NSW Health

Engineering Services Guide

12 December 2022

Contents

1. Background

1. Background

These Engineering Services Guidelines are a performance-based guide for the development of design and specification documentation for health care facilities. Through the process of developing deliverables as outlined in Section 4 the Service Consultants are tasked with developing appropriate project specific solutions and detailed designs and documentation to enable the procurement and delivery of projects.

A key objective for delivery of healthcare facility projects is the provision of facilities that:

- Optimise patient care utilising a contemporary model of care
- Provides for future focused and innovative infrastructure that delivers optimal environmental and social outcomes
- Facilitate contemporary approaches to design, resilience and sustainability
- Practical and easy usage
- Are fit for purpose
- Provide value for money and consider whole of life cycle costs.

It is expected that all projects will be delivered in accordance with the requirements of all relevant codes and regulations, and all Service Consultants should be aware of these obligations. The emphasis is also on encouraging innovation above prescriptive requirements where benefits can be proven.

Any engineered deviations from relevant Statutory requirements and other standards due to unique project circumstances need to be thoroughly and holistically assessed, proved, clearly articulated / documented and signed off through by the relevant Authority.

Additionally, it is expected all Service Consultants will assess the provisions of standards such as the Australian Health Facility Guidelines (AusHFG) and determine an appropriate application of these to a particular project. In new healthcare developments it is expected the requirements of AusHFG will be closely adhered to, except where deviations are associated with new models of care, operational policies or procedures or innovative approaches to the delivery of health services. However, on smaller projects, those of lesser acuity, and projects where substantial refurbishment is envisaged, it is expected the Service Consultants will critically evaluate the AusHFG to determine their applicability and suitability to the project during planning.

In all projects, it is envisaged all Service Consultants will assess the intent of the AusHFG and make recommendations as to how these can be most appropriately incorporated into the project. A considered understanding of the intent of the AusHFG is expected, together with advice and progressive thinking on how this intent can be best achieved within a particular context of the project, consistent with contemporary models of care and hospital design.

To meet requirements to embrace environmental responsibility, this document recommends an integrated building design process, which considers all aspects of a building, its environment and life cycle, by a team of Service Consultants which includes all relevant professionals and stakeholders working together throughout the process, rather than sequentially and independently. The deliverable for these processes must be in accordance with Section 4.

Potential benefits of integrated design include:

- Addressing the needs of patient’s, health services, occupants and the environment
- Opportunities for innovation
- A better designed product (design teams explore a wider range of solutions)
- More efficient design and construction (consultants identify design opportunities and constraints early on)
- Increased building performance and occupant satisfaction (promotes better understanding of building use and performance by all concerned)

- Holistic and innovative environmental solutions
- Consistent design solutions across all projects.

2. Principles

2. Principles

2.1. Fundamental principles

Designers of healthcare facilities must focus on achieving facilities that improve the health and well-being of occupants. The following engineering principles, objectives and targets must be considered during design. Key consideration areas for engineering design performance are outlined in Table below.

2.2. Engineering design context and appropriateness

Table 1: Health infrastructure design focus areas

Categories	Actions
Functional integration	Open and integrated systems with passive and active error detection, diagnostics and reporting
Security, vandalism and robustness	Consider security, vandalism and robustness considering spatial and temporal risk profile and facility classification
Infection prevention and control	Include infection prevention and control and cleaning protocols within designs.
Disaster and emergency management	Consider service delivery requirements along the emergency management continuum, systematic and random failures and the ‘all hazards approach’.
Sustainability, lifecycle and waste management	A focus on energy, water and materials to improve environment and economically sustainable outcomes.
Maintenance and logistics support	Consider location specific issues, alignment of reliability parameters, and aim for design innovation.
Emerging technology	Innovation is encouraged. A requirement for designers to provide a Business Case to support adoption of design innovation.
Certification and compliance	Alternative standards acceptable if proven technically superior.

Each project must be considered and designed in a way that is appropriate to factors such as size, type, location, whether the project includes new, refurbished or expanded / extended facilities. Other factors such as economics, resilience, sustainability and practicality will also influence decisions. Some considerations include:

- Size and type - will influence the choice and configuration of systems
- Location - the availability of support skills will influence the level of complexity and technology in systems
- New, refurbished and extended - the age, condition and relative size between new and old will influence design solutions on systems such as building management and control system (BMCS), nurse call, suction, chilled water and heating water systems. Whether systems between stages should be replaced, or extended if technically possible, or simply added onto, or stand-alone from each other, must be considered with practicality in mind and with the full understanding of users regarding operational consequences (e.g. operational and environmental costs).
- Economics and practicality - these Guidelines, whilst being adhered to, should also be applied with economic common sense and practicality. In situations where a strict adherence leads to quantum leaps in cost, such as additional infrastructure (e.g. sub-station or chiller plant) then the consultant is expected to make due consideration and recommendations. The ongoing costs of operating the facility will also be considered to reduce the whole of life-cycle impact.

2.3. Engineering design principles

The following principles must be addressed, including:

- Hospital functionality, clinical services delivery, internal environmental conditions (staff, patient and visitor well-being), departmental operation and system modularity must be at the forefront of design
- Overall masterplans must be reviewed and used for the guidance and integration of engineering elements, infrastructure and utilities
- Integrated built environment sustainability must be considered, including appropriate designs for energy and water, using appropriate materials
- Architecture must encourage effective service delivery, logistical efficiency, and reduction / elimination of maintenance. The ‘indoor environment’ must consider air quality, ventilation, daylight, and other factors that influence thermal, visual, acoustic and psychological comfort (e.g. biophilic design)
- Adaptation for future use must be considered, including system configuration and equipment capacity and selection, system design integration, space allowances, all within the master planning framework.

2.4. Engineering design objectives

Engineering design must address objectives including:

- Design must be appropriate for the location in terms of climatic conditions, sophistication of services, availability of skills and support
- Design must be reasonably able to be adaptive to respond to changes in infrastructure planning and clinical health care models, and the likely changes in use
- Systems and equipment including information and communication technology (ICT), major medical equipment (MME) and furniture, fixtures and equipment (FF&E) must be considered in terms of sustainability, availability, reliability and life-cycle costs to achieve the overall targets and aspirations of the facility

- Design must be robust and resilient, and consider the services delivered during normal operations, as well as disaster scenarios, as defined for each hospital
- Designs for infrastructure with useful lives greater than 25 years must consider future adaptability and operational costs
- Designers must avoid excessive/ redundant ‘safety margins’ or ‘contingencies’ to disguise inadequate design investigation and/ or analysis.

2.5. Targets

Engineering design will be considered successful if design addresses the principles and objectives above, and satisfies targets in the following categories:

- All systems function in a coordinated and consistent manner
- Security, vandalism and robustness
- Infection prevention and control including cleaning
- Disaster and emergency management
- Sustainability, resilience, life-cycle and waste management
- Maintenance and logistical support
- Emerging technologies
- Certification and compliance.

2.5.1. Functional integration

Designers must use open technologies, systems and architectures to promote interoperability and functional integration.

Design alone cannot provide functional or efficient outcomes. The future operation and management of systems must also be considered by designers.

The design team must liaise with the local health district (LHD) / specialty health network (SHN) to ascertain that design features are appropriate, understood, and that the systems are commissioned correctly and can be operated efficiently after verification and handover.

A comprehensive assessment process must be considered for functional integration during the design process to ensure that new construction and or refurbishments detect and correct design deficiencies and contribute to future design activities.

2.5.2. Building information management

BIM is a process utilising software, technology and systems to develop and coordinate a digital representation of physical locations, buildings, assets and associated data for construction and asset operation. BIM enables data-based decision making, across the entire asset lifecycle and asset management.

Health Infrastructure Projects have a mandatory requirement to be delivered within a BIM environment as set out in the Consultant Service Agreement, General Contract 21 and Preliminaries, and the BIM Requirements for Projects documents.

All engineering and technical service consultants must utilise BIM technologies to produce 3D models, facilitate services co-ordination, data inputs to the Project Database (dRofus), building Systems and assets, and all related outputs or deliverables. The 3D Model must also be synchronised with the Project Database (dRofus), with rooms, spaces and services equipment validated according to the governing

documents outlined above.

2.5.3. Security, vandalism and robustness

Designers must identify and incorporate security, vandalism and infrastructure robustness and resilience features within design.

Robustness must consider issues associated with an ‘All Hazards Approach’ and in particular examine the alignment of failure modes, ‘mean time between failures’ and ‘mean time for repairs’ of components to avoid critical failure modes. This is also appropriate for uninterruptable power supplies (UPS) and the like.

