on the design and/or installation of the above can be found in planning notes and technical memoranda available on the HFS website.

4.14 To assist with understanding and mitigating risks associated with bacterial contamination of water distribution and supply systems, it is recommended that the NHS Board should have in place a Water Safety Plan (WSP) as outlined in SHTM 04-01 providing a risk management approach to the microbiological safety of water and establishing good practice in local water distribution and supply. Those organisations with robust water management policies for *Legionella* will already have in place much of the integral requirements for delivering a WSP.

Note: Refer to Health Protection Scotland Guidance for neonatal units (NNUs) (levels 1, 2 & 3), adult and paediatric intensive care units (ICUs) in Scotland to minimise the risk of *Pseudomonas aeruginosa* infection from water.

	Process and corresponding RIBA Plan of Work Stage	**Planning process Time Period**	**Issues to consider**	
Design Stage	0:Strategic Definition		Space Catering Specialist area Engineering facilities Laundry	Waste Cleaning/disinfection/ sterilisation
	1:Preparation and Brief	1 in 200 (some preliminary designs) 1:500 →		
	2:Concept Design/3:Developed Design	1 in 200 draft activity data sheets equipment lists usually wish lists →	Storage (linen, waste, patient equipment, domestic equipment) Ancillary areas Changing facilities	Lifts Pneumatic delivery systems Patient placement Single rooms Isolation rooms
	Outline business case			
	3:Developed Design/ 4:Technical Design (Depending on Procurement Route)	1 in 50: fixtures and fitting (fixed items Group 1) →	Ventilation Heat/light Water systems Sewerage Vacuum	Wash-hand basins Storage systems Ward kitchens Workflow Fixture and fittings
Procurement	Full business case			
	Tender			
	5:Contract			
Delivery	Construction		Equipment Space Specialist equipment	
	6:Handover & close-out	→		
	7: In use		↓	Check for any changes made to original agreement/plan

Table 1: Project Development Chart

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Typical Key Stages of Project Team Input

1. **The Brief/Concept/Feasibility study: Project Team should contribute to the review of operational policies and procedures, such as:**
   - adding beds to ward area may require an additional sluice or single rooms;
   - adding extra theatres will need a review of decontamination services for instruments.
   - additional specialised areas will need extra prevention and control of infection input;
   - traffic flows.
2. **Concept design/developed design: Sketch plans at 1:200 scale available at this stage, the Project Team needs to give a broad view of prevention and control of infection issues e.g. rooms missing, wards without ancillary areas such as disposal rooms or dirty utility.**
3. **Technical design: (1/50 designs – early period)**
   There is a need to finalise locations of rooms for correct workflows/prevention and control of infection practice, i.e. wards, theatres.
4. **Technical design: (1/50 designs – later period)**
   Need to discuss finer details within rooms: location and type of fixtures and fittings, e.g. hand-wash basins/types of basins; airflows in theatres, flooring.
5. **Construction:** A designated individual should be appointed particularly if the new build is attached to an existing healthcare building, to ensure that control measures prevent risks to patients.
6. **Equipment: decisions on equipment should be made as an ongoing process, but it is at this stage that it will be seen that previous equipment 'wish-lists' may not fit the rooms/departments or are now outdated. It is important that Project Teams also have input during this period (especially if it is a PFI/PPP build).**
7. **Commission/equipping: Project Teams must have input during this stage if costly and dangerous mistakes are to be avoided.**
8. **In use: this is an important stage in which lessons learnt can be highlighted for future projects, both within NHS Boards and throughout NHSScotland. Post-project evaluation is mandatory and results should be available to other NHS Boards.**

Table 2: The Key Stages of the Planning Process and examples of Project Team input

Accommodation areas/internal environment/general services	Examples: Key issues and areas to be considered
Accommodation areas	
Bed areas: Single-bed rooms.	Placement of patients at high-risk. En-suite facilities. Doors on bays.
Dirty utility/clean utility.	Standardisation of rooms/choice of equipment. Appropriate storage. Space.
Domestic services room.	Space, adequate sinks and storage.
Workflow/layout.	Standard ward area versus specialised area.
Bed planning.	Elective. Emergency.
Linen services and facilities.	Storage, transport and handling.
Catering/kitchen areas.	Furnishing, fixtures and fittings plus workflow crucial for HACCP. Commercial systems e.g. cook-chill versus in-house systems.
Intensive care unit/High dependency unit (ITU/HDU).	Single rooms versus 4/6 bed bays.
Clinical wash-hand basins.	Number dependent on room types. Correct wash hand basin specifications. Facilities to ensure compliance with hand hygiene. Located to encourage staff use.
Staff change areas/storage of uniforms.	Type of uniform provided inline with national uniform policy.
Decontamination facilities. Central Decontamination Unit/Local Decontamination Unit (CDU/LDU).	Operational policy dictated by choice of decontamination strategy.
Equipment.	Bed/mattresses. Purchase versus hire. Endoscopes/instruments. Cleaning/disinfection-requirement. Patient specific. Enough equipment available. Area for Decontamination facilities.

Table 3: Infection control issues for the Project Team to consider in the Capital Planning Process.

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Specialty areas		
Critical care. Ultra clean ventilation. Theatres. Hydrotherapy. Mortuaries. SCBUs and maternity.	Renal units. Oncology. Neurology. Paediatrics. Decontamination units. Pharmacy aseptic dispensary.	Every specialist area will have different requirements and infection control issues so cannot be planned as standard departments.
Internal environment		
Ventilation.		Single rooms, bays, theatres, pacing rooms, treatment rooms, internal sanitary areas, enhanced single bed rooms with positive pressure lobby for isolation.
Heating/ventilation.		Dust-free options i.e. hidden heat panels versus radiators. Minor procedure rooms.
Lighting.		Quantity. The use of sealed units.
Furnishings, fittings and artwork.		Walls/floors/ceilings – hygiene versus aesthetics.
Water.		Dead-legs. Water turnover. Appropriate temperature for hot and cold systems. Water coolers/fountains.
General services		
Disposal of waste.		NHS versus Private Sector. Storage.
Communications.		IT systems (timely information on pathology, etc, operational policies, infection control policies, procedures and training).
Emergency plans.		Water storage if water cut off/heating/medical gases and vacuum/suction/emergency generator, ventilation, etc.

Table 3 continued: Infection control issues for the Project Team to consider in the Capital Planning Process.

Note: This is not an exhaustive list

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Design Development stages

4.15 It is during the design stages that the Project Manager should verify with the Infection Prevention and Control Team that advice given previously is being followed up. As members of the Design Team, drawings and specifications should be available to them to explain how the design fulfils their requirements at the 1:200 and 1:50 plan stages of the project. Suggestions for improvement in operability are encouraged at this stage.

Note: Plans should be physically signed-off on completion of this stage to confirm full collaborative agreement. This is set out in Part B - Implementation Strategy section of this documentation.

4.16 In alteration or refurbishment projects, consideration should also be given to the impact on existing local facilities, e.g. ventilation, water supplies, etc.

Note: The Project Manager will need to recognise that value engineering will take place and that collective decisions should be taken on the basis of value for money.

Provision of single-bed room accommodation and bed space

4.17 Reference should be made to SHPN 04-01: 'Adult in-patient facilities'. CEL 27(2010) Provision of SHPN single room accommodation and bed spacing states that for:-

New build facilities

For all new-build hospitals and other healthcare facilities which will provide inpatient accommodation there should be a presumption that all patients will be accommodated in single rooms unless there are clinical reasons for multi-bedded rooms to be available. These reasons should be clearly identified and articulated in the appropriate Business Case and will be subject to Scottish Government agreement as part of the Business Case approval process.

Refurbishment of existing healthcare facilities

For projects where existing accommodation is being refurbished it is recognised that each building to be refurbished will present unique problems. Taking into account the constraints of the existing building, a minimum of 50% single room accommodation will be allowed but close to 100% will be expected. Issues related to the adaptability of existing engineering services will have to be assessed.

Bed space

4.18 In relation to the issue of bed spacing for multi-bedded rooms, the current advice remains unchanged. That is, taking into account the ergonomic criteria, primarily the space required for patient handling and other activities which take place in the immediate vicinity of the bed, it is recognised that the minimum bed

space should not be less than 3.6m wide x 3.7m deep. Further guidance can be found in the notebox following paragraph 4.27.

4.19 When carrying out refurbishment work to existing multi-bedded ward accommodation, the NHS Boards should seek to achieve this bed spacing. This may require considering reducing the number of beds in the room and a risk based approach should be applied. NHS Boards should also seek to achieve this bed spacing standard in accommodation which is not being refurbished or replaced. Again a risk based approach should be applied.

Sizing of space

4.20 As indicated above in new build projects the bed provision will be in single rooms and the optimum space standards are set out in SHPN 04-01: 'Adult in-patient facilities'. Where single bedroom accommodation is not possible in the alteration or refurbishment of existing wards and the minimum bed space of not less than 3.6m wide x 3.7m deep cannot be achieved then a risk assessment will be required to establish that appropriate space between beds is provided in accordance with the type of clinical intervention to be undertaken in the immediate patient environment.

4.21 Design, accessibility and space in patient areas all contribute to ease of manual handling, cleaning and maintenance.

4.22 Spacing must take into account access to equipment around the bed and access for staff to hand hygiene facilities. Sufficient space for equipment (e.g. hoists) is a health and safety issue for staff and patients.

4.23 Where it is not possible to meet the guidance recommendations set out in SHPNs and HBNs, Healthcare facilities must provide sufficient sanitary facilities including showers/bathrooms to ensure easy access, convenience and independence.

4.24 The principle should be to maintain sufficient space for ergonomic reasons to allow activities to take place safely, such as moving of equipment, patient lifting and movement, as well as ongoing maintenance. The exact space needed will vary according to numbers and activity of staff, type of patient, and environmental factors such as ventilation and humidity. Health Building Notes (HBN) 00-03: 'Clinical and clinical support spaces' and HBN 00-02: 'Sanitary spaces' provide details on calculating the optimum spaces required.

4.25 Particular issues for consideration sizing space include:

- patient groups;
- transmission of micro-organisms;
  - avoiding cross-infection;
  - the environment and its role in cross infection;
  - shared equipment;
  - movement of patients.

- management of issues:
  - clinical pressures;
  - best use of single rooms;
  - avoiding unnecessary movement of patients between areas.

Bed density

4.26 The increase in the prevalence of antibiotic–resistant bacteria and immuno-compromised in-patients was one of the compelling reasons for mandating the maximum provision of en-suite single rooms.

4.27 Provision of isolation/single rooms used to segregate patients will help prevent the spread of micro-organisms, especially those transferred by the airborne route or those easily disseminated into the immediate patient environment.

Note: The source of guidance related to the provision of single bedrooms and bed spacing requirements can be found in Scottish Health Planning Note 04-01: 'Adult in-patient facilities' and CEL 27 (2010) issued by Health Finance Directorate of the Scottish Government 20 July 2010.

4.28 As previously described, the provision of adequate space around the bed can significantly improve the quality of the patient's experience and aid the clinical and healing process. Clinicians and carers need adequate space around the bed, arranged in a functionally suitable way, to undertake their work efficiently and safely, making the most effective use of resources. Facilities should also serve the psychological needs of patients and their families providing a place of safety and privacy.

Departmental issues

4.29 There are some departments in a healthcare facility where infection risk is higher. The adjacency of these departments should be arranged so as not to increase further the risk of infection.

4.30 For example, departments with patients at a higher risk of contracting infection should be located and serviced to minimise risk of contamination from departments where patients are an infection risk.

4.31 For particular information on the content and conditions to be maintained within various rooms reference should be made to the Scottish Health Planning Notes (SHPN) or Health Building Notes (HBN) still applicable in Scotland that are appropriate to the department under review.

Interior finishes, fixtures and fittings

Note: Throughout this section of the document there is frequent reference to interior finishes, fixtures and fittings not being physically affected by detergents and disinfectants. Health Facilities Scotland National Cleaning Specification provides details on cleaning procedures and frequencies for use within NHS Scotland Healthcare Facilities. Additionally, Appendix 11 of Health Protection Scotland's belonging to National Infection Prevention and Control Manual gives guidance on the management of blood and body fluid spillages and states that use of:

10,000ppm available chlorine disinfectant is recommended for disinfection of surfaces contaminated with spills of blood or certain body fluids (cerebrospinal fluid; peritoneal fluid; pleural fluid; synovial fluid; amniotic fluid; semen; vaginal secretions; breast milk; any other body fluid with visible blood).

1,000ppm available chlorine disinfectant is recommended for disinfection of surfaces contaminated with spills of urine/faeces/vomit/sputum only.

In addition, the Transmission Based Precautions section of the same document states 1,000ppm available chlorine disinfectant is recommended for environmental decontamination when caring for: patients with symptoms of infection; asymptomatic patients who are suspected or incubating an infection; or patients colonised with an infectious agent (i.e. Transmission Based Precautions).

Among other things, consideration should be given to meeting the requirements set out in these documents when selecting interior finishes, fixtures and fittings.

Flooring in clinical areas

(SHTM 61: Flooring)

4.32 Flooring must be seamless, impermeable, slip-resistant, easily cleaned and appropriately wear-resistant. There should be coving between the floor and the wall to prevent accumulation of dust and dirt in corners and crevices. Any joints should be welded or sealed to prevent accumulation of dirt and damage due to water ingress. Wood, tiles and flooring with unsealed joints are difficult to keep clean and should be avoided.

4.33 In areas where frequent wet cleaning methods are employed, floors should be of a material that is unaffected by the agents likely to be used, such as a disinfectant solution of 1,000 parts per million available chlorine.

4.34 Floors that are particularly subject to traffic when wet (bathrooms, kitchens) should be seamless, impermeable and slip-resistant, but be easily cleaned. Consideration will be required as to the suitability of existing cleaning equipment and its compatibility with new floor finishes.

4.35 Carpets are not recommended in clinical areas. Exceptions may include palliative care setting and audiology departments, however if there is a risk of blood/body fluid contamination in these areas the carpets should be able to

withstand exposure to a disinfectant solution of 10,000 parts per million available chlorine.

Walls

(SHTM 56: Partitions)

4.36 Smooth wipable impermeable surfaces are recommended in clinical areas and design should ensure that surfaces are easily accessed and will not be physically affected by detergents and disinfectants. Additional protection to walls should be considered to guard against gouging and impacts from bedhead and trolley movements. Surfaces should be free from fissures and crevices. Floors or walls penetrated by pipes, ducts and conduits should be sealed to prevent entry of pests and ease cleaning.

Ceilings

(SHTM 60: Ceilings)

4.37 Smooth jointless impermeable ceilings should be used in operating theatres and special ventilated isolation rooms.

4.38 Suspended ceilings may be installed in general clinical areas and other areas. Smooth wipable impermeable surfaces are recommended in clinical areas and design should ensure that surfaces are easily accessed.

4.39 Dust and fungal spores may accumulate on the upper surfaces of ceiling tiles over time and dispersal on removal of tiles may pose an inhalation risk to highly immuno-compromised patients. An HAI-SCRIBE review should be carried out before such work is undertaken.

Note: Routine and repetitive maintenance activities do not require fresh risk assessments on every occasion they are carried out.

Doors

(SMTM 56: Doors)

4.40 Doors should be cleanable, that is, smooth, wipable and have impermeable surfaces to ensure that surfaces will not be physically affected by detergents and disinfectants. This applies especially in clinical areas where contamination with blood or body fluid is a possibility.

4.41 Doors should have handles that can be easily cleaned and dried. Additional protection to doors should be considered to guard against gouging and impacts from bed and trolley movement. Particular advice related to mental health units is contained in Appendix 3.

Windows

(SHTM 55: Windows)

4.42 Windows should be sealed and unopenable in operating theatres. Consideration should be given to the elimination of windows in such accommodation. Windows should be sealed and unopenable in ICUs, Neonatal, Oncology and Haematology departments and special ventilated isolation rooms. Internal ledges to all windows should be avoided to prevent build up of dust and clutter. Sloping ledges should be considered in clinical areas.

Fixtures and fittings

4.43 All surfaces should be easily accessed, wipable and will not be physically affected by detergents and disinfectants. All work surfaces should be impermeable, designed for easy cleaning and be free of fissures and unsealed joints. They should be able to withstand the effects of regular cleaning with both detergents and disinfectants.

4.44 Gaps, ledges, etc., should be eliminated or minimised as they will harbour dust, particularly where fixtures and fittings interact with walls and floors making them difficult to clean.

Sanitary fittings

(SHTM 64 Sanitary assemblies and HBN 00-02 Sanitary spaces)

Hand hygiene facilities

4.45 Compliance with hand hygiene guidelines can be improved by conveniently placed and well-designed hand hygiene facilities. The importance of facilities to encourage and facilitate good hand hygiene practices should be high on the list of priorities when designing and planning new healthcare premises or refurbishment of existing premises is being undertaken.

Wash-hand basin design

(SHTM 64 Sanitary Facilities)

Clinical wash-hand basins - Specification

4.46 The dimensions of a clinical wash-hand basin should be large enough to contain most splashes and therefore enable the correct hand-wash technique to be performed without excessive splashing of the user or surrounding surfaces. This can also occur if the water outlet is placed too high above the basin.

4.47 Clinical wash-hand basins should be wall-mounted using concealed brackets and fixings. They should also be sealed to a seamless waterproof splash-back to allow effective cleaning of all surfaces. It should be noted that tile grouting is difficult to keep clean.

4.48 They should not have a plug or a recess capable of taking a plug. A plug allows the basin to be used to soak and reprocess equipment that should not be reprocessed in such an uncontrolled way.

4.49 Clinical wash-hand basins should not have overflows as these are difficult to clean and become contaminated.

4.50 Taps should not be aligned to run directly into the drain aperture, as contamination from the waste outlet could be mobilised and splashing could occur.

Clinical wash-hand basins - Provision

4.51 The location and provision of clinical wash-hand basins should ensure that they are all readily available and convenient for use. The location of clinical wash-hand basins is as important as the bed-to-basin ratio. Multi-bed room rooms' basins should be located to ensure access by staff with the minimum travel between patient and basin; for example, one clinical wash-hand basin on each side of the entrance or at opposite sides of the room.

4.52 Taps in augmented care wards should not have flow straighteners (aerators), as Biofilm can develop on flow straighteners, rosettes and aerators. It is therefore recommended that these are removed. However, the decision to remove flow straighteners, rosettes and aerators should be based on risk assessment, as their removal can create turbulent flow at increased pressure resulting in splashing of surrounding surfaces and flooring.

4.53 Hand hygiene facilities to support the practices as set out in Health Protection Scotland's National Infection Prevention and Control Manual should be readily available in all clinical areas. There should be sufficient numbers and appropriate sizes of clinical wash-hand basins to encourage and assist staff to conform readily to hand hygiene practices as set out in the HPS manual.

4.54 Guidelines for the appropriate numbers and location of clinical wash-hand basins in wards are given in Scottish Health Planning Note 04-01 'Adult in-patient facilities' and in other clinical areas in Health Building Note 00-03 Clinical and clinical support spaces. In order to encourage good practice and to give reasonable access, it is recommended that:

- in en-suite single bedrooms a clinical wash-hand basin should be located in the bedroom and a general wash-hand basin for patient's personal hygiene in the en-suite;
- in four bedded rooms there should be two clinical wash-hand basins in the room and a general wash-hand basin for patient's personal hygiene in the en-suite. (Note that there should be no more than four beds in a multi-bed room in line with Health Building Note 04-01); Space may preclude this being provided in refurbishment projects within existing premises and risk assessments may accept this situation given the provision of alcohol-based hand rub facilities as the first choice for routine hand hygiene;
- in intensive care and high dependency units (critical care areas), a clinical wash-hand basin should be available by each bed space. It should be noted,

however, that under-usage of basins encourages colonisation with Legionella and other microorganisms. Whilst there should be sufficient hand wash stations for hand washing, the provision of more than is necessary presents an avoidable risk of infection from water. Advice on number and location of hand wash stations in clinical areas should be sought from the IP&CT.

Note: Outlets that are used infrequently are a potential problem with water stagnation in all clinical areas. Measures to control the spread of microorganisms in healthcare premises include the regular use of alcohol-based hand-rubs, and this can result in a significant reduction in the use of hand-wash basins. There has also been a trend to providing an enhanced provision of hand wash basins resulting in reduced throughput of water to each. Under-use of taps encourages colonisation with *Legionella* and other microorganisms such as *Pseudomonas* spp. Designers should be aware of these issues and, accordingly, consider how they might impact on the frequency of use of hand washing.

4.55 NHS Boards should have policies in place to avoid contamination of the delivery system and ensure that clinical wash-hand basins are not used for other purposes such as emptying of patient bathing water into the water delivery system where they can colonise existing biofilms.

4.56 HBN 00-03 'Clinical and clinical support spaces' and HBN 00-02 'Sanitary spaces' give guidance on activity spaces required for clinical wash-hand basins including in primary care and out-patient settings, where clinical procedures or examination of patients/clients are undertaken. A clinical wash-hand basin should be accessible to where the procedure is carried out.

General wash-hand basins

4.57 All en-suite facilities should have a wash-hand basin for use by patients.

4.58 All toilet facilities should have a wash-hand basin. Wash-hand basins should not have overflows as these are difficult to clean and become contaminated.

4.59 Taps should not be aligned to run directly into the drain aperture.

4.60 All general wash-hand basins should be sealed to a seamless waterproof splash-back.

4.61 HBN 00-02: 'Sanitary spaces' gives guidance on activity spaces for en-suites, showers, baths and changing facilities.

4.62 SHTM 64 gives details of sanitary assemblies for other areas such as theatre scrubs, kitchens etc.

Note: For guidance on mental health and learning disability settings, see Appendix 3.

Water/taps

4.63 Health and Safety regulations (The Workplace (Health, Safety and Welfare) Regulations, 1992) require that both hot and cold running water should be available in areas where employees are expected to wash their hands.

4.64 Hands should always be washed under running water; mixer taps allow this to be practised in safety in healthcare settings where hot water temperatures may be high to control *Legionella* spp. (see Scottish Health Technical Memorandum 04-01).

4.65 Taps can be fitted with thermostatic mixing valves (TMVs) to ensure that the temperature of the water delivered does not cause scalding etc (no greater than 41°C). TMVs are recommended in most healthcare settings depending upon outcomes of local risk assessments. TMVs should be sited within the tap or on pipework immediately prior to the taps. Taps should be capable of accommodating point-of-use filters which may have to be retro-fitted at some time following an outbreak of Legionellosis or *Pseudomonas* infection. (Scottish Health Technical Memorandum 04-01 refers).

4.66 There have been multiple observations of TMV colonisation with *Pseudomonas* spp. including *Pseudomonas aeruginosa* particularly in older TMVs. This observation includes colonisation with multiple antibiotic-resistant strains. This is most significant in high dependency units (for example, intensive therapy units, special care baby units, and burns units) where patients may be particularly susceptible to colonisation and infection with this opportunist pathogen. Conventional manual mixer taps may not be as prone to such colonisation and may be appropriate in situations where monitored patients are confined to their beds and consequently there may be under-usage at these outlets.

4.67 Consideration should be given to the provision of removable, accessible, TMVs and/or taps or taps with removable spouts in high dependency accommodation. By holding a float of spares, decontamination could be undertaken without prolonged interruption to hot and cold water supplies.

4.68 A local risk assessment of patient susceptibility to *Pseudomonas* infection versus scald risk where patients operate taps could be used to inform the use of TMVs or conventional manual mixer taps.

4.69 Non-TMV taps are also available for certain applications (for example, kitchens and cleaners' sinks). These taps allow the user free rein to determine the temperature of the water delivered at the point of use. However, a local risk assessment should be undertaken first.

4.70 Taps should be easy to turn on and off without contaminating the hands and be elbow/wrist operated or sensor operated.

4.71 Taps discharging directly into a drain hole can cause splashing, which could disperse contaminated droplets. The tap outlet flow should not discharge directly into the waste aperture.

4.72 Swan-neck tap outlets are not recommended for new build projects nor in refurbishment schemes, as they do not fully empty after use. Strainers, aerators (flow straighteners) and anti-splash fittings at outlets are recommended not to be used as they become colonised with bacteria. Adjustments to flow may be required to minimise splash risks. Careful consideration as to the appropriateness should be given to the need to provide sensor taps in clinical wash hand basins.

4.73 Where water systems are closed down, a *Legionella* risk assessment should be undertaken. This should include the risk bacterial overgrowth in dead-legs poses to adjacent water systems. Flushing and hyperchlorination should also be considered when the system is reinstated.

Alcohol based hand rub/Soap dispensers

4.74 Liquid soap dispensers should be wall-mounted at all wash-hand basins and be designed to be operated without contamination from the user's hands coming into direct contact with the dispensing mechanism. Dispensers should not be refillable but be of a disposable, single cartridge design (see Appendix 3 for guidance on mental health units).

4.75 Alcohol based hand rub dispensers should be available to staff as near to each individual patient as possible, subject to local risk assessment. Users and IPC teams should liaise and advise on the precise position and number of these units in clinical areas (Further information can be found in CNO (2005)1).

Hand drying

4.76 Paper hand-towel dispensers should be conveniently placed by all wash-hand basins (clinical and non clinical).

4.77 The use of paper towels in rolls should be discouraged. They are difficult to tear off without contaminating the remaining roll.

4.78 Fabric towels are a source of cross-contamination and must not be used for hand hygiene.

4.79 Hot-air hand dryers reduce paper waste and may be considered for use in public areas of healthcare facilities. Many machines dry hands more slowly than paper towels, and these should not be installed for staff use in clinical areas. They are noisy and should not be used in clinical areas where patients could be disturbed.

4.80 Hands-free waste bins, sack holders or receptacles, with appropriate colour-coded waste bags, should be provided by each wash-hand basin.

Sinks and slop-hoppers

4.81 Using sinks for both hand-washing and the cleaning of equipment is not allowed as this will significantly increase the risk of hand and environmental contamination. Dirty utility rooms should contain:

- a hopper;
- a macerator;
- a separate sink for cleaning equipment;
- a clinical wash-hand basin;
- space to accommodate colour-coded disposal bags for bagging waste.

4.82 Convenient access to these is important, as contaminated fluids such as patients' wash-water should not be emptied down clinical wash-hand basins in adjacent ward areas.

Note: Equipment for destruction of disposable bedpans or cleansing non-disposable bedpans may generate significant noise. Care should be taken to eliminate this spreading to adjacent accommodation.

4.83 Slop-hoppers should be provided in areas where dirty waste water, is disposed, e.g. domestic services room, cleaners' cupboards/areas for cleaning equipment. Hoppers should be provided in dirty utility rooms where required for the disposal of small amounts of liquid waste e.g. from urinalysis. (Further detail is provided in HBN 00-03 Clinical and clinical support spaces).

Soft furnishings

4.84 Soft furnishing used within clinical areas should be chosen for ease of cleaning and compatibility with detergents and disinfectants. They should be covered with material that is impermeable, preferably seam-free or heat-sealed.

Curtains and blinds

4.85 Privacy curtains become contaminated with micro-organisms which can be transmitted to staff hands. Where patients may be particularly susceptible to infection, curtains should have fittings that allow quick and convenient replacement. Consideration should be given to disposable curtains for which such fittings are common.

4.86 In new-build or refurbished augmented care units, consideration should be given to having separate curtains for each multi-bed space sufficiently separated such that staff can easily and correctly identify which curtain belongs to which bed space.

4.87 Reusable curtains should be able to withstand decontamination in healthcare laundering processes.

4.88 There should be a local policy on the changing of privacy curtains both for routine changing when the curtains become soiled and after discharge of a patient with a known or suspected infection. The policy for changing of privacy curtains both for routine changing when the curtains become soiled and after discharge of a patient with a known or suspected infection should reflect the practice set out in the National Cleaning Services Specification.

4.89 Window blinds are not recommended in clinical areas for new-build or refurbishment applications but where currently in place they require to be readily and regularly cleaned as part of local policy.

Equipment

4.90 The purchase of fixed equipment (Group 1&2) will normally take place before the operational commissioning period. (A full definition of Group 1&2 equipment can be accessed in Appendix 1).However, it is important during the design, construction and equipment scheduling stages that there is consultation with the Infection Prevention and Control Team in discussion of equipment. Some of this will be purchased/fitted by the Contractor and may have significant design implications. All equipment must be compatible with the need for prevention and control of infection and all equipment must be compliant with decontamination guidance.

4.91 Technical commissioning of the building, services and equipment should include any areas that require inspection and testing to demonstrate compliance with prevention and control of infection standards, i.e. theatres, hydrotherapy pools, isolation/segregation rooms and clean rooms in pharmacy and Central Decontamination Units (CDUs). There is a legal requirement for compliance in CDUs and pharmacies.

Procurement Stages

Infection Prevention and Control Expertise in Procurement activities

4.92 Infection Prevention and Control Specialist input is essential at the procurement stage of any construction/refurbishment project. This input is initially required when consideration is being given to the selection of Architects and Designers following interview.

Tender/contract

4.93 The Project Manager should seek the views of the Project Team as part of the tender evaluation process and scoring of relevant sections of tenders/contracts to assess competence in relation to the technical nature of the build.

Health & Safety expertise

4.94 Prevention and Control of HAI is a Health and Safety concern and the actions or omissions of those involved in the provision or operation of the facility could become evidence in any legal action stemming from an infection. For this reason it is essential that, as with other considerations of professional competence, all those involved in the design and planning are able to demonstrate that appropriate expertise was in place and advice sought.

Legislative issues

4.95 Before any work commences, there is a need to be aware of all legislative issues, which apply to the project. Examples of relevant legislation may include

- The Health and Safety at Work etc Act 1974;
- The Construction (Design and Management) Regulations 2007 (CDM);
- The Provision and Use of Work Equipment Regulations (PUWER) 1998;
- The Control of Substances Hazardous to Health (COSHH) Regulations 2002.

An expanded list appears in the References section of this document.

Delivering a safe environment

4.96 A number of pieces of legislation put the primary responsibility for the safety of the facility, including HAI, on the employer, usually the NHS Board. In construction procurement the 'employer' sets the resource, assesses the competence of the Design Team and evaluates the output. This means the employer should lead on setting the quality culture that will deliver a safe environment.

Delivery/Construction Stages

4.97 HAI-SCRIBE provides additional information on infection prevention and control.

Construction (new build)

4.98 When the project is a new-build, the largest risk is at the beginning of the project where there may be excavations of large amounts of soil together with its transportation away from the site. NHS Project Managers should visit the site at appropriate and mutually convenient times, as soon as possible after the Contractor has taken ownership of the site, meeting with the Contractor and observing work practice and familiarising themselves with the layout of the various departments. This will help them to detect any unidentified problems or ones caused by design changes. Any changes identified should be risk assessed in compliance with the Management of Health and Safety at Work and recorded.

Construction (new-build attached to existing site or refurbishment)

4.99 Involvement of Project Teams in refurbishment projects is important not only for ensuring that 'designed-in' prevention and control of infection is achieved, but also for assessing the potential risks to patients in existing buildings from dust, dirt and pathogens.

Note: The Health and Safety file and method statement should be reviewed prior to handling over the site to the contractor. It should include clear indications as to how waste is transferred, controlled and the site managed. By listing the HAI control measures in the Health & Safety file or similar documents the design team will have the opportunity to evaluate the suitability of the proposed controls prior to commencing HAI-SCRIBE assessment.

4.100 Measures that limit the spread of dust, dirt and pathogens during construction may include the following:

- undertaking work in winter as the risk is lower for *Aspergillus* spp. and other fungal infections. Clinical teams would need to bear in mind the impact of winter bed pressures and Norovirus outbreaks when planning work over this period;
- cleaning and vacuuming areas under construction and the surrounding areas frequently;
- placing adhesive floor strips outside the door to the construction area to trap dust; these should be replaced regularly to remain effective;
- sealing windows, doors and roof-space to control dust;
- installation of temporary sealed partitions where appropriate;
- provision of barriers which should be physically robust, smooth and easy to clean;
- damp-mopping the area just outside the door to the construction area daily or more often if necessary;
- using a high-efficiency particulate air (HEPA) filtered vacuum to clean areas daily or more often if necessary eg where there is a greater risk of infection spread or a greater need for control of infection;
- transporting debris in containers with tightly fitting lids, or covering debris with a wet sheet;
- all debris should be bagged and sealed for removal at convenient times. This would reduce the risk associated with frequent travel. Follow-on cleaning of the traffic routes would be required as appropriate;
- not hauling debris through patient-care areas;
- removing debris after normal work hours through an exit restricted to the construction personnel;
- designating an entrance, a lift and a hallway that the construction workers must use outwith times that it would be used by patients, visitors or healthcare workers;
- shampooing carpets when the construction project is completed;
- commissioning hotel services regarding cleaning during construction stage.