Infrastructure should avoid single points of failures and co-location of critical services or design elements.

Designers should examine issues associated with security performance and vandalism, particularly in areas of defined risks, and ensure systemic issues do not increase the vulnerability of the infrastructure (for example, excessive number of external doors).

2.5.4. Infection prevention and control

Optimum ventilation rates should be maintained to improve the indoor environmental quality. Generally, the design of ventilation systems must consider ventilation rates specified in AS 1668.2. However, these standards set minimum general requirements for outdoor air supply to prevent excess accumulation of airborne contaminants. It does not cover other associated factors such as temperature, humidity, air-movement and noise.

Eliminating the sources of pollutants and contaminant is important during the design process. The location and detailing of air intakes, door seals, expansion and construction joints, can all influence infection control and cleaning protocols.

The use of non-porous materials, fixtures and fittings which are easily accessible and can be thoroughly cleaned should be considered. Materials should also be robust and able to withstand frequent cleaning and disinfection.

Non-contact activation of systems should also be promoted to avoid potential exposure and transmission of infections.

Procedural separation of visitors, patients and staff can minimise infection transmission, as well as standardisation of patient treatment areas for ease of cleaning and quality control.

Quarantine and isolation requirements must also be understood and addressed in accordance with the AusHFG, relevant Australian and international standards, NSW Health policies to inform the planning, design and commissioning related to isolation rooms.

2.5.5. Disaster and emergency management

Hospitals are generally regarded by the community as locations of safe haven, and designers should consider the operational consequences of design through the emergency cycle from business as usual through to critical infrastructure emergency management through to recovery and reinstatement.

Health Infrastructure encourages designers to consider the ‘All Hazards Approach’ to disaster and emergency management and provide designs that address continuity of services.

Design teams must consult with Health Infrastructure and hospitals to establish the level and extent of requirements. These requirements will vary depending upon hospital classification, geographical locations, EMPLAN (NSW State Emergency Management Plan), legislation and critical infrastructure risk assessments.

For the purposes of these Guidelines, all hospitals with a level 6 intensive care unit (ICU) shall be

considered as hospitals for disaster and emergency management. Any new hospital meeting these criteria shall be provided with back up provisions over and above other hospitals in respect of:

- A 24-hour water storage
- A 24-hour fuel storage for standby power, and with N+1 plant configuration of standby power generator system
- In addition to standby power provisions described in Section 5, the air conditioning to operating theatres, sterile stock rooms, emergency department (including local imaging equipment) and ICU should also be provided with standby power.

Other hospitals are categorised into three categories with Category A being the highest category. Category C shall be provided with all back up power, UPS and water supply provisions as described in other sections of these guidelines. Category B shall be provided additionally with air conditioning to all operating theatres, central sterilising services departments (CSSD), emergency departments (ED) and ICUs. Category A shall be provided with further additions of UPS to one of each type of medical imaging equipment.

All hospitals in NSW are grouped into peer groups with alphanumeric groups, with A1 being the highest level (NSW Health IB2016_013 NSW Hospital Peer Groups).

Peer groups are arranged under each category. There may be exceptions to this arrangement where an LHD has no hospitals within Category A (e.g. Far West LHD). Categories by peer group include:

Category A

A1 Principal referral

A2 Paediatric specialist

A3 Ungrouped acute – tertiary referral

B1 Major hospital group 1

B2 Major hospital group 2

Category B

C1 District group 1

C2 District group 2

D1a Community hospital with surgery

D1b Community hospital without surgery

Category C

E Ungrouped acute – other

F1 Psychiatric

F2 Nursing home

F3 MPS

F4 Sub-acute

F5 Palliative care

F6 Rehabilitation (designated)

F7 Mothercraft

F8 Other

F9 Dialysis

2.5.6. Sustainability, resilience, lifecycle and waste management

Healthcare facilities, by their nature, are complex, with a wide range of functional and services requirements that place a high demand on energy, water and materials.

The NSW Government continually upgrade and develop new strategies to respond to changes and challenges on environmental and energy minimisation matters. Designers are required to keep themselves up to date with these new developments and strategies.

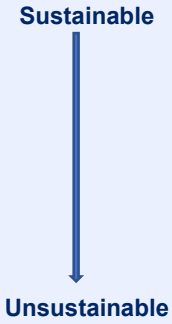
Proposed designs should include passive sustainable design strategies such as day lighting, demand management, gravity systems, energy and water efficiency and conservation techniques, use of non-toxic and environmentally sound materials and finishes, and consider life-cycle sustainability and maintenance implications.

In addition to the general principles described in these guidelines, the following are mandatory requirements:

- The Health Infrastructure Sustainability Framework
- Design Guidance Note (DGN) 58, which provides details of environmentally sustainable design (ESD) assessment pertaining to the Green Star equivalency conditions from the Department of Planning, Industry and Environment
- NSW Government Resource Efficiency Policy (GREP)
- All projects shall achieve energy performance 10% better than NCC Part J, or the current version of GREP, whichever has the higher performance requirement.

Designers must pay close attention to energy issues. The design team should integrate an approach such as an energy hierarchy to inform a responsible decision-making process. A suggested hierarchy is described in Figure 1.

Figure 1: Sustainable energy hierarchy



- Energy conservation (reducing total energy demand)
- Energy efficiency and demand management
- Use of renewable, sustainable resources
- Use of non-sustainable resources using low/ no-carbon technologies
- Use of conventional resources

Engineering design should be applied to reduce energy wastage and carbon dioxide emissions arising from the operation of the hospital, while maintaining clinical and functional standards.

Energy design must embrace:

- An enterprise-level energy management program integrated with other functions (risk management, cost control, quality assurance, employee recognition)
- Include integrated performance monitoring and controls as well as incorporate operational information within maintenance and an ongoing process assessment
- Provide facility operations staff with site-specific training to minimise energy usage.

Active measures can be incorporated into the design to reduce energy wastage by:

- Considering gravity systems and inherently low energy demand designs and techniques, all mechanical equipment to comply with minimum energy performance (MEPS)

- Energy management systems integrated with a direct digitally controlled BMCS allows monitoring, targeting and load-shedding capability of selected plant
- The incorporation of modular variable speed pumps to minimise and reduce energy output for peak and non-peak demands
- Efficient insulation of hot and warm water distribution pipe-work to minimise heat losses
- Considering energy input for hot water systems including energy and heat recovery from mechanical plant heating systems
- System zoning and time control of reticulated services to enable maximum turn down during night and weekend off peak parameters
- Intelligent design of maintenance and duty-cycle parameters to ensure availability and maintenance cycles encourage energy efficiency, noting that tariff efficiency may also be impacted in terms of load-factor issues for example
- Initiatives, such as PV solar panels ad mixed mode ventilation in public areas, will be pursued.

2.5.7. Water

Water efficiency is of high importance. Designing for hospital water quality and quantity, and satisfying the associated demand, require provision of:

- Potential for use of gravity systems
- Water (potable, grey, black) recycling options for example waste reject water from reverse osmosis (RO) systems and condensate from mechanical plant could be considered for non-potable recycled water
- Providing options to maximise water conservation
- Metering and monitoring of systems to detect excessive water usage or leakage
- Fire test water re-use in non-potable water systems or changes to fire systems test procedures to minimise water use
- Rainwater harvesting to reduce potable water consumption, based on cost benefits analysis
- Installation of high efficiency fixtures such as, the high water efficiency labelling and standards scheme (WELS) rating
- Efficient irrigation systems (and using appropriate species).

2.5.8. Materials

Material selection and efficiency of material use is an important aspect of design. Consideration should be given to materials of low embodied energy content, high recycled content and / or highly recyclable.

Designers should consider the quantities of materials and alternative design that reduce material use (for example mass concrete versus post-tension designs).

Additionally, designers should select the best combination of materials based on criterion such as source, transportation distances, availability, budget, and balanced against known embodied energy content.

Material selection must focus on:

- Use of locally sourced materials
- Selecting low embodied energy materials (which may include materials with a high recycled content)
- Specifying products and materials that are either reused or contain high recycled content

- Promoting the specification of recyclable manufactured type materials and fittings
- Giving preference to materials manufactured using renewable energy sources
- Designing to minimise materials
- Assessing the life cycle costs of products.

At a minimum, the following items should be incorporated in the material selection process to:

- Consider structural steel products composed of recycled content
- Reduce the amount of cement by replacing it with recycled concrete
- Minimisation of PVC products that are detrimental to the environment
- Avoid health risk factors by improving indoor air quality and consider the impact of volatiles and solvents in relation to volatile organic compound (VOC) and CO2
- Give preference to reused timber, legally sourced timber, and timber sourced from forests whose conservation values are not degraded
- Improve daylight access whilst reducing solar heat gains by incorporating glazing, shading and roof / wall insulation
- Make effective use of mean radiant heat
- Design to material sizes and common packaging quantities, to avoid off-cut wastage and unnecessary consumption.

2.5.9. Maintenance and logistics support

Designers should consider location, skills, spare parts supply, tools and techniques required for on-going maintenance and logistical support of elements they design.

Designers will demonstrate how the design minimises maintenance out of systems.

Designers are discouraged from incorporating customised and proprietary solutions, with restrictive maintenance agreements and vulnerable logistical supply chains.

2.5.10. Emerging technology

Technology research, systems developments, and advancements in equipment and materials, create opportunities for emerging technologies.

While health care projects are not appropriate environments for these technologies to be applied prematurely, it is incumbent upon designers to be aware of such developments and provide advice on these matters.

2.5.11. Certification and compliance

It is required that:

- Designs to be appropriately certified and verified as compliant to relevant codes and standards
- Certifications to be provided by appropriately qualified and credentialed engineering professionals (CPEng for example)
- Encourages appropriate good practice and may accept standards other than those commonly accepted standards, if the designer can demonstrate the alternative approach is superior and can comply with certification requirements.

It ought to be noted, the requirement of this clause, relate to the quality of design and compliance of brief, rather than any statutory compliance that is required for occupation of a building.

3. Specification, installation, commissioning and maintenance

3. Specification, installation, commissioning and maintenance

3.1. Specification

Project specifications are to be project specific, avoid using standard specifications, and define the following key issues:

- Scope
- Construction engineering responsibility
- Equipment performance and quality
- Workmanship and installation standards
- Commissioning and handover requirements
- User training
- Manuals and records.

Commissioning of the building services systems should result in the verification that the design requirements are met.

This will require the physical testing of all equipment and as such appropriate test points and facilities need to be designed and staff will need to be made available by the contractor to facilitate simulation of operation if required.

All test results will need to be presented in electronic format.

3.2. Installation and maintenance

Ease of installation, buildability and future replacement are important considerations in any design. The driving factors are initial system planning and reticulation concepts, and the timing of their incorporation in the architectural planning. Sound concepts incorporated in a timely manner lead to integrated overall building solutions which are easy to build and function naturally in operation.

When plant and reticulation concepts form part of the early planning, these routes can be laid out in a clear manner that can be interpreted correctly by contractors and thus built successfully.

This leads on to maintenance and maintainability. Systems that have been designed with proper plant space and reticulation can be built easily most likely will result in better access and thus maintainability. In addition, the choice of equipment should be made with reliability and low maintenance as key considerations. While it is inevitable to have ceiling mounted equipment in some instances, this should be kept to the minimum possible and located in such a way to minimise disruptions whilst maintenance takes place.

3.3. Commissioning

Commissioning is a critical element of project delivery and plays an integral role in enabling good designs to be good operational systems. It is vitally important to the safe and energy efficient operation of buildings. It must be carried out systematically. Some key watch points in commissioning include:

- The recognition and inclusion of seasonal adjustments in heating, ventilation and air conditioning (HVAC) systems

- The early preparation of commissioning plans in the delivery process
- The engagement of an independent commissioning agent is highly desirable and should only be omitted if the project is of relatively simple where there is not a BMCS and therefore minimal coordination across disciplines
- The recognition of the cross relationship between systems (e.g. BMCS and other systems) and thus the need of thorough and integrated commissioning across all systems
- The allocation of resources and efforts in systems monitoring post occupation
- The thoroughness in testing and monitoring of systems extended from existing site systems
- The requirement of robust commissioning procedures, the chartered institution of building services engineers (CIBSE) codes provide good references
- The need for independent verification of commissioning results
- The need of reviewing and rechecking of results in the first year on a seasonal basis
- The appropriate programming allowance of time in the delivery and handover process
- The emphasis of its importance in contractual terms.

4. Relationship to other documents and guidelines

4. Relationship to other documents and guidelines

This document refers to the latest applicable statutory requirements and other Standards. The Services Consultant must verify and utilise the latest statutory requirements and other Standards available at the time of design.

This document is one of the Health Infrastructure Standards Policies, Procedures and Guidelines (SPPG) developed by the organisation to guide the design and delivery of healthcare facilities in NSW.

The following are documents in the Services Consultants' Conditions of Engagement that are associated with this Guideline:

Section 3 Project specific requirements – outlines the scope, context and nature of the project

Section 4 Scope of services - this document defines the Services Consultants' scope of work and deliverables with respect to their engagement

Section 5 Conditions of agreement for the Services Consultants' engagement.

Other documents that are also relevant include:

- Health Infrastructure design guidance notes (DGN) that are issued as required and supplement the information within this Guideline
- Design Guide for HealthCare, (Draft) Health Infrastructure, 2021
- Health Precinct Strategy - Delivering improved health, social and economic outcomes for the people of NSW (Draft), Health Infrastructure, 2021
- Sustainability Guide (Draft), Health Infrastructure, to be published during 2022
- NSW Health policies and guidelines
- National Construction Code (NCC) / Australian Standards / Legislation and Regulations
- AusHFG.

It is a pre-requisite that designers make themselves familiar with the above documents as well as the relevant parts of any specific reference documents noted in Section 3.

The designer will note the existence of the following documents and be conversant with them where appropriate.

- NHS Estates Health Technical Memoranda
- NSW Government Facilities Energy Efficiency Guide
- Green Guide for Healthcare
- Building Services Research and Information Association (BSRIA)
- CIBSE
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

For some of the larger projects, there may be helicopter land sites introduced either on the roof of buildings or on-grade on the hospital site. The NSW Health GL 2020_014 Guidelines for Hospital Helicopter Landing Sites in NSW should be referred to and complied with for these installations.

Service consultants are invited to provide feedback on any aspect of relevant Standards that may be considered of benefit to facilitate continuous improvement in the design and operation of the healthcare facilities.

5. Electrical

5. Electrical

5.1. Introduction

The purpose of electrical services in healthcare buildings is to provide safe, reliable and flexible power and lighting systems to support the buildings safe operation.

It is the designers' responsibility to deliver best practice designs while focusing on cost-effective solutions, encourage energy efficiency through innovation and provide a catalyst for future flexibility and improvement.

Significant aspects of the electrical services design are governed by statutory requirements contained principally in the codes and standards including:

- NCC
- AS / NZS 3000 Electrical Installations
- AS / NZS 3003 Electrical Installations – Patient areas
- AS / NZS 3009 Standby Power Systems.

There are other areas of the electrical services systems which will be influenced by the following criteria:

- Recommendations of Australian Standards Specific project briefing process
- Best engineering practice from similar projects.

5.2. Scope

- High voltage and substation services
- Renewable energy sources
- Incoming mains supply
- Metering
- Main switchboards
- Power Factor Correction and/ or Active Harmonic Filters
- Emergency power generation and reticulation system
- UPS
- Sub-mains
- Distribution switchboards
- Earthing
- Lighting and power sub circuit wiring including protected wiring systems for both body and cardiac protection in patient areas
- Socket outlets
- Luminaires (internal, external, security), lighting control and functionally specialised lighting
- Emergency and exit lighting system
- Long life battery technology
- Earthing and lightning protection systems.

5.3. General requirements

Electrical services provide the systems and infrastructure to support all building and clinical systems requiring all forms of electrical power.

5.4. Planning and context

All projects must consider and document the impacts of the project on existing and future planning on the site considering any masterplans that exist for the site.

The issues to be highlighted include:

- Site location in context to existing substations and/ or associated main switch-rooms
- Site location in context to any existing standby generation and associated connectivity
- Proposed and existing cabling routes to connect a new or refurbished facility to the substations/ main switch-rooms and standby generation
- The site wide infrastructure needs are to be balanced with the needs of the project and the needs of future projects, including land divestment opportunities.

5.5. Design criteria

The AusHFG describes services provisions in many commonly briefed rooms and this information should inform the design criteria. Note that the design criteria are provided as an initial basis and must be verified with the project team and user groups to ensure functional requirements are met.