Note: The Project Manager or delegated person should monitor the effectiveness of dust control measures and any signs of dust accumulation outwith the contained area. The frequency would be based on the risk assessment of surrounding clinical areas.

4.101 HAI-SCRIBE control measures must be clearly documented, followed and recorded. Similarly, a daily checklist is maintained as a minimum during the progress of the construction project and signed off by the designated appropriate person.

Barriers		N/A
Construction signs posted for the area	Yes/No	
Doors properly closed and sealed	Yes/No	
Floor area clean, no dust tracked	Yes/No	
Air handling		
All windows closed behind barrier	Yes/No	
Negative air pressure at barrier entrance	Yes/No	
Negative air pressure machine running	Yes/No	
Project area		
Debris removed in covered container daily	Yes/No	
Waste materials in appropriate container	Yes/No	
Routine cleaning done on job site	Yes/No	
Traffic control		
Restricted to construction workers and necessary staff only	Yes/No	
All doors and exits free of debris	Yes/No	
Dress code		
Appropriate for the area (e.g., Theatres, CDU)	Yes/No	
Required to enter	Yes/No	
Required to leave	Yes/No	

Table 4: Daily construction survey

Surveillance and monitoring during renovation or construction work

4.102 Incidences of *Aspergillosis* and *Legionellosis* associated with environmental changes arising from construction and renovation work have been reported (Fournel *et al* 2010, Boivin *et al* 2012).Therefore the need for additional surveillance and environmental monitoring may be identified by the Project Team through Risk Assessment.

4.103 Where any patients may be placed at risk, it is important that an appropriate risk assessment be carried out. This would be undertaken in advance of any demolition works or disturbance/alterations to the building fabric/ventilation systems. Advice on patient groupings should be obtained from clinicians.

4.104 Since the airborne spores of *Aspergillus* spp. can travel significant distances, this will apply generally to all works in the immediate vicinity or within the boundary of the healthcare site. The need would be dependent on the HAI Risk classification such as type 3 or type 4. Particular care will be required in Transplant units and other accommodation for Immuno-compromised patients.

Delivery/Commissioning Stage

4.105 Upon completion of construction, the facility must be brought into use; the complexity of the task involved generally means that a Commissioning Manager and Commissioning Team will be needed. Senior managers, infection prevention and control teams, specialist teams and users should be fully involved in the process. The commissioning entails:

- drafting operational procedures;
- establishing baseline and future staffing profiles;
- establishing baseline and future revenue budgets;
- establishing final equipment requirements;
- identifying policy issues for referral to the Commissioning Team or the construction project team;
- identifying staff training needs;
- establishing the occupation programme for each user function, for incorporating into the overall masterplan.

4.106 The Project Team may also need to be involved in processes for:

- transfer of facilities;
- phased or staged occupation;
- strategy for equipping;
- selection of equipment;
- storage and subsequent cleaning/disinfection of any furniture or equipment;
- commissioning domestic services for cleaning;
- site visits;
- artwork;
- furnishing and fittings including decorating;
- interior finishes and fixtures;
- post-handover period;
- decommissioning of redundant facilities;
- period of handover to operational management.

Note: Although this must be robustly resisted, commissioning of building services is frequently curtailed to meet deadlines or put in the hands of inadequately qualified or inexperienced personnel. This is invariably to the detriment of user satisfaction, operational efficiency, HAI risk and running costs and should be avoided.

Post Project Evaluation

4.107 The purpose of post-project evaluation is to improve project appraisal, design, management and implementation. This typically takes place 12 months post-handover and is a learning process that should not be seen as a means of allocating blame. There are three stages:

- project appraisal;
- monitoring and evaluation of the project;

- review of project operations.

4.108 It is useful for members of the Project Team to be included at this stage in the evaluation teams that are reviewing project alternatives. The outcomes (activity and its consequences) of the project will not be amenable to evaluation until the facility has been in use for some time. However, if the project is part of a phased refurbishment or new build, valuable lessons can be learned and implemented during ongoing project work.

Note: It is important that the project is evaluated in terms of its original objectives, not in the light of any new legislation or development.

4.109 Reference should be made to the HAI-SCRIBE questionsets in Part B - the Implementation Strategy and Assessment Process section of this guidance relating to the design and planning stage of any development.

Logistics

4.110 The design of the healthcare facility must realistically consider the logistics of a functioning facility. It is essential that systems are in place which will inhibit the spread of infection and resources and personnel are managed so that they do not contribute to the risk of infection.

4.111 Examples of logistical issues to consider include:

- the delivery and distribution of clean materials and people via connecting corridors and lifts;
- the collection, transportation and storage pending removal or disposal of waste materials;
- the separation of clean and dirty traffic flows;
- clinical workflows.

4.112 These issues require careful planning and design which recognise the potential for infection spread through the mismanagement of such issues.

Summary

4.113 The following are the main issues for designers and Project Team personnel to consider in designing a healthcare facility. However, the infection risk should be assessed in conjunction with other risks as conflicts can arise (e.g. with respect to the needs of dementia patients).

4.114 Design to facilitate cleanliness and cleaning:

- use finishes that are impermeable, smooth, seamless and durable, as far as practicable;
- cove hard flooring up the walls for a short distance to provide an easy to clean junction;

- eliminate or minimise dead-legs and blind ends in water systems, both in the original design and as the systems are modified;
- provide hands-free operation for as many facilities as is practicable – for example: bins, taps, lights, sanitary equipment, flushing, doors;
- consider integral blinds as an alternative to curtains at internal windows.

4.115 To facilitate safe working practices (for example, tidiness, and hand hygiene):

- provide sufficient space for activities to take place and to avoid cross-contamination between adjacent spaces;
- provide sufficient storage for patients' possessions and for all supplies to discourage clutter;
- ensure proper segregation and management of waste, including healthcare waste and linen;
- provide sufficient domestic waste receptacles;
- provide bedside waste disposal facilities for patient use;
- eliminate or minimise difficult to clean gaps and ledges or horizontal surfaces such as window sills which encourage clutter;
- provide enough wash-hand basins and soap dispensers;
- plan for and deliver good separation of clean and dirty activities;
- provide sufficient space for storage and preparation of cleaning equipment and materials;
- provide suitable facilities for cleaning of equipment.

4.116 Design for easy cleaning:

- it is always best practice to maintain a visibly clean environment that is free from dust and soilage, and acceptable to patients, their visitors and staff;
- good design can make cleaning immeasurably easier, for example
  - using finishes that are easy to clean;
  - in clinical areas, flooring should be seamless and smooth, slip-resistant, easily cleaned and appropriately wear-resistant.
- consultation should take place with the local IPC team prior to purchase and on planning.

4.117 The Infection Prevention and Control Team should be consulted throughout a building or renovation project and their advice and recommendations taken into account and documented.

5. Typical rooms: purpose and content

Note: For the purposes of this guidance, the following terminology is used (A full Glossary of terms can be found in Appendix 2):

a. **Multi-bed room** is a room that contains more than one bed. It is best practice for these to have both en-suite toilet with shower, clinical wash-hand basin and doors to the main ward area.

b. **Single-bed room** is a room with space for one patient and usually contains as a minimum: a bed; locker/ wardrobe; and clinical wash-hand basin**. (NB: single-bed rooms without en-suite sanitary facilities are not recommended).**

c. **En-suite single-bed room** this is the same as 'b' but with en-suite shower, WC and wash-hand basin. (In new build, space for a social support zone for overnight stay and a clinical support zone is also provided).

d. **Enhanced Single room (with en-suite facilities)** this is the same as 'c' but with a ventilation system that prevents uncontrolled escape of infectious aerosols from the room to adjacent areas. It can also provide a degree of dilution of infectious aerosols in the room for the safety of staff and visitors. The room should have extract ventilation that exceeds its supply, such that gaps in its fabric leak inwards not outwards.

e. **Enhanced Single room (with en-suite facilities and ventilated lobby)** this is the same as 'd' but with a lobby having positive pressure ventilation.

SHPN 04:01 Supplement 1: Within this guidance Isolation facilities either suite/room with specialised ventilation are parts d & e.

Generic rooms

Note: Information on sanitary fittings, taps, etc. is contained in paragraphs 4.45 – 4.73. For further information on room contents, refer to Activity Data Base (ADB) sheets generally issued as part of briefing information.

Isolation Facilities

5.1 The primary aim of Project Team is to prevent the spread of infection between patients, visitors and staff by control or containment of potentially pathogenic organisms. Many of these organisms can be controlled by basic IPC practices such as hand hygiene and environmental cleanliness and this can be facilitated by single room isolation. A small proportion of patients requiring isolation will require isolation facilities as per d & e. (SHPN 04-01 Supplement 1: 'Isolation facilities in acute settings').

5.2 The key to effective isolation on general wards is the provision of sufficient en-suite single-bed rooms to prevent patients known to be a risk for spreading

infections being cared for in open ward areas. Single rooms reduce the risk of cross-infection for non-airborne diseases. Most patients requiring segregation/isolation on general wards can be isolated effectively in en-suite single rooms.

5.3 NHS Boards should audit the use of en-suite single-bed rooms to determine local requirements.

Note: In Accident & Emergency departments, where it is feasible to do so, a dedicated room should be provided for patients with a known or suspected infectious agent/disease transmitted wholly or partly by the airborne route. If source isolation is required, this room should be at negative pressure to the corridor; a lobby is not required. This room should be suitable for general use when not required for isolation.

5.4 Multi-bed rooms can also be used to cohort patients with the same infection if they have en-suite toilet and shower, and a door to the main ward area. The possible need for this should be considered at the design stage.

5.5 Storage of, and ready access to, clean disposable PPE to support the practices set out in Health Protection Scotland's National Infection Prevention and Control Manual is important to encourage its use plus appropriate waste receptacles for disposal once worn.

5.6 Gloves and aprons and other disposable PPE should be sited at the entrance to single-bed rooms.

5.7 Additional storage facilities will be required for the care and treatment of patients in isolation facilities, especially if the isolation is likely to last for some time:

- the storage of the minimum amount of supplies needed;
- lockable provision for personal clothing and possessions. (see Appendix 3, paragraph 3/11 for additional information).

Design

5.8 Scottish Health Planning Note 04, Supplement 1 – 'Isolation facilities for infectious patients in acute settings' provides guidance on the facilities required for isolating infectious patients on acute general wards (source isolation). It also provides guidance on the ventilation parameters for an enhanced single bed room and ventilated lobby.

Ceilings

5.9 Removable ceiling tiles are not advised for specialist ventilated isolation rooms/suites (SHTM 60).

Doors

5.10 Doors design is critical to the design of a specialist ventilation isolation room/suite. For specific guidance on source isolation, refer to Scottish Health Planning Note 04-01, Supplement 1 – 'Isolation facilities for infectious patients in acute settings'.

Enhanced single room with en-suite facilities and ventilated lobby 'e'

5.11 Lobbies provide an area for staff to undertake hand hygiene and to don and remove PPE. (SHPN 04: Supplement 1).

Engineering requirements for special ventilated isolation rooms/suites

5.12 Maintenance programme and revalidation programmes should be established for specialised ventilated isolation rooms to ensure the design criteria are maintained and met at all times. Although it is impossible to give specific maintenance frequencies, each unit should be included in a Planned Preventive Maintenance (PPM) programme that includes pressure/air flow monitoring equipment.

Recommendations

- single-bed rooms with en-suite sanitary facilities are optimum for infection prevention and control design;
- there should be sufficient en-suite single-bed rooms to prevent patients known to be a risk for spreading infections being cared for in open ward areas. Healthcare providers should audit the use of en-suite single-bed rooms to determine where further local requirements and adaptations are greatest;
- the provision of additional isolation facilities should be considered when designing new healthcare buildings and renovating existing buildings.

Ancillary Areas

5.13 It is important that ancillary areas are of an acceptable standard to support effective infection prevention and control. Clean and dirty areas should be in separate rooms and the workflow patterns of each area should be clearly defined.

5.14 The design and finish of ancillary areas should facilitate good cleaning, have facilities for hand hygiene, and sufficient storage for supplies and equipment together with provision for the removal of Personal Protective Equipment to waste or to wash.

5.15 Infection Prevention and Control issues are determined on:

- the use of the ancillary area;
- who will have access; and
- what type of activity will be carried out there

5.16 Ancillary areas include:

- dirty utility;
- clean utility;
- clean linen store;
- domestic services rooms (DSRs);
- decontamination facility/disposal room;
- day room/patient waiting areas;
- play areas;
- nappy-changing area;
- storage;
- visitors' toilets;
- laundry departments;
- changing accommodation;
- treatment room.

5.17 Key activity spaces for each of the above functions are described in HBN 00-03. SHPN 04-01 and SHPN 36 describe the design requirements for the above rooms in hospital or community facilities.

Dirty utility room

(SHPN 04-01, SHPN 36 and HBN 00-03)

5.18 A dirty utility room should include facilities for:

- cleaning items of equipment;
- testing urine;
- disposal of body fluids;
- decontamination of commodes;
- temporarily holding items requiring reprocessing;
- hand hygiene.

5.19 Space and facilities for holding, reprocessing or disposal of bedpans, urinals and emesis (vomit) bowls are required. Commodes, unused bedpans, urinals, vomit bowls and linen bag carriers can also be stored. Closed storage is required for aprons and gloves. Storage cupboards should be provided.

5.20 A working stock of clean goods should be stored within a Dirty Utility Room. Clean goods would include unused bedpans & urinals and cleaned commodes.

5.21 Where commodes are to be used, there should be sufficient space allowed for their decontamination and storage of a working stock.

5.22 A clinical wash-hand basin is necessary plus a deep sink for equipment with draining board (or macerator, if available) for urine disposal and a separate deep sink for decontaminating equipment.

5.23 There needs to be clear demarcation achieved between clean/unused equipment and soiled/dirty equipment. A defined clean-to-dirty workflow is also required.

Clean utility room

(SHPN 04-01 and HBN 00-03)

5.24 A clean utility room is required where drugs and lotions may be stored and prepared, a supply of clean and sterile supplies may be held and dressing trolleys prepared. Designated hand hygiene facilities are required but must be positioned sufficiently far away from infusate preparation to prevent splashing and contamination.

5.25 The room should be located adjacent to the treatment area.

5.26 It is important that planners/design teams think about the type of storage facilities provided. There are three options: cantilevered units, mobile units or units fixed to the floor with no gaps.

5.27 It is important that sufficient dedicated worktop area is provided to enable aseptic preparation to be carried out, e.g. preparation of intravenous infusion. This provision should be sufficiently distant from the wash hand basin as to prevent contamination.

5.28 Storage facilities should be able to be cleaned easily and quickly while protecting clean stores and equipment from dust and contamination. Sloping surfaces should be provided up to ceiling level to permit cleaning.

Clean linen store

(SHPN 04-01 and HBN 00-03)

5.29 Clinical areas should have designated areas for the storage of clean linen to maintain the cleanliness of the linen and allow easy access. Storage should be on slatted shelving or racking and be off the floor. Where shelving is fixed, it should be provided with kick boarding provided to avoid the need to clean the floor underneath. Shelving should be cleanable and not harbour dust.

Treatment room

(SHPN 04-01 and HBN 00-03)

5.30 A treatment room may be required for in-patient examination or investigations on the ward. It will certainly be needed in primary care settings and will require different design features according to its planned use, for example, immunisation, wound dressing or surgical intervention and investigations.

5.31 A clinical wash-hand basin should be provided (see Health Building Note 00-03).

5.32 Carpets should not be used in a treatment room.

5.33 Space should be available to allow for the storage of equipment and sterile supplies.

Disposal room

(SHPN 04-01)

5.34 This area should be secure and not be accessible to patients/public.

5.35 The disposal room is for temporary storage of supplies and equipment that have to be removed for cleaning, reprocessing or disposal, for example, items to be returned to the sterile services department (SSD).

5.36 The sizing and location of disposal rooms should be considered at the design stage, taking into account the predicted levels and types of waste to be generated and the planned operational policies relating to frequency and work flow of waste and linen collection.

D.S.R. (Domestic service room)

(HBN 00-03)

5.37 This room is used to deliver day-to-day cleaning services for a defined area. Cleaning materials and equipment in daily use should be stored in cupboards within this room.

Note: It should be noted that the requirements for DSRs have recently been under review by the domestic services review group.

5.38 The room should be provided with a sink with draining board and slop-hopper as well as a wash-hand basin situated well away from the equipment washing sink and slop hopper. There should be unrestricted access to the sink and slop-hopper.

5.39 Space should be provided for segregation and storage of mops, buckets and other cleaning equipment vacuum cleaner and scrubbing/polishing machine (for hard floors) and for lockable COSHH cupboard for cleaning supplies.

Day room/patient waiting areas

(HBN 00-03)

5.40 There is often conflict between the aesthetics of these areas and the prevention of contamination of the environment or furnishings and ease of cleaning/disinfection. This is especially the case in waiting areas such as in accident and emergency departments, primary care and minor injury units.

5.41 It is important that where blood and body-fluid spillages may occur, the environment should be able to be decontaminated effectively. Use of carpets should be the exception and then only after much consideration and risk assessment.

Note: There are special requirements for Mental Health Units which are categorised as low risk.

Play area

(HBN 00-03)

5.42 All equipment, finishes and furnishing will be wipable, impermeable and be able to withstand cleaning and disinfection. This is particularly important for play mats and soft floor coverings.

Nappy-changing area

(HBN 00-03)

5.43 Facilities for disposal of soiled nappies and for hand washing in the immediate environment are required along with a regular cleaning programme of equipment used.

5.44 The area for nappy-changing will have a surface that can be easily cleaned and disinfected.

Staff/Visitors' toilets

(SHPN 04-01 and HBN 00-02)

5.45 These are heavily used and will provide enough space with wipable, impermeable, durable finishes to maintain a high standard of cleanliness.

5.46 There will be provision of disposal facilities for sanitary waste in both women's, assisted, disabled and unisex toilets.

5.47 The number of toilets, wash-hand basins and hand drying facilities provided will be sufficient for the size of the facility (see Health Building Note 00-02). Minimum numbers for staff and patient toilets and visitor toilets in non-public areas are determined by NHS guidance documents. Provision for visitors in public areas will be determined by the Scottish Building Control technical standards.

5.48 Hand drying should be by single-use paper hand towels or hot air hand driers. If a facility is, in or closely adjacent to, areas where patients may be sleeping, hot air hand driers will be avoided due to noise.

Equipment storage

(SHPN 04-01, SHPN 36, and SHTM 63)

5.49 Storage areas need to be appropriate for the operational requirements of each clinical area.

5.50 The need for sufficient secure storage should not be underestimated. Many briefs start with sufficient storage, but this space is often lost to other areas during the design process. This can have implications for both clinical practice and infection prevention and control.

5.51 Storage away from areas of clinical activity is required for both small and bulky items of equipment to minimise clutter, enabling efficient environmental cleaning.

5.52 All healthcare premises need a storage area for large pieces of equipment such as beds, mattresses, hoists, wheelchairs and trolleys that are not currently in use. The use of equipment libraries can be an effective way of storing, maintaining and decontaminating large or electrical equipment.

5.53 Cleaning equipment, laundry and healthcare (including clinical) waste need to be stored in separate purpose-built areas to prevent cross-contamination.

5.54 Sufficient and appropriate storage will protect equipment from damage, contamination and dust, which may potentially carry microorganisms, but should also allow free access to floors and shelves for cleaning.

Storage for patients' possessions

(HBN 00-03)

5.55 Adequate space should be allocated for the storage of patients' possessions. Wardrobes and lockers used for storage of patients' possessions should be selected to be easily and efficiently cleaned. Louvre doors should not be fitted, as they are difficult to keep clean.

5.56 Consideration and risk assessment should inform choice of furniture, vandalism and ligature issues affecting all types of accommodation.

Out-patient and day surgery changing facilities

(HBN 00-03)

5.57 In areas such as out-patients, imaging and minor injuries units, it will be necessary to provide sufficient changing/storage facilities for patients if clothing has to be removed and kept safe. These should be included at the planning stage and should be able to be cleaned easily.

Clinical staff changing

(HBN 04-01 and HBN 00-02)

5.58 By providing staff changing facilities, sanitary facilities, showers and sufficient locker space for outdoor clothing staff will be able to change out of their uniform on-site. Wash-hand basins and shower facilities for staff should be made available and easily accessible in case of substantial blood or body fluid contamination. There needs to be sufficient storage for clean scrub suits and footwear. Facilities for disposal should also be available. Specialist departments will require local specialist staff changing (eg theatres and aseptic suites). Where these are not available, staff should change and contaminated uniforms bagged.

Maintenance staff changing

(HBN 04-01 and HBN 00-02)

5.59 Changing facilities should be provided for maintenance staff who undertake activities that could expose them to contamination. There should also be access to showers in case of significant contamination.

- appropriately sized changing facilities should be provided for staff, to encourage them to change out of their uniform on-site;
- wash-hand basins and sanitary facilities should be included in showers in the event of contamination by blood or body fluid.

Linen cupboard

5.60 Each ward should have an area for the storage of clean linen which, in new build accommodation, should be purpose-designed. The area used for the storage of clean linen should ensure that linen is not exposed to contaminants. The areas are required to have:

- good ventilation;
- adequate lighting;
- impermeable flooring that is easy to clean and fitted with coving between the floor and the wall to avoid accumulation of dust and dirt in corners and crevices;
- smooth, impermeable and easy to clean slatted shelving to ensure free flow of air.

5.61 If linen trolleys are used to store linen within the ward area, they should be managed so that:

- they are kept clean and tidy and enclosed with an impervious covering to ensure that linen is not exposed to dust;
- linen bags are not left open or lying on the floor with the potential for exposure to dust which may potentially carry micro-organisms;

- appropriate procedures are in place to allow cleaning of linen trolleys.

Used linen storage

5.62 The following types of linen should be segregated at source before sending to the laundry;

- used linen;
- infectious linen;
- heat labile linen.

Central or local NHS Laundry facilities

Note: Prior to installation, it is important to ensure that validation, testing and recording of the laundry process (including thermal disinfection) can be undertaken, as this is vital for the effective decontamination of laundry in NHS settings. This is the responsibility of the maintenance manager or engineer.

5.63 The layout of laundry areas must be designed to ensure that effective cleaning can be undertaken. Finishes to walls, floors, work surfaces and equipment must be capable of withstanding regular cleaning and the impact of mechanical cleaning equipment. The area should be large enough to allow access for decontamination trolleys.

5.64 Laundry facilities should provide:

- suitable space for laundry machinery;
- suitable storage for used linen and for separation of used and laundered linen;
- storage space which is designed to prevent odours from migrating from storage areas to adjacent areas;
- storage space designed to accommodate trolleys, etc., used in the transportation of linen;
- appropriate facilities to allow the segregation of used linen, heat labile linen and infectious linen, in appropriate containers which are clearly identifiable;
- suitable facilities to allow compliance with hand hygiene practices;
- a laundry policy to ensure infection risks are minimised;
- a ventilation system that will minimise the level of airborne contamination and dust to minimise the risk of cross infection.

If processing infectious linen suitable vent pipes should be routed to a safe area outwith the laundry and effluent from the drains must be sealed from the machine to the drainage area outwith the laundry.

5.65 Ward based machines (industrial or domestic):

- ward based machines must not be used within the NHS for processing 'infectious linen' or 'contaminated uniforms';
- as it is costly and difficult to validate domestic washing machines, these should only be used in areas agreed by the IP&CT such as rehabilitation units for patients' own laundering or laundering of heat labile baby clothes. Validation and thermal disinfection processes is not required or suitable for domestic machines;
- it is preferable to install industrial type machines in ward areas as in the long term these are more cost effective due to durability, in addition some models have temperature recording facilities that can be used to ensure thermal disinfection is reached but this is not a requirement in this setting.

5.66 Tumble driers should be used to further support thermal disinfection where domestic washing machines are used.

Catering/food hygiene

(HBN 04-01)

5.67 There should be facilities for staff who prepare and serve food to wash their hands. Additionally;

- in centralised kitchens, physical separation must be provided for storage, preparation and cooking areas including any equipment that is used which is effectively done by use of colour coding;
- cooked and raw products must be physically separated at all times;
- ward kitchens should have a separate staff wash-hand basin with non-touch taps, liquid soap and paper towels;
- storage areas such as cupboards must be clean and intact;
- the refrigerator should have a thermometer either built in or separate and this should record daily temperatures to ensure the fridge is 5°C or below.

Waste management

5.68 Guidance on the management of all wastes arising within healthcare facilities or wherever NHSScotland services are delivered is provided in Scottish Health Technical Note (SHTN) 3. SHTN 3 is published for use by NHS Boards' staff and its contractors and comprises the following parts:

- Part A: Summary of requirements – best practice overview;
- Part B: Waste management policy template;
- Part C: Compendium of regulatory requirements;
- Part D: Exemplar waste procedures; and,
- Part E: Waste prevention and re-use guide.

5.69 Many of the regulatory requirements for NHS Boards' wastes are captured within 'Duty of Care' under the Environmental Protection Act 1990 (as amended).

Responsibilities under 'duty of care'

5.70 The 'Duty of Care' is described in Section 34 of the Environmental Protection Act 1990. The Act was recently amended in Scotland by the Waste (Scotland) Regulations 2012. Guidance on its use and interpretation can be found in the 'Duty of Care – A Code of Practice' published in October 2012.

5.71 The Code of Practice outlines the obligations of those involved in the waste management chain from waste producer to final disposal. It requires producers and others who are involved in the management of waste to prevent its escape and take all reasonable measures to ensure that the waste is dealt with appropriately from the point of production to the point of final disposal. In order to comply with this requirement NHS Boards should:

- ensure that waste is segregated in a manner which allows for the recovery of materials;
- ensure that a written description accompanies all waste movements, adequately describing the type and quantity of waste;
- ensure that those who manage the waste and sites receiving the waste are authorised to do so; and,
- maintain records of all waste movements.

5.72 One of the main responsibilities under duty-of-care, which has major implications for IPC and the built environment, is to ensure that waste is stored safely on-site. Essentially:

- storage areas at ward and unit level should be secure and not publicly accessible;
- storage areas should be sufficient in size to allow packaged waste to be segregated and to avoid waste of different classifications being stored together in the same area;
- SHTN 3 provides further detail on waste segregation, receptacles and storage.

Waste segregation and storage

5.73 Any new capital developments should have enough space for waste receptacles to be located close to the point of waste production.

5.74 Healthcare wastes such as potentially infectious waste and pharmaceutical waste should be segregated into colour-coded receptacles in accordance with SHTN 3. Healthcare waste receptacles should not be accessible to the public.

5.75 Receptacles for recyclates should be easily accessible and clearly marked using the best practice colour coding specified in SHTN 3. Receptacles for

recyclates should be available in all locations where domestic waste is produced.

5.76 Residual waste is the name given to domestic waste once recyclates have been segregated at source. This waste should be placed into clear (preferable) or black bags. Receptacles for this waste stream should be clearly labelled.

5.77 Dedicated secure storage areas for waste are best located at entrances to wards or departments, preferably with access from both ward and hospital corridor to facilitate collection by authorised personnel only.

5.78 Storage for used linen should be in a clearly designated area separate from waste. This should minimise any risks of used linen being accidentally taken for disposal or waste being taken to the laundry.

5.79 Dedicated waste storage areas should be able to be cleaned easily and efficiently. The holding area should be of sufficient size to hold wheeled-bins and waste sacks ensuring that healthcare waste is clearly segregated from other wastes to avoid contamination.

5.80 A designated, secure area is also necessary to hold receptacles from the whole site (central waste yard) from which waste can be collected for off-site treatment and recycling. Guidance on the design and facilities required in waste storage areas is available in SHTN 3.

Note: Similar consideration will be required to route, contain and retain waste arising from construction activities in order to prevent debris and dust permeating clinical areas.

Waste receptacles

5.81 Comprehensive guidance on the size and colours of waste receptacles is available in SHTN 3. Waste receptacles should be of suitable size to meet waste arisings taking collection arrangements into consideration. Receptacles should be easy to clean, hands-free (i.e. foot operated) and comply with the requirements of SHTM 83: 'Firecode'.

5.82 Lids of waste receptacles that are used for healthcare waste need to be capable of being cleaned and disinfected. Avoid attaching temporary labels that would inhibit effective cleaning.

Healthcare waste (including healthcare waste generated in primary care and community settings)

5.83 In healthcare facilities such as care homes and primary care settings, all waste should be contained appropriately and kept secure at all times.

Note: There are special requirements for MHUs and Custodial accommodation.

5.84 The system and frequency of collection of waste service needs to be taken into account when planning facilities. Areas for temporary storage e.g. holding bays and/or intermediate rigid receptacles such as wheeled bins may be required.

Temporary storage facilities should be washable, secure and animal-proof. Only rigid lockable receptacles should be stored in external areas.

5.85 There should be a strict routine for removing waste to ensure it does not remain uncollected for extended periods.

Storage capacity

5.86 Storage areas need to be fit for purpose and a suitable size to allow different waste types to be stored safely and separately. Collection frequencies including contingency requirements (in the event of a failure in waste collection) should be taken into consideration when specifying the size of storage areas. The design of the facility should also take account of accessibility and space needed for vehicles collecting the waste.

Waste segregation

5.87 The storage area should be sufficient for different waste streams to be segregated pending collection in line with local policy. This will normally (at minimum) require that domestic wastes, including source segregated recyclates is to be kept separate from healthcare wastes (such as orange bags) taking into consideration appropriate treatment and disposal routes. See SHTN 3 for further details.

Note: The Waste (Scotland) Regulations 2012 have effectively banned the use of food waste disposal units (macerators) and food waste digesters involving the discharge of 'treated food' into the public sewer network.

6. Engineering services

Note: This section discusses various aspects of engineering services and the Infection Prevention and Control implications of each.

Heat emitters and temperature control

General

6.1 The selection of heat emitters will not only have a spatial impact but also on infection prevention and control.

Wall-mounted radiators

6.2 Options to ensure safety are as follows:

- low surface temperature heat emitters should be used;
- where existing conventional radiators are being retained, guards/covers should be fitted. Ease of covers removal to facilitate cleaning is essential. (paragraphs 6.3 and 6.4 also refer);
- temperature controls should fail to a safe position.

6.3 Of these options, covered heat emitters have raised the most prevention and control of infection concern. Heat emitter covers allow dust to build up beneath and inside the heat emitter grille. This dust has been found to contain potentially pathogenic organisms, and when heat emitters are switched on during the winter months, dust and bacteria are dispersed by heat convection to the ward area.

6.4 Where heat emitter covers are used, regular planned maintenance and cleaning should be undertaken to prevent the problems described.

6.5 When installing wall-mounted heat emitters, it is necessary to provide adequate space underneath the emitter to allow easy access for cleaning machinery to be used. Gaps and dust traps should be minimised.

Note: Ceiling-mounted radiant panels are intrinsically safe as hot surfaces are out of reach while also eliminating dust-traps.

Pipe-work siting and access

6.6 Where pipe-work is surface mounted it should be contained in a smooth-surfaced box that is easy to clean.

6.7 Penetrations where pipes and cables pass through walls above false ceilings should be sealed.

Heating, general ventilation and lighting grilles

6.8 Heating, ventilation and lighting grilles need to be accessed easily for inclusion in cleaning programmes by cleaning and estates staff.

Ventilation

Ventilation ductwork

6.9 Ventilation ductwork should be installed in such a way that it can be accessed. (This is important for extract ductwork as this has the most significant accumulations of lint and dust requiring removal, particularly if heat reclamation systems are used).

Specialised ventilation

6.10 The same basic principle applies for all clinical areas whereby positive pressurisation is maintained by providing supply ventilation in cleanest areas cascading to dirty areas where negative pressure will be achieved. This will inhibit the spread of contamination.

6.11 In healthcare premises, certain activities will necessitate the provision of ventilation equipment with additional special features in order to achieve and maintain specific conditions. For infection prevention in specialist areas such as operating theatres, ventilation should ensure contaminated air does not enter designated clean areas by ensuring that air flows from the cleanest to sequentially less clean areas. This direction of air flow prevents contaminated air passing in the opposite direction.

Note: See Scottish Health Technical Memorandum 03-01 Parts A and B for comprehensive guidance on the design, installation and operational management of ventilation systems in healthcare premises.

6.12 The following will usually have specialised ventilation requirements for infection prevention in:

- operating department;
- source isolation;
- bronchoscopy and sputum induction rooms, where a risk assessment has indicated a tuberculosis risk;
- protective isolation accommodation for highly immuno-compromised patients;
- cardiac catheter, interventional radiology units;
- microbiology containment laboratories;
- mortuaries.