5.6. Specific requirements and guidance

5.6.1. Electrical supply

Electrical supply demand

Electrical infrastructure in the design of many projects can easily be over-sized due to estimates and conservative allowances for unknowns. Accurate maximum demand and profile calculations shall be carried out. This will result in correctly sized systems and optimise the capital and recurrent costs of the project.

Load profiles and maximum demand MUST be calculated from detailed assessment of the project-specific requirements after adequate investigation by the designers.

The Service Consultant shall use best endeavours to design the electrical system to reflect as close as reasonably possible the actual loads that would be realised plus realistic allowance for future expansion as required. Realistic diversity figures should be used when sizing substations, switchboards, generators and the like.

The following is to be considered:

- Gross area of the new or refurbished building
- Diversified VA/ m² figures for appropriate area types (a figure of 100VA/ m² overall can be considered as a rule of thumb starting point, most recent hospital projects are consuming less and currently in the region of 85VA/ m² in actual conditions)
- Supply demand of the existing electrical installation (if any) proposed to be de-commissioned as part of the project

- Consideration of specific equipment electrical parameters
- Demand assessment and diversities of the actual connected circuits, systems, plant and equipment
- Number of lifts and the individual supply demand
- Reference shall be made to actual demands from similar existing hospitals as a final sanity check.

Substation/transformer spare capacity

An appropriate allowance for the space / capacity for future expansion should be allowed for. Spare capacity shall be balanced with the appropriate allocation of available budget and should be agreed to by the design team and health service on a project by project basis.

Where a project's electrical maximum demand dictates that a substation is required to supply that load from the supply authority the following shall be applied:

- With regard to transformer sizing, all supply authorities now apply an output derating to their substation transformers (whether they are for an indoor chamber or a kiosk/ padmount type). This derating factor that the supply authority apply is 0.9 of their stated transformer size. The following are shown as examples of this in the Table below

Table 2: Transformer sizing

Stated transformer size by the supply authority	Derating factor applied to transformer rating	Final available maximum output from the transformer
1500kVA	0.9	1350kVA
1000kVA	0.9	900kVA
750kVA	0.9	675kVA
500kVA	0.9	450kVA

- Therefore, the maximum demand, calculated by the electrical engineer responsible for the design, shall not exceed the 'final available maximum' output from the transformer after the derating has been applied
- Maximum demands more than the 'final available maximum' output from the transformer, after the derating has been applied, shall trigger the use of the next available size transformer to be used
- For multiple transformer installations at a substation location, the same set of conditions apply.

Where the calculated maximum demand exceeds the maximum available output from the transformers, the next increase in size of transformers shall be used as detailed in the Table below.

Table 3: Transformer sizing

Calculated maximum demand	Suggested transformer sizing after considering the derating factor
1000kVA	1 x 1500kVA
1200kVA	1 x 1500kVA
1500kVA	2 x 1000kVA
2000kVA	2 x 1500kVA
3000kVA	3 x 1500kVA

Where the projects electrical maximum demand is such that it is small enough to be supplied at low voltage from the supply authority low voltage network without the use of a transformer, then it is not required to allow for any future spare capacity to be added to the calculated maximum demand of the project, when submitting details to the supply authority.

Consumer mains spare capacity

Consumer mains connected to the low voltage output of a transformer shall be fully rated for the final available maximum output from that transformer. A maximum of 0.5% voltage drop should be considered as standard for consumer mains, however, this may be increased based on the individual project circumstances and economic benefits, i.e., long consumer mains.

Consumer mains connected to a supply authority low voltage network supply without the need for a customer substation shall be rated equal to or greater than the supply authority supply fuse or circuit breaker protection.

Substation design and high voltage capacity

The substation capacity will be sized to include the assessed maximum demand and spare capacity as appropriate. Substations shall be either kiosk/ padmount or chamber type as appropriate for the particular project.

The choice between a kiosk/ padmount or chamber substations shall be determined at the early stages of a project and may include the following considerations:

- Capacity of the installation
- Capital cost contributions from the supply authority
- The capital cost to the project in terms of built areas
- Reliability
- Project program implications
- Supply authority requirements and preferences
- Future expansion requirements
- Appropriate distortion is continuing use of land use on site
- Maintainability.

Security of supply

Where hospitals cannot function for a time with loss of the external supply, standby power generation regardless of the form of the normal power supply shall be provided.

Supply authority power supply to a healthcare facility

Major city and regional hospitals

In some circumstances the provision of dual supplies from the supply authority can be provided to improve electricity supply reliability. In this case and where practical, feeders shall emanate from two independent network circuits/ zone feeder substations and from two different street reticulation routes. Preference shall be given to ring main reticulation from multiple sources. Automatic transfer between feeders is to be considered.

Where dual supplies to hospitals are not readily available and/ or are subject to substantial costs, provide a single high voltage (HV) site connection (spur connection).

The underground HV supply shall be adopted in lieu of overhead HV cables where at all possible to improve reliability and where cost-effective.

Rural hospitals and multipurpose services

These facilities shall be provided with a single supply (as a minimum) by means of one of the following methods:

1. Via an underground HV supply cable reticulation (this is the preferred choice)
2. Via an overhead HV supply reticulation. This shall only be used where the underground installation is either not an option or is cost prohibitive for the project.
3. Where the electrical maximum demand for the project does not require a HV supply and associated substation, then the power supply to the project shall be from a low voltage (LV) supply which shall, preferably be underground.

Power factor correction and active harmonic filters

Power factor correction (PFC) equipment will comply with authority requirements and shall be incorporated into the design to improve the power factor of the electrical installation to 0.98 lag to minimise the energy authority demand charge and improve energy efficiency.

PFC systems shall be interfaced to disconnect under standby generator operation.

Harmonics

Harmonic distortion is continuing to increase on electrical installations due to the type of loads connected. The provision of PFCs alone will not correct these harmonics. Therefore, active harmonic filters shall be installed to reduce the overall harmonic distortion.

The maximum total harmonic distortion that will be acceptable for an installation shall be 5% current (THDi) at point of common coupling for the facility.

Active harmonic filters also provide a degree of PFC. It may be possible that these filters also provide the PFC to the required 0.98 lag for a specific installation. However, if this is not achievable then additional separate PFC equipment shall be provided as well as the active harmonic filters.

It should be noted that due to the continued near 100% use in LED lighting for projects, a few facilities are starting to see a resultant leading power factor. Leading power factors are not acceptable, and the use of active harmonic filters will also assist in reducing this leading power factor to unity.

5.6.2. Standby power and uninterruptable power supply provisions

The following sections and paragraphs provide standby power and UPS requirements for all category 3 hospitals. Category 1 and 2 hospitals are provided with additional capacities as detailed in Section 2 of these guidelines.

Standby electrical power shall be provided and guided by the recommendations of AS/NZS 3009 in addition to information within this section.

Standby power shall also be provided to all subsidiary mechanical, hydraulic and medical gas systems (which are dependent on an electrical power source to operate) and are essential in delivering services to the critical care areas.

Standby sub-mains to be provided with standby generator supply will be separate from the normal supply sub-mains.

System capacity

Underground petroleum storage system musts comply with the Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2019.

The capacity of the standby generating plant will be sized to match the diversified maximum demand adjusted to the standby coverage agreed for the project. The need and extent of standby power will be determined on a project by project basis. In determining the coverage of standby power provision, the following principles apply:

- All life and safety requirements as required by the NCC
- All active equipment within ICT communication rooms
- Pneumatic tube, medical air and suction equipment
- Renal dialysis equipment
- A minimum of 30% of lighting and power in all areas. This can vary depending on the number of light fittings and power outlets used in a particular room
- 100% lighting and power in critical areas, which include ED, operating theatres, sterile stock rooms, recovery units, coronary care units (CCU), ICU, neonatal intensive care units (NICU), cardiac catheterisation laboratories, burns units, mortuaries and the renal dialysis units. This will include all air handling and exhaust fans serving these areas
- All air handling and exhaust fans serving isolation rooms, CSSD and pathology units
- Selected medical imaging areas to support ED
- Critical storage such as -80ºC fridges and blood fridges
- Sewage pumping stations if these were used
- Domestic water pumps if these were used.

Spare capacity should only be provided from the difference between the actual ‘next size’ rating of the generator and the calculated standby requirement. This means:

- Generators should be rated for standby duty
- Generators should be able to meet the power load on start up without stalling
- Large medical equipment loads need to be considered
- Motor loads should incorporate delay start-up where necessary to diversify the start-up currents over time in lieu of a peak current condition to allow the set to reach satisfactory operating conditions without stalling.

Plant configuration

Generator plant should be sized such that they are matched as closely as possible to the actual load. Consideration should be given to installing a few smaller generators if required to ensure that they are loaded appropriately.

Plant configuration shall be assessed on capital and recurrent cost considerations as well as diversity of range of output. Projects requiring over 1MVA of standby capacity shall be provided with at least two generators.

The operation of the standby generator(s) shall be automatic upon mains supply failure.

Connection of loads to the standby supply system shall be designed to avoid stalling of the generator engines. Diesel generator machines will generally only accept electrical loads of no more than 50% of their ‘nameplate’ output rating without being subject to stalling and/ or causing a voltage and/or frequency sag below the compliant limits. Therefore, the electrical design shall take this into account by providing multiple transfer switches or circuit breakers to ensure that each step in the ‘load build-up’ or ‘load shedding’ that is connected to the generator never exceeds 50% of its name plate output rating and never causes a voltage and/ or frequency sag below the compliant limits.

This requirement applies to each generator individually. So, if there are multiple generators connected in parallel for the standby power supply, then the resultant ‘load build-up’ or ‘load shedding’ shall remain at 50% load increments of the summation of the nameplate outputs and never causes a voltage and/ or frequency sag below the compliant limits of the remaining operational machines. This shall apply during the time when one machine is non-operational due to machine failure or for periodic maintenance. It is important that at any time in the operation of single or multiple set standby generator installation that the generator, or the generators remaining in operation in a multiple set installation, do not stall.

Load testing of generators

The power distribution system will be designed to permit testing of the generators on load without the need for imported load banks.

The preferred method of load testing generators (subject to approval of the energy supply authority) is to use the hospital load as the test load and to connect and disconnect the load by synchronising the generator(s) with the normal electricity supply (synchronised closed transfer).

The building distribution system shall be arranged to allow the appropriate amount of building load to be available for testing the generator.

Fuel storage

A minimum of 24 hours of fuel storage capacity at full load is required. Larger storage capacity may be provided based on justifiable clinical need or local factors.

Connection of temporary generator

Regardless of whether the hospital has permanent diesel generating plant installed, provision of a quick connection facility (i.e. ‘power lock’ connection or busbar cable connection facility) for linking the loads identified under standby power to a temporary (mobile) generator set, will be provided.

Uninterruptible power supply

In selected areas, critical computer and communication systems and those systems supporting critical and major medical equipment will need to keep on operating without interruption in the event of a power outage. Some equipment and lighting cannot tolerate the delay between the power outage and the stand-by generator coming online and so an UPS may be used to provide power to lighting and selected equipment until the stand-by generator is online and powering the critical load.

In simple terms, a UPS is a device that comprises a battery charger and a number of batteries with control circuitry to monitor the mains power and charge the batteries. The UPS may be integral in a piece of equipment. When the mains power fails, the batteries provide power via an inverter that converts the battery voltage to 230 volt AC. The on-battery runtime of most uninterruptible power sources is relatively short (up to 15 minutes is usually adequate) but it is sufficient to power the load until the stand-by generator is online, or until the protected equipment can properly shut down.

In most cases a UPS will not be specified to supply high power equipment (e.g. x-ray generators) during the period with no power, but rather will be specified to keep the computers and control circuitry for major medical equipment operating, until the stand-by generator power is available.

UPS will ideally be provided through a centralised plant room, where possible to avoid locating in clinical areas.

Note: The intent of this section is to provide guidance on requirements for major medical equipment. Requirements for UPS as it relates to ICT are documented in the NSW Health ICT Structured Cabling Standard.

UPS systems will be required for specific critical loads. This includes ICT equipment, and medical equipment in several clinical areas as basic requirements. Consideration should be given, on a project by project basis, as to what loads require UPS support and whether local or centralised UPS are best suited. As some equipment may be provided with inbuilt UPS, this should be accounted for in any design and capacity calculations.

5.6.3. UPS power supplies

UPS resilience

A resilient system can be defined as one that can withstand several system component failures while continuing to operate. This can be achieved by installing additional redundant components and minimising single points of failure. A balanced approach to resilience is essential and must consider the

total system, costs, benefits and ongoing maintenance.

UPS are manufactured in two different designs configurations including:

- Fixed output UPS without the facility to expand the UPS in the future as the load grows
- Modular/ stackable UPS which comprises individual smaller UPS modules that plug into a common bus in a common equipment rack. These units generally provide a total output (in one rack) of up to 200kVA and comprise smaller plug-in units between 15kVA and 25kVA ratings.

The modular/stackable UPS is becoming more popular with hospital installations as they provide a degree of expansion by plugging in additional modules as the load increases. However, the degree of redundancy is different for each type of UPS.

Fixed UPS

With fixed size UPS. the following redundancies apply:

- 'N' rated UPS = a single UPS with no redundancy
- 'N+1' rated UPS = three UPSs with each fixed UPS rated at half the electrical load. This results in each of these three UPS running at one third of the electrical load so that if one fails the remaining two UPS ramp up to accept half the full electrical load each
- '2N' rated UPS = two UPS with each UPS rated at the full electrical load (i.e. each UPS is running at 50% load so that if one fails then the remaining UPS ramps up to accept the full load).

There is no facility to expand the fixed size UPS for future increases in load without replacing it.

Modular/ Stackable UPS

With modular/ stackable UPS, each equipment rack comprises a number of smaller plug-in, hot swappable UPS modules (which generally range from 15kVA up to 25kVA each). The total UPS rating for each rack (fully loaded) is generally around 200kVA.

Therefore, a UPS load of 100kVA with an 'N' output rating would have 4 x 25kVA modules or 5 x 20kVA modules, each configuration giving 100kVA. This configuration provides spare space within the rack to plug in additional modules for future expansion.

For an 'N+1' output rating for the same 100kVA load, there would be 5 x 25kVA modules or 6 x 20kVA modules, each configuration giving 100kVA firm output with 1 x spare 20kVA or 25kVA module available for immediate connection should one of the other plug-in modules fail. This configuration provides spare space within the rack to plug in additional modules for future expansion.

For a '2N' output rating for the same 100kVA load there would be two separate modular UPS in separate equipment racks. Each UPS would comprise 5 x 25kVA modules or 6 x 20kVA, each configuration giving 100kVA firm output with a 1 x spare 20kVA or 25kVA module available for immediate connection in each UPS. Again, there is spare space within each UPS rack to plug in additional modules for future expansion.

Equipment to be connected to a UPS

The following three separate major systems at a hospital shall each have their own dedicated separate centralised UPS located in a dedicated UPS room(s):

- System 1 - ICT/ communications services which will include all floor distributors, building distributors, campus distributors, carrier rooms and file server rooms
- System 2 - Clinical/ medical services
- System 3 - Any atrium lighting requirements for the emergency lighting requirements.

Provide as a minimum 'N+1' redundancy UPS for:

- ICT/ communications services
- Clinical/ medical services/ Major Medical Equipment.

Provide as a minimum ‘N’ redundancy UPS for:

- Atrium lighting.

Regarding the ICT/communications services, provide the following UPS configuration as a minimum to each communications rack:

- The ‘A’ power rail in each equipment rack shall be connected to an essential power supply via an ‘N+1’ minimum configured UPS on a dedicated sub main from the main switchboard
- The ‘B’ power rail in each equipment rack shall be connected to an essential power supply via a line conditioner connected from a separate sub-main and essential bus bar section at the main switchboard and a separate automatic transfer switch (ATS) to the supply to the ‘A’ power rail.

It is important that both supplies to the equipment racks do not originate from the same essential bus bar and/ or ATS at the main switchboard.

Where the installation is small such, as a multipurpose service, or there is only one ATS at the main switchboard (such as for a small rural hospital) then the power supply to the ‘B’ power rail may be connected to the non-essential bus bar at the main switchboard.

It should be noted that all major metropolitan and regional hospitals will have multiple transfer switches with multiple essential bus bars.

It is essential that the power supplies to all ICT/ communication equipment racks (the “A” power rail and the ‘B’ power rail) are never connected directly to ‘RAW’ supply authority mains or ‘RAW’ standby diesel generator supplies without a UPS.

The NSW Health Infrastructure Structured Cabling standard requires a redundancy of N+1 for ICT systems. This same level of redundancy will be provided to clinical UPS systems. This can be achieved either through two separate UPS systems, each loaded at 50%, but both capable of supplying 100% in the event of a single UPS system failure, OR three separate UPS systems each loaded at 33.3% but two systems being capable of supplying 100% in the event of one of the UPSs failing.