Note: For information on ventilation for Isolation Rooms refer to Paragraphs 5.8 - 5.12.

Split and cassette air-cooling units

6.13 Only units that are readily amenable to regular cleaning in a working hospital unit should be used. If installed they should be cleaned as part of a regular planned maintenance scheme. Particular consideration should be paid to the accessibility of the condensate drip tray for cleaning and to the disruption to normal use of the accommodation while maintenance is being undertaken. A preferred solution would be not to install these units in critical patient areas.

Chilled beam units

6.14 These comprise heat-exchange beams in a ceiling through which is passed water to cool or heat air that passes across them. They should be installed so that they can operate without generating condensate. They must be accessible for regular cleaning and maintenance.

Hot and cold water systems

Note: Reference should be made to Scottish Health Technical Memorandum 04-01: Parts A and B for comprehensive guidance on the design, installation and operational management of water systems in healthcare premises.

6.15 The Water Quality (Scotland) 2010 Regulations contain provisions to ensure that the drinking water supply within buildings to which the public has access remains wholesome and is not adversely affected by the local distribution system.

6.16 Immuno-compromised patients are at particular risk from cryptosporidium. Very low numbers of cryptosporidium cysts can occasionally occur in mains potable water.

Storage and distribution of water

6.17 Many organisms capable of causing disease, particularly in highly susceptible hospital patients, such as *Pseudomonas* and *Legionella*, have been isolated from hospital water systems. Preventive measures include:

- routine inspection of water storage tanks with cleaning as required;
- identifying and removing dead-legs and blind ends;
- keeping cold water systems cold and hot water systems hot; and
- ensuring rapid turnover in water storage.

6.18 Temperature control is the preferred strategy for reducing the risk from *Legionella* spp. in water systems. This will require temperature monitoring on a regular basis. The recommended test frequencies are given in Scottish Health Technical Memorandum 04-01, Part B. It is good practice to ensure that hot and cold water pipe-work is insulated and separated. Cold water pipes should also be segregated from other heat sources and preferably not in the same service-ways to avoid unwanted heat transfer to the cold water supply.

6.19 Chemical and other water treatments that have been shown to be capable of controlling *Legionella* spp. to some extent may also be considered. They will only work in systems that are amenable to their use, for example those that do not have dead-legs and blind ends.

6.20 Scottish Health Technical Memorandum 04-01, Part B – 'Operational policy' provides guidance on the monitoring and maintenance of water systems (including water storage).

Sanitary facilities

6.21 WCs, urinals, bathrooms and showers should be designed to be easily cleaned and maintained. Wash-hand basins should be provided adjacent to WCs and urinals.

6.22 Showers are generally more practical than baths in the clinical situation and are easier to keep clean. Any fixture within a shower such as a seat should be easily cleanable, without small gaps and dust traps.

6.23 To minimise the possibility of bacterial colonisation of shower heads, they should be regularly cleaned and de-scaled.

6.24 Bidets may present infection risks, depending on design and patient group. The appliance should be rimless with an over-rim water supply. They are most frequently specified in maternity units. Therefore, if used, they should conform to the specifications given in SHTM 64: 'Sanitary assemblies' and HBN 00-02: 'Sanitary spaces'. Baths and birthing pools in Maternity units should be easy to clean and not of a ™Jacuzzi type.

Note: SHTM 64 'Sanitary Assemblies' and HBN 00-02 'Sanitary spaces' contain guidance to assist the design team in the selection, specification and application of sanitary assemblies in healthcare buildings. They also give guidance on the appropriate cleaning and maintenance regimes.

Wet rooms

6.25 These require high quality water-resistant cladding on walls to prevent mould.

Water fittings

6.26 Water fittings (washers, etc.) should not support microbiological growth. All fittings should satisfy the requirements of the Water Supply (Water Fittings) Regulations 1999.

6.27 Flexible hoses used in water supply systems should be identified and risk-assessed for the possibility of contamination with harmful microorganisms. Where flexible hoses must be used (for example, on essential equipment such as hi-low baths), they must be lined with a suitable alternative to ethylene propylene diene monomer (EPDM), and be Water Regulations Advisory Scheme (WRAS)-approved. Care should be taken to avoid kinking or distorting them during installation (see Health Facilities Scotland Safety Action Notice

SAN (SC) 09/03 Flexible water supply hoses risks of harmful micro-organisms and paragraph 11.35 of SHTM 04-01 Part A).

Ice for patient consumption

6.28 Where suitable for use, ice machines should be of a type that dispenses ice by a non-touch nozzle.

6.29 Ice should be made directly from water that is of drinking quality. Ice for the immuno-compromised should be made by putting sterile water into single-use ice-making bags, then into a conventional freezer.

Further guidance can be found in the Safety Action Notice (SAN) 06/46

Electrical services

Lighting

Note: Efficient lighting in all areas of wards or departments enables cleaning staff to undertake cleaning more effectively. The Chartered Institution of Building Services Engineers' LG2 – 'Healthcare and hospital lighting' gives guidance on lighting levels in healthcare facilities. SHTM 06-01 also refers.

Luminaires

6.30 Luminaires should be selected and installed to eliminate or minimise ledges/gaps/dust traps and, as far as is practicable, be accessible and easily cleanable.

Bedhead services

6.31 Bedhead services should be smooth, accessible and easy to wipe clean. Ledges, gaps and dust traps should be eliminated or minimised.

6.32 Sufficient dedicated 13-amp socket outlets should be provided in corridors and in individual rooms to enable cleaning appliances with 9m long leads to operate over the whole department.

6.33 Where possible, socket outlets should be provided flush-mounted or in trunking systems to enable easy cleaning and prevent the build up of dust.

Patient entertainment systems

6.34 Radio and TV headsets should be capable of being cleaned or disinfected between patient uses or be single use, whichever is the most economical method to adopt.

6.35 Risk mitigation measures should be considered, including the implications of power interruption when all electrical fittings are either non-touch of sensor operated.

Wastewater and sanitation

6.36 Wastewater is generated from a huge number of tasks carried out in healthcare buildings, which range from domestic cleaning, hand-washing, specialist laundries, surgical operations and areas such as renal dialysis units. Most of this wastewater contains pathogenic microorganisms and must be disposed of via a safely contained internal drainage system into the external waste water sewerage system.

Internal drainage system

6.37 An internal drainage system should use the minimum amount of pipe work, retain water and be airtight at joints and connectors. It should be sufficiently ventilated to retain the integrity of water seals.

6.38 The design should comply with the relevant British Standards and Codes of Practice, including BS EN 12056, Scottish Building Standards Technical Handbook and recommendations for spatial and access requirements for public health engineering services are contained in The Chartered Institution of Building Services Engineers' Guide G, 2014.

6.39 Provision for inspection, rodding and maintenance should be located to minimise disruption or possible contamination, eg access points should not be sited in clean clinical areas.

Bedpan washer-disinfectors/macerators

6.40 Where reusable bedpans are used, ward areas require adequate and suitable bedpan washer-disinfectors that comply with BS EN ISO standards 15883-Parts 1-3: 2009, IEC 610010-2-040: 2005 and SHTM 2030 Part 1, 2 and 3.

6.41 Where fitted, bedpan washer-disinfectors should be installed according to the Scottish Water Bylaws 2004 Part 2 (4) and using fittings listed on the Water Supply Regulations Advisory Scheme (WRAS) directory.

6.42 When considering installation of bedpan macerators, it should be established that both internal drains and the external sewerage system can cope with the model proposed.

6.43 Where recommended by the manufacturer reusable supports should be decontaminated in the washer disinfector. Further advice should also be obtained from the Infection Prevention and Control team.

Medical gases and vacuum systems

6.44 Scottish Health Technical Memorandum 02-01 gives guidance regarding piped medical gases and vacuum systems and includes recommendations on: emergency procedures; power failure; access for cleaning contaminated vacuum systems; training and communication; maintenance and infection risk.

Pneumatic air tube transport systems

6.45 Guidance for the design and management of pneumatic transport systems can be found in Scottish Health Technical Memorandum 08-04.

6.46 The pneumatic piping system should be designed to permit cleaning and disinfection of the tubing.

Computer equipment

6.47 Prior to purchasing computers or hand held devices which are to be used in clinical areas it is important that these must be able to withstand cleaning and disinfection compatible with the device. As with other equipment this should be monitored for signs of damage.

7. Importance of maintenance

7.1 Good design and equipment selection will ensure future maintenance is easy and cost effective. A planned maintenance system should be set up to start at the same time as handover or occupancy. A record of Planned Preventive Maintenance needs to be kept. Regular reviews of the building fabric should be undertaken as accidental damage to smooth surfaces makes effective decontamination difficult to achieve. The use of soft, difficult to decontaminate fabrics must be, as far as possible, avoided.

Access for maintenance

7.2 There should be adequate space to allow maintenance work to be carried out. Measures such as locating isolating or regulating valves or ventilation ductwork dampers and access panels outwith clinical or patient occupied areas (e.g. corridors) will reduce the need for unwanted intrusion by estates staff.

Reference should be made to SHTM 03-01 and SHTM 04-01.

8. Demolition

8.1 Work of this type will require a building warrant and a Decommissioning Team should be established. The Decommissioning Team usually needs to include a CDM Co-ordinator and consideration should be given to the likely spread of dust/dirt which the works will cause. Issues such as limitation of airborne fungal contamination need to be considered. (The role of CDM coordinator is currently under review by the Health & Safety Executive).

Decontamination of buildings and equipment

8.2 Reference should be made to records containing asbestos survey data before commencement of any activities. Buildings should be thoroughly cleaned after all furniture etc has been removed. Airborne decontamination methods should be considered to minimise the risk prior to demolition. Equipment should be decontaminated prior to reuse elsewhere or final disposal. The Decommissioning Team will have to risk assess health and safety issues with the advice of the CDM Co-ordinator and NHS Board's Health & Safety department.

Effect upon adjacent healthcare premises

8.3 There are health and safety issues which the Decommissioning Team will have to risk assess and consider with the advice of the CDM Co-ordinator. Additional cleaning may be required due to the additional dust likely to be caused. Ventilation filters in areas likely to be subject to a high airborne dust load should be checked and changed if necessary, prior to demolition works starting. An overloaded filter can collapse and cause contamination. Filters should also be checked and changed if necessary once work is complete.

Planning for demolition works

8.4 Prevailing wind direction and the distance of the demolition works from occupied areas are key considerations when planning demolition works.

8.5 The demolition Project Plan should contain details of measures to be taken to minimise contamination of other areas. The person responsible for each control measure should also be named.

8.6 On completion of the work, the success or otherwise of the control outcomes should be formally assessed and the lessons learned disseminated widely, including outwith the organisation, for the benefit of colleagues involved in similar projects.

8.7 There have been instances where hospital sites with dangerous materials such as healthcare waste and asbestos have disposed of these within the hospital site. Decontamination of the site intending to be disposed of is the responsibility of the owner, eg healthcare body. Contaminated land may need

to be disposed of as special waste and can be extremely expensive as the soil removed must also be classified as special waste.

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Appendix 1: Equipment groups

Equipment supplied for new building schemes can be one of four categories:

Group 1 items are specified at the design stage and are supplied and fixed under the terms of the building/engineering contract and funded within the works cost. These are generally fixtures and fittings or plant/equipment which are permanently wired/installed, e.g.

- sanitary fittings;
- specialised equipment items best suited to central purchasing arrangements;
- cupboards, worktops, shelving;
- excluded from this Group will be large medical equipment/fixtures and items subject to late selection or procurement by the NHS Board e.g. CT Scanners, Linear Accelerators, Autoclaves.

Group 2 Items are installed under the terms of building/engineering contracts, but are supplied or purchased by the NHS Board under a separate equipment budget. They may have implications in respect of space or building services e.g.

- paper towel dispensers;
- soap/scrub dispensers;
- washer/disinfectors;
- washing machines.

Group 3 Items are purchased directly by the Client and may have implications in respect of space, construction or engineering services e.g.

- small refrigerators;
- loose furniture;
- monitors;
- trolleys.

Group 4 Items may have storage implications but otherwise have no impact on space or engineering services e.g.

- small medical devices;
- computers, laptops;
- small loose equipment.

Appendix 2: Glossary

(Applicable to all parts of this Guidance)

Airborne (aerosol) transmission: The spread of infection from one person to another by airborne particles (aerosols) containing infectious agents.

Airborne particles (aerosols): Very small particles that may contain infectious agents. They can remain in the air for long periods of time and can be carried over long distances by air currents. Airborne particles can be released when a person coughs or sneezes, and during aerosol generating procedures (AGPs).

***Aspergillosis*:** A fungal infection caused by *Aspergillus* spp., commonly found in soil, decaying vegetable matter, damp cellars, building materials and ventilation systems. The most common mode of transmission is by the airborne route, for example dispersal of contaminated aerosol. In fact, airborne *aspergillosis* is a risk to patients with highly compromised immunity.

Cleaning: The process of physically removing contamination including soil, dust, large numbers of micro-organisms and the organic matter that protects them.

Cohorting: Placing a group of two or more patients (a cohort) with the same confirmed infection in the same room or area.

Cohort Nursing: Use of a dedicated team of healthcare staff to care for a cohort of patients, and who do not care for any other patients.

Contact transmission: The spread of infectious agents from one person to another by contact. This can be either direct contact, or indirect contact (via a contaminated object/fomite).

Contamination: The presence of an infectious agent on a body surface; also on or in clothes, bedding, toys, surgical instruments or dressings, or other inanimate articles or substances including water and food.

Cross-infection: The transmission of infection from one person to another.

Dead-legs: In a water supply and distribution system, pipes that are capped off or rarely used, or regions of pipework which are not scavenged by flow.

Disinfection: The reduction of the number of micro-organisms to a safe or relatively safe, level but not usually the destruction of spores.

Healthcare associated infections (HAI): Infections that occur as a result of medical care, or treatment, in any healthcare setting.

Heat labile: That which is likely to be damaged or destroyed by the normal heat disinfection process.

Immunocompromised patient: Any person whose immune response is impaired or deficient, usually because they have a disease or are undergoing treatment. People who are immunocompromised are more vulnerable to infection.

Indirect contact: A mode of transmission of infection involving fomites or vectors.

Non-touch (taps): Includes elbow/wrist operated or infrared sensor taps.

Pathogen: A bacterium, virus, or other micro-organism that can cause disease.

Reservoir (of infection): Any person, animal, plant, soil or substance, or a combination of these, in which an infectious agent can live and multiply, on which it depends primarily for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host: the natural habitat of an infectious agent.

Single room/En-suite single room/Isolation room/Bay: For the purposes of this document, the following terminology is used:

a. **Multi-bed room** is a room that contains more than one bed. It is best practice for these to have both en-suite toilet with shower, clinical wash-hand basin and doors to the main ward area;
b. **Single-bed room** is a room with space for one patient and usually contains as a minimum: a bed; locker/ wardrobe; and clinical wash-hand basin**. (NB: single-bed rooms without en-suite sanitary facilities are not recommended.)**;
c. **En-suite single-bed room** is the same as 'b' but with en-suite shower, WC and wash-hand basin. . (In new build, space for a social support zone for overnight stay and a clinical support zone is also provided);
d. **Enhanced Single room (with en-suite facilities)** this is the same as 'c' but with a ventilation system that prevents uncontrolled escape of infectious aerosols from the room to adjacent areas. It can also provide a degree of dilution of infectious aerosols in the room for the safety of staff and visitors. The room should have extract ventilation that exceeds its supply, such that gaps in its fabric leak inwards not outwards;
e. **Enhanced Single room (with en-suite facilities and ventilated lobby)** this is the same as 'd' but with a lobby having positive pressure ventilation.

Spore: Some species of bacteria, particularly those of the genera *Bacillus* and *Clostridium*, which are significant cause of infection in humans, develop highly resistant structures called spores when they are exposed to adverse conditions, such as a lack of nutrients or water. Spores are resistant to disinfectants and to high or low temperatures. They may remain viable for many years until environmental conditions improve, the spores germinate and the bacterial cell inside starts to multiply again.

Sterilisation: The process of removing or destroying micro-organisms including spores, usually by heat or chemical means.

Thermostatic mixing valves: Valves that mix the hot and cold water of the system to provide water at a predetermined temperature.

Appendix 3: Infection control in Community Care facilities, Mental Health units, custodial facilities and accommodation for patients with learning disabilities.

3/1 The need to minimise the risk of cross-infection remains important in accommodation of these types, but other factors such as maintaining a homely ambience, ligature risks and the creation of a positive therapeutic environment will need to be taken into consideration.

3/2 The IPC requirements for those using mental health environments should be made in conjunction with health and safety teams, risk management teams and clinicians when advising on the built environment. Specific design guidance for mental health units comprises SHPN 35, Health Building Note 03-01 – 'Adult acute mental health units'. Additionally, the Department of Health's Environmental Design Guide: Adult Medium Secure Services should also be consulted.

For dementia settings, additional considerations are discussed in the "dementia design checklist" (Health Facilities Scotland, 2007).The University of Stirling's Dementia Services Development Centre has also produced guidance on Design Features to assist patients with dementia in general hospitals and emergency departments.

Recommendations

3/3 Creating/maintaining a non clinical feel to the environment can be achieved by using furnishings and fittings that are manufactured especially for this setting, and are easy to clean and maintain. For example, wood-effect vinyl can be used to create a less clinical environment, but cleanliness can be maintained. Vinyl is easy to maintain and will require less frequent replacement.

3/4 In some specialties for example where there is a potential for self harm, vitreous china (porcelain) basins and toilets would present a risk to a vulnerable patient; alternatives such as resin or stainless steel should be considered. Cleaning of these materials should, however, be considered carefully.

3/5 There should be sufficient access to hand hygiene facilities for staff. Siting of clinical wash-hand basins should be carefully considered and may need to be restricted to supervised areas such as the clean utility room, treatment rooms and dirty utility room. In addition, the provision of staff-held hand gel is essential. Where necessary, the use of patient wash-hand basins in en suite rooms can be used with care to avoid recontamination of hands.

3/6 Where required in the likes of secure mental health units, hand dryers or vandal-proof integral hand-wash dryers in communal toilets may provide a safer option for hand hygiene while encouraging those in the service to clean hands.

3/7 Where single rooms are used for source isolation, risk assessment should inform the storage of protective clothing, soap and paper towels, healthcare waste receptacles etc. Risk assessment will determine the need for fixtures and fittings to be of the anti-ligature type. It should be noted that where rooms are used for isolation it is acceptable for the room to contain only a healthcare waste receptacle. Receptacles (bins) for other streams such as recyclates and residual waste are not required and should be discouraged.

3/8 Assessment of the need for a macerator or bedpan washer-disinfector should be undertaken. If a specific dirty utility room is not required, alternative procedures should be in place.

3/9 DH's 'Environmental design guide: adult medium secure services' advises on floor coverings to reduce risk of harm to self or others.

3/10 Consideration should be given to the use of underfloor heating where patients are susceptible, vulnerable or of low sensitivity. There is a need, however, to allocate space to accommodate above-floor manifolds and such systems can be slow to react to changes in temperature requirements due to inherent inertia.

3/11 Design guidance on storage space for Patients belongings can be found in SHPN 04, SHPN 35 and HBN 03-01.

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SHFN 30
Part B: HAI-SCRIBE

Implementation strategy and assessment process

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Preface

Collaboration among Capital Planners, Infection Prevention & Control Teams, Clinical staff, Design Teams and Estates & Facilities Teams is the key to ensuring that infection control risks are highlighted, managed and mitigated.

Scrutiny of this guidance will highlight the frequent use of the word "Partnership". Successful use of HAI-SCRIBE requires participation and cooperation particularly between Estates & Facilities staff and Infection Prevention and Control Teams.

To manage or mitigate the risks highlighted through use of HAI-SCRIBE requires knowledge from many sources. However, it is not expected that any group will possess full knowledge or experience of another's discipline. It is expected, therefore, that there will be an ongoing liaison during each stage of development where appropriate specialist knowledge from all sources of relevant expertise can be derived and incorporated into the project briefing, contract conditions, specification, and quality control of construction and maintenance.

The principal stages of development of any healthcare facility comprise:

- consideration of the proposed site and relevant implications;
- design and planning;
- construction and refurbishment;
- ongoing maintenance.

Note: The Scottish Government's 2020 Vision is that by 2020 everyone should be able to live longer healthier lives at home, or in a homely setting. It states that when hospital treatment is required, and cannot be provided in a community setting, day case treatment will be the norm.

Good infection prevention and control to reduce the spread of infection is no less important in these community-based settings so an extension of this guidance to these settings, when appropriate, would appear to be a logical progression. However, there is a perception that conditions in community-based settings could potentially be less demanding than in an acute setting. Additionally, there is an awareness of the need to project a more homely environment. Despite these views, the need to minimise the risk of cross-infection is no less important in community health settings than in the acute sector, but other factors such as creation of a homely environment will need to be taken into consideration when managing the risks associated with the prevention and control of infection.

HAI-SCRIBE: a point of reference

This document introduces the main components of HAI-SCRIBE and identifies the steps required to ensure that HAI-SCRIBE is successfully utilised and implemented and that the assessment process is carried through.

Note: This document can provide an insight to the key factors within the built environment which can impact on prevention and control of infection. It is intended as a point of reference for healthcare estates and facilities managers, designers, project managers, contractors, engineers, surveyors, health planners and Infection Prevention and Control Teams working on healthcare estate new build and refurbishment projects. It will also be useful as a guide for best practice in existing healthcare facilities.

This guidance consists of two parts:

- **SHFN 30 Part A: Manual**: This provides Built Environment Infection Prevention and Control information for Design Teams, Construction Teams, Infection Prevention and Control Teams and Estates & Facilities Teams.
- **SHFN 30 Part B: HAI-SCRIBE:** comprises the Implementation and Assessment Process which describes the process for identifying, eliminating or managing built environment infection control risks. It also describes the key personnel involved in this process together with their roles and responsibilities and the fact that collaboration among all those involved in the process is pivotal to its success.

It is envisaged that participants will use the HAI-SCRIBE document (SHFN 30 Part B) to help them identify, manage and record built environment infection control risks. The same Group will use the Manual document (SHFN 30 Part A) on sourcing information to help in the decision making process so that identified risks can either be eliminated or successfully managed.

Questionsets and Proformas

Arrangements have been made to make available on the HFS Website, separately, the portfolio of Questionsets and Pro-formas for each stage of project development suitable for photocopying and application to individual projects as appropriate.

1. Setting the scene

Healthcare Associated Infection

1.1 Healthcare Associated Infection (HAI) is the term used to describe infections that occur as a result of medical care, or treatment, in any healthcare setting. It is seen as a widespread issue and the prevention and control of these infections is a priority issue for NHSScotland.

1.2 Infection originating or spread in hospitals and other healthcare facilities is recognised as a serious and widespread problem. Although standards of hygiene in healthcare facilities and standards of personal hygiene have been identified as potential sources of infection and infection spread, it can also be said that the design, planning, construction, refurbishment and ongoing maintenance of a healthcare facility also have an important role to play in the prevention and control of infection. For example, controls can be designed-in and risks designed-out such as extending wall storage units right up to ceiling level to avoid having the potential build up of dust on high level ledges that are difficult to clean.

The Challenge

1.3 Patients using healthcare facilities are more likely to be immuno-compromised and also more likely to receive intensive medical interventions, which in turn increase their vulnerability to opportunistic infections. Every effort must be taken to acknowledge and ultimately reduce these risks. This includes risks associated with the built environment that can arise from, for example, demolition, construction and refurbishment activities.

1.4 Research and investigation have consistently confirmed that the healthcare environment can be a reservoir for organisms with the potential for infecting patients, whether internally or from external sources (via openable windows or fresh air intakes). For HAIs to be reduced, it is imperative that Infection Prevention and Control (IPC) measures are “designed-in” and IPC risks are “designed-out” at the very outset of the planning and design stages of a healthcare facility and that input continues up to, into and beyond the final building stage. Inevitably, there will be residual risks which will require identification, registering and monitoring.

1.5 To achieve this, it is necessary that designers, architects, engineers, facilities managers and planners work in collaborative partnership with IPC teams, healthcare staff and the users to deliver facilities in which IPC needs have been anticipated, planned for and met.

Note: HAI-SCRIBE is an acronym for **H**ealthcare **A**ssociated **I**nfection **S**ystem (for) **C**ontrolling **R**isk **I**n the **B**uilt **E**nvironment. The procedure has been developed as a framework for these groups to work together to identify, manage and mitigate issues in the built environment impacting on infection prevention and control risks.

Throughout this document, the term 'Project Team' is referred to. The term describes the team of NHS Staff assembled to fulfil the role of 'The Client' and to manage the delivery of the project. Through the various stages of the project it may include NHS Project Managers, Clinicians, Estates Staff and Infection Prevention and Control specialists.

This would be best achieved with the establishment of a Project Team with HAI-SCRIBE procedures as part of their responsibilities. (The note box above and Paragraphs 1.8 and 2.1 to 2.4 also refer).

1.6 HAI-SCRIBE aims to ensure that IPC measures are not only designed-in but also maintained throughout the lifetime of the healthcare facility. It also aims to highlight potential IPC risks so that these can be designed-out. This is achieved through identifying the infection control risk associated throughout each of the following stages of lifecycle of the healthcare facility.

- Development Stage 1 - consideration of the initial brief and **proposed site for development.** This coincides with Business Case Stage: 1A**;**
- Development Stage 2 - **Design and planning;**
- Development Stage 3 - **Construction and refurbishment;**
- Development Stage 4 - **Pre-handover check, ongoing maintenance and feedback.**

(Many maintenance-related projects do not necessarily go through this approval process but the need for collaboration remains undiminished).

1.7 The purpose of HAI-SCRIBE is to provide a framework around which potential risks associated with the proposed site development, design and planning, construction/refurbishment and ongoing maintenance of Healthcare Facilities can be identified assessed and subsequently managed or mitigated.

1.8 To facilitate this and for ease of use the Implementation Strategy document is divided into three key parts which describe the activities associated with its use, namely;

Part A Assembling the Project Team with HAI-SCRIBE forming part of its responsibilities.

Part B Assessing the risk via use of Questionsets (1) – (4).

Part C Gathering the information to inform dialogue. NB: This is set out in the planning and design manual (SHFN 30, Part A) which accompanies this document.

Getting Started - preparation

1.9 It is important that the following procedures are followed:

- always consult the Estates & Facilities Management and Infection Prevention and Control Team at an early stage:
  - whenever refurbishment is planned;
  - whenever major capital bids are planned;
- do not wait until patients are ready to move in;
- do not wait until fixtures, fittings and furnishings have been purchased;
- do not let immediate cost or space consideration override reason or functional requirements;
- long-term value for money/risk reduction considerations should prevail.

Note: The best products or designs may be more expensive initially but in the long term they will probably realise cost benefits as they may prevent outbreaks. They may last longer, require less maintenance and be more durable.

Who should implement HAI-SCRIBE?

1.10 Successful use of HAI-SCRIBE is dependent on meaningful and ongoing dialogue and exchanges of information generated from representatives from Infection Prevention and Control and Estates & Facilities Managers, Project Managers and construction professionals who can contribute individual and relevant expertise in their own disciplines. Their active partnership and participation is essential. Similar dialogue is necessary when these parties are not involved, such as routine or periodic maintenance activities.

Note: NHS Boards' internal governance should identify who is responsible for implementing or taking ownership of HAI-SCRIBE procedures. These procedures may vary among NHS Boards. Typical NHS Board organisational structure is provided in Appendix 9.

1.11 It is recognised that the risks identified from the design process will be competing against other risks identified via other risk management processes. Consideration and prioritisation of all risks identified will have to take place.

1.12 Implementation of HAI-SCRIBE should be the responsibility of a specialist multi-disciplinary professional team who possess the necessary skills in relation to the healthcare facility being planned, designed, constructed, refurbished or maintained. The multi-factorial nature of projects and activities dictate the need for a multi-disciplinary team and include an array of both healthcare professionals and contractor personnel where appropriate to take ownership of relevant documents and risk assessments throughout each stage. It is essential, however, that all members of the assembled Team have a

background understanding of the principles of prevention and control of infection in the built healthcare environment for the specific project.

1.13 There are instances where the need to implement HAI-SCRIBE assessments will not be obvious (e.g. external works, offices, laboratories). Any decision to do so should be based on the impact any works would have on accommodation in the nearby area used for patient care.

1.14 The services of a member of administration staff will be helpful in providing administration support to members of the Project Team throughout the project.

1.15 Project Teams should not succumb to unacceptable pressures of time and financial expenditure that would compromise decision-taking and clinical outcomes. It is essential that proposals should be signed-off by the Project Team before any start on site.

1.16 It is essential that members of the Project Team including the Project Manager should be aware that externally funded projects have the potential to proceed without prior knowledge of Infection Prevention and Control specialists or representatives of Estates and Facilities department and Project Managers. This must not be allowed to happen.

Refurbishment issues

1.17 Implementation of HAI-SCRIBE is aimed at all personnel who may be involved in providing not only new build, but also refurbished or extended healthcare establishments.

Note: For the avoidance of any doubt, there is a clear demarcation between “redecoration” or “refreshing of accommodation” and “refurbishment”. The need for input from Infection Prevention and Control specialists should be verified when upgrading of facilities is limited to cosmetic attention as even in these circumstances attendant activities could generate risks from dust generation or disruption to air or water systems or switchgear.

1.18 Any of the following “refurbishment” activities would have the potential to generate dust. This is not an exhaustive list:

- removal of lay-in or screwed-in ceiling tiles from a suspended ceiling grid;
- unscrewing of service ducts access panels;
- unscrewing of panels forming part of integrated plumbing systems and general services concealment;
- removal of protective covers from radiators;
- lifting and replacement or repair of floor coverings;
- drilling masonry or plasterboard walls;
- replacement of door-sets;
- drilling through plasterboard partitions;

- replacement of sanitary fittings;
- removing or patching thermal insulation on pipes and ducts;
- raggling of plastered walls;
- general hammering;
- sanding and planing of surfaces;
- plasterwork, (new work, patching and repair);
- removal of redundant electrical socket outlets;
- dismantling luminaires;
- dismantling grilles and diffusers;
- inadequate sealing of ductwork serving adjacent areas during modifications;
- bagging and disposal of debris.

Note: Any premises constructed pre-2000 have the potential to contain asbestos as part of the fabric (e.g. thermal insulation, suspended ceiling tiles, thermo-plastic floor tiles, etc.) This would be confirmed in the NHS Board's Asbestos Management Plan where presence and condition of asbestos containing materials (ACMs) should be recorded.

1.19 Events such as the generation of dust or disruption to a facility's air or water system have the potential to spread micro-organisms. These could disperse, if not checked, into adjacent areas where patients may continue to be treated. It can be seen that advice from and liaison with Infection Prevention and Control specialists is essential under these circumstances whereas this would be less likely when work is restricted to redecoration. As individual circumstances could vary from site to site, all such work in or adjacent to patient treatment accommodation should be risk assessed and appropriate precautions implemented.

Note: Appendices 6 and 7 show in flow chart form, the procedures to be followed where demolition work or removal of fixed structures is involved where moderate or high levels of dust can be expected. Appendices 4 and 5 show the procedures for activities where little or no dust is generated.

1.20 Given that NHS procurement can be by Framework, Non-Profit Distribution (NPD) or HUB essentially to achieve a transfer of risk from public to private sector, it should be noted that its application to existing premises subject to refurbishment or alteration will entail risks that cannot be predicted with certainty. Therefore cost effectiveness will be difficult to predict.

1.21 Advances in technical and therapeutic methodologies are among the range of factors which present further challenges in relation to control of infection. Organisms with antimicrobial resistance have become a major public health threat, making infection occurring within healthcare premises increasingly difficult to treat. Infection originating in hospitals and other healthcare facilities

is now recognised as a serious and widespread problem. The physical environment has to assist, not hinder, good practice.

1.22 Routine maintenance should follow the NHS Board's Standard Operating Procedures (SOPs) for the various applications and departments. SOPs should in themselves be subject to risk assessments which may be iterative reflecting changes in parameters. NHS Boards have developed HAI-SCRIBE method statements for common, repetitive, activities which allow common tasks to be risk assessed and generic control measures put in place. Communication between Infection Prevention & Control and Estates staff when this process was being carried out is still necessary.

The neighbourhood environment

1.23 Neighbourhoods change whereby new or extended industries and commercial operations could have been developed since initial assessment of the site. The Capital Planning managers of the healthcare facility need to be alert to this as it may present a new HAI risk.

Record keeping

1.24 A detailed record of the initial application of HAI-SCRIBE and all subsequent applications and reviews must be kept in legible writing and be available for reference, retained in a central register and an audit trail maintained highlighting good and bad practice. The records of the applications of HAI-SCRIBE and the regular reviews of the system should be available for the appropriate management group of the healthcare facility. This may be the NHS Board's risk management steering group headed by the Chief Executive Officer which addresses risk management. However, this arrangement may vary from Board to Board. There should also be checks to ensure that control measures are being adhered to; these should also be recorded.

1.25 Internal governance should ensure that records are kept of out-of-hours working and any contractors involved. This should also identify who oversees the HAI-SCRIBE processes.

Works involving low risk

1.26 In attempting to differentiate between minor and major works in the context of applying the correct level of HAI-SCRIBE procedures, this will come down to the project's complexity or impact of activities, rather than size or extent. It is not always appropriate to follow the entire HAI-SCRIBE processes when dealing with small scale and minor works projects, Figure 1 on the following page comprises a decision-making tool for evaluating the extent of proposed activities and their impact. It might be helpful to maintain an ongoing log of activities. A typical exemplar for minor works is shown in Appendix 8.

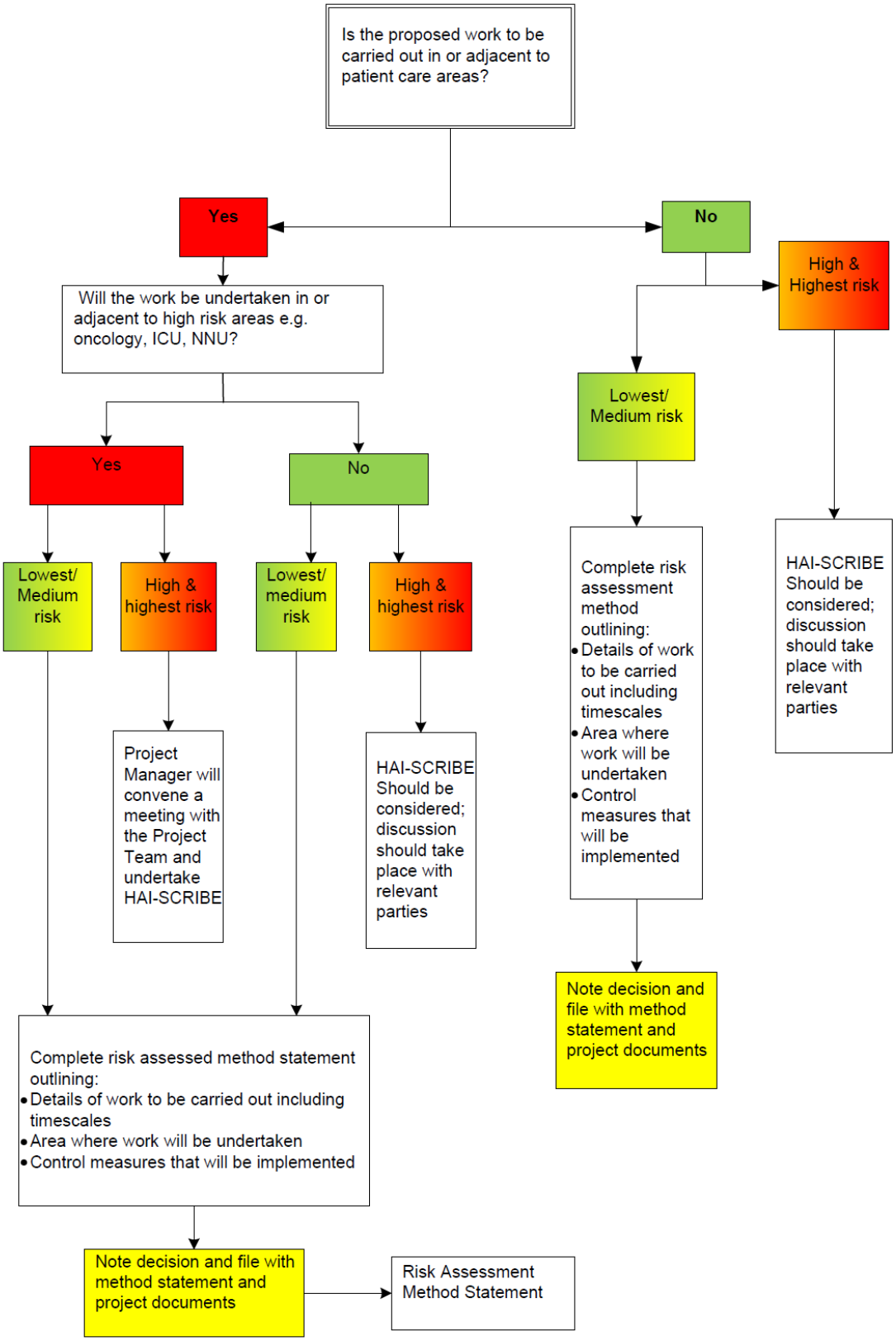


Figure 1: Decision-making tool for evaluating need for Minor Works and Small Repairs

Note: Consideration could be given to employing proformas such as contained in the following Appendices:

Appendix 1: Pre-start and construction proforma for particulars of project comprising a routine reporting procedure for submission to the Project Team before and during works setting out performance checks and assessment of hazards.

Appendix 2: Commissioning stage proforma comprising contract particulars setting out requirements prior to commissioning activities.

Appendix 3: Permit-to-work form comprising particulars, processes and criteria relative to the issue of Permits-to-Work, where required.

Appendix 4: Flow chart for work stages and procedures associated with minor works and small repairs in areas categorised as High, Medium and Low Risk.

Appendix 5: Ditto for small scale works.

Appendix 6: Ditto for works involving removal of fixed structures or where moderate to high levels of dust are generated.

Appendix 7: Ditto for major demolition and construction.

Appendix 8: Overview exemplar comprising typical monitoring spreadsheet for minor works.

Appendix 9: Gives an example of a Typical NHS Board organisational structure.

Appendix 10: Overview exemplar of a completed questionset.

1.27 Whatever risk designation is agreed, there will be a need for the NHS Board to re-visit the project prior to handover to verify that the brief has been completely fulfilled.

Note: Common maintenance tasks should be assessed and method statements produced setting out how to manage risks. There should be no need to reassess every time the same task is repeated unless parameters change such as working in a low risk patient group risk area and then in a high patient group risk area.

2. Part A

Assembling the Project Team

2.1 This part of the documentation sets out the responsibilities of all those involved in implementing HAI-SCRIBE and the processes to be employed in doing so.

Responsibilities in relation to HAI-SCRIBE

2.2 The successful implementation of HAI-SCRIBE requires input from a wide range of professionals including Managers, Facilities Staff, Planners, Infection Prevention and Control Staff and Clinical Staff. Overall responsibility for ensuring the implementation of HAI-SCRIBE is determined by the Development Stage as indicated in the following text. Some NHS Boards may wish to give responsibility to another project team member. In such instances it is important that the responsible person for each stage is named.

Development stage

- Stage 1: “Initial brief and Proposed site for development” - the responsible officer is the Project Owner/Sponsor;
- Stage 2: “Design and planning stage” - the responsible officer is the Project Manager;
- Stage 3: “Construction and refurbishment” - the responsible officer is the Project Manager;
- Stage 4: “Pre-handover check (carried out by the Project Team) and ongoing maintenance” (carried out by the Estates team).

2.3 For Capital Project and Refurbishment schemes, the Project Team will have been assembled already. HAI-SCRIBE implementation will be one of their responsibilities as part of ensuring that an accurate design brief is developed. Regular meetings and communication with stakeholders in the Team to discuss design, tendering, build and commissioning will ensure the facility is functionally suitable and fit for purpose. This will ensure that due attention is paid to prevention and control of infection risks for subsequent elimination or mitigation.

Who should lead?

2.4 The allocation of the lead role will be a function of the type, size and complexity of the project, its adjacency to sources of contamination (known or suspected), its proximity to other operational departments and the type of patients being treated. Priorities will vary depending on these issues. The principal role of the designated leader of the Project Team is to ensure that the most appropriate representation is achieved with specialist knowledge provided when it is required.

2.5 The following suggested activities and allocation of responsibilities are offered for guidance.

Project Owner/Sponsor

2.6 In ensuring that HAI-SCRIBE is completed for all major Development Stage 1 Projects, the Project Owner/Sponsor shall:

- identify an appropriate individual to lead the HAI-SCRIBE process;
- ensure that a formal risk assessment is undertaken by a designated clinical member of the Project Team in relation to the risk to patients for all construction activity. This is in addition to the HAI-SCRIBE Risk Assessment and should be recorded with an entry made in the risk register;
- ensure that the risk assessment includes the identification of "particularly at risk" patients and that designated clinical members of the Project Team will generate options for care. The rationale for deciding upon a course of action should be recorded and reviewed on a regular basis throughout the contract period;
- ensure that key personnel are involved in undertaking HAI-SCRIBE i.e. Infection Prevention and Control, Health & Safety and other specialist advisors as necessary. As a minimum at Stage 1, representatives from the Project Manager, Infection Prevention and Control, Health & Safety, Estates, Clinical Environment, Domestic Services and Fire Safety should be in attendance;
- ensure that HAI-SCRIBE documentation has been signed-off by key representatives involved in the process;
- ensure that the requirements identified by HAI-SCRIBE are incorporated into the contract documentation including a requirement that the contractor signs a specific statement relating to the implementation of HAI-SCRIBE and that it is adhered to during the project.

HAI-SCRIBE Project Manager

2.7 The main responsibilities of the Project Manager are:

- taking ownership of and leading the HAI-SCRIBE process;
- ensuring that HAI-SCRIBE is completed for all **Development Stage 2, 3 and 4** projects;
- identifying appropriate individuals to undertake the HAI-SCRIBE process;
- ensuring that a formal risk assessment is undertaken by a designated clinical member of the Project Team in relation to the risk to patients for all construction activity. This is in addition to the HAI-SCRIBE Risk Assessment and should be recorded with an entry made in the risk register;
- ensuring that value for money in capital and life cycle costs are taken into account;

- ensuring that the risk assessment includes identification of "particularly at risk" patients and that designated clinical members of the Project Team will generate options for care. The rationale for deciding upon a course of action should be recorded and reviewed on a regular basis throughout the contract period;
- ensuring that key personnel are involved in undertaking HAI-SCRIBE i.e. Infection Prevention and Control, Health & Safety and other specialist advisors as necessary. As a minimum at Stage 2 and 3, representatives from the Project Manager, Infection Prevention and Control, Health & Safety, Estates, Clinical, Environment, Domestic Services and Fire Safety should be in attendance. This applies to major projects;
- ensuring HAI-SCRIBE documentation has been signed-off by all key representatives involved in the process;
- ensuring that the requirements identified by HAI-SCRIBE are incorporated into the contract documentation, including a requirement that the contractor signs a specific statement relating to the implementation of HAI-SCRIBE and that it is adhered to during the project;
- ensuring that systems are in place to monitor contractors' compliance throughout the duration of the project, including documented evidence of compliance with agreed monitoring arrangements;
- exercising authority to stop work if there is a breach of any infection control preventive measures during construction or refurbishment;
- reporting any issues on the risk management system (e.g. Datix) from ongoing activity that may affect HAI-SCRIBE and require re-assessment. Datix investigation must clearly identify causes and assurance that these will then be managed accordingly;
- ensuring that the HAI-SCRIBE assessment is reviewed should there be any significant changes to the management of the project;
- keeping a record of the initial application of HAI-SCRIBE and all subsequent applications and reviews for reference in a central register.

Estates/Facilities Manager/Maintenance (Soft FM and Hard FM)

2.8 The above responsibilities undertaken by the Project Manager include involvement of the Project Team in the HAI-SCRIBE process. This will include full briefing of the Estates Manager. Where no Project Manager is appointed the person authorising the work will assume the main responsibilities.

The Estates/Facilities Manager must also keep the Project Team up-to-date on new projects where the project work itself potentially increases the risk of HAI as determined by the Infection Prevention and Control Risk Assessment for the Project as specified in HAI-SCRIBE.

- Other responsibilities of the Estates/Facilities Manager:
  - **Partnership Working** with the Infection Prevention and Control specialists and other members of the Project Team and designers;

- **Communication** with the Infection Prevention and Control specialists to keep everyone up to date on all new projects where the work potentially increases the risk of HAI;
- **Safe methods of working** - ensuring that all visiting contractors work safely in the existing healthcare environment.

Note: 'Turnkey' procurement arrangements occur where the supplier carries out everything for the project and enables the user to "turn the key". This kind of arrangement would apply for, say, a supplier of an X-ray machine who would be handed a 'stripped-out space' in which they would fit out an X-ray room with power, lighting and other services from identified interface points on the services installations, provide and install floor coverings, wall panels and ceilings, connect up and commission the room, the machine and all the supply systems before handover to the user with manuals etc. Typical applications would comprise MRI installations, CT Scanners, Linear Accelerators and other large pieces of specialist equipment such as Sterilisers, etc.

Infection Prevention and Control

2.9 The main responsibilities of Infection Prevention and Control specialists are:

- advising the Project Team on the principles of infection prevention and control of infection as applied to the built environment;
- contributing to risk assessment and providing advice on infection risk to susceptible patients;
- contributing to advice and guidance on control measures to be implemented;
- advising Project Manager/Estates Manager as to the need to stop work where infection prevention and control measures have not been adequately implemented or have failed;
- providing education on infection prevention and control measures to relevant staff involved in the project where required;
- determining with the Project Team and Health & Safety representatives a suitable and sufficient dust monitoring methodology for each project;
- assisting in the review of all HAI-SCRIBE assessments within agreed timescale.

Health and Safety

2.10 The main responsibilities of Health & Safety representatives are:

- advising the Project Team on the principles of risk assessment as applied to the built environment;
- contributing to the risk assessment process and providing advice and guidance on control measures to be implemented;

- inspecting the construction site in order to evaluate on-site health and safety competence of contractors employed where the risk has been determined as significant;
- advising the Project Manager/Estates Manager of the need to stop work where health and safety measures have not been adequately implemented or have failed;
- providing education on health and safety risk management and control measures to relevant staff involved in the project where required;
- contributing to and understanding the roles of the various members of the Project Team;
- assisting in the review of all HAI-SCRIBE assessments within agreed timescales.

Note: To ensure compliance with HAI-SCRIBE procedures during the construction/refurbishment phase it is recommended that a Supervising Officer is designated by the NHS Board with the remit of recording deviations, liaising with Infection Prevention and Control Specialists and given delegated authority immediately to stop work or advise the Project Manager of the need to do so until remediation has been satisfactorily completed, this may be the Project Supervisor.

Lead Consultant/Architect (if appointed)

(NB: Parts of these responsibilities can be undertaken by the Project Manager)

2.11 The main responsibilities of the Lead Consultant/Architect/Design Team are:

- facilitating partnership working with the Infection Prevention and Control specialists, Estates and Facilities Managers and other members of the Project Team;
- ensuring outcomes of HAI-SCRIBE are incorporated into the design of the building;
- ensuring design enhances the prevention and control of infection;
- ensuring that materials utilised are suitable and enhance the prevention and control of infection;
- ensuring compliance with professional standards, NHS guidance and statutory regulations in development and design;
- maintaining up to date knowledge and understanding of infection prevention and control principles.

Note: The Lead Consultant and Design Team should consider the views of all relevant healthcare personnel into the final design of the new healthcare facility. In addition, the timescale involved to plan a new healthcare build or refurbish an existing establishment can vary from a short period of a few months in the case of a small refurbishment to as long as three or four years for a major capital project.

It is important that Infection Prevention and Control teams are notified of potential projects or contracts awarded, at the earliest possible opportunity. This applies irrespective of the form of contract adopted or whether in-house facilities or consultant or contractor design teams are employed.

Every consideration should be given to the quality of composition of the Design Team. Selection of Design Teams entirely, or primarily, on cost is contrary to public sector procurement requirements which demand a best-value approach. Architects and Designers for healthcare projects must be suitably experienced in terms of their knowledge and understanding of prevention and control of infection**.** Deficiencies in knowledge of or experience with HAI-SCRIBE will be informed by interview and should be determined during the pre-qualification stages *prior to appointment*. In Non Profit Distribution (NPD), HUB and Framework Projects the appointment of designers is through the Contractor team. It is therefore essential that those responsible for appointments are acquainted as to these issues and that the NHS Board takes account of the Contractor's selected designers and their relationship with and attitude towards them.

Lead Contractor/Contractors

2.12 The main responsibilities of the Contractor, under this guidance, are:

- coordinating and advising the Infection Prevention & Control Team to assist in identifying potential risks and control measures prior to and during construction;
- incorporating and coordinating above in pre-construction H&S Plan and construction method statements to enable safe working during works;
- regular monitoring of risks, control measures and documentation; updating as project develops to ensure continuous safe working during and after works.

The above may also include post-completion works, e.g. snagging and latent defects.

Note: The Lead Contractor is the representative of the team responsible for delivering the works. In most cases this is also the 'Principal Contractor' as defined in the Construction (Design and Management) Regulations 2007. This requires a Principal Contractor and a CDM Co-ordinator to be appointed if a project is notifiable. Construction is notifiable if it lasts more than 30 working days or involves more than 500 person-days (for example 50 people working over ten days). In smaller projects, this may be the site manager of the firm contracted to deliver the works. The works may include construction, demolition, repairs and /or maintenance.

NB**:** The role of CDM Co-ordinator is currently under review by the Health & Safety Executive.

Domestic Services Manager/Soft Facilities Manager

2.13 The main responsibilities of the Domestic Manager are:

- ensuring that staff are monitoring dust levels and advising when increases in dust levels occur;
- advising on any additional cleaning requirements required, either within the area in which the work is being undertaken or adjacent areas;
- advising on cleaning required from contractors on completion of work and prior to hand over;
- advising on and ensuring that cleaning required from domestic services is undertaken after handover and before the area is put into use.

Departmental Representatives

2.14 Key healthcare staff, currently working in relevant wards and/or departments, should be involved in the project from the earliest opportunity to ensure that the needs of patients and staff are taken into consideration when planning the new or refurbished facility.

- Main responsibilities of the Ward/Departmental representatives:
  - **Partnership Working** with the Infection Prevention and Control specialists and other members of the Project Team;
  - **Patient safety** - awareness of the patient population and the potential health risks that may occur during a project;
  - **Special precautions** - require to be identified to mitigate risks for specific patient groups e.g. patients who are immuno-compromised or who have underlying medical conditions;
  - **Fit for Purpose** - advice on the new facility being functionally suitable for healthcare delivery and patient use.

Note: The required input from the various representatives will be at varying levels dependent on the type of accommodation being provided and during various stages of design development and construction.

Minimising infection risks

2.15 A variety of measures will contribute to the prevention and control of infection. However, despite every best effort, not all infections are preventable. Resources must be directed towards minimising the risk where infection can be prevented and facility design plays an important role in achieving this. HAI-SCRIBE can be applied to other operational areas of NHSScotland.

2.16 There are three key steps involved in HAI-SCRIBE:

- identifying the hazard;
- assessing the risk from the identified hazard;
- managing the risk to eliminate or minimise its impact.

2.17 The application of these three key steps of HAI-SCRIBE is aided by a range of questions set out in Section 3 which are appropriate for particular development stages of the healthcare facility.

Note: Care needs to be taken to ensure that the System does not solely become a mechanical 'box-ticking' exercise, but rather a rigorous questioning and auditing of proposals and of operating facilities.

2.18 In assessing the risk from the identified hazards, and in determining how to manage the risk to eliminate or minimise its impact, the nature of exposed population is a critical consideration.

2.19 In most cases there will be no option but to manage the risk to eliminate or minimise its impact. Health economics will inevitably be applied by the management of the healthcare facility in circumstances where there are several competing bids for resources and where those with an infection risk have a number of options suggested for the management of the risk. In such cases, the assessment of risk and the measures necessary to manage the risk must be evaluated carefully as part of the health economics decision-making.

2.20 This dedicated Project Team should be representative of the appropriate specialists but small enough in number to ensure effective decision-making.

2.21 Implementation of HAI-SCRIBE requires an accurate record of the process of hazard assessment and risk management which is essential 'due diligence' information.

2.22 Records of the applications of HAI-SCRIBE and the regular reviews of the System should be reported to the Project Manager of ongoing work.

2.23 In circumstances where HAI-SCRIBE is being applied to the site for a proposed development, design and planning, or the construction of a new- build

healthcare facility, the Project Board needs to be advised of the outcome. In cases where it is being applied to the refurbishment or operational management of an existing healthcare facility, the organisation's risk management steering group should be advised of the outcome of the HAI-SCRIBE applications on an annual basis.

Summarising

2.24 The following questions should be answered:

- have all members of the multi-disciplinary Project Team been identified?
- has it been confirmed that all members of the Project Team have background knowledge and access to specialist knowledge in infection prevention and control?
- has a person been identified who will lead on HAI-SCRIBE assessments?
- have full telephone and e-mail contact details been obtained to confirm full commitment and availability to participate in the project?

Note: Do not proceed to the questionsets within the next Step until you can answer "**Yes**" to the above questions.

3. Part B

Assessing the risk via use of Questionsets

3.1 The assessment process has been developed into a series of questionsets for each of the four stages of development. It will be noted that, although the framework and process for each stage is broadly similar, the construction and refurbishment stage poses particular problems arising from dust and other pollutants which could potentially impact on nearby facilities for ongoing patient care. Much of the content of the questionsets for the post-construction stage will refer to decisions already taken but should be revisited to allow responses to verify that they were correctly implemented and maintained in optimum condition.

3.2 The various questionsets forming part of the assessment process are set out for self-assessment. All questions in each of the Development Stages of HAI-SCRIBE should be answered.

Note: It is expected that many of the questions will have a 'Yes' response but the process should not be regarded as a 'box ticking' exercise.

3.3 Each "Yes" or "No" answer should be backed up with additional written information relevant to the particular question, as some questions may require further consideration. Such information will be useful for reference at different stages of a new build project. (A worked example of a Development Stage 1 Questionset is contained in Appendix 10).

3.4 For example, if answering 'Yes' to the following question at Development Stage 1:

"Are there industries or other sources in the neighbourhood which may present a risk of noise, other pollution or infection e.g. animal by-products processing plant?"

It is necessary to describe fully what these 'industries' or 'other sources' are.

Similarly, if answering 'Yes' to:

"Will lack of space limit the proposed development and future expansion of the facility?"

It is necessary to describe fully what the "limitations" are and what actions need to be taken to eliminate or minimise the risk they pose together with who is responsible for ensuring that the actions are carried out.

Situations can arise when a decision related to managing risk cannot be taken in a satisfactory or compliant manner. When this happens the issue should be recorded and escalated to a higher authority.

Detailed assessments

Note: The following section comprises the questionsets that should be scored for each of first two Stages of development of projects from inception to ongoing use. They follow basically the same format except that the Questionset covering construction and refurbishment involving dust and pollutants arising from construction and refurbishment activities sets out additional risks to be assessed and managed. The Questionset for ongoing use etc. covers similar ground to Questionset applicable at the design and planning stage in that the latter reflects decisions taken in the former and should be seen as a checklist.

Questionset for Initial brief and proposed site for development

3.5 The initial application of HAI-SCRIBE examines the intended brief and site for the new build healthcare facility.

3.6 If any actual or potential hazards are identified during this initial stage, it is important that a full risk assessment is carried out to identify the nature of the risk. If risks are highlighted, remedial measures need to be identified in order that systems and processes can be designed into the project plans so that the impact of the risk can either be eliminated or its impact reduced.

3.7 The risks and the remedial actions should be clearly documented.

Constraints of developing on a pre-determined brief or site

3.8 In some cases the brief is driven by outside factors or there is no choice in the use of a particular site and steps must be taken to minimise any inherent adverse issues encountered. These would include a lack of space limiting the proposed development and any future expansion or reconfiguration of the facility (e.g. to increase single room provision). This might potentially create or increase the risk of infection.

(Further information is set out in greater detail in the Manual (SHFN 30 Part A) of this document).

3.9 The questionsets do not necessarily comprise an exhaustive list of points that need to be considered.

3.10 Where a potential hazard is identified a careful assessment of that hazard must be undertaken. Some hazards may present a risk of pollution rather than direct infection but the consequences for the healthcare facility may be to keep windows and ventilation intakes closed and this, in turn, may increase the risk of HAI in the healthcare facility. Solving one problem can lead to another and clinical outcomes should themselves be risk assessed. It may be necessary, therefore, to seek further information as part of the assessment of the hazard and this may include questions about:

- the extent of the dust, noise, smell and other pollution;
- the hours of operation;

- the volume of traffic;
- the kind of materials being handled and processed;
- the volumes of materials being handled and processed;
- the time/frequency of deliveries and traffic movement volume;
- the deliveries being in closed or open containers;
- the transfer arrangements from delivery vehicles to storage/processing facilities;
- the exhaust flues from the processing plant;
- the prevailing wind direction;
- the areas of the healthcare development most likely to be affected;
- the measures which could be designed into the proposed healthcare development to eliminate or minimise the impact of the pollution and if these measures might increase the risk of HAI.

3.11 Other existing industries in the area of the proposed healthcare facility development may present a more obvious and direct risk of bacterial or fungal infection e.g. any cooling towers posing a potential *Legionella* risk, and/or any demolition or construction work posing a fungal infection risk. The assessment must take account of the source of the potential risk, its relationship to the healthcare facility and particular areas of the healthcare facility, the exposed population, and the measures which are available to the healthcare facility to reduce the impact of the infection risk. Consideration should also be given to infection risks at outpatient departments within the healthcare facility and access to the facility and outpatient departments.

In considering whether a site presents a potential HAI hazard, the following questions should be examined. In signing-off or initialling resolution of issues, it is necessary also to print the name of the individual completing the responses.

Note: Records of cooling towers in the vicinity of the NHS premises will be held by the Local Authority if not the NHS Board's own public health department with whom consultation should take place in assessing the locality.

Risk assessments require to be kept up to date and amended as and when new circumstances/issues come to light both in surrounding premises and on site.

Initial brief and proposed site for development HAI – SCRIBE Sign off		
HAI-SCRIBE Name of Project		
Name of Establishment		National allocated number
HAI-SCRIBE Review Team		
Completed By (Print Name)		Date
Signature(s)		Date
Stage 1:		
Additional Notes:		

Note: Advice may be required from specialists on issues such land engineering, etc.

Development stage 1: Initial brief and proposed site for development

Some Hazards in the surrounding areas may present a risk of pollution rather than direct infection with the control measures for the healthcare facility to keep windows and ventilation intakes closed however. However, this may increase the risk of HAI in the healthcare facility. It may be necessary to seek further information as part of the assessment of the hazard. Potential hazards from adjacent sites may include:

- the extent of the dust, noise, smell and other pollution;
- the risk of bacterial or fungal infection from existing industries in the area which may be present e.g. cooling towers and/or demolition or construction works;
- the hours of operation;
- the volume of traffic;
- the kind of materials being handled and processed;
- the volumes of materials being handled and processed;
- the time/frequency of deliveries and site traffic movement volume;
- the deliveries being in closed or open containers;
- the transfer arrangements from delivery vehicles to storage/processing facilities;
- the exhaust flues from the processing plant;
- the prevailing wind direction;
- the areas of the healthcare development most likely to be affected;
- the measures which could be designed into the proposed healthcare development to eliminate or minimise the impact of the pollution and if these measures might increase the risk of HAI;
- risk of flooding;
- asbestos in any existing buildings;
- proximity of rivers or streams;
- previous use of site, greenfield/brownfield site;
- land contamination;
- potentially polluting activities during periods of high rainfall.

Initial Brief and proposed Site for development identification of hazards, associated risks and control measures		
1.a	Brief description of the proposed development project and the planned development site.	
1.b	Identify any potential hazards associated with the design and/or proposed site.	
1.c	Identify any risk associated with the hazards above.	
1.d	Outline the control measures that require to be implemented to eliminate or mitigate the identified risks. Ensure these are entered on the project risk register.	
	Control Measures.	
1.e	It has been recognised that control measures identified to address the project risk may have unintended consequences e.g. closure of windows can lead to increased temperatures in some areas. Such issues should be considered at this point, they should be noted and action to address these taken.	
	Potential Problems.	
	Control Measures.	
1.f	Actions to be addressed.	
By		Deadline

Initial Brief and proposed site for development, development stage 1: checklist to ensure all aspects have been addressed		
1.1	Is contaminated land an issue? e.g. asbestos, oils and heavy metals. (Refer to the Contaminated Land Register) Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.2	Is there a locally recognised increased risk of contamination or infection e.g. cryptosporidium? If yes give details. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.3	Are there industries or other sources in the neighbourhood which may present a risk of infection or pollution e.g. animal by-products processing plant? If yes give details. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.4	If there are any industries or other sources identified in question 1.3 above, will they affect the designed operation of the healthcare system? Consider the planned function of the design as well as issues such as: Ventilation Opening of doors and windows Water systems etc. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		

Initial Brief and proposed site for development, development stage 1: checklist to ensure all aspects have been addressed continued		
1.5	Are there construction/demolition works programmed in the neighbourhood which may present a risk of pollution or infection (including fungal infection)? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.6	Are there cooling towers in the neighbourhood which may present a risk of *Legionella* infection? Consider also air handling units, water pipes etc. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.7	Does the topography of the site in relation to the surrounding area and the prevailing wind direction present any HAI risk e.g. from entrainment of plumes containing *Legionella*? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.9	Will the proposed development impact on the surrounding area in any way which may present potential for infection risk? Consider possible restrictions being applied to the operation of the proposed facility e.g. Facilities Management routes. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		

Initial Brief and proposed site for development, development stage 1: checklist to ensure all aspects have been addressed continued		
1.10	Will lack of space limit the proposed development and any future expansion or change of use of the facility? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.11	Has a demolition/refurbishment asbestos survey been carried out? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
1.12	Has consideration been given to the projected lifespan of the facility and its impact on planning and development?	Yes ☐ No ☐ N/A ☐
Comments		
Additional notes - Stage 1		

Development Stage 1: HAI-SCRIBE applied to the initial brief and proposed site for development			
Certification that the following documents have been accessed and the contents discussed and addressed at the Infection Control and Patient Protection Meeting held on.			
Venue		Date	
'Healthcare Associated Infection System for Controlling Risk in the Built Environment' *'HAI-SCRIBE' Implementation Strategy: Scottish Health Facilities Note (SHFN) 30: Part B*			
Declaration: We hereby certify that we have co-operated in the application of and where applicable to the aforesaid documentation.			
Present			
Print name	Signature	Company	Telephone Numbers	Email address

Questionset for design and planning stage

Note: The application of HAI-SCRIBE is essential in the detailed planning and design of a new healthcare facility or a major redevelopment, refurbishment or extension of an existing healthcare facility. It is at the planning and design stage that hazards associated with potential HAI risk should be identified and assessed and measures taken to manage the risks. It is sensible to 'design-in' at this stage, measures which will eliminate or minimise the impact of identified hazards and effectively manage the HAI risk. It is also essential to ensure that the appropriate guidance as applicable in Scotland is being followed.

3.12 HAI-SCRIBE, as applied to healthcare facility plans and designs, will involve a systematic and thorough review of the plans with a view to identifying and assessing potential hazards and managing the risks by eliminating or minimising their impact. This may well involve amendments to plans, bearing in mind that it is likely to be more cost effective to achieve the management of HAI risk at the planning stage rather than after physical completion.

3.13 Issues to be considered include the following:

- while the introduction of people to a healthcare facility immediately introduces challenges in terms of managing infection risk, the design and layout of the healthcare facility should discourage the spread of infection;
- the design and layout of the healthcare facility should take account of the proposed healthcare procedures and services and the appropriate management of risk required for the range of population groups.

3.14 Issues to be considered at the design and planning stage of the development will include:

- an overall assessment of infection and infection spread risk from the design and layout of the healthcare facility;
- an assessment of infection risk from detailed engineering and building features. Further issues to be considered at this stage might include those set out below.

Logistics

3.15 The design of the healthcare facility must realistically consider the logistics of a functioning facility. It is essential that systems are in place which will reduce the risk of spread of infection and resources and personnel are managed so they do not contribute to the risk of infection.

3.16 Examples of logistical issues to consider include:

- the delivery and distribution of materials and people via connecting corridors and lifts;
- the collection, transportation and storage pending removal or management of waste materials;

- clinical workflows.

3.17 These issues require careful planning and design which recognise the potential for infection spread through the mismanagement of such issues.