Alternatively, a modular UPS system can be considered. Modular UPS systems split the load between multiple smaller UPS modules specified to include N+1 redundant modules in a single or multiple cabinet(s). This solution tends to be more cost-effective than providing fully rated redundant UPS but does not provide redundancy in the overall UPS system. This approach to redundancy is seen as acceptable under the following conditions.

The modular stackable hot swappable UPS are an acceptable approach in providing a more cost-effective UPS solution even though they do not provide the same redundancy to the overall UPS system. They have the added advantage as being easily expandable as the load increases in the future. However, in making the selection to use the modular stackable UPS, the designer shall apply the following conditions including:

- On-board intelligence and galvanic isolation of each UPS module such that a fault in one module does not cascade and take out other UPS modules
- Each UPS module shall be hot swappable
- N+1 UPS modules installed
- Separate UPS power outlet and standby power outlet at each communications rack. Outlets fed from separate distribution boards. Active equipment provided with dual power supplies
- The two power rails at each ICT/communication equipment rack, the ‘A’ power rail fed from the UPS supply and the ‘B’ rail fed from a separate essential supply, directly from the main switchboard via a separate sub-main and on a separate transfer switch on the main switchboard to the UPS supply. The ‘B’ rail power supply shall be via a line conditioner as a minimum
- Standby GPO installed adjacent to UPS GPO such that critical medical equipment can be moved to standby power in the event of a catastrophic UPS failure
- UPS external wrap around bypass installed
- Monitored UPS alarms.

UPS batteries for either the fixed UPS or the modular UPS shall comply with both items 1 and 2 below:

1. One battery pack for each UPS. Therefore, an N+1 system comprising three UPSs shall have three battery packs and a 2N system comprising two UPSs shall have two battery packs
2. Each battery pack shall contain multiple parallel strings such that a single string failure in each battery pack or planned maintenance does not affect the specified UPS system battery autonomy.

Table 4: Requirements for major medical equipment

MME Category	Standby Power Required	UPS Required	Capacity (indicative)	Notes
Medical Imaging equipment				
Fixed general and specialised x-ray machines (general, chest or, trauma rooms)	Yes	Yes	2 -10 kVA	UPS to power computing equipment. UPS to supply the table and monitoring may be optional.
Mobile x-ray machines	No	No		These units contain batteries which are charged from a wall outlet when not in use.
Fluoroscopy rooms with fixed screening or multi-purpose equipment	Yes	Yes	2 -10 kVA	UPS to power computing equipment. Table, monitoring and fluoroscopy functionality may require a 40kVA UPS.
Mobile fluoroscopy machines (often called C-arms or image intensifiers)	No	No		
CT scanners	Yes	Yes	3 - 20 kVA	UPS to power computing and control equipment. UPS to enable table movement may be optional.
MRI scanners	Yes	Yes	10 -15 kVA	UPS to power computing and control equipment. UPS to enable table movement may be optional.
Imaging workstations	Yes	Yes	2 -10 kVA	Central UPS with a number of UPS outlets at desk.
Plate readers for computed radiology systems	Yes	No		
Mammography machines	Yes	No		
Dental x-ray machines	Yes	No		
Orthopantomography machines	Yes	No		
Ultrasonic scanners	Yes	No		
Gamma cameras	Yes	Yes	3 - 15 kVA	
SPECT-CT scanners	Yes	Yes	3 - 15 kVA	
PET-CT scanners	Yes	Yes	3 - 15 kVA	
Angiography and Cardiac Catheter Laboratory				
Ceiling or floor-mounted imaging systems with associated haemodynamic monitoring	Yes	Yes	3 -15 kVA	UPS to power computing and control equipment. Table, monitoring and fluoroscopy functionality may require an 80kVA or higher rated UPS.
Radiotherapy equipment				
Linear accelerators	Yes	Yes	3 -15 kVA	Many of these devices have UPS supplied with them at purchase.
Brachytherapy devices	Yes	Yes	3 -15 kVA	Many of these devices have UPS supplied with them at purchase.
Superficial orthovoltage devices	Yes	Yes	3 -15 kVA	Many of these devices have UPS supplied with them at purchase.

MME Category	Standby Power Required	UPS Required	Capacity (indicative)	Notes
Radiotherapy equipment				
Planning CT scanners	Yes	Yes	3 -15 kVA	Many of these devices have UPS supplied with them at purchase.
Simulation devices	Yes	Yes	3 -15 kVA	Many of these devices have UPS supplied with them at purchase.
Operating theatre equipment				
Operating theatre, including, operating lights, pendants, monitors, anaesthetic machines and monitors,	Yes	Yes	8 – 10 kVA	The operating theatres will have UPS power supplied from a central UPS to a number of GPO per pendant. Allowance per room.
Operating theatre integration products	Yes	Yes	10 kVA	Many manufacturers supply UPS with the server rack equipment.
Integrated imaging systems	Yes	Yes	3 – 15 kVA	UPS to power computing and control equipment. Table, monitoring and fluoroscopy functionality may require 80kVA or higher rated UPS.
Operating theatre tables	Yes	No		
Surgical microscopes	Yes	No		
Surgical diathermy units and associated surgical plume evacuators	Yes	No		
Surgical lasers of various types	Yes	No		
Suction devices (like the Neptune Rover and docking station product)	Yes	No		
Infection control (CSSD / SSU) equipment				
Ultrasonic cleaners	Yes	No		
Washer / disinfectors (cart washers, batch washers, tunnel washers, etc.)	Yes	No		Minimum one washer to be on standby power.
Pre-vacuum steam sterilisers	Yes	No		
Low temperature sterilisers	Yes	No		
Steam sterilisers	Yes	No		Minimum one steam steriliser to be on standby power.
Drying cabinets	Yes	No		
Endoscope washers / disinfectors (re-processors)	Yes	No		
Endoscope drying and storage cabinets	Yes	No		
Bulk detergent dispensing plant	Yes	No		
Reverse osmosis treatment units	Yes	No		
Instrument tracking systems	Yes	Yes	5 kVA	

MME Category	Standby Power Required	UPS Required	Capacity (indicative)	Notes
Dental equipment				
Dental chairs	Yes	No		
Dental units				No
Dental lights (if separate from the chair and dental unit)	Yes	No		
Dental x-ray units	Yes	No		Typically, now digital.
Dental sterilisers	Yes	No		
Dental plate scanners	Yes	No		
Birthing, ICU, NICU and ED Resuscitation bay pendants	Yes	Yes	2.5 – 3kVA per bed	The pendants will have UPS power supplied from the central UPS to a number of GPO per pendant.
Switchable' glass (intensive care units)				
Patient bedroom glazing, where used	Yes	No		
Neurological diagnostics				
EEG	Yes	Yes		Important when used to monitor seizures such as is needed in epilepsy services.
Major clinical equipment				
Hospital-wide cardiac monitoring equipment including telemetry and wireless monitors	Yes	Yes, for telemetry		
Hospital-wide central monitors at the Staff Stations	Yes	Yes	5 kVA	UPS at each central monitoring station and for ADT and database servers if applicable
ECG management systems and associated ECG recorders and carts	Yes	No		UPS may be required on the server which is likely to be in the computer room and hence UPS backed up.
Clinical information systems	Yes	Yes		
Other clinical equipment including continuous haemodialysis and high frequency oscillation ventilation (HFOV)	Yes	Yes		
Pharmacy robotic systems	Yes	No		
Automated medication dispensing systems (like Pyxis)	Yes	No		
Ophthalmological diagnostic equipment	Yes	No		

Note 1: Information relating to kVA requirements is indicative only as the requirement is very much dependent on which procedure is required to be undertaken and also which make and model is purchased.

5.6.4. Sub-mains

The types of sub-mains for distribution of electricity supply from the main switchboard or distribution boards can broadly be categorised into the following groups:

- Group A – Safety services (AS/NZS 3000 defined)
- Group B - Critical care services
- Group C - General services (remainder).

Group A – Safety Services

AS / NZS 3000 defines safety services, some or all of which will be required in the hospital design. Sub-mains for the services require special provisions to ensure integrity of supply in fire and other building emergency situations.

Group B – Critical Care Services

Standby lighting and power systems to AS/ NZS 3009 will be provided in critical care areas.