3.18 Initial planning and design in new builds need to consider:

- numbers of beds;
- provision of single bed rooms (paragraphs 4.14 and 4.15 in SHFN 30 Part A (Manual)) refer;
- appropriate space required between beds;
- design, accessibility and space in patient areas;
- access to equipment around the bed;
- access for staff to hand hygiene facilities;
- sufficient space for equipment (e.g. hoists);
- sanitary facilities and showers/bathrooms for easy access, convenience and independence where possible;
- sufficient space for activities to take place and to avoid transmission of organisms either by air or by contact with blood, body fluid or equipment.

3.19 Particular aspects for consideration include:

- patient groups;
- transmission of micro-organisms:
  - avoiding cross-infection;
  - the environment and its role in cross infection;
  - shared equipment;
  - movement of patients.
- management of patients:
  - clinical pressures;
  - best use of single rooms;
  - avoiding unnecessary movement of patients between areas.
- implications of choosing natural ventilation;
- optional forms of heat emitters;
- provision and pattern of sanitary fitting and types of taps;
- concealment of pipes and ducts;
- importance of maintenance;
- access for maintenance.

3.20 HAI-SCRIBE, as applied to healthcare facility plans and designs, will involve a systematic and thorough review of the plans with a view to identifying and assessing potential hazards and managing the risks by eliminating or minimising their impact. This may well involve amendments to plans, bearing in mind that it is likely to be more cost effective to achieve the management of HAI risk at the planning stage rather than after physical completion.

3.21 The design and layout of the facility should take account of the proposed healthcare procedures and services and the appropriate management of risk required for the range of population groups.

3.22 Reference should also be made to the Questionset applied to the built healthcare facility in operation for more detail of the issues to be addressed in relation to:

- finishes and floors, walls, ceilings, ceiling voids, doors, windows, fixtures and fittings;
- space around beds;
- isolation rooms;
- provision of hand-wash basins, liquid soap dispensers, paper towels and alcohol-based hand rub dispensers;
- provision of sinks for decontamination purposes;
- engineering services;
- storage;
- laundry and linen services;
- spaces for large pieces of equipment;
- disposal of healthcare and food waste.

Development stage 2: Design and planning		
HAI-SCRIBE Name of Project		
Name of Establishment		National allocated number
HAI-SCRIBE Review Team		
HAI – SCRIBE **Sign Off**		
Completed by (Print name)		Date
Signature(s)		Date
Stage 2		
Additional notes		

Development Stage 2: HAI-SCRIBE applied to the design and planning stage of the development

Issues to be considered at the design and planning stage of the development will include an overall assessment of the project and any infection spread risk from the design and layout of the facility. An assessment of infection risk from detailed engineering and building features should also be undertaken.

Issues to be considered include (but are not limited to) the following:

- the design and layout of the healthcare facility should inhibit the spread of infection;
- the design and layout of the healthcare facility should take account of the healthcare procedures and services to be provided and the appropriate management of risk required for the range of population groups (refer to Table 2) verification of work carried out);
- finishes and floors, walls, ceilings, doors, windows, fixtures and fittings;
- space around beds;
- isolation rooms;
- provision of hand-wash basins, liquid soap dispensers, paper towel and alcohol hand rub dispensers;
- provision of sinks for decontamination purposes;
- engineering services;
- storage facilities;
- laundry and linen services.

Note: It should be noted that this document can be used for clinical and non clinical areas and some of the questions in the checklist may not apply e.g. building external plant rooms, car parking facilities. In these cases other issues may require to be addressed and the project team should consider these. All additional information should be added to the appropriate section of this document.

Design and Planning: checklist to ensure all aspects have been addressed		
2.a	Brief description of the work being undertaken.	
2.b	Identify any potential hazards associated with this work.	
2.c	Identify any risk associated with the hazards identified above.	
2.d	Outline the control measures that require to be implemented to eliminate or mitigate the identified risks. Ensure these are entered on the project risk register.	
	Control Measures.	
2.e	It has been recognised that control measures identified to address the project risk may have unintended consequences e.g. closure of windows can lead to increased temperatures in some areas. Such issues should be considered at this point, they should be noted and action to address these taken.	
	Potential Problems.	
	Control Measures.	
2.f	Actions to be addressed.	
By		Deadline

General overview		
2.1	In order to minimise the risk of HAI contamination is there separation of dirty areas from clean areas? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
2.2	Are the food preparation areas (including ward kitchens) and distribution systems fit for purpose and complying with current food safety and hygiene standards? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
2.3	Are waste management facilities and systems robust and fit for purpose and in compliance with the Waste (Scotland) Regulations? Consider: Local and central storage Systems for handling and compaction of waste Systems for segregation and security of waste (especially waste generated from healthcare requiring specialist treatment/disposal) to avoid mixing with other waste and recyclates. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		

General overview continued		
2.4	Are there satisfactory arrangements for effective management of laundry facilities? Consider: Local and central storage Systems for movement of laundry to central storage Systems for handling laundry Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
2.5	Are there sufficient facilities and space for the cleaning and storage of equipment used by hotel services staff? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
2.6	Are staff changing and showering facilities suitably sited and readily accessible for use, particularly in the event of contamination incidents? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
2.7	Is the space around beds for inpatients, day case and recovery spaces in accordance with current relevant NHSScotland guidance?	Yes ☐ No ☐ N/A ☐
Comments		

General overview continued		
2.8	Are there sufficient single rooms to accommodate patients known to be an infection or potential infection risk?	Yes ☐ No ☐ N/A ☐
Comments		
2.9	Are all surfaces, fittings, fixtures and furnishings designed for easy cleaning?	Yes ☐ No ☐ N/A ☐
Comments		
2.10	Are soft furnishings covered in an impervious material in all clinical and associated areas, and are curtains able to withstand washing at disinfection temperatures?	Yes ☐ No ☐ N/A ☐
Comments		
2.11 P	Is the bathroom/shower/toilet accommodation sufficient and conveniently accessible, with toilet facilities no more than 12m from the bed area?	Yes ☐ No ☐ N/A ☐
Comments		
2.12 D	Are the bathroom/shower/toilet facilities easy to clean?	Yes ☐ No ☐ N/A ☐
Comments		
2.13	Where required are there sufficient en-suite single rooms with negative/positive pressure ventilation to minimise risk of infection spread from patients who are a known or potential infection risk?	Yes ☐ No ☐ N/A ☐
Comments		

NB: In the above and following Table “D” refers to “Design” and “P” refers to “Planning”.

Provision of hand-wash basins, liquid soap dispensers, paper towels and alcohol rub dispensers		
2.14	Does each single room have clinical hand-wash basin, liquid soap dispenser, paper towels, and alcohol rub dispenser in addition to the hand-wash basin in the en-suite facility?	Yes ☐ No ☐ N/A ☐
Comments		
2.15	Do intensive care and high dependency units have sufficient clinical hand-wash basins, liquid soap dispensers, paper towels, and alcohol rub dispensers conveniently accessible to ensure the practice of good hand hygiene? An assessment should be made, however, to ensure that there is not an over-provision of hand-wash basins resulting in under-use.	Yes ☐ No ☐ N/A ☐
Comments		
2.16	Is there provision of clinical l hand-wash basins, liquid soap dispensers, paper towels, and alcohol rub dispensers in lower dependency settings like mental health units, acute, elderly and long term care settings appropriate to the situation with a ratio of 1 basin/dispenser to 4–6 beds?	Yes ☐ No ☐ N/A ☐
Comments		
2.17	Do out-patient areas and primary care settings have a clinical hand-wash basin close to where clinical procedures are carried out?	Yes ☐ No ☐ N/A ☐
Comments		
2.18	Do all toilets have a hand-wash basin, liquid soap dispenser and paper towels?	Yes ☐ No ☐ N/A ☐
Comments		
2.19	Are all clinical hand-wash basins exclusively for hand hygiene purposes?	Yes ☐ No ☐ N/A ☐
Comments		

Provision of hand-wash basins, liquid soap dispensers, paper towels and alcohol rub dispensers continued		
2.20	Does each clinical hand-wash basin have wall mounted liquid soap dispenser, paper towel dispenser?	Yes ☐ No ☐ N/A ☐
Comments		
2.21 D	Does each clinical hand-wash basin satisfy the requirement not to be fitted with a plug?	Yes ☐ No ☐ N/A ☐
Comments		
2.22 D	Are elbow-operated or other non-touch mixer taps provided in clinical areas?	Yes ☐ No ☐ N/A ☐
Comments		
2.23 D	Does each hand-wash basin have a waterproof splash back surface?	Yes ☐ No ☐ N/A ☐
Comments		
2.24 D	Is each hand-wash basin provided with an appropriate waste bin for used hand towels?	Yes ☐ No ☐ N/A ☐
Comments		

Provision of facilities for Decontamination LDU		
2.25 D	Are separate, appropriately sized sinks provided locally, where required, for decontamination? (The sinks should be large enough to immerse the largest piece of equipment and there should be twin sinks, one for washing and one for rinsing. A clinical hand-wash basin should be provided close to the twin sinks).	Yes ☐ No ☐ N/A ☐
Comments		
2.26 P	Are appropriate decontamination facilities provided centrally for sterilisation of specialist equipment?	Yes ☐ No ☐ N/A ☐
Comments		
2.27 P	Is there adequate provision in terms of transport, storage, etc. to ensure separation of clean and used equipment and to prevent any risk of contamination of cleaned equipment?	Yes ☐ No ☐ N/A ☐
Comments		
2.28 P	Does the system in operation comply with the current guidance on decontamination facilities and procedures?	Yes ☐ No ☐ N/A ☐
Comments		

Storage		
2.29 P	Is there suitable and sufficient storage provided in each area of the healthcare facility for the following if required patients' clothes and possessions, domestic cleaning equipment and laundry, large pieces of equipment e.g. beds, mattresses, hoists, wheelchairs, trolleys, and other equipment including medical devices, wound care, and intravenous infusion equipment, consumables etc?	Yes ☐ No ☐ N/A ☐
Comments		
2.30 P	Is there separate, suitable storage for contaminated material and clean material to prevent risk of contamination?	Yes ☐ No ☐ N/A ☐
Comments		
Engineering services (Ventilation)		
2.31 P	Are heat emitters, including low surface temperature radiators, designed, installed and maintained in a manner that prevents build up of dust and contaminants and are they easy to clean?	Yes ☐ No ☐ N/A ☐
Comments		
2.32 D	Is the ventilation system designed in accordance with the requirements of SHTM 03-01 'Ventilation in Healthcare Premises'?	Yes ☐ No ☐ N/A ☐
Comments		
2.33 D	Is the ventilation system designed so that it does not contribute to the spread of infection within the healthcare facility? *(Ventilation should dilute airborne contamination by removing contaminated air from the room or immediate patient vicinity and replacing it with clean air from the outside or from low-risk areas within the healthcare facility.)*	Yes ☐ No ☐ N/A ☐
Comments		

Engineering services (Ventilation) continued		
2.34 D	Are the ventilation system components e.g. air handling, ventilation ductwork, grilles and diffusers designed to allow them to be easily cleaned?	Yes ☐ No ☐ N/A ☐
Comments		
2.35 P & D	Are ventilation discharges located a suitable distance from intakes to prevent risk of contamination?	Yes ☐ No ☐ N/A ☐
Comments		
2.36 P	Does the design and operation of re-circulation of air systems take account of dilution of contaminates and the space to be served? *(NB: Recirculation would only arise in UCV theatres)*	Yes ☐ No ☐ N/A ☐
Comments		
2.37	Is the ventilation of theatres and isolation rooms in accordance with current guidance?	Yes ☐ No ☐ N/A ☐
Comments		
2.38	Do means of control of pathogens consider whether dilution or entrainment is the more appropriate for particular situations?	Yes ☐ No ☐ N/A ☐
Comments		
2.39	Where ventilation systems are used for removal of pathogens, does their design and operation take account of infection risk associated with maintenance of the system?	Yes ☐ No ☐ N/A ☐
Comments		
2.40	Are specialised ventilation systems such as fume cupboards installed and maintained in accordance with manufacturers' instructions?	Yes ☐ No ☐ N/A ☐
Comments		

Engineering services (Lighting)		
2.41 D	Is the lighting designed so that lamps can be easily cleaned with minimal opportunity for dust to collect?	Yes ☐ No ☐ N/A ☐
Comments		
Engineering services (Water services)		
2.42 D	Are water systems designed, installed and maintained in accordance with current guidance?	Yes ☐ No ☐ N/A ☐
Comments		
2.43	Are facilities available to enable special interventions for *Legionella*?	Yes ☐ No ☐ N/A ☐
Comments		
2.44	Is the drainage system design, especially within the healthcare facility building, fit for purpose with access points for maintenance carefully sited to minimise HAI risk?	Yes ☐ No ☐ N/A ☐
Comments		
2.45	Are surface mounted services avoided and services concealed with sufficient access points appropriately sited to ease maintenance and cleaning? (These services would include water, drainage, heating, medical gas, wiring, alarm system, telecoms, equipment such as light fittings, bedhead services, heat emitters.)	Yes ☐ No ☐ N/A ☐
Comments		

Estates services (Pest control)		
2.46	Is the concealed service ducting designed, installed and maintained to minimise risk of pest infestation?	Yes ☐ No ☐ N/A ☐
Comments		
Estates services (Maintenance access)		
2.47	Does the design and build of the facility allow programmed maintenance of the fabric to ensure the integrity of the structure and particularly the prevention of water ingress and leaks and prevention of pigeon and other bird access?	Yes ☐ No ☐ N/A ☐
Comments		
Additional notes - Stage 2		

Development stage 2: HAI-SCRIBE applied to the planning and design stage of the development.			
Certification that the following documents have been accessed and the contents discussed and addressed at the Infection Control and Patient Protection Meeting held on.			
Venue		Date	
'Healthcare Associated Infection System for Controlling Risk in the Built Environment' *('HAI-SCRIBE) Implementation Strategy Scottish Health Facilities Note (SHFN) 30: Part B).*			
Declaration: We hereby certify that we have co-operated in the application of and where applicable to the aforesaid documentation.			
Present			
Print name	Signature	Company	Telephone Numbers	Email address

Questionset for construction and refurbishment

Refurbishment of existing healthcare facilities

3.23 HAI-SCRIBE would be appropriate in redevelopment and refurbishment situations where the business of the healthcare facility continues concurrently with construction work on site. There are obligations on the contractors to undertake their construction operations in such a way that health and safety and other issues are adequately addressed.

3.24 Redevelopment and refurbishment of healthcare facilities in Scotland are common and the kind of work involved is varied.

3.25 In assessing the hazards of the above construction activities and the management of the potential risks, account has to be taken of the exposed population (in this case the patients), staff and visitors likely to be affected.

3.26 A range of precautions is needed to eliminate or manage the risk of infection.

- In order to ensure the risk of infection is minimised during construction works consideration must be given to:
  - the type of construction/refurbishment work being carried out (Table 1);
  - the population group being treated (Table 2);
  - the risk associated with these two factors (Table 3).

Table 1 highlights different types of construction/refurbishment activities likely to take place in the healthcare facility.

Table 2 highlights the different population groups within the healthcare facility and the risk associated with each group.

Table 3 estimates the overall risk of infection arising and indicates the level of precaution that should be implemented.

Note: Appendices 4-8 show a proposed process chart for each type of activity.

Type	Construction/Refurbishment Activity
Type 1	**Inspection and non-invasive activities.** Includes, but is not limited to, removal of ceiling tiles or access hatches for visual inspection, painting which does not include sanding, wall covering, electrical trim work, minor plumbing and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
Type 2	**Small scale, short duration activities which create minimal dust.** Includes, but is not limited to, installation of telephone and computer cabling, access to chase spaces, cutting of walls or ceiling where dust migration can be controlled.
Type 3	**Any work which generates a moderate to high level of dust, aerosols and other contaminants or requires demolition or removal of any fixed building components or assemblies.** Includes, but is not limited to, sanding of walls for painting or wall covering, removal of floor coverings, ceiling tiles and casework, new wall construction, minor duct work or electrical work above ceilings, major cabling activities, and any activity which cannot be completed within a single work shift.
Type 4	**Major demolition and construction projects.** Includes, but it not limited to, activities which require consecutive work shifts, requires heavy demolition or removal of a complete cabling system, and new construction.

Table 1: Redevelopment and refurbishment construction activity.

Risk to patients of infection from construction work in healthcare premises, by clinical areas	
Risk rating	**Area**
Group 1 Lowest risk	1. Office areas; 2. Unoccupied wards; 3. Public areas/Reception; 4. Custodial facilities; 5. Mental Health facilities.
Group 2 Medium risk	1. All other patient care areas (unless included in Group 3 or Group 4); 2. Outpatient clinics (unless in Group 3 or Group 4); 3. Admission or discharge units; 4. Community/GP facilities; 5. Social Care or Elderly facilities.
Group 3 High risk	1. A & E (Accident and Emergency); 2. Medical wards; 3. Surgical wards (including Day Surgery) and Surgical outpatients; 4. Obstetric wards and neonatal nurseries; 5. Paediatrics; 6. Acute and long-stay care of the elderly; 7. Patient investigation areas, including; • Cardiac catheterisation; • Invasive radiology; • Nuclear medicine; • Endoscopy. Also (indirect risk) 8. Pharmacy preparation areas; 9. Ultra clean room standard laboratories (risk of pseudo-outbreaks and unnecessary treatment); 10. Pharmacy Aseptic suites.
Group 4 Highest Risk	1. Any area caring for immuno-compromised patients*, including: • Transplant units and outpatient clinics for patients who have received bone marrow or solid organ transplants; • Oncology Units and outpatient clinics for patients with cancer; • Haematology units • Burns Units. 2. All Intensive Care Units; 3. All operating theatres; Also (indirect risk) 4. CSSUs (Central Sterile Supply Units).

Table 2: The different areas within the healthcare facility and the risk associated with each area.

Immuno-compromised patients are:

- those patients whose immune mechanisms are deficient because of immunologic disorders (e.g. human immunodeficiency virus [HIV] infection or congenital immune deficiency syndrome);
- patients with chronic diseases (e.g. diabetes, cancer, emphysema, or cardiac failure);
- patients undergoing immuno-suppressive therapy (e.g. radiation, cytoxic chemotherapy, anti-rejection medication, or steroids. (CCDR 2001).

Immuno-compromised patients who are identified as high-risk patients have the greatest risk of infection caused by airborne or waterborne micro-organisms. Patients in this subset include:

- persons who are severely neutropenic for prolonged periods of time (ie an absolute neutrophil count [ANC] of ≤ 500 cells/mL);
- allogeneic Haemopoietic Stem Cell Transplantation patients;
- renal dialysis patients;
- those who have received the most intensive chemotherapy (e.g. childhood acute myelogneous leukaemia patients). (CDC 2003).

Immuno-suppresive conditions identified as risk factors for construction-related nosocomial fungal infections include:

- graft-versus-host disease requiring treatment;
- prolonged neutropenia or granulocytopenia because of cytoxic chemotherapy;
- prolonged use of antibiotics; and steroid therapy. (CCDR 2001).

Other risk factors for the development of *aspergillosis* include dialysis and mechanical ventilation, smoking and patient age, the very young and very old being at greater risk.

	Construction Project Type			
Patient Risk Group	**TYPE 1**	**TYPE 2**	**TYPE 3**	**TYPE 4**
Lowest Risk	Class I	Class II	Class II	Class III/IV
Medium Risk	Class I	Class II	Class III	Class IV
High Risk	Class I	Class II	Class III/IV	Class IV
Highest Risk	Class II	Class III/IV	Class III/IV	Class IV

Table 3: Estimates the overall risk of infection arising and will indicate the class of precaution that should be implemented.

3.27 Having highlighted the overall degree of infection risk, appropriate infection prevention and control measures can be implemented to manage or eliminate the risk of transmission. Table 4 highlights the appropriate prevention and

control of infection precautions. Appendices 4-8 give an indication of how this can be processed.

3.28 Consideration should be given to the likelihood of patient movement outwith their speciality care area and the need for appropriate measures to control infection risk.

Surveillance and monitoring during renovation or construction work

3.29 There have been several documented outbreaks due to construction work however routine bacteriological sampling of floors, walls, surfaces and air is rarely indicated.

Note: The need for additional surveillance and environmental monitoring may be identified by the Project Team through risk assessment.

3.30 In 1995 there was widespread contamination of potable water with *Legionella pneumophila* during a period of major construction resulting in two fatal cases of healthcare associated *Legionellosis*. Multiple outbreaks of healthcare associated A*spergillosis* have also been described, including one specifically attributed to hospital renovation. It has been suggested that heightened surveillance and preventive measures may be warranted during periods of excavation on hospital grounds or when potable water supplies are otherwise shut down and later depressurised.

3.31 Since the airborne spores of *Aspergillus* spp. can travel significant distances, this will apply generally to all works in the immediate vicinity or within the boundary of the healthcare site.

Some further points for consideration

3.32 It is necessary to ensure that robust documentary evidence can be provided when considering the above issues. This will ensure that facts and data are available for reference at future stages of the project.

3.33 Barriers with signage will require to be positioned to make staff, patients and visitors aware of works.

3.34 There are key issues to be considered in assessing the hazard with a view to managing the risk. Therefore, in each situation where there is to be construction and refurbishment or repair work, the multi-disciplinary team of specialists referred to in Section 2 entitled “Assembling the Project Team” should be involved and the following questions need to be addressed.

Certain situations will require the use of barrier structures to contain contamination whilst others will require different measures eg a change of process. Therefore the following questions need to be addressed for each of these situations:

Control measures			
	During Construction Work	**After Construction Work**	**By**
Class I	• Execute work by methods to minimise raising dust from construction operations;. • Immediately replace any ceiling tiles displaced during inspection.	• Clean areas by damp dusting with neutral detergent in warm water;. • Vacuum floor and damp mop.	Request via domestic supervisor. Request via domestic supervisor.
Class II	• Provide active means to prevent airborne dust from dispersing into atmosphere; • Water mist work surfaces to control dust while cutting; • Seal unused doors with duct tape; • Block off and seal air vents; • Place dust mat at entrance and exit of work area; • Remove or isolate HVAC system in areas where work is being performed.	• Dampwork surfaces and ledges with neutral detergent solution; • Contain construction waste before transport in tightly covered containers; • Damp mop and/or vacuum with HEPA filtered vacuum before leaving work area; • Remove isolation of HVAC system in areas where work is being performed.	Request via domestic supervisor. Estates staff. Request via domestic supervisor. Estates staff.
Class III	• Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system; • Complete all critical barriers eg plasterboard, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins; • Maintain negative air pressure within work site utilizing HEPA equipped air filtration units; • Contain construction waste before transport in tightly covered containers; • Cover transport receptacles or carts. Tape covering unless solid lid.	• Do not remove barriers from work area until completed project is inspected by the Board's Health & Safety representative and Infection Control Department and thoroughly cleaned by the Board's domestic services staff;. • Remove barrier materials carefully to minimise spreading of dirt and debris associated with construction; • Vacuum work area with HEPA filtered vacuums; • Damp mop area with neutral detergent and warm water; • Remove isolation of HVAC system in areas where work is being performed.	Request by Estates Dept. Contractor/Estates Staff. Request via domestic supervisor. Request via domestic supervisor. Contractor/Estates Staff.

Table 4: Describes the required Infection Control Precautions depending on class of risk

	During Construction Work	After Construction Work	By
Class IV	• Isolate HVAC system in area where work is being done to prevent contamination of duct system; • Complete all critical barriers eg plasterboard, plywood, plastic to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins; • Maintain negative air pressure within work site utilizing HEPA equipped air filtration units; • Seal holes, pipes, conduits, and punctures appropriately; • Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave the work site; • All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area; • Do not remove barriers from work area until completed project is inspected.	• Remove barrier material carefully to minimise spreading of dirt and debris associated with construction; • Contain construction waste before transport in tightly covered containers;. • Cover transport receptacles or carts. Tape covering unless solid lid; • Vacuum work area with HEPA filtered vacuums; • Damp dust area with neutral detergent and warm water; • Scrub floor area with neutral detergent in warm water; • Remove isolation of HVAC system in areas where work is being performed.	Contractor. Contractor. Contractor. Request via domestic supervisor. Request via domestic supervisor. Contractor/Estates Staff.

Table 4 continued: Describes the required Infection Control Precautions depending on class of risk

Note: Temporary critical barrier partitions should be inspected and their condition monitored and signed off on a daily basis to assess any damage, gaps, etc. Polythene sheeting and tape would only be suitable in small areas for limited periods.

Development stage 3: Construction and refurbishment work			
HAI-SCRIBE Name of Project			
Name of Establishment			
National allocated number			
HAI-SCRIBE Review Team			
HAI-SCRIBE Sign Off			
Completed By (Project Manager) (Print Name)			Date
Signature			Date
Stage 3			
Additional Notes			

Immuno-compromised patients who are identified as high-risk patients have the greatest risk of infection caused by airborne or waterborne micro-organisms. Patients in this subset include persons who are severely neutropenic for prolonged periods of time (ie an absolute neutrophil count [ANC] of ≤ 500 cells/mL), allogeneic HSCT patients, and those who have received the most intensive chemotherapy (e.g. childhood acute myelogneous leukaemia patients). (**CDC 2003**)

Immuno-suppresive conditions identified as risk factors for construction-related nosocomial fungal infections include graft-versus-host disease requiring treatment; prolonged neutropenia or granulocytopenia because of cytoxic chemotherapy; prolonged use of antibiotics; and steroid therapy. Other risk factors for the development of aspergillosis include dialysis and mechanical ventilation, smoking and patient age, the very young and very old being at greater risk Grauhan and colleagues reported that the risk of a fungal infection increases in patients who exhibit three or more risk factors ($p<0.001$). **CCDR (2001)**

Development stage 3: HAI-SCRIBE applied to the proposed site for development Prior to the commencement of work		
3.1.1	Brief description of the work being carried out.	
3.1.2	Using the matrix above establish the type and extent of construction and refurbishment /repair work, patients at risk and level of control measures.	
Type of work.		
Patient risk group.		
Risk class.		
3.1.3	Identify any potential hazards associated with this work.	
3.1.4	Identify any risk associated with the hazards identified above.	
3.1.5	Outline the control measures that require to be implemented to eliminate or mitigate the identified risks. Ensure these are entered on the project risk register.	
Control measures		
3.1.6	It has been recognised that control measures identified to address the project risk may have unintended consequences e.g. closure of windows can lead to increased temperatures in some areas. Such issues should be considered at this point, they should be noted and action to address these taken.	
Potential problems		
Control measures		
3.1.7	Actions to be addressed	
By		Deadline

In terms of infection risk have the following been addressed		
3.2.1	The population groups most susceptible to infection. Items to be considered: Adjacent rooms, wards and departments Relocation of susceptible patients Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
3.2.2	The hours of operation of the construction work and the impact of this on the clinical area. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
3.2.3	Separation of construction and healthcare activities including delivery and supply routes, removal of waste and patient transfers. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
3.2.4	The construction of temporary barriers and/or sealing of doors and windows to minimise contamination of the environment by dust and potentially infectious particles created during the construction works. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		

In terms of infection risk have the following been addressed continued		
3.2.5	Airflow patterns including:	
	Internal and external ventilation systems	Yes ☐ No ☐ N/A ☐
	Exhaust ventilation	Yes ☐ No ☐ N/A ☐
	Sealing of doors and windows	Yes ☐ No ☐ N/A ☐
	Oxygen and Suction points	Yes ☐ No ☐ N/A ☐
	Air handlers, coils, fans and grilles	Yes ☐ No ☐ N/A ☐
	Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐
Comments		
3.2.6	Work with sinks or plumbing which could give rise to aerosol water droplets in high risk areas.	Yes ☐ No ☐ N/A ☐
	Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐
Comments		
3.2.7	Impact on stock storage areas including:	
	Sterile and non-sterile items	Yes ☐ No ☐ N/A ☐
	Patient care equipment	Yes ☐ No ☐ N/A ☐
	Medications	Yes ☐ No ☐ N/A ☐
	Medical records and documentation	Yes ☐ No ☐ N/A ☐
	Linen and waste facilities including sharps	Yes ☐ No ☐ N/A ☐
	Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐
Comments		

During the construction phase have the following been addressed?		
3.3.1	Where external work is being carried out: Prevention of insect and rodent entry and prevention of weather/water entry to internal areas during the construction phase. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
3.3.2	Cleaning of site and adjacent areas both during the construction phase and prior to handover. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
3.3.3	Enforcement of control and reporting system to ensure compliance with above issues. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☐ N/A ☐ Yes ☐ No ☐ N/A ☐
Comments		
Additional notes - Stage 3		

Development stage 3: HAI-SCRIBE applied to the construction/redevelopment phase				
Certification that the following documents have been accessed and the contents discussed and addressed at the Infection Control and Patient Protection Meeting held on				
Venue		Date		
'Healthcare Associated Infection System for Controlling Risk in the Built Environment' *('HAI-SCRIBE) Implementation Strategy Scottish Health Facilities Note (SHFN) 30: Part B).*				
Declaration: We hereby certify that we have co-operated in the application of and where applicable to the aforesaid documentation.				
Present				
Print name	Signature	Company	Telephone Numbers	Email address

Contractor Endorsement Certificate

(I) Statement of Intent:

Healthcare Associated Infection (HAI) is a complex issue involving the many different elements of patient care and provision. Due to its multi-factorial nature, there is a need to develop a holistic approach to minimising the risk of infection in the built environment.

NHS National Services Scotland Health Facilities Scotland (NSS HFS), in conjunction with other organisations, has endeavoured comprehensively to tackle this situation through the creation of documents such as the 'Healthcare Associated Infection System for Controlling Risk of Infection In the Built Environment': (HAI-SCRIBE) comprising 'Scottish Health Facilities Note (SHFN) 30: Parts A & B.

Non-application of these documents is extremely detrimental in preventing the spread of infection and to the healthcare sector in general. In certifying this endorsement you verify that you will endeavour to do all within your power to aid in this process and reduce the risk of infection within the built environment.

(II) Certification of the following documents;

'Healthcare Associated Infection System for Controlling Risk In the Built Environment' (HAI-SCRIBE) comprising 'Scottish Health Facilities Note (SHFN) 30': Parts A & B.

(III) Declaration:

We hereby certify that we agree to co-operate in the application of, on whole or where applicable to the aforementioned documentation and any amendment /revision forthwith enclosed or existing at the time of this declaration.

Name (please print) _____

Signed _____

Designation _____

Company Name_____

Witnessed by (please print)_____

Signed _____

Designation _____

Company Name _____

Questionset for pre-handover check - Ongoing use of HAI-SCRIBE in an existing healthcare facility

3.35 Once a Project (new build or refurbishment) is ready for operation, This Questionset would be used as an assessment that the outcomes from the earlier Questionsets have been successfully fulfilled. The Questionset relevant to this stage should be seen as a final, pre-handover checklist that everything briefed has been provided.

Design in use

3.36 Within the built healthcare facility it is important to ensure there will be an ongoing application of HAI-SCRIBE. This is a verification process of particular importance not only where there are subsequent alterations to the building, but also to arrangements within the building, and to procedures and practices. The three key stages involved in HAI-SCRIBE have a continuous application:

- identifying the hazard;
- assessing the risk from the identified hazard;
- managing the risk to eliminate or minimise impact.

Physical monitoring

3.37 Physical monitoring of the healthcare environment includes temperature, humidity, air change rates, leak rates, direction of air and water flow, particle counts and filter efficiency.

3.38 Testing methods can help ensure that environmental conditions in the healthcare facility are such that they do not contribute to the spread of infection.

3.39 Stagnant air, possibly through poor ventilation, can contribute to fungal contamination whilst excessive air turbulence can increase airborne particulate levels and contribute to the dispersal of micro-organisms.

3.40 Visual inspection must be part of physical monitoring to ensure for instance that filters are fitted correctly, that surfaces are smooth, impermeable, free of cracks and joins, and without the accumulation of dust which may harbour fungi and bacteria.

Microbial monitoring

3.41 In terms of quality assurance, microbial monitoring may be required on the advice of the Project Team. Microbial sampling of the air, water and surfaces of the healthcare facility has an important role to play in helping combat the spread of infection within the built healthcare environment.

3.42 NHS Boards should have a formal protocol for infection prevention and control monitoring of the built healthcare environment with regard to the prevention and control of infection. When sampling of the area is carried out, the laboratory should have appropriate accreditation for carrying out the sampling. Some

sampling may have to be performed in response to an investigation of an outbreak of infection. Results obtained should be interpreted using scientifically established baseline values for comparison e.g. Health and Safety Executive guidelines. On completion of analysis, actions to be implemented should be based on the results obtained.