Critical care areas are those areas where acute resuscitation procedures occur on a regular basis. These areas include:

- All clinical areas of the ED
- All clinical areas of the operating theatre suite
- Day procedures rooms
- CCU
- ICU
- NICU
- Renal dialysis units including the RO plant
- Angiography, cardiac catheterisation rooms electrophysiology (EP) rooms
- Selected areas of medical imaging unit.

AS/ NZS 3009 requires that 100% of all power outlets in the ‘surgical suite’ (the operating room, anaesthetic preparation room, scrub and exit bay as a minimum) be connected to the emergency supply, or a UPS supply which is fed from the emergency supply.

Light and general-purpose power outlets in Group B critical care areas shall have dedicated sub-mains originating from the main switchboard, feeding dedicated distribution boards.

There will be a minimum of three dedicated sub-mains and distribution boards to Group B areas/ departments including:

1. A non-essential sub-main and distribution board
2. Essential sub-main and distribution board no. 1
3. Essential sub-main and distribution board no. 2.

All patient bed locations and treatment spaces/ rooms shall be connected to both essential distribution boards and the load shall be split evenly across both supplies.

The non-essential distribution board shall be used for non-patient locations associated with cleaners GPO, a percentage of the office/ workstation GPO, utility rooms, store rooms etc.

In addition to the three separate sub-mains, an additional sub-main and distribution board may be required to specific spaces/ rooms for UPS supplies (e.g. the operating theatre suite, ICU, NICU and medical imaging department).

These group B sub-mains shall be a direct feed from the building’s main LV switchboard.

Group B sub-mains cables are not required to be fire rated, however protection against mechanical damage shall be provided.

Two dedicated sub-mains circuits and distribution boards will be provided to serve critical care essential lighting and power distribution boards, with as even as possible distribution to both lighting and power from each distribution board.

Group B sub-mains shall be a direct feed from an emergency power generation (EPG) switchboard rather than the main switchboard.

Group C – General Services

The remaining sub-mains for non-critical services and equipment will be wired in accordance with AS/NZS 3000 and will comprise:

- General light and power throughout the buildings
- General lighting and power in all the inpatient units that are not covered under the Group B cable reticulation requirements
- Mechanical services systems
- Medical imaging systems
- Computer (IT servers) system, and
- Hydraulic services system.

There will be a minimum of two sub-mains and distribution boards to the following areas/ departments including general lighting and power in all non-clinical/back of house/administration areas and consulting rooms.

This will include:

1. A non-essential sub-main and distribution board
2. Essential sub-main and distribution board

However general lighting and power in all the remaining clinical inpatient units that are not covered under the group B cable reticulation requirements shall have three sub-mains and distribution boards comprising:

1. A non-essential sub-main and distribution board
2. Essential sub-main and distribution board no. 1
3. Essential sub-main and distribution board no. 2.

It is important that both the above essential supplies to these distribution boards do not originate from the same essential bus bar and/ or ATS at the main switchboard.

It should be noted that all major metropolitan and regional hospitals will have multiply transfer switches with multiple essential bus bars.

Where the installation is small such, as a multipurpose service, or there is only one ATS at the main switchboard (such as for a small rural hospital/MPS) then the second essential distribution board power supply is not required. In these circumstances there will be one non-essential distribution board and one essential distribution board.

All patient bed locations and treatment spaces/ rooms shall be connected to both essential distribution boards and the load shall be split evenly across both supplies.

The non-essential distribution board shall be used for non-patient locations associated with cleaners GPOs, a percentage of the office/ workstation GPOs, utility rooms, store rooms etc.

These Group C sub-mains do not need to be fed directly from the main switchboard but can be connected to a rising main system with tap off units at each floor.

Group C sub-mains cables are not required to be fire rated, however protection against mechanical damage shall be provided.

Regarding the medical imaging department, the following split shall be applied to medical imaging machines connected to a non-essential supply or an essential supply:

- Single general x-ray or fluoroscopy machine installed at a facility shall be connected to the essential supply
- Multiple general x-ray or fluoroscopy machines installed at a facility should connect at least one machine of each type to the essential supply
- Single CT or PET/ CT scanner installed at a facility shall be connected to the essential supply
- Multiple CT or PET/ CT scanners installed at a facility should connect at least one machine of each type to the essential supply
- Single MRI machine installed at a facility shall be connected to the essential supply
- Multiple MRI machines installed at a facility shall connect at least one machine to the essential supply. This includes the chiller serving the MRI.

Other

The following services shall be provided with standby electrical supply from a diesel generating plant in accordance with the recommendations of AS/NZS 3009 and as modified herein.

Table 5: Standby power coverage

Area/ Facility	Lighting	Power
Angiography Laboratory - Angiography equipment	100%	100% 100%
Blood bank refrigerators	30%	100%
Blood bank type and cross matching areas	30%	100%
Building maintenance control system (BMCS)		100%
Cardiac catheterisation room - Catheter Lab equipment	100%	100% 100%
Coronary Care Unit - Patient bed spaces - Elsewhere	 100% 60%	 All socket outlets per bed 50% socket outlets
Critical Care Areas (see DP14)	50%	100%
Diagnostic laboratories (e.g. cardiac)	30%	30%
Emergency department - All patient bays - Procedure and treatment rooms - Staff stations - Elsewhere	 100% 100% 100% 50%	 All socket outlets per bed 100% socket outlets 60% socket outlets 30%socket outlets
Kitchens (main)	50%	30%
Intensive Care Unit - Patient bed spaces - Elsewhere - Ventilation	 100% 50% 100%	 All socket outlets per bed 50% socket outlets Ventilation System
Maternity services - Birthing suite - Staff station and work area - recovery rooms	 30% 30% 30%	 All socket outlets All socket outlets All socket outlets
Renal dialysis units plus the RO plant	30%	100%
Neonatal intensive care units	50%	100%
Operating theatre suite - Operating rooms	 100%	 All socket outlets

Area/ Facility	Lighting	Power
- Anaesthetic preparation rooms and sterile stores	100%	All socket outlets
- Elsewhere	30%	60% socket outlets
Inpatient Units - Bed rooms	100%	All socket outlets
Close observation unit beds	100%	All socket outlets per bed
Mortuary (refrigerated storage)	100%	100%
Severe burns inpatient unit	100%	100%
Lifts	NIL	All lifts
Smoke exhaust fans	NIL	NIL
All ICT/ communications Rooms/ distributors	50%	100%
Fire alarm system	NIL	100%
Security alarm system	NIL	100%
Medical gases, suction and air system	NIL	100%
Offices and workspace	30%	30%
Toilets/bathrooms	50%	NIL
Change rooms	30%	NIL
Therapy rooms	30%	50%
Reception/ waiting	30%	60%
Dirty utility	30%	NIL
Clean utility	30%	30%
Tutorial room	30%	NIL
Consult room	30%	30%
Engineering workshop	30%	30%
Air conditioning refrigeration plants	N/A	To be discussed on a project by project basis
General corridors	50%	NIL
Helipad	100%	100%

Note 1: The quantity of power outlets to be connected to the standby supply system has very little impact on the generator capacity requirement. However, the wiring for power outlets will be simplified significantly and hence cost-reduced if all outlets are on the same system.

Note 2: Power will be made available to bring all lift cars down to the ground level sequentially. When all cars are brought down, only one selected car in each lift group will be provided will standby power to continue in service. This will be the lift available for transportation of critical care patients and shall include a lift that transports patients from helipad to the emergency department.

Note 3: The supply of standby power to chilled water plant servicing critical areas should be considered with practicality and cost effectiveness and budget constraint parameters.

Sub-mains capacities

In addition to the assessed capacity for the present requirement, supply sub-mains shall include spare capacities suitable to meet the needs of future expansion outlined for any specific project.

Sub-mains for fire services and lifts shall be sized to match the rated duties of the equipment.

Neutrals shall be sized the same as the active conductors (as a minimum) or the maximum current generated by the addition of harmonics, whichever is greater.

General cable insulation

Insulation materials for cables shall be in accordance with the relevant codes and standards. The use of low smoke zero halogen (LSZH) is not mandated. Cables will be selected on code requirements and value for money.

Main switchboards / main distribution boards

Main switchboard shall have a minimum form of separation of at least Form 3b.