3.43 It may be necessary for an NHS Board to seek specialist advice on microbial monitoring protocols to allow the Project Team to take responsibility. Areas where the built environment is suspected of contributing to the spread of infection or where construction or refurbishment work is proposed should be referred to the Infection Prevention and Control Team for consideration of monitoring and advice as appropriate.

Feedback

3.44 The Scottish Capital Investment Manual states that feedback is a mandatory requirement as part of Post Project Evaluation to ensure lessons are learned and disseminated for future projects.

HAI-SCRIBE auditing of accommodation *in use* should also make use of the following questionsets:

Development stage 4: Review of completed project	
HAI-SCRIBE Name of project	
Name of Establishment	National allocated number
HAI-SCRIBE Review Team	
HAI-SCRIBE **Sign Off**	
Completed by (Print name)	Date
Signature(s)	Date
Stage 4	
Additional notes	

General overview		
4.1	Is the space around beds in accordance with current NHSScotland guidance?	Yes ☐ No ☐ N/A ☐
4.2	Are there sufficient single rooms to accommodate patients known to be an infection of potential infection risk?	Yes ☐ No ☐ N/A ☐
4.3	Are all surfaces, fittings, fixtures and furnishings designed for easy cleaning?	Yes ☐ No ☐ N/A ☐
4. 4	Are soft furnishings covered in an impervious material in all clinical and associated areas, and are curtains able to withstand washing at disinfection temperatures?	Yes ☐ No ☐ N/A ☐
4. 5	Is the bathroom/shower/toilet accommodation sufficient and conveniently accessible, with toilet facilities no more than 12m from the bed area?	Yes ☐ No ☐ N/A ☐
4.6	Are the bathroom/shower/toilet facilities easy to clean?	Yes ☐ No ☐ N/A ☐
4.7	Where required are there sufficient en-suite single rooms with negative/positive pressure ventilation to minimise risk of infection spread from patients who are a known or potential infection risk?	Yes ☐ No ☐ N/A ☐
Provision of hand-wash basins, liquid soap dispensers, paper towels and alcohol rub dispensers		
4.8	Does each single room have a clinical hand-wash basin, liquid soap dispenser, paper towels, and alcohol rub dispenser over and above the hand-wash basin in the en-suite facility?	Yes ☐ No ☐ N/A ☐
4.9	Do intensive care and high dependency units have sufficient clinical hand wash basins, liquid soap dispensers, paper towels, and alcohol rub dispensers conveniently accessible to ensure the practice of good hand hygiene? An assessment should be made, however, to ensure that there is not an over-provision of hand-wash basins resulting in under-use.	Yes ☐ No ☐ N/A ☐
4.10	Is there provision of clinical hand-wash basins, liquid soap dispensers, paper towels, and alcohol rub dispensers in lower dependency settings like mental health units, acute, elderly and long term care settings appropriate to the situation with a ratio of 1 basin/dispenser to 4–6 beds?	Yes ☐ No ☐ N/A ☐
4.11	Do out-patient areas and primary care settings have a clinical hand-wash basin close to where clinical procedures are carried out?	Yes ☐ No ☐ N/A ☐
4.12	Do all toilets have a hand-wash basin, liquid soap dispenser and paper towels?	Yes ☐ No ☐ N/A ☐
4.13	Are all clinical hand-wash basins exclusively for hand hygiene purposes?	Yes ☐ No ☐ N/A ☐
4.14	Does each clinical hand-wash basin have wall mounted liquid soap dispenser, paper towel dispenser?	Yes ☐ No ☐ N/A ☐

Provision of hand-wash basins, liquid soap dispensers, paper towels and alcohol rub dispensers continued		
4.15	Does each clinical hand-wash basin satisfy the requirement not to be fitted with a plug?	Yes ☐ No ☐ N/A ☐
4.16	Are elbow-operated or other non-touch mixer taps provided in clinical areas?	Yes ☐ No ☐ N/A ☐
4.17	Does each hand-wash basin have a waterproof splash back surface?	Yes ☐ No ☐ N/A ☐
4.18	Is each hand-wash basin provided with an appropriate waste bin for used hand towels?	Yes ☐ No ☐ N/A ☐
Provision of facilities for Decontamination		
4.19	Are separate, appropriately sized sinks provided locally, where required, for decontamination? *(The sinks should be large enough to immerse the largest piece of equipment and there should be twin sinks, one for washing and one for rinsing. A clinical hand-wash basin should be provided close to the twin sinks).*	Yes ☐ No ☐ N/A ☐
4.20	Are appropriate decontamination facilities provided centrally for sterilisation of specialist equipment?	Yes ☐ No ☐ N/A ☐
4.21	Is there adequate provision in terms of transport, storage, etc. to ensure separation of clean and used equipment and to prevent any risk of contamination of cleaned equipment?	Yes ☐ No ☐ N/A ☐
4.22	Does the system in operation comply with the current guidance on decontamination facilities and procedures?	Yes ☐ No ☐ N/A ☐
Storage		
4.23	Is there suitable and sufficient storage provided in each area of the healthcare facility for the following if required patients' clothes and possessions, domestic cleaning equipment and laundry, large pieces of equipment e.g. beds, mattresses, hoists, wheelchairs, trolleys, and other equipment including medical devices, wound care, and intravenous infusion equipment, consumables etc?	Yes ☐ No ☐ N/A ☐
4.24	Is there separate, suitable storage for contaminated material and clean material to prevent risk of contamination?	Yes ☐ No ☐ N/A ☐

Engineering services (Ventilation)		
4.25	Are heat emitters, including low surface temperature radiators, designed, installed and maintained in a manner that prevents build up of dust and contaminants and are they easy to clean?	Yes ☐ No ☐ N/A ☐
4.26	Is the ventilation system designed in accordance with the requirements of SHTM 03-01 'Ventilation in Healthcare Premises'?	Yes ☐ No ☐ N/A ☐
4.27	Is the ventilation system designed so that it does not contribute to the spread of infection within the healthcare facility? *(Ventilation should dilute airborne contamination by removing contaminated air from the room or immediate patient vicinity and replacing it with clean air from the outside or from low-risk areas within the healthcare facility.)*	Yes ☐ No ☐ N/A ☐
4.28	Are the ventilation system components e.g. air handling, ventilation ductwork, grilles and diffusers designed to allow them to be easily cleaned?	Yes ☐ No ☐ N/A ☐
4.29	Are ventilation discharges located a suitable distance from intakes to prevent risk of contamination?	Yes ☐ No ☐ N/A ☐
4.30	Does the design and operation of re-circulation of air systems take account of dilution of contaminates and the space to be served? *(NB: Recirculation would only arise in UCV theatres)*	Yes ☐ No ☐ N/A ☐
4.31	Is the ventilation of theatres and isolation rooms in accordance with current guidance SHTM 03-01, SHPN 04-01 Supplement 1 and the Scottish Hospital Infection Manual)?	Yes ☐ No ☐ N/A ☐
4.32	Do means of control of pathogens consider whether dilution or entrainment is the more appropriate for particular situations?	Yes ☐ No ☐ N/A ☐
4.33	Where ventilation systems are used for removal of pathogens, does their design and operation take account of infection risk associated with maintenance of the system?	Yes ☐ No ☐ N/A ☐
4.34	Are specialised ventilation systems such as fume cupboards installed and maintained in accordance with manufacturers' instructions?	Yes ☐ No ☐ N/A ☐
Engineering services (Lighting)		
4.35	Is the lighting designed so that lamps can be easily cleaned with minimal opportunity for dust to collect?	Yes ☐ No ☐ N/A ☐
Engineering services (Vacuum Units)		
4.36	Are vacuum-controlled units with overflow protection devices for mechanical suction used to avoid contaminating the system with aspirated body fluid?	Yes ☐ No ☐ N/A ☐

Engineering services (Water services)		
4.37	Are water systems designed, installed and maintained in accordance with current guidance? (SHTM 04-01 series – Water safety)	Yes ☐ No ☐ N/A ☐
4.38	Are facilities available to enable special interventions for *Legionella* such as chlorination/chlorine dioxide, copper/silver ionisation treatment of water?	Yes ☐ No ☐ N/A ☐
4.39	Is the drainage system design, especially within the healthcare facility building, fit for purpose with access points for maintenance carefully sited to minimise HAI risk?	Yes ☐ No ☐ N/A ☐
4.40	Are surface mounted services avoided and services concealed with sufficient access points appropriately sited to ease maintenance and cleaning? (These services would include water, drainage, heating, medical gas, wiring, alarm system, telecoms, equipment such as light fittings, bedhead services, heat emitters.)	Yes ☐ No ☐ N/A ☐
Estates services (Pest control)		
4.41	Is the concealed service ducting designed, installed and maintained to minimise risk of pest infestation?	Yes ☐ No ☐ N/A ☐
Estates services (Maintenance access)		
4.42	Does the design and build of the facility allow programmed maintenance of the fabric to ensure the integrity of the structure and particularly the prevention of water ingress and leaks and prevention of pigeon and other bird access?	Yes ☐ No ☐ N/A ☐
Additional notes – Stage 4		

Development stage 4: HAI-SCRIBE Review of completed project	
4.43	Brief description of the work carried that was carried out.
4.44	Identify any issues associated with this work.
4.45	Identify any risk associated with the issues identified above.
4.46	Outline the measures that required to be implemented to eliminate or mitigate the identified issues. Ensure these are entered on the project risk register.

Appendix 1

Construction and Refurbishment Stage – Minor Works

Work in progress

Form to be submitted to the Project Team before work commences, with minimum monthly updates for the duration of complex/long-term projects.

Name of person completing: _____

Date: _____

Project *(brief Summary including site, specialty)*

New build	Yes	☐	No	☐
Redesign	Yes	☐	No	☐
Near patient activity likely	Yes	☐	No	☐

Date of initial meeting _____

Work expected to commence _____

Work due for completion _____

Responsible Officers

Department	Name	Designation
Estates & Property		
Infection prevention & Control		
Domestic Services		
Health & Safety		
Procurement		
Clinical representative		

While work is being carried out and particularly where there are building activities in or near patients' areas there should be regular, recorded visits and inspections to the site by appropriate members of the group.

Issues to be considered for Construction and Refurbishment Stage

This is not exhaustive and, depending on the specialty and facility; there may be further issues which require consideration.

Onsite contractors aware of safety measures	Yes	☐	No	☐
Limited spread of dust	Yes	☐	No	☐
Additional cleaning ongoing	Yes	☐	No	☐
Water/ventilation to surrounding areas isolated	Yes	☐	No	☐
Staff in surrounding areas satisfied with precautions	Yes	☐	No	☐

The answers to the questions above should be "yes". Where a potential hazard is identified a careful assessment of that hazard must be undertaken.

Additional Issues/Potential Hazards
Discussion
Outcome

Appendix 2

Commissioning Stage

To be with Project Team before expected completion date.

Name: _____ Date: _____

Project *(brief Summary including site, specialty)*

New build	Yes	☐	No	☐
Redesign	Yes	☐	No	☐
Near patient activity likely	Yes	☐	No	☐

Date of initial meeting _____
Work commenced _____
Work completed _____

Responsible Officers

Department	Name	Designation
Estates & Property		
Infection Prevention & Control		
Domestic Services		
Health & Safety		
Microbiology		

Issues to be considered for Commissioning Stage

This is not exhaustive and, depending on the specialty and facility, there may be further issues which require consideration.

Approved plans followed	Yes	☐	No	☐
Infection Prevention & Control measures adhered to	Yes	☐	No	☐

The answers to the questions above should be "yes". Where a potential hazard is identified a careful assessment of that hazard must be undertaken.

Additional Issues/Potential Hazards
Discussion
Outcome

What commissioning checks are required for this project?

Settle plates	Yes	☐	No	☐
Air sampling	Yes	☐	No	☐
On site inspection	Yes	☐	No	☐

Appendix 3

Permission to Work (if necessary)

Description of work to be completed:

Specific area e.g. room number within ward area.

Risk assessment completed Yes ☐ No ☐

Signature _____ Date _____

Risks identified

Comments/Actions taken

Date work planned _____

Estimated completion _____

Nurse in charge Signature _____Date _____

Acceptance of work

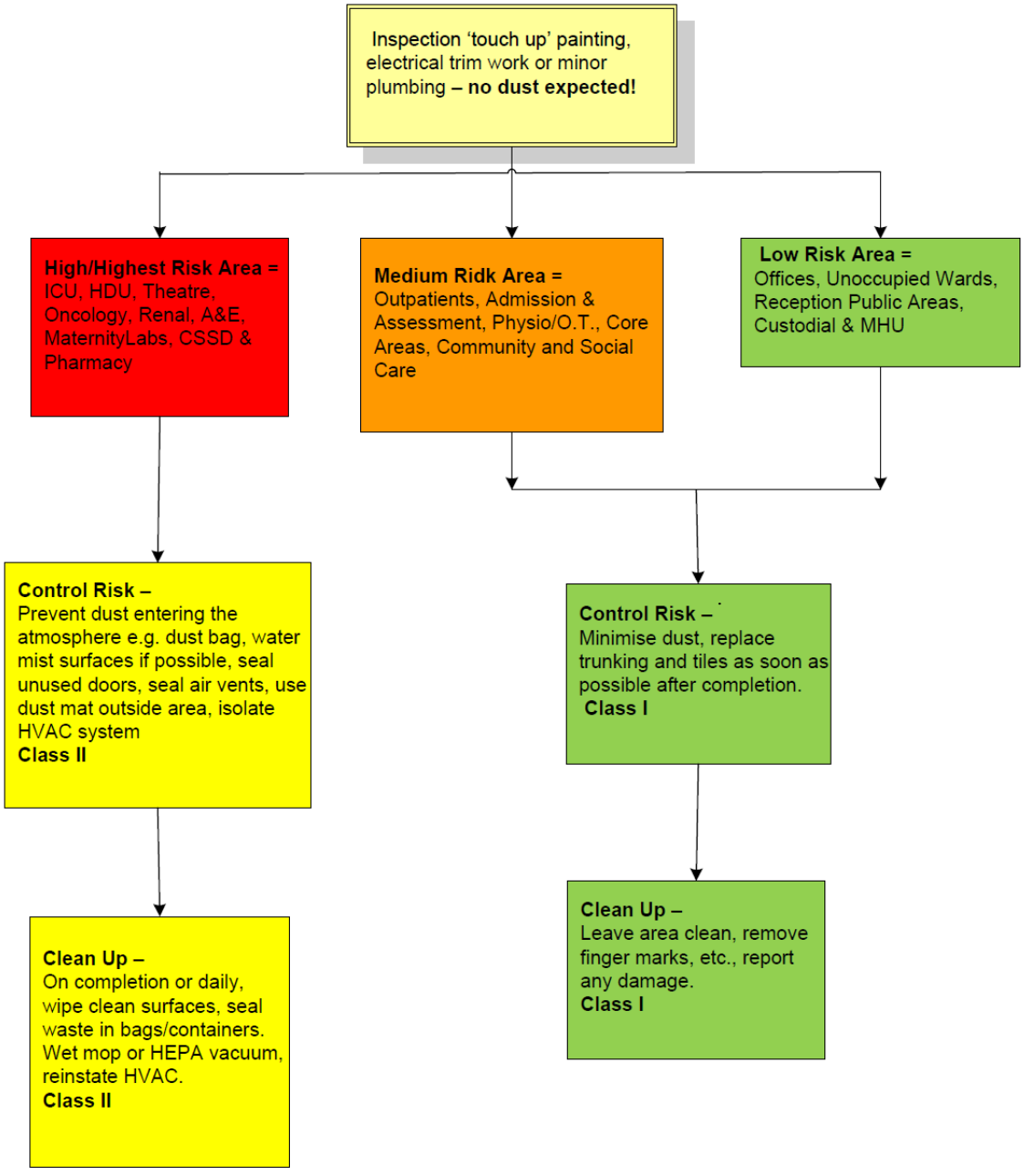
Sister/Charge Nurse acceptance of work on completion _____

Estates Officer Signature _____

Comments:

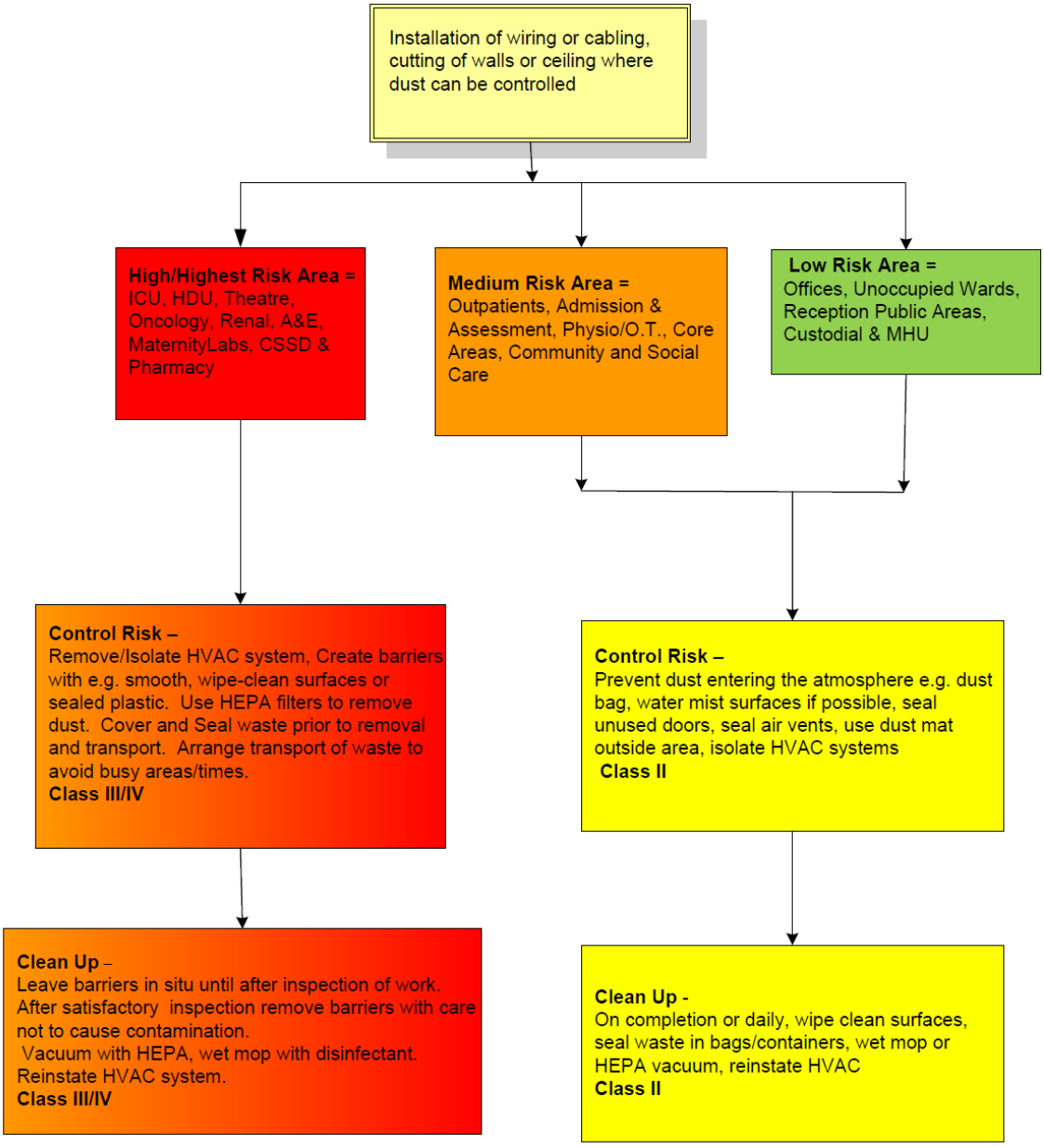
Appendix 4

Minor Works and Small Repairs



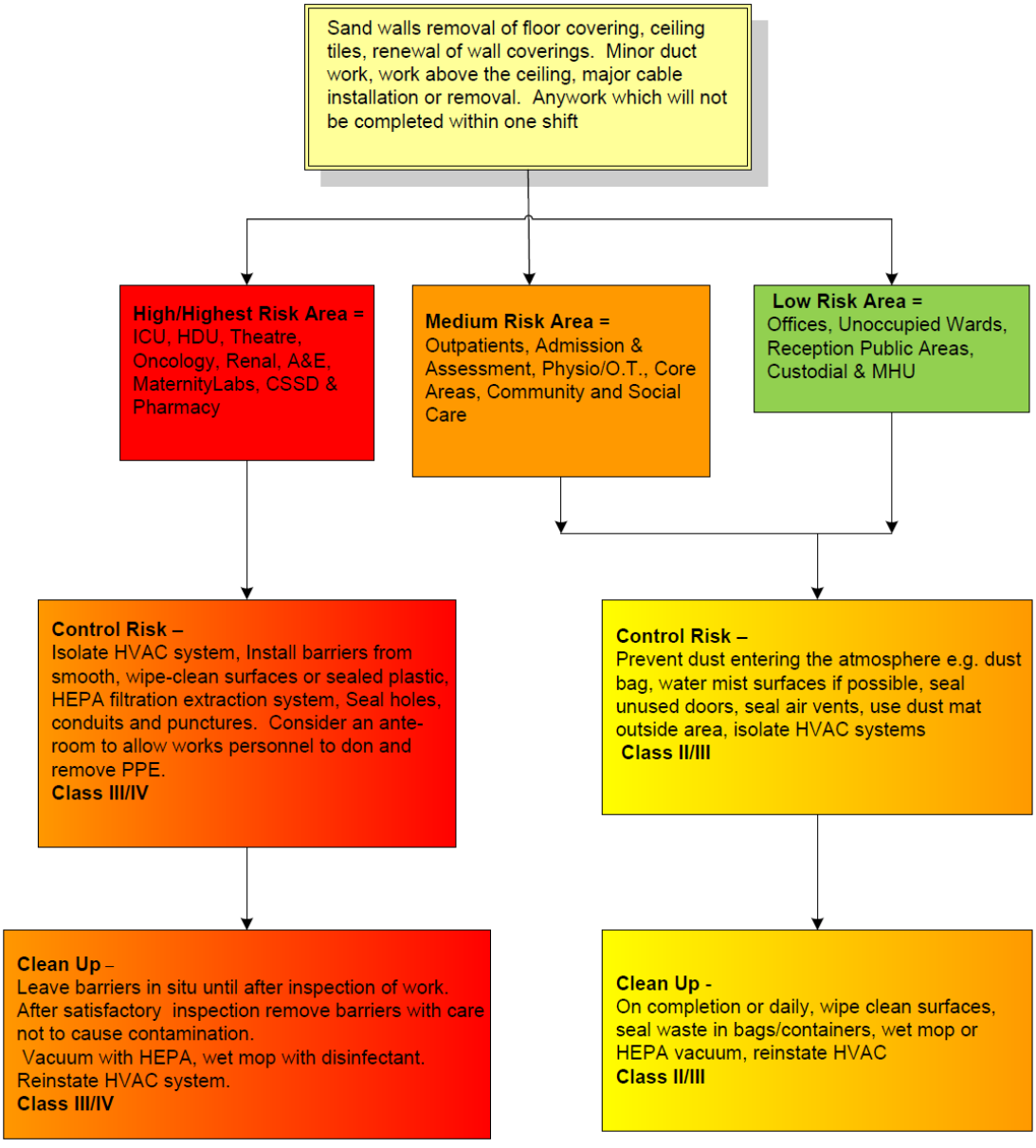
Appendix 5

Small Scale Work



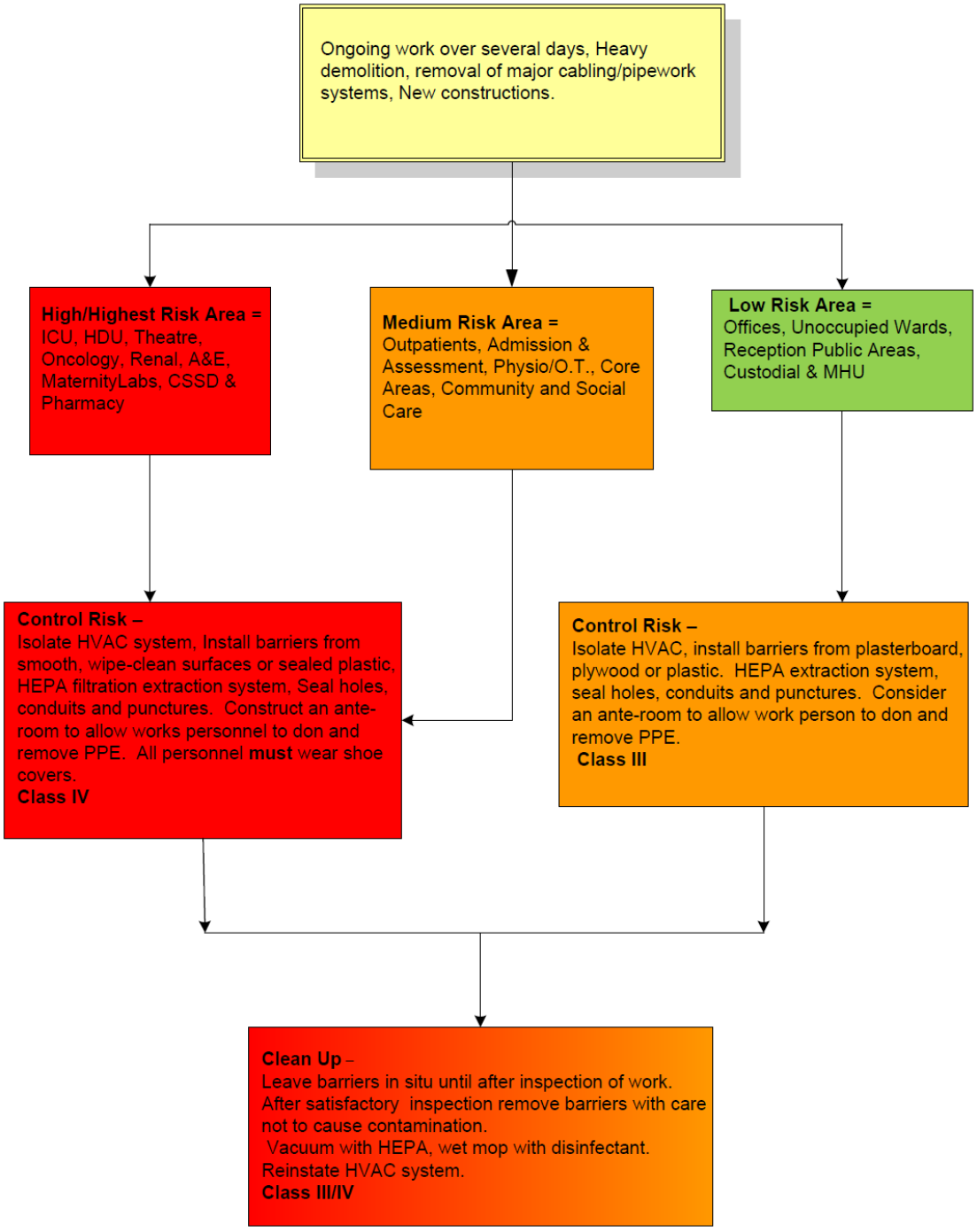
Appendix 6

Demolition work or removal of fixed structures or work where moderate-high level dust expected



Appendix 7

Major demolition work and construction



Appendix 8

A typical exemplar is set out below comprising an overview of various ongoing HAI-SCRIBE activities for minor works.
The entries are fictitious.

HAI-SCRIBE Reg No.	Date of issue by	Site location	Project details	Stage	Risk level	Date Assess review (optional)	Date Assess complete	Date Project started	Date Project finished	Comments
W/1	11-8-12 IGS	West ward block, Level 3	Painting bedrooms	Stage 3	Low	N/A	N/A	01/10/2012	30/10/2012	Access problems
L/6	20-8-12 BB	Lab Block	Replacing defective pipework at risers	Stage 3	Low	N/A	N/A	03/09/2012	05/10/2012	No issues
W/12	02/09/2012 WD	East ward block isolation rooms	HEPA filter replacement	Stage 3	Low/Medium	05/09/2012	Cancelled			Bedroom occupied
D/23	06/10/2012 FF	Dining Room entrance	Replacement floor covering	Stage 3	Low/Medium		31/10/2012	15/11/2012	Delayed	Asbestos found

Appendix 9

The following sets out typical NHS Board organisation showing the inter-relationship between the Board's internal organisation and external resources, when employed. This should be read in conjunction with Section 2.

NHS Board internal organisation

- **NHS Board** - should monitor cost and progress of all capital investment projects at regular meetings. If problems are identified, it needs to be satisfied that appropriate steps are being taken to resolve them;
- **Chief Executive Officer** (CEO) – accountable to the NHS Board and perhaps the only person with total responsibility for project and any other related activities. The CEO takes responsibility for management of all major capital schemes at all stages of the process from inception to post project evaluation;
- **Project Board** - comprising senior staff within the NHS Board who are responsible for the project and whose activities will be affected by the project, such as staff from clinical areas including infection prevention and control specialists and Estates & Facilities managers;
- **Project Director** - responsible for overall project management also managing the NHS Board's interest in the Project. Other responsibilities include evaluating competence of and appointing Consultants and Contractors who will undertake design and construction activity and acting as point of contract in dealings with Contractors;
- **Estates Adviser** - experienced in procuring construction, design and operation of healthcare facilities;
- **User Panel** - representatives of each of the relevant service departments, in each case authorised to define their department's needs and to review and agree how those needs are to be met.

NHS Board External resources:

- **Project Manager** – NHS Boards do not necessarily have capacity in-house to develop and manage all aspects of the project, therefore it is often necessary to appoint external Consultants. The Project Manager's role is to provide a single point of responsibility for the project brief and design. A list of responsibilities is set out in paragraph 2.7.
- **External Consultants** – this includes CDM Coordinator, Medical Planners, Designers and Contractor. They are managed by the Project Manager, appointed by the Project Director. However, their responsibility will be to, and their contracts with, the NHS Board.

Appendix 10

Exemplar questionset

Initial Brief and proposed Site for development identification of hazards, associated risks and control measures		
1.a	Brief description of the proposed development project and the planned development site	New build two-storey development at Lochee Hospital comprising treatment wards and clinics for haematology patients.
1.b	Identify any potential hazards associated with the design and/or proposed site.	Adjacent brewery has cooling towers on site.
1.c	Identify any risk associated with the hazards above	There is the potential for air with water-borne bacteria to be drawn into the new accommodation.
1.d	Outline the control measures that require to be implemented to eliminate or mitigate the identified risks. Ensure these are entered on the project risk register.	Windows may require to be non openable and mechanical ventilation relied upon. Air intakes will have to be located on the lee side of the building.
Control Measures		
1.e	It has been recognised that control measures identified to address the project risk may have unintended consequences e.g. closure of windows can lead to increased temperatures in some areas. Such issues should be considered at this point, they should be noted and action to address these taken	
	Potential Problems Patient and staff discomfort and fatigue due to potential overheating during hot weather if building is sealed.	
	Control Measures Mechanical ventilation will be required	
1.f	Actions to be addressed • Check out climate profile to determine extent of summer temperatures in excess of internal design temperatures. • Make initial assessment of extent of sources of internal heat gains. • Determine need for mechanical cooling of incoming ventilation supply air using rule of thumb method. • Check affordability.	
By Gordon Strachan		Deadline 31st March 2015

Initial Brief and proposed site for development, development stage 1: checklist to ensure all aspects have been addressed						
1.1	Is contaminated land an issue? e.g. asbestos, oils and heavy metals. (Refer to the Contaminated Land Register) Have these issues and actions to be taken been noted in actions to be addressed section?	Yes		No	x	N/A
		Yes		No		N/A x
Comments Contaminated Land Register and geotechnical surveys confirmed that historical use of site was non-industrial						
1.2	Is there a locally recognised increased risk of contamination or infection e.g. *cryptosporidium*? If yes give details. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes		No	x	N/A
		Yes		No		N/A x
Comments No record has been traced. (see comments re 1.1)						
1.3	Are there industries or other sources in the neighbourhood which may present a risk of infection or pollution e.g. animal by-products processing plant? If yes give details Have these issues and actions to be taken been noted in actions to be addressed section?	Yes x		No		N/A
		Yes x		No		N/A
Comments Adjacent brewery produces smells and vapour-laden discharges from plant and cooling towers. This confirms need for sealed windows, mechanical ventilation and (potentially) cooling. Charcoal filters may be required to mitigate ingress of odours.						
1.4	If there are any industries or other sources identified in question 1.3 above, will they affect the designed operation of the healthcare system? Consider the planned function of the design as well as issues such as: Ventilation Opening of doors and windows Water systems etc. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes x		No		N/A
		Yes x		No		N/A
Comments As per section 1.3. The water system is unaffected.						

Initial Brief and proposed site for development, development stage 1 – checklist to ensure all aspects have been addressed continued		
1.5	Are there construction/demolition works programmed in the neighbourhood which may present a risk of pollution or infection (including fungal infection)? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☐ No ☒ N/A ☐ Yes ☐ No ☐ N/A ☒
Comments No issues arising		
1.6	Are there cooling towers in the neighbourhood which may present a risk of *Legionella* infection? Consider also air handling units, water pipes etc. Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☒ No ☐ N/A ☐ Yes ☒ No ☐ N/A ☐
Comments See under 1.3		
1.7	Does the topography of the site in relation to the surrounding area and the prevailing wind direction present any HAI risk e.g. from entrainment of plumes containing *Legionella*? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☒ No ☐ N/A ☐ Yes ☒ No ☐ N/A ☐
Comments		
1.9	Will the proposed development impact on the surrounding area in any way which may present potential for infection risk? Consider possible restrictions being applied to the operation of the proposed facility e.g. Facilities Management routes Have these issues and actions to be taken been noted in actions to be addressed section?	Yes ☒ No ☐ N/A ☐ Yes ☐ No ☒ N/A ☐
Comments Previous 'issues to be addressed' related to the new build. For surrounding accommodation, consideration will have to be given to the need for temporary closure of windows, impact on internal environmental conditions, suppression of dust from excavations, plant noise, creation of segregated routes for waste removal.		

Initial Brief and proposed site for development, development stage 1 – checklist to ensure all aspects have been addressed continued		
1.10	Will lack of space limit the proposed development and any future expansion or change of use of the facility? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes [x] No [ ] N/A [ ] Yes [x] No [ ] N/A [ ]
Comments It cannot be ruled out that restricted space may inhibit future development or impact on the current project but this cannot be determined until the extent and type of project is known.		
1.11	Has a demolition/refurbishment asbestos survey been carried out? Have these issues and actions to be taken been noted in actions to be addressed section?	Yes [x] No [ ] N/A [ ] Yes [x] No [ ] N/A [ ]
Comments Question 1.1 also refers. No demolition is necessary as part of this new-build project. The hospital asbestos register is held in the estates office and confirms that no asbestos is present in the vicinity of the proposed site.		
1.12	Has consideration been given to the projected lifespan of the facility and its impact on planning and development?	Yes [ ] No [ ] N/A [ ]
Comments		

Additional notes - Stage 1

This project would not normally incorporate mechanical ventilation/cooling within a sealed building. It is necessary to verify that the cost allowance will accommodate this abnormal provision to avoid the need for unwanted compromises later in order to reduce costs.

Restricted site space will not necessarily impact on the current development but may have an impact in future on both the current Project and surrounding areas.

Development Stage 1: HAI-SCRIBE applied to the initial brief and proposed site for development			
Certification that the following documents have been accessed and the contents discussed and addressed at the Infection Control and Patient Protection Meeting held in			
Venue	Seminar Room 2, Lochee Hospital	Date	15th July 2014
'Healthcare Associated Infection System for Controlling Risk in the Built Environment' *(HAI-SCRIBE), comprising 'Scottish Health Facilities Note (SHFN) 30: Parts A & B..*			
Declaration: We hereby certify that we have co-operated in the application of and where applicable to the aforesaid documentation.			
Present			

Print name	Signature	Company	Telephone Numbers	Email address

References

CCDR (2001), **Construction-related Nosocomial Infections in Patients in Health Care Facilities Decreasing the Risk of Aspergillus, Legionella and Other Infections**, Division of Nosocomial and Occupational Infections, Bureau of Infectious Diseases, Centre for Infectious Disease Prevention and Control, Population and Public Health Branch, Health Canada, Ottawa, Ontario, Canada K1A 0L2

CDC (2003), **Guideline for Environmental Infection Control in Health-Care Facilities, 2003 Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)**, Hospital Infection Control Practices Advisory Committee.

From:	McNeil, Elaine
To:	Boyd, Moira; Cleaver, Don; Forsyth, Ewen; Fulton, Tom; Gallacher, Alan; Hunter, William; Kane, Mary Anne; Maclean, Alistair; McFadden, Jim; McIlwee, Joseph; McIntyre, Hazel; Mclean, Ken; Menzies, John; Pace, David; Powrie, Ian; Wallace, Stephen
Cc:	Matheson, Fiona; Gardner, Andrew; McPhail, Pamela; Hagan, Cathy; Walker, Elaine; Frame, May; Cochrane, Margaret; Speirs, Karen; Lamont, Moyra
Subject:	Estates SMT Group Meeting 27 January 2015
Date:	23 January 2015 14:25:11
Attachments:	Agenda 27 01 15.doc Minutes 09 10 14.doc Estates SMT Rolling Action List Updated October 2014.doc
Importance:	High

Dear Colleagues

I have attached the agenda, previous minutes and action list for the Estates SMT Group meeting scheduled for Tuesday 27 January 2015 at 9am in Meeting Room L1/A/008a/b, 1st Floor, New Labs Building, Southern General Hospital.

Regards

Elaine McNeil

Facilities Department
PA/Administrative Officer to Billy Hunter General Manager - Facilities, Clyde & South Sector & Alan Gallacher, Sector Estates Manager, Clyde Sector
1st Floor Estates Building
Royal Alexandra Hospital
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Estates Senior Management Team (SMT) Meeting
Tuesday 27th January 2015 at 9.00am
Meeting Room L1/A/008a/b, 1st Floor, New Labs Building, Southern General Hospital

AGENDA

1.	Apologies	
2.	Pricewaterhousecooper Audit/Procurement Updates	Ewen Forsyth
3.	Minute of Previous Meeting (9 October 2014) (paper attached)	
4.	Matters Arising/Rolling Actions (paper attached)	
5.	Asbestos Management Update	Moira Boyd
6.	Estates Strategy Roll Out Clyde Update & Partnership Update	Billy Hunter/David Pace
7.	Water Safety - Written Scheme SHTM04-01 Part G - Water Testing Review	Alan Gallacher
8.	Authorising Engineers Update	Alan Gallacher
9.	HAI SCRIBE Risk Assessment Update	Billy Hunter
10.	Health & Safety Climate Change Tool Project	Joe McIlwee
11.	Lifts - Response Times to Entrapments - New Lift Contract (Commences 1 November 2014)	All
12.	AOCB	
13.	Date & Time of Next Meeting	

Tuesday 17th March 2015 at 1.00pm in Meeting Room LO/A/010, Ground Floor, New Labs Building, Southern General Hospital

Facilities Directorate
Estates Senior Management Team (SMT) Meeting
9th October 2014 at 1.00pm
Meeting Room L1/A/008b, New Labs Building, Southern General Hospital

Present:

Mary Anne Kane (Chair) (MAK)	–	Interim Director of Facilities
Moira Boyd (MB)	–	Asbestos Manager
Don Cleaver (DC)	–	Senior Estates Manager, West
Ewen Forsyth (EF)	–	Commodity Manager
Billy Hunter (BH)	–	General Manager, South & Clyde
Alistair MacLean (AMacL)	–	General Manager, North East & West
Jim McFadden (JMcF)	–	Sector Estates Manager, South
Ken McLean (KMcL)	–	Sector Estates Manager, Partnerships
John Menzies (JM)	–	Senior Estates Manager, VoL
David Pace (DJP)	–	General Manager, Partnerships
Ian Powrie (IP)	–	Sector Estates Manager, NSGH
Stephen Wallace (SW)	–	Head of HR, Facilities

Apologies:

Tom Fulton (TF)	–	Site Estates Manager, GRI
Alan Gallacher (AG)	–	Sector Estates Manager, Clyde

In Attendance:

Sarah Cockram (SC)	–	Senior Commodity Officer

1. Apologies **Action**

As noted above.

2. Pricewaterhousecooper PwC Presentation
National Procurement Presentation
West of Scotland Intensive Improvement Activity Group Presentation

National Procurement and West of Scotland Intensive Improvement Activity Group delivered presentations at 12.30pm to the Sector Estates Managers.

Pricewaterhousecooper delivered a presentation and tabled a paper on Internal Audit Terms of Reference 2014/15 Estates to the group and explained the scope, timetable and policy and procedures across Sectors as follows:

The timetable from 20 – 29 October 2014 1 hour meetings with SEM's, will be arranged with Gary from PwC to document evidence , collate findings and have discussion to which a report will be submitted to MAK and EF. Estates Officers (EO) may be required to be in involved in the process as the EOs undertake the bulk of the buying and can provide supporting evidence. MAK noted that when dates have been agreed to ensure that a portfolio of evidence is available. EF and SC will arrange the meetings with PwC and will forward the information on what will be required.

MAK noted that an investigation is currently underway within one of the Sector's and the contract registers are being scrutinised.

The scope of the audit will be used as an indicator to help teams develop a workplan.

Once the audit is complete an action plan will be produced and sent to the Audit Committee for review. The Audit Committee may seek further details. The details will be processed through the Board.

3. Minutes from Previous Meeting (19 August 2014)

The minute was agreed as an accurate record.

4. Matters Arising/Rolling Actions

The action list was discussed with actions noted. The updated action list will be circulated with the minutes.

5. [redacted]

6. NewSGH Job Matching Update

SW noted that the job matching for the Duty Manager and Supervisor posts, the interviews will be held on 16 October 2014.

There is only 3 displaced staff which are maintenance assistants to complete the process, internal vacancies will become available on completion of the process. Backfill issues will arise relating to the staff who have been redeployed.

SW sought information from group members relating to staff on long term sickness and who are due to retire. Group members to forward the information to SW. **ALL**

Vacancies will be released in the next few weeks on completion of the job matching process for the NSGH.

7. Estates Strategy Roll Out

BH and DP have provided proposals, BH noted that the Clyde Sector proposal requires further work to include more information, need to move forward in order for vacancies to be released.

To meet formally with staffside to discuss how to progress the Clyde Sector, this leaves GRI and GGH to finalise. Job descriptions are required by end of March 2015 and the need to be using a standardised approach by 31 March 2015.

PPMs and data from FMFirst to be looked at and to be demonstrated with the need to defend the position and justify. MAK has held discussion with Grant Archibald, Chief Operating Officer and Peter Gallagher, Director of Finance regarding asset surveys to be undertaken and also dialogues with Mike Baxter. DP noted that NHS Lanarkshire is way ahead of NHSGG&C regarding EAMS etc. MAK to notify the Board there may be a risk and that we are almost there on completion. **MAK**

8. On-Call Compensatory Rest Arrangement

SW noted that issues/concerns have been raised on how we are applying the compensatory rest requirements. SW has summarised in the paper circulated to the group the minimum daily rest and the weekly daily rest. Minimum daily rest equates to ½ day if contacted up to 11pm or a full day if contacted after 11pm. Any telephone calls are classed as working. If on call at the weekends with no telephone calls, staff are not required as working

If no calls are received throughout the weekend and no work undertaken: No Compensatory Rest requires to be provided in lieu. If calls are received which prevent the employee from having uninterrupted 35 hours rest during the weekend. The employee should receive the next Friday as time in lieu. (which will maintain an uninterrupted 70 hour rest in a fortnight). Other Directorates may not have picked up on the AfC 35/70 hours.

MAK noted that within one Sector the Estate Officer's (EO's) receive the first call which is then forwarded to a Tradesman. Looking for a different way in receiving the telephone calls e.g. triage. KMcL noted that there are still issues within Partnerships and Partnerships should be using Section C of the summary. There are challenges within several Sectors that require to be rectified. **MAK/SW**

9. Water Systems Safety Policy

MAK noted at the last Board Water Safety Group the Written Scheme SHTM-01 Part G requires to be reviewed. The Sector minutes were checked and it was noted that water testing is not noted within the minutes. DC noted that a quarterly report is produced for the West Sector and discussed at the Infection Control meetings. DP noted that testing is not undertaken within Partnerships. MAK noted that from a governance perspective testing is required to be noted within the Sector minutes. **SEMs**

MAK noted the recent situation within Partnerships where the AE provide different advice from the Microbiologist. The AE has been appointed to provide expert advice to NHSGG&C. KMcL concluded the situation with taking the AE's advice.

DP noted the issues of the hot and cold water system within the new build at Leverndale Hospital, expert engineers are on site and will monitor the situation. Remedial work is underway, on completion will dose and then test, the guidance is contained within the SHTM.

IP noted the need for a baseline to work from. IP noted that HFS will be taking forward the scenario of the NSGH Tap Low Straightners Risk Assessment as discussed at the Board Water Safety Group meeting on 2 October 2014. The written schemes etc require to be reviewed. It was suggested to liaise with the company who deals with asbestos in order to develop modules.

MAK reiterated that the NSGH will be paperlite.

DP asked regarding the Compliance Manager post that has been discussed previously. It was noted that the post will be discussed at the SCART Steering Group meeting.

10. Authorising Engineers Update

Deferred to next meeting.

11. HAI Scribe Update

Completed in June 2014.

12. Lifts

Response Times to Entrapment
Discussion took place at the previous Estates SMT meeting on 19 August 2014 regarding concerns on whether NHSGG&C train our own employees to release entrapments. The group agreed that the entrapments should be undertaken by the Contractor.

The national contract is a 1 hour response time, MAK noted for a variation to contract to be administered to amend the response time to ½ hour, EF to negotiate with the new supplier.

IP noted that the response time for the NSGH is 2 hours, MAK noted to involve Brookfield to negotiate to ½ hour.

New Lift Contract (Commences 1 November 2014)
Group members noted the commencement of the new lift contract from 1 November 2014.

13. AOCB

MA Apprenticeship
MAK noted that the next cohort of MA's is due to commence. NHSGG&C requires to have a more structured and centralised approach to the development of staff. MAK suggested to put a hold on the recruiting of MA's this year, due to the requirement for fully qualified staff. Rob Anderson has confirmed that monies are available for the recruitment of MA's although the challenge being that we have to sacrifice qualified posts to recruit MA's. Group members agreed not to recruit MA's this year.

14. Date & Time of Next Meeting

The next meeting is scheduled for Tuesday 27th January 2015 at 9.00am in Meeting Room L1/A/008a/b, 1st Floor, New Labs Building, Southern General Hospital.

Estates SMT Meetings 2013/14
Rolling Actions List

Action Ref (9 October 2014 Agenda item)	Action Item	Owner	Due Date	Outcome/Conclusion
08.04.14:7	Provide feedback on revised Working at Height Policy to JG	All JG		John Green to update the Policy. IP noted to take into account the NSGH regarding roof access etc. IP to contact John Green and identify all areas. JG to issue the Policy for comment. IP noted for the NSGH to include steeplejacks etc within the Policy. JG to update and circulate the document.
08.04.14:11a	A central electronic storage area is to be created for all HAI SCRIBE documentation	GB/ALL	ALL/GB	A request has been submitted to IT, Gail Bradbury will provide administration access for this group. Need to know what level of access is required with a timeline of 30 June 2014 for completion. Gail to provide an update.

Completed Actions

Action Ref (Date of meeting/ Agenda item)	Action Item	Owner	Due Date	Outcome/Conclusion
10.6.14 item 6	**Compensatory Rest Update** BH noted the need to understand the impact on the service with the need to discuss further, therefore all SEMs and SMMs were asked to pass comments and issues on the impact to the service to SW by end of June 2014.	SEMs/SMMs	KMcL BH	KMcL still has issues around the 35 hours, meeting was held on 12 August 2014 to pick up with Partnerships. AG noted the need to look at the amount of hours that compensatory rest is affecting the day to day maintenance. BH to issue a template for group members to complete from April – June 2014 in order to work out the amount of hours affected.
08.04.14:5	A Fact Sheet on Water Safety is to be developed and distributed via the SCN Forums	AG/MAK/BH	May 2014 AG	AG and Pamela Joannidis will undertake a program of visits across sites by the end of July 2014. AG and Pamela Joannidis delivering presentations across sites on legionella and Pseudomonas. Presentations have been delivered.
08.04.14:12	MAK to discuss Bill Skelly the level of detailed required re EAMS reporting by sites	MAK	HMcI	Discussion has been held with Bill Skelly on high, medium and low risks. Hazel McIntyre to provide an update to this group with a discussion on how to correlate the HEI. BH to liaise with MAK regarding the meeting held with Bill Skelly. Billy Skelly has met with the relevant individuals.
08.04.14:4	Moira Boyd to issue a checklist for managers to use as guidance for CLASP buildings.	MB		It was agreed that a process is required to be put in place. AG to look at the actions for the Clyde Sector associated with CLASP buildings. Issued and complete.
08.04.14:9	Provide any further feedback to IP on revised Estates JDs	All	ASAP	IP has received feedback from JMcF, DC has not received job descriptions for feedback. SW will re-issue the job descriptions which has been agreed with indicative bandings. Complete.
08.04.14:10	MAK will send the job matching which was done by	MAK	DP	SW requires numbers from partnerships.

Action Ref (Date of meeting/ Agenda item)	Action Item	Owner	Due Date	Outcome/Conclusion
	Stephen Wallace to the SEMs.			Complete.
08.04.14:11	All sites are to update their HAI-SCRIBE Audit Results risk summary spreadsheets	All	End June 2014	There was some level of uncertainty about the exact information requirement therefore BH agreed to convene a session on 17th June to review RAH documentation. It was recognised that MAK required all information returned by end of June 2014 to provide a detailed Directorate update to OMG at 9th July meeting. Work around EAMS to be undertaken on a continuous basis. Complete.
16.12.13:4a	SW will find out how the impact of the Compensatory Rest period on the guaranteed uninterrupted hours is being handled in other Directorates.	SW	Next meeting	MAK to see SW re issuance of guidance. Item to be carried over to the next meeting. Guidance was disseminated in April 2014. Complete.

From:	Matthewson, Ian
To:	Macleod, Mairi; Griffin, Heather; Loudon, David; "David.Hal[redacted]"; Beattie, Gordon; Moir, Peter; Connelly, Karen; McCluskey, Fiona; Wrath, Frances; McColl, Eleanor; Greig, Mark; Campbell, Margaret; Powrie, Ian; McSweeney, Karen; Connolly, Stephen; Turnpenny, Annette; Macdonald, David; Murray, Kate; Magee, James; McGarrity, John; Forsyth, Graham; MacDonald, Marion; Hunter, William; Johnston, Sally; Kean, Gary; McFall, Kathy; Rankin, Linden; McCafferty, Annette; Wright, John; Stewart, Alan; Machell, Mandy; Morrison, Lynn; Young, Scott; Horne, Marilyn; Munday, Angela; Murray, Kate; Owners, Service Transfer; Peebles, Lorraine; McAllister, Linda; Murray, Lorna; Sommerville, Eleanor
Cc:	"Douglas Ross (douglas.ross[redacted])"; Hirst, Allyson; Frew, Shiona; Craig, Carol; Cavanagh, Joyce
Subject:	NSGH Phase 1 Close-out Programme detailing progress update as of 19/01/2015
Date:	19 January 2015 10:17:48
Attachments:	050115 NSGH Phase 1 Close-out Programme - progress update 190115.pdf
Importance:	High

All – please note attached Phase 1 close-out update, which is current as of today's date.

Noted percentages are again in line with various discussions I've had with you all, as well as what I've gleaned from observation over the course of the last week.

Generally things are 'OK' but with a niggling underlying trend for activities to get to a point nearing completion but not actually being closed out (e.g. the dreaded 90 / 95 percents). Whilst this it's not disastrous, from a resource management / workload perspective, it typically leads to a 'stacking effect', where not one isolated activity is a problem in its own right but in overall terms, essentially when considered alongside all other activities, has the 'increasing' potential to become a problem over time. That said, and I very much appreciate this is difficult to manage in practice, I would strongly recommend that where practical to do so as much as possible is closed out by controlling parties, even if it means it's not 'perfect' but fundamentally is adequate to close out and move on.

Overridingly, this week is all about the imminent handover date (26/1/15) & associated NHS / Project Team mobilisation prep-work (e.g. inductions & orientations, moving to new P/O set-up, processing of risk assessments, finalising of delivery & deployment requirements, etc, etc), all tied in with what is agreed with Brookfield in terms of agreed snagging works, outstanding works and additional works (NB. inclusive of agreed timescales).

Alongside the above, keep an eye on those 'barometer' activities I've noted previously (e.g. HI&T, Telecomms, Equipping, Early Moves & BMG, Group 5, Clinical Cleaning, pre-stocking, etc – ref. programme 'flow' document circulated last week), noting that these are typically 'black & white / point and shoot activities' that can either progress or not (not much grey). If it's the latter, overall progress tends to be adversely affected, characterised by work progressing all over the place but not actually being finished; however, if it's the former, things tend to be moving well and in accordance with programme requirements, work is being completed with areas being closed down and moving to operational / live status. Needless to say, from a monitoring perspective, I will be looking very closely at said barometer activities.

I'm now directing my attention to drafting and finalising the Phase 2 Close-out Programme (ref. NHS Commissioning Period), which I'll complete and circulate at the end of this week (latest), essentially in readiness for handover on 26/1/15.

As ever, any questions please don't hesitate to give me a call.

Regards,

Ian

Ian Matthewson - Senior Project Planner
New South Glasgow Hospitals' Project
NHS Project Office, Top Floor, Modular Office Block
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Tel (DD): [redacted]
Email: [redacted]

From: Matthewson, Ian
Sent: 12 January 2015 10:26
To: Macleod, Mairi; Griffin, Heather; Loudon, David; 'David.Hal[redacted]'; Beattie, Gordon; Moir, Peter; Connelly, Karen; McCluskey, Fiona; Wrath, Frances; McColl, Eleanor; Greig, Mark; Campbell, Margaret; Powrie, Ian; McSweeney, Karen; Connolly, Stephen; Turnpenny, Annette; Macdonald, David; Murray, Kate; Magee, James; McGarrity, John; Forsyth, Graham; MacDonald, Marion; Hunter, William; Johnston, Sally; Kean, Gary; McFall, Kathy; Rankin, Linden; McCafferty, Annette; Wright, John; Stewart, Alan; Machell, Mandy; Morrison, Lynn; Young, Scott; Horne, Marilyn; Munday, Angela; Murray, Kate; Owners, Service Transfer; Peebles, Lorraine; McAllister, Linda; Murray, Lorna; Sommerville, Eleanor
Cc: 'Douglas Ross (douglas.ross[redacted])'; Hirst, Allyson; Frew, Shiona; Craig, Carol; Cavanagh, Joyce
Subject: RE: NSGH Phase 1 Close-out Programme detailing progress update as of 12/01/2015
Importance: High

All – please note the attached, which details progress as of today's date.

Noted progress percentages are in line with various discussions & feedback gleaned over the course of the last week. That said, if there are any percentages you feel (relative to your respective remits) are incorrect please advise and I'll correct accordingly.

Next update will follow a week today – I'll obviously be in touch with you all through the course of this week to develop related activities, as well as track progress.

Regards,

Ian

Ian Matthewson - Senior Project Planner
New South Glasgow Hospitals' Project
NHS Project Office, Top Floor, Modular Office Block
Construction Site on SGH Campus
Hardgate Road, Glasgow, G51 4SX

Tel (DD): [redacted]
Email: [redacted]

From: Matthewson, Ian
Sent: 05 January 2015 17:00
To: Macleod, Mairi; Griffin, Heather; Loudon, David; 'David.Hal[redacted]'; Beattie, Gordon; Moir, Peter; Connelly, Karen; McCluskey, Fiona; Wrath, Frances; McColl, Eleanor; Greig, Mark; Campbell, Margaret; Powrie, Ian; McSweeney, Karen; Connolly, Stephen; Turnpenny, Annette; Macdonald, David; Murray, Kate; Magee, James; McGarrity, John; Forsyth, Graham; MacDonald, Marion; Hunter, William; Johnston, Sally; Kean, Gary; McFall, Kathy; Rankin, Linden; McCafferty, Annette; Wright, John; Stewart, Alan; Machell, Mandy; Morrison, Lynn; Young, Scott; Horne, Marilyn; Munday, Angela; Murray, Kate; Owners, Service Transfer; Peebles, Lorraine; McAllister, Linda

Cc: 'Douglas Ross ([redacted])'; Hirst, Allyson; Frew, Shiona; Craig, Carol
Subject: NSGH Phase 1 Close-out Programme
Importance: High

All,

Please find attached for your attention a copy of the signed off Phase 1 Close-out Programme (i.e. from 8/12/14 to handover), complete with supportive narrative.

Any questions, please don't hesitate to give me a call, noting I'll be in touch with the vast majority of you over the course of the next few days / weeks to develop noted sub-primary activities as detailed.

Regards,

Ian

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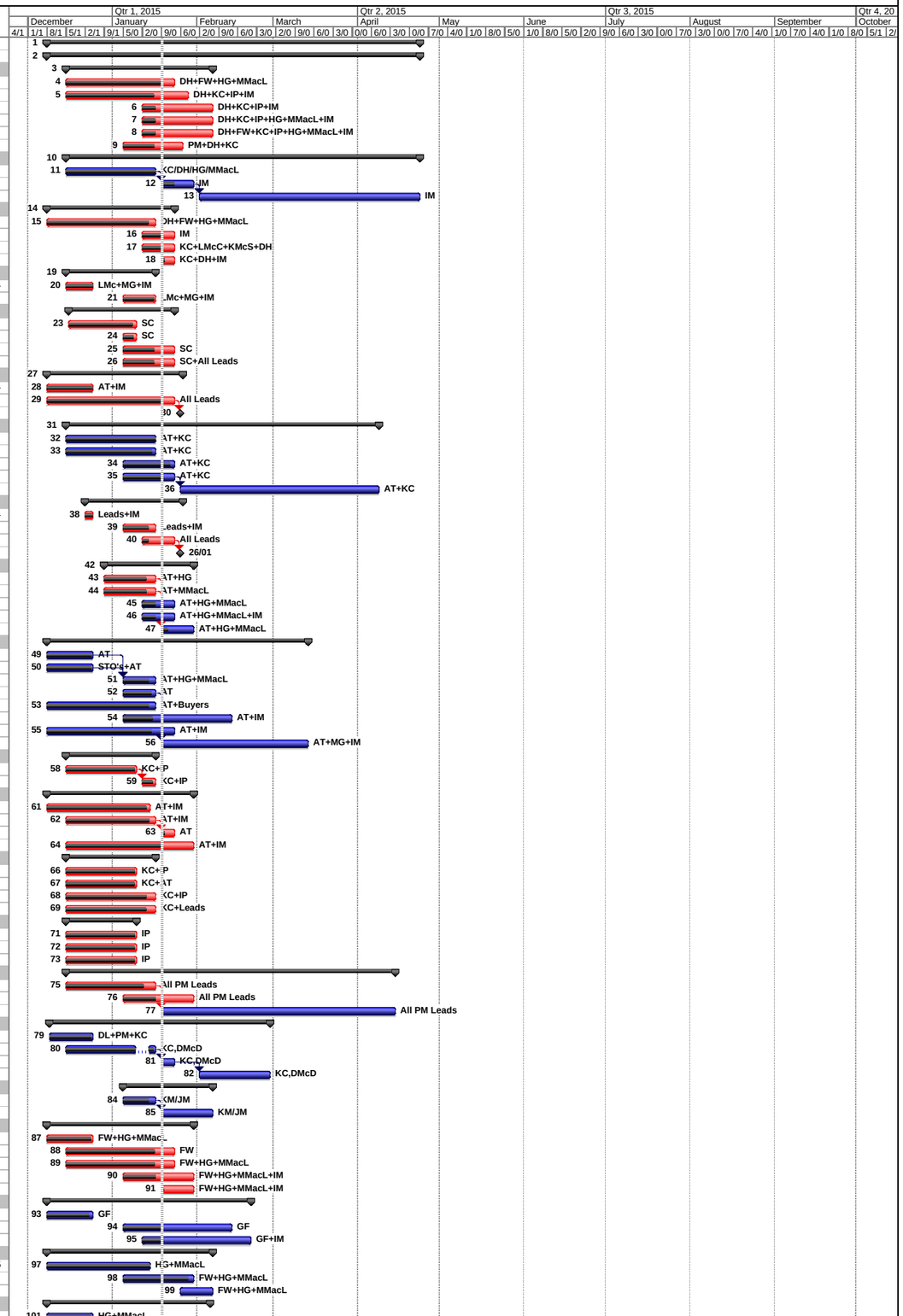
Tel (DD): [redacted]
Email: [redacted]

NSGH Phase 1 Close-out Programme up to handover date - 26th January 2015

Signed off / 'Work to' Programme - Progress Update 19/01/2015

ID	Task Name	Resource Names	Duration	Start	Finish	Actual Start	% Complete	Actual Finish
1	**Phase 1 of NHS Close-out Programme for NSGH:**		**93 days**	**Mon 08/12/14**	**Thu 23/04/15**	**Mon 08/12/14**	**56%**	**NA**
2	**Primary Pre-Handover Activities, Tasks & Prep-work (NB. commonly referred to as 'week -1' by the Project Team)**		**93 days**	**Mon 08/12/14**	**Thu 23/04/15**	**Mon 08/12/14**	**56%**	**NA**
3	**NSGH Handover interface with Brookfield Multiplex (NB. ***critical interface & baseline / trigger event***)**	***DL+*PM**	**36 days**	**Mon 15/12/14**	**Fri 06/02/15**	**Mon 15/12/14**	**50%**	**NA**
4	Agree & formalise handover criteria & associated interface with Brookfield Multiplex (NB ***inclusive of contractual drafting***)	DH+FW+HG+MMacL	26 days	Mon 15/12/14	Fri 23/01/15	Mon 15/12/14	81%	NA
5	Critically assess & review (in conjunction with the above) related programme assumptions & NHS commissioning logic	DH+KC+IP+IM	29 days	Mon 15/12/14	Wed 28/01/15	Mon 15/12/14	70%	NA
6	Re-adjust related programmes if required and communicate to relevant parties	DH+KC+IP+IM	20 days	Mon 12/01/15	Fri 06/02/15	Mon 12/01/15	25%	NA
7	Schedule all agreed outstanding works by Brookfield, inclusive of agreed timing (e.g. snagging, incomplete works, etc)	DH+KC+IP+HG+MMacL+IM	20 days	Mon 12/01/15	Fri 06/02/15	Mon 12/01/15	25%	NA
8	Schedule all agreed 'additional' works to be addressed by Brookfield, inclusive of change orders & agreed timing	DH+FW+KC+IP+HG+MMacL+IM	20 days	Mon 12/01/15	Fri 06/02/15	Mon 12/01/15	25%	NA
9	Agree & communicate CDM particulars that will come into play after Hospital handover	PM+DH+KC	16 days	Mon 05/01/15	Mon 26/01/15	Mon 05/01/15	60%	NA
10	**General flow & progressive occupation of new hospital between handover & migration period**	***KC+*DH**	**88 days**	**Mon 15/12/14**	**Thu 23/04/15**	**Mon 15/12/14**	**30%**	**NA**
11	Finalise general flow & occupation plan for new hospital between noted period (i.e. high level overview)	KC/DH/HG/MMacL	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	100%	Fri 16/01/15
12	Circulate & communicate to relevant lead parties associated with building handover & NHS commissioning works	IM	10 days	Mon 19/01/15	Fri 30/01/15	Mon 19/01/15	50%	NA
13	Monitor & update intended flow & occupation plan as and when required, communicating accordingly	IM	57 days	Mon 02/02/15	Thu 23/04/15	NA	0%	NA
14	**NHS Commissioning Programme (i.e. general & specialist commissioning requirements)**	***KC**	**31 days**	**Mon 08/12/14**	**Fri 23/01/15**	**Mon 08/12/14**	**70%**	**NA**
15	Further refine NHS Commissioning Programme for NSGH (NB. inclusive of internal & external resourcing)	DH+FW+HG+MMacL	26 days	Mon 08/12/14	Fri 16/01/15	Mon 08/12/14	90%	NA
16	Circulate refined NHS Commissioning Programme for comment & final sign-off by relevant parties	IM	10 days	Mon 12/01/15	Fri 23/01/15	Mon 12/01/15	55%	NA
17	Ensure NHS Commissioning Programme complements HI&T + Telecomms Programmes & visa versa (NB. 'Check-mark' activity)	KC+LMcC+KMcS+DH	10 days	Mon 12/01/15	Fri 23/01/15	Mon 12/01/15	55%	NA
18	Sign NHS Commissioning Programme off & distribute to relevant parties (various - primary & supportive)	KC+DH+IM	5 days	Mon 19/01/15	Fri 23/01/15	Mon 19/01/15	25%	NA
19	**Finalise HI&T Programme from Handover to start of Migration Period**	***LMcC**	**21 days**	**Mon 15/12/14**	**Fri 16/01/15**	**Mon 15/12/14**	**97%**	**NA**
20	Circulate current HI&T programme for any final comments & subsequent sign-off by relevant parties	LMc+MG+IM	8 days	Mon 15/12/14	Wed 24/12/14	Mon 15/12/14	100%	Wed 24/12/14
21	Incorporate final comments (if applicable) & issue final version for incorporation into master programme	LMc+MG+IM	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	95%	NA
22	**Telecomms (i.e. Phase 1 close-out prep work for Phase 2 NHS Commissioning Period)**	***KMcS+*SC**	**25 days**	**Tue 16/12/14**	**Fri 23/01/15**	**Tue 16/12/14**	**74%**	**NA**
23	Define Phase 2 Telecomms works relative to NHS Commissioning Period	SC	15 days	Tue 16/12/14	Fri 09/01/15	Tue 16/12/14	90%	NA
24	Confirm list of Telecomm Supply & Installation parties	SC	5 days	Mon 05/01/15	Fri 09/01/15	Mon 05/01/15	80%	NA
25	Agree & formalise best sequencing, inclusive of associated interfaces with HI&T, identified Early Moves, FM, etc.	SC	15 days	Mon 05/01/15	Fri 23/01/15	Mon 05/01/15	65%	NA
26	Agree & formalise training requirements to be implemented during Phase 2 / NHS Commissioning Period	SC+All Leads	15 days	Mon 05/01/15	Fri 23/01/15	Mon 05/01/15	65%	NA
27	**Finalise Early Moves Scope & associated Brief from Handover to start of Migration Period**	***AT+*KC**	**32 days**	**Mon 08/12/14**	**Mon 26/01/15**	**Mon 08/12/14**	**87%**	**NA**
28	Finalise an agreed list of Early Moves to NSGH for noted period	AT+IM	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	100%	Wed 24/12/14
29	Finalise brief, scope & timing of Early Moves (ref. MWB's, interface with BMG, STO's remit, etc)	All Leads	31 days	Mon 08/12/14	Fri 23/01/15	Mon 08/12/14	84%	NA
30	Start implementing Early Moves scope & associated programme timing as agreed & signed off	All Leads	1 day	Mon 26/01/15	Mon 26/01/15	NA	0%	NA
31	**Building Protection Post Handover & during Migration Period (NB. 2 separate & distinct periods)**	***AT/*KC**	**77 days**	**Mon 15/12/14**	**Wed 08/04/15**	**Mon 15/12/14**	**53%**	**NA**
32	Establish what protection Brookfield will be leaving in place and summarize / communicate same to relevant parties	AT+KC	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	100%	Fri 16/01/15
33	Finalise Protection Scope & Requirements for NHS Commissioning / Pre-equipping Period (i.e. in addition to above)	AT+KC	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	95%	NA
34	Agree who will address the above and scope / appoint accordingly (e.g. may be Brookfield totally for this period)	AT+KC	15 days	Mon 05/01/15	Fri 23/01/15	Mon 05/01/15	90%	NA
35	Establish how the above dove-tails with the follow-on Migration Period Protection	AT+KC	15 days	Mon 05/01/15	Fri 23/01/15	Mon 05/01/15	70%	NA
36	Agree who will address the Migration Period protection + scope / appoint accordingly (e.g. Brookfield, BMG or ANOther)?	AT+KC	51 days	Mon 26/01/15	Wed 08/04/15	NA	0%	NA
37	**Delivery & Deployment (i.e. during Phase 2 / NHS Commissioning Period)**	***KC**	**22 days**	**Mon 22/12/14**	**Mon 26/01/15**	**Mon 22/12/14**	**54%**	**NA**
38	Identify where this is applicable (e.g. HI&T, Telecoms, Equipment, etc). Circulate & get agreement to same	Leads+IM	3 days	Mon 22/12/14	Wed 24/12/14	Mon 22/12/14	100%	Wed 24/12/14
39	Develop delivery & deployment requirements for each identified requirement	Leads+IM	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	75%	NA
40	Sign off & implement	All Leads	10 days	Mon 12/01/15	Fri 23/01/15	Mon 12/01/15	25%	NA
41	Start of agreed delivery & deployment process	All Leads	1 day	Mon 26/01/15	Mon 26/01/15	NA	0%	NA
42	**Finalise Scope & Location of Pre-Equipping requirements**	***AT**	**23 days**	**Mon 29/12/14**	**Fri 30/01/15**	**Mon 29/12/14**	**57%**	**NA**
43	For 350 beds to Adult Hospital part of NSHG	AT+HG	13 days	Mon 29/12/14	Fri 16/01/15	Mon 29/12/14	75%	NA
44	For 100 beds to Children's Hospital part of NSGH	AT+MMacL	13 days	Mon 29/12/14	Fri 16/01/15	Mon 29/12/14	75%	NA
45	Clarify & finalise any other locations that are required & confirm / formalise same	AT+HG+MMacL	10 days	Mon 12/01/15	Fri 23/01/15	Mon 12/01/15	50%	NA
46	Communicate finalised arrangements to relevant parties	AT+HG+MMacL+IM	10 days	Mon 12/01/15	Fri 23/01/15	Mon 12/01/15	50%	NA
47	Complete Room Equipment Data Sheets (etc / from BoFQ) & arrange to locate on room doors & other relevant locations	AT+HG+MMacL	10 days	Mon 19/01/15	Fri 30/01/15	Mon 19/01/15	25%	NA
48	**Finalise split between new equipment and the transfer of existing equipment (ref. demitting exercise)**	***AT**	**66 days**	**Mon 08/12/14**	**Fri 13/03/15**	**Mon 08/12/14**	**57%**	**NA**
49	Finalise New Equipment Bill of Quantities (NB. inclusive of Change Management, variation record, location, etc)	AT	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	95%	NA
50	Finalise List & Location of existing equipment (i.e. current & future position, inclusive of Group 5)	STO's+AT	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	95%	NA
51	Distribute both new and existing equipment details & lists to relevant parties (i.e. by way of information & confirmation)	AT+HG+MMacL	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	75%	NA
52	Clearly establish, if any, bottlenecks inhibiting the finalising of any new equipment (i.e. both ordering & final procurement)	AT	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	85%	NA
53	Establish with relevant parties programme dates for the supply, sequencing & installation of new equipment	AT+Buyers	26 days	Mon 08/12/14	Fri 16/01/15	Mon 08/12/14	90%	NA
54	Progressively circulate & communicate new equipment dates / sequencing to relevant parties (i.e. periodic updates)	AT+IM	30 days	Mon 05/01/15	Fri 13/02/15	Mon 05/01/15	30%	NA
55	Establish with relevant parties programme dates for the movement & installation of existing equipment (e.g. BMG)	AT+IM	31 days	Mon 08/12/14	Fri 23/01/15	Mon 08/12/14	80%	NA
56	Progressively circulate & communicate existing equipment updates, inclusive of decommissioning / demitting interface	AT+MG+IM	40 days	Mon 19/01/15	Fri 13/03/15	NA	0%	NA
57	**FM / Estate's Security & Induction Protocols for NSGH after handover date**	***KC**	**21 days**	**Mon 15/12/14**	**Fri 16/01/15**	**Mon 15/12/14**	**91%**	**NA**
58	Finalise related protocols (inclusive of applicable documentation, templates, ID's, etc)	KC+IP	16 days	Mon 15/12/14	Fri 09/01/15	Mon 15/12/14	95%	NA
59	Sign off & formalise with relevant lead parties (e.g. ICT, Equipping, Commissioning, etc) & formally distribute / action / enforce	KC+IP	5 days	Mon 12/01/15	Fri 16/01/15	Mon 12/01/15	80%	NA
60	**Finalise Move Management Company's Appointment (i.e. for BMG - ref. current quote & appointment)**	***AT**	**36 days**	**Mon 08/12/14**	**Fri 30/01/15**	**Mon 08/12/14**	**80%**	**NA**
61	Schedule all proposed adjustments & variations to BMG's current quote / appointment (e.g. early moves, protection, etc)	AT+IM	24 days	Mon 08/12/14	Wed 14/01/15	Mon 08/12/14	95%	NA
62	Agree related adjustments & variations with BMG, inclusive of where relevant quote adjustments are required	AT+IM	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	90%	NA
63	Circulate / communicate related details to relevant parties, fully detailing BMG's details / remit / responsibilities / etc.	AT	5 days	Mon 19/01/15	Fri 23/01/15	Mon 19/01/15	25%	NA
64	Actively develop early move requirements, details, etc with BMG & other relevant parties / departments	AT+IM	31 days	Mon 15/12/14	Fri 30/01/15	Mon 15/12/14	70%	NA
65	**FM & Estate's Access, Distribution & Traffic Management Protocols Post Handover**	***KC+*IP**	**21 days**	**Mon 15/12/14**	**Fri 16/01/15**	**Mon 15/12/14**	**89%**	**NA**
66	Agree & Formalise access, distribution & traffic management protocols out with the Hospital building	KC+IP	16 days	Mon 15/12/14	Fri 09/01/15	Mon 15/12/14	95%	NA
67	Agree & Formalise access & distribution protocols within the Hospital building (e.g. lift access & usage, prescribed routes, etc).	KC+AT	16 days	Mon 15/12/14	Fri 09/01/15	Mon 15/12/14	95%	NA
68	Agree & formalise temporary hold and/or storage points out-with the Hospital building	KC+IP	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	85%	NA
69	Agree & formalise temporary hold and/or storage points within the Hospital building	KC+Leads	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	85%	NA
70	**FM / Estate's Risk Assessment, Method Statement & Permit Protocols**	***IP**	**16 days**	**Mon 15/12/14**	**Fri 09/01/15**	**Mon 15/12/14**	**95%**	**NA**
71	Finalise requirements for Risk Assessment submission & approval	IP	16 days	Mon 15/12/14	Fri 09/01/15	Mon 15/12/14	95%	NA
72	Finalise requirements for Method Statement submission & approval	IP	16 days	Mon 15/12/14	Fri 09/01/15	Mon 15/12/14	95%	NA
73	Finalise requirements for Permit to Work submission, protocol & approval	IP	16 days	Mon 15/12/14	Fri 09/01/15	Mon 15/12/14	95%	NA
74	**NHS Contractors (i.e. via respective leads) requiring access between handover and start of migration period**	***All PM Leads**	**81 days**	**Mon 15/12/14**	**Tue 14/04/15**	**Mon 15/12/14**	**27%**	**NA**
75	Respective lead parties (e.g. for ICT, Equipping, etc) to progressively confirm full list of parties (NB. to an agreed format)	All PM Leads	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	80%	NA
76	Overarching summary schedule to be produced to capture the above	All PM Leads	20 days	Mon 05/01/15	Fri 30/01/15	Mon 05/01/15	50%	NA
77	Respective leads to update overarching schedule on a weekly basis (e.g. CoP on a Thursday evening)	All PM Leads	60 days	Mon 19/01/15	Tue 14/04/15	NA	0%	NA
78	**NSGH Cleaning requirements & various stages (NB. inclusive of internal & external resourcing)**	***KC**	**55 days**	**Tue 09/12/14**	**Fri 27/02/15**	**Tue 09/12/14**	**53%**	**NA**
79	Finalise cleaning requirements up to handover with Brookfield Multiplex	DL+PM+KC	12 days	Tue 09/12/14	Wed 24/12/14	Tue 09/12/14	95%	NA
80	Finalise cleaning requirements between handover & migration period	KC,DMcD	18.38 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	95%	NA
81	Finalise any external appointments / additional resource relative to the above period	KC,DMcD	5 days	Mon 19/01/15	Fri 23/01/15	Mon 19/01/15	10%	NA
82	Finalise cleaning requirements for migration period	KC,DMcD	20 days	Mon 02/02/15	Fri 27/02/15	NA	0%	NA
83	**Linen Laundry Services & Associated Mobilisation**	***KM/*JM**	**25 days**	**Mon 05/01/15**	**Fri 06/02/15**	**Mon 05/01/15**	**30%**	**NA**
84	Define what is required during Phase 2 NHS Commissioning Period (e.g. pre-stocking of linen, etc)	KM/JM	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	75%	NA
85	Communicate to relevant parties & mobilise accordingly	KM/JM	15 days	Mon 19/01/15	Fri 06/02/15	NA	0%	NA
86	**Finalise NHS Enhancement Work Packages (i.e. between handover & start of migration period)**	***FW+*HG+*MMacL**	**36 days**	**Mon 08/12/14**	**Fri 30/01/15**	**Mon 08/12/14**	**68%**	**NA**
87	Finalise full list of work packages, inclusive of scope, content, programme duration, etc.	FW+HG+MMacL	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	95%	NA
88	Formally appoint (where required) all related work package parties	FW	26 days	Mon 15/12/14	Fri 23/01/15	Mon 15/12/14	80%	NA
89	Agree / define / apportion all related attendances & interfaces (i.e. general and/or special)	FW+HG+MMacL	26 days	Mon 15/12/14	Fri 23/01/15	Mon 15/12/14	80%	NA
90	Communicate related requirements / information to relevant parties (e.g. FM, etc)	FW+HG+MMacL+IM	20 days	Mon 05/01/15	Fri 30/01/15	Mon 05/01/15	50%	NA
91	Agree & identify, if any, works that may go beyond commissioning period (i.e. beyond April 2015)	FW+HG+MMacL+IM	10 days	Mon 19/01/15	Fri 30/01/15	Mon 19/01/15	10%	NA
92	**Retail Fit-out**	***KC+*GF**	**51 days**	**Mon 08/12/14**	**Fri 20/02/15**	**Mon 08/12/14**	**39%**	**NA**
93	Finalise full extent of retail fit-out (incl. of scope, programme, WP's, interfaces, attendances, etc)	GF	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	90%	NA
94	Finalise the appointment of retail work package (WP) contractors as appropriate	GF	30 days	Mon 05/01/15	Fri 13/02/15	Mon 05/01/15	35%	NA
95	Communicate finalized retail fit-out details to relevant parties (various / e.g. FM, etc)	GF+IM	30 days	Mon 12/01/15	Fri 20/02/15	Mon 12/01/15	20%	NA
96	**Legacy Art Work Requirements**	***HG+*MMacL**	**41 days**	**Mon 08/12/14**	**Fri 06/02/15**	**Mon 08/12/14**	**78%**	**NA**
97	Finalise legacy art work requirements & agree / communicate with relevant parties	HG+MMacL	24 days	Mon 08/12/14	Wed 14/01/15	Mon 08/12/14	100%	Wed 14/01/15
98	Finalise the appointment of relevant contractors (if applicable), inclusive of scope / programme / attendances / etc.	FW+HG+MMacL	20 days	Mon 05/01/15	Fri 30/01/15	Mon 05/01/15	90%	NA
99	Circulate / communicate to relevant parties	FW+HG+MMacL	10 days	Mon 26/01/15	Fri 06/02/15	NA	0%	NA
100	**New Artwork Requirements (NB. commissioned & managed directly by NHS, not Brookfield)**	***HG+*MMacL**	**40 days**	**Mon 08/12/14**	**Thu 05/02/15**	**Mon 08/12/14**	**53%**	**NA**
101	Finalise above noted new artwork requirements, inclusive of any interface requirements with Brookfield (e.g. builderswork)	HG+MMacL	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	95%	NA



Project: NSGH Commissioning & Migra
Date: Mon 19/01/15

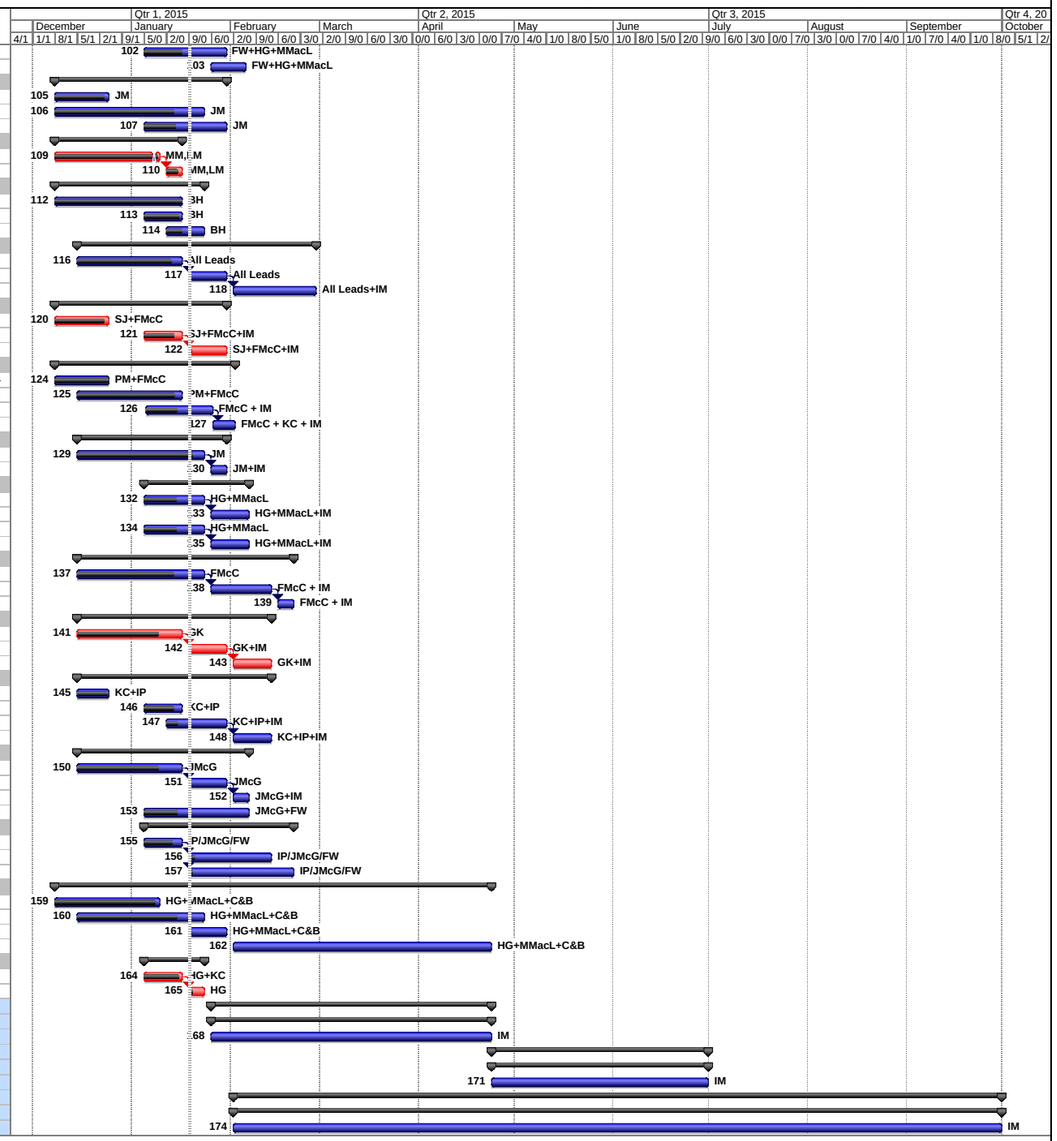
Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External MileTask | Split

Programme Owner: Ian Matthewson (NSGH Senior Project Planner), Tel# [redacted], Email [redacted]

NSGH Phase 1 Close-out Programme up to handover date - 26th January 2015

Signed off / 'Work to' Programme - Progress Update 19/01/2015

ID	Task Name	Resource Names	Duration	Start	Finish	Actual Start	% Complete	Actual Finish
102	Finalise the appointment of relevant contractors (if applicable), inclusive of scope / programme / attendances / etc.	FW+HG+MMacL	20 days	Mon 05/01/15	Fri 30/01/15	Mon 05/01/15	50%	NA
103	Circulate / communicate to relevant parties	FW+HG+MMacL	9 days	Mon 26/01/15	Thu 05/02/15	NA	0%	NA
104	**Helipad Requirements Pre-Handover & in readiness for commissioning & migration periods**	*JM	36 days	Mon 08/12/14	Fri 30/01/15	Mon 08/12/14	67%	NA
105	Finalise requirements, inclusive of formal sign-off & approvals	JM	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	90%	NA
106	Ensure all pre / outstanding building works are addressed (e.g.. flight lighting, fire fighting, etc)	JM	31 days	Mon 08/12/14	Fri 23/01/15	Mon 08/12/14	75%	NA
107	Finalise appointment(s) of relevant testing & commissioning specialist parties & companies	JM	20 days	Mon 05/01/15	Fri 30/01/15	Mon 05/01/15	40%	NA
108	**Hospital Fire Officer's Requirements**	*KC+*MM	26 days	Mon 08/12/14	Fri 16/01/15	Mon 08/12/14	91%	NA
109	Finalise Fire Officer's requirements, inclusive of testing / sequencing / access / relevant parties / etc	MM,LM	19.95 days	Mon 08/12/14	Fri 09/01/15	Mon 08/12/14	95%	NA
110	Sign-off with & circulate to relevant parties (NB. strong interface with NHS Commissioning)	MM,LM	5 days	Mon 12/01/15	Fri 16/01/15	Mon 12/01/15	75%	NA
111	**FM Helpdesk**	*KC	31 days	Mon 08/12/14	Fri 23/01/15	Mon 08/12/14	87%	NA
112	Establish requirements from start of handover date	BH	26 days	Mon 08/12/14	Fri 16/01/15	Mon 08/12/14	100%	Fri 16/01/15
113	Further advance related details for comment and approval by relevant parties	BH	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	90%	NA
114	Incorporate comments and confirm agreed finalised requirements with relevant parties	BH	10 days	Mon 12/01/15	Fri 23/01/15	Mon 12/01/15	50%	NA
115	**Training (e.g. AGV's / Service Yard) & Familiarisation of Equipment, Systems, etc**	*KC+*IP+*AT+*STO's	51 days	Mon 15/12/14	Fri 27/02/15	Mon 15/12/14	35%	NA
116	Finalise requirements for training & familiarisation of equipment, systems, etc.	All Leads	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	85%	NA
117	Circulate for final sign-off / agreement with relevant parties	All Leads	10 days	Mon 19/01/15	Fri 30/01/15	NA	0%	NA
118	Development detailed programme for all agreed training & familiarisation requirements, inclusive of specific timing	All Leads+IM	20 days	Mon 02/02/15	Fri 27/02/15	NA	0%	NA
119	**Emergency Scenario / Disaster Planning Requirements & Exercises**	*SJ+*FMcC	36 days	Mon 08/12/14	Fri 30/01/15	Mon 08/12/14	61%	NA
120	Agree / draft specifics and associated timing in terms of related exercises, timing, resources, protocols, etc.	SJ+FMcC	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	90%	NA
121	Circulate details to relevant parties for comment	SJ+FMcC+IM	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	75%	NA
122	Finalise details & formally programme / issue for implementation	SJ+FMcC+IM	10 days	Mon 19/01/15	Fri 30/01/15	Mon 19/01/15	10%	NA
123	**DDA (Dementia) Signage by the hospital / NHS (i.e. not Brookfield Multiplex)**	*PM+*FMcC	36.75 days	Mon 08/12/14	Mon 02/02/15	Mon 08/12/14	73%	NA
124	Finalise list / procurement of DDA (Dementia) signage to be installed directly by NHS	PM+FMcC	13 days	Mon 08/12/14	Wed 24/12/14	Mon 08/12/14	100%	Wed 24/12/14
125	Finalise appointment of installation contractor(s) if / where applicable	PM+FMcC	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	90%	NA
126	Compile a programme of works schedule detailing a logical progression through the hospital for related works	FMcC + IM	15 days	Mon 05/01/15	Mon 26/01/15	Mon 05/01/15	50%	NA
127	Communicate related information to all relevant parties	FMcC + KC + IM	5 days	Mon 26/01/15	Mon 02/02/15	NA	0%	NA
128	**Waste Management Protocols between handover & start of migration period**	*KC+*JM	31 days	Mon 15/12/14	Fri 30/01/15	Mon 15/12/14	71%	NA
129	Finalise NHS waste management protocols that will be in operation between noted period	JM	26 days	Mon 15/12/14	Fri 23/01/15	Mon 15/12/14	85%	NA
130	Identify & Circulate related details to relevant parties	JM+IM	5 days	Mon 26/01/15	Fri 30/01/15	NA	0%	NA
131	**Site Visit Requirements between handover & start of migration period**	*HG+*MMacL	25 days	Mon 05/01/15	Fri 06/02/15	Mon 05/01/15	33%	NA
132	Finalise internal site visit requirements between noted period (i.e. dates, parties, relevance, etc)	HG+MMacL	15 days	Mon 05/01/15	Fri 23/01/15	Mon 05/01/15	55%	NA
133	Circulate & communicate internal site visit requirements to relevant parties	HG+MMacL+IM	10 days	Mon 26/01/15	Fri 06/02/15	NA	0%	NA
134	Finalise external site visit requirements between noted period (i.e. dates, parties, relevance, etc)	HG+MMacL	15 days	Mon 05/01/15	Fri 23/01/15	Mon 05/01/15	55%	NA
135	Circulate & communicate external site visit requirements to relevant parties	HG+MMacL+IM	10 days	Mon 26/01/15	Fri 06/02/15	NA	0%	NA
136	**Establish Mock Appointment requirements between handover & start of migration period**	*FMcC	46 days	Mon 15/12/14	Fri 20/02/15	Mon 15/12/14	40%	NA
137	Draft mock appointment requirements and circulate to all relevant parties for comment	FMcC	26 days	Mon 15/12/14	Fri 23/01/15	Mon 15/12/14	70%	NA
138	Finalise mock appointment requirements in line with agreed requirements & feedback comments	FMcC + IM	15 days	Mon 26/01/15	Fri 13/02/15	NA	0%	NA
139	Circulate & communicate related information to relevant parties	FMcC + IM	5 days	Mon 16/02/15	Fri 20/02/15	NA	0%	NA
140	**Establish full extent of Pre-Stocking requirements between handover & start of migration period**	*GK	41 days	Mon 15/12/14	Fri 13/02/15	Mon 15/12/14	38%	NA
141	Draft pre-stocking plan for noted period	GK	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	75%	NA
142	Identify & Circulate to relevant parties for comment and agreement	GK+IM	10 days	Mon 19/01/15	Fri 30/01/15	NA	0%	NA
143	Finalise pre-stocking plan for implementation with relevant parties	GK+IM	10 days	Mon 02/02/15	Fri 13/02/15	NA	0%	NA
144	**Establish requirements for familiarisation of external bodies between handover & start of migration period**	*KC+*IP	41 days	Mon 15/12/14	Fri 13/02/15	Mon 15/12/14	44%	NA
145	Identify parties applicable to this requirement (e.g. fire service, police, etc)	KC+IP	8 days	Mon 15/12/14	Wed 24/12/14	Mon 15/12/14	95%	NA
146	Meet with related parties to agree requirements, interfaces, resources, protocols, etc.	KC+IP	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	75%	NA
147	Draft related plan and circulate for comment / agreement with relevant parties	KC+IP+IM	15 days	Mon 12/01/15	Fri 30/01/15	Mon 12/01/15	25%	NA
148	Finalise related plan in line with received comments and agreed requirements / interfaces / dates / etc.	KC+IP+IM	10 days	Mon 02/02/15	Fri 13/02/15	NA	0%	NA
149	**Establish requirements for installation of patient monitoring system from handover & start of migration period**	*JMcG	36 days	Mon 15/12/14	Fri 06/02/15	Mon 15/12/14	40%	NA
150	Draft related requirements for noted period & circulate for comment by relevant parties	JMcG	21 days	Mon 15/12/14	Fri 16/01/15	Mon 15/12/14	75%	NA
151	Finalise related requirements in line with comments received and agreed way forward for noted period	JMcG	10 days	Mon 19/01/15	Fri 30/01/15	NA	0%	NA
152	Circulate & communicate finalised information / plan with relevant parties	JMcG+IM	5 days	Mon 02/02/15	Fri 06/02/15	NA	0%	NA
153	If applicable, appoint supply chain / installation party for noted works	JMcG+FW	25 days	Mon 05/01/15	Fri 06/02/15	Mon 05/01/15	35%	NA
154	**Management of 'Other / Miscellaneous' Works during NHS Commissioning Period**	*IP/*JMcG/*FW	35 days	Mon 05/01/15	Fri 20/02/15	Mon 05/01/15	19%	NA
155	Define fully what this entails / consists of & draft up accordingly (e.g. Estates workshop fit out, etc)	IP/JMcG/FW	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	70%	NA
156	Appoint & coordinate relevant installation parties (i.e. in-house or otherwise)	IP/JMcG/FW	20 days	Mon 19/01/15	Fri 13/02/15	Mon 19/01/15	10%	NA
157	Communicate related works to relevant parties, inclusive of time frames, sequencing, interfaces, etc.	IP/JMcG/FW	25 days	Mon 19/01/15	Fri 20/02/15	Mon 19/01/15	5%	NA
158	**Migration Period Workbooks & associated completeness / interface relative to NHS Commissioning Period**	*HG+*MMacL	93 days	Mon 08/12/14	Thu 23/04/15	Mon 08/12/14	35%	NA
159	Agree exact status or Migration Period Workbooks relative to NHS Commissioning Period (e.g. any dependencies, etc therein)?	HG+MMacL+C&B	21 days	Mon 08/12/14	Fri 09/01/15	Mon 08/12/14	95%	NA
160	Away from the above, ensure all information that affects the NHS Commissioning Period is clearly understood & in place	HG+MMacL+C&B	26 days	Mon 15/12/14	Fri 23/01/15	Mon 15/12/14	75%	NA
161	Circulate & communicate all related information associated with the above to relevant parties	HG+MMacL+C&B	10 days	Mon 19/01/15	Fri 30/01/15	Mon 19/01/15	10%	NA
162	Finalise Migration Workbooks (NB. Indicative period given / will be addressed in accordance with C&B's appointment)	HG+MMacL+C&B	57 days	Mon 02/02/15	Thu 23/04/15	NA	0%	NA
163	**Pre-work & Planning for the Establishment of 'Base Camp' once the NSGH is handed over**	*HG	15 days	Mon 05/01/15	Fri 23/01/15	Mon 05/01/15	68%	NA
164	Define fully what this entails / consists of & draft up details accordingly	HG+KC	10 days	Mon 05/01/15	Fri 16/01/15	Mon 05/01/15	90%	NA
165	Communicate to relevant parties & mobilise in line with agree requirements	HG	5 days	Mon 19/01/15	Fri 23/01/15	Mon 19/01/15	25%	NA
166	**Phase 2 of NHS Close-out Programme for NSGH:**	*DL/*PM	62 days	Mon 26/01/15	Thu 23/04/15	NA	0%	NA
167	NHS 12 Week Commissioning Programme Period (i.e. starting 26/1/15 & ending 23/4/15)	*KC	62 days	Mon 26/01/15	Thu 23/04/15	NA	0%	NA
168	Update of related activities TBC shortly by Ian Matthewson / Senior Project Planner	IM	62 days	Mon 26/01/15	Thu 23/04/15	NA	0%	NA
169	**Phase 3 of NHS Close-out Programme for NSGH:**	*DL/*PM	46 days	Fri 24/04/15	Tue 30/06/15	NA	0%	NA
170	NHS 16 Week Clinical Migration Period (i.e. starting 24/4/15 & ending 30/6/15)	*FMcC	46 days	Fri 24/04/15	Tue 30/06/15	NA	0%	NA
171	Update of related activities TBC shortly by Ian Matthewson / Senior Project Planner	IM	46 days	Fri 24/04/15	Tue 30/06/15	NA	0%	NA
172	**Phase 4 of NHS Close-out Programme for NSGH:**	*DL/*PM	169 days	Mon 02/02/15	Wed 30/09/15	NA	0%	NA
173	Decommissioning of Existing Equipment & Existing Southern General Hospital Site (NB. overall duration TBC)	*MC	169 days	Mon 02/02/15	Wed 30/09/15	NA	0%	NA
174	Update of related activities TBC shortly by Ian Matthewson / Senior Project Planner (NB. ***noted duration is currently purely indicative***)	IM	169 days	Mon 02/02/15	Wed 30/09/15	NA	0%	NA



Project: NSGH Commissioning & Migra
Date: Mon 19/01/15

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External MileTask | Split

Programme Owner: Ian Matthewson (NSGH Senior Project Planner), Tel# [redacted], [redacted]

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SCOTTISH HOSPITALS INQUIRY

Bundle of documents for Oral hearings commencing from 13 May 2025 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 46 – Volume 3

Correspondence on Potentially Deficient Features