Main switchboards at all new heath care facilities shall, as a minimum, aim to be designed to the following standards:

- The main switchboard shall be housed in a separate air-conditioned room that is accessible, suitably ventilated and not subject to flooding
- The main busbar system will be divided into separate ‘essential’, 'fire safety' and 'non-essential' circuits, each segregated from the other by fixed and continuous barriers. Clearly label each segregated section of the busbar system. Based on the design of the essential services and the sizing of the standby generator plant, it is expected that there will be more than one ‘essential bus bar system’ each with its own dedicated transfer switch/circuit breaker
- 25% spare capacity on all busbar sections. All spare ways/ spaces on the main switchboard shall be fitted with plug in modules already connected to the main bus bar assembly. There is no need to install spare breakers
- Provide complete grading and discrimination of all switchgear throughout the installation with the utility and standby generation system

Distribution boards

Boards shall have a minimum Form of Separation of Form 2.

For light and power sub-mains, at least one distribution board will be provided for each fire compartment to minimise the number of small penetrations through fire walls.

Distribution boards shall be fitted with circuit breakers and residual current devices (RCD) where required for all final sub-circuits.

Energy metering

Subsidiary electrical metering of various areas of the installation can assist in the auditing of energy use and troubleshooting for system abnormalities. Digital multi-function meters will be incorporated at various strategic locations of the electrical network. As a minimum, multi-function meters will be provided to monitor all sub-mains servicing distribution boards, mechanical services switchboards and all other major control cabinets.

Energy metering will be in accordance with the latest NCC requirements as a minimum. This is to be interfaced to the mechanical BMCS.

5.6.5. Building automation

Switchboards supplying emergency, critical and UPS loads will be provided with switchgear that is monitored at the BMCS. The BMCS will be able to monitor circuit breaker status including ‘opened’, ‘closed’, and ‘trip’ and provide alarms. UPS alarms will also be connected to the BMCS and security panels.

5.6.6. Electromagnetic radiation (EMR)

Diagnostic equipment relies on measuring extremely small bio-signals against a background of large size electromagnetic interference. Electromagnetic interference can arise from low frequency sources

such as major cable routes or large transformers, or high frequency sources such as radio, television or paging transmitters.

Neurophysiology (EEG and EMG) departments are particularly susceptible to EMR particularly the low frequency type caused by mains interference. The location of major cable routes or transformer equipment will be considered in relation to their surroundings and appropriate measures provided to mitigate electromagnetic influences. The installation of sub-main cables should be such that interference caused by EMR is mitigated.

Where sensitive electronic equipment is to be installed, a radiofrequency interference (RFI) study and/ or site survey should be undertaken. Once an installation is completed and operational, additional checking for RFI may be considered, to establish the presence of any RF “hot spots”.

The study or site survey should indicate a hostile RF environment and whether electromagnetic shielding by way of a Faraday Cage is required. New diagnostic equipment with inherently high interference rejection, measures to make the area ‘electrically quiet’ and intelligent patient positioning, are more effective than a Faraday Cage.

5.6.7. Lightning protection

The building will be evaluated and designed in accordance with AS1768 – Lightning Protection.

5.6.8. Patient electrical protection systems (body and cardiac patient areas)

- Electrical installations will be designed to comply with AS / NZS 3003 Electrical installations - patient areas and follow the guiding principles below:
- Compliance with AS / NZS 3003 is a statutory requirement in all NSW hospitals and healthcare facilities
- All patient areas in hospitals and healthcare facilities must be wired at least as body-protected electrical areas and protected with 10mA RCD
- Patient safety is not increased by the installation of cardiac-protected electrical areas when performing body-protected procedures
- Cardiac-type procedures are defined by AS / NZS 2500 and are limited to those which make direct contact with cardiac tissue
- Patient areas should only be wired as cardiac-protected electrical areas in defined areas according to AS / NZS 3003, or where cardiac-type procedures will be regularly or routinely undertaken
- Defined areas for cardiac-protected electrical wiring include:
  - Cardiac catheter laboratories (CCL) and control rooms
  - Cardiac intensive care unit (CICU)
  - CCU
  - ICU with regular thermo-dilution Swann-Ganz monitoring
  - NICU (Level 3)
  - Operating theatres used for cardiac/ thoracic surgery or interventional radiological procedures.
- All other areas should be wired as body-protected electrical areas
- If an UPS is required in the procedure area, then an isolated power supply should be installed rather than RCD protection (e.g. cardiopulmonary bypass pumps, operating microscopes, laser unit, etc.). A risk benefit analysis should be done to determine the need for uninterruptible power in the procedure area.

Power points

A frequent excessive cost is the number of general purpose outlets requested to meet perceived usage requirements. In many instances these requirements far exceed the normal needs of the room and are subsequently left untouched in everyday use.

As a starting point in the design, the scales of provision of socket outlets should be in accordance with the room data sheets (RDS) in the AusHFG.

Labelling and safety shutters

All RCD protected outlets provided under AS / NZS 3003 will be identified and labelled in accordance with the Standard. All other outlets and switches will be labelled in accordance with AS / NZS 3000 and colour coded to AS / NZS 3003.

Outlets in mental health facilities, neonatal/ special care and paediatric inpatient units should be fitted with safety shutters.

5.6.9. Medical services panels

The different medical services panels (MSP) configurations will be documented on the RDS.

Attention shall be paid to ensure that the provision of MSP (wall boxes and face plates) for all services is included in either the electrical or mechanical services, and not lost between the two trades. It is important that the final MSP installation is a coordinated product using consistent materials, finishes and physical size provided by one common manufacturer.

The main coordination of the design and construction of the MSP will be between the electrical trade and the medical gas trade.

Designers shall advise the users on the standardisation of panels as far as possible. This will reduce capital costs and minimise the risk of errors during manufacture and construction.

5.6.10. Mental health areas

The following measures will be incorporated in mental health areas:

- Tamper proof luminaires including emergency / exit luminaires
- Socket outlets and light switches to be tamper proof
- Extended UPS autonomy for security systems.

6. Fire Services

6. Fire Services

6.1. Introduction

The purpose of fire services in healthcare buildings includes, but is not limited to:

- Call the local fire brigade
- Warn occupants of an emergency
- Provide for safe evacuation
- Restrict the spread of fire, and
- Extinguish a fire

6.2. Scope

Fire services are required to achieve compliance with NCC and referenced standards. The following services/ systems will be considered as part of fire services:

- Fire detection control and indicating equipment (FDCIE)
- Emergency warning control and intercom systems (EWCIE)
- Water based suppression systems (sprinklers, hydrants, hose reels)
- Passive fire elements (e.g., fire /smoke doors, penetration seals & dampers)
- Exit and Emergency Lighting
- Mechanical Ventilation (fire mode only)

NSW Health prefers sprinkler systems installed on all projects irrespective of building height or other means of achieving NCC compliance as this is a proactive way of providing life and safety operation instead of relying on escape facilitation. This may also provide some additional benefits in planning and fire compartment sizes but should not be relied as a convenience solution for planning outcomes.

In conjunction with the above fire services/ systems, other services will be utilised in the safe evacuation of buildings, including:

- Smoke management systems
- Exit and emergency lighting systems
- Emergency control organisations and procedures for buildings, structures and workplaces.

6.3. General requirements

Fire services are generally required to provide life safety and property protection by one or a combination of methods listed above, to achieve the following:

- Warn occupants of an emergency
- Provide for safe evacuation
- Restrict the spread of fire
- Extinguish a fire and protect property.

6.4. Planning and context

Fire services masterplans will be complimentary to site conditions.

Planning is a critical part in the strategy for fire services design for health buildings. Depending on the project size, new build compared with existing refurbishments, a planning strategy should address:

- Any impact to the sites existing essential fire safety measures
- For brown field sites; the design and installation standards of the existing essential fire safety measures and any current system issues. Further consideration needs to be given to the potential for the need to upgrade.
- The design and installation standards relating to the existing hydrant infrastructure. If compliance to the current standards are not proposed, liaison with Fire & Rescue NSW needs to occur with consideration given to compliance with flow/pressure. Existing internal site services relating to refurbishment and extensions
- Location of plant and equipment
- Cost and budget impacts
- Future expansion of services and masterplan analysis
- Architectural and building impacts
- Maintenance access and replacement of services and plant without interruption to critical hospital services
- Noise and vibration impact
- Valving and zoning of services to allow minimal disruption should maintenance be required. Note ¼ turn valves are not permitted on hydrant equipment including backflow prevention kits.

Projects with clearly identified future stages and masterplans will be designed so that services infrastructure has the adaptability to cater for proposed future buildings to the site without having to replace or rebuild systems. Consideration will be made to future connections not to disrupt hospital services.

In planning a new building project or refurbishment, the fire response should be considered, not only in relation to the building in question, but also in relation to the entire site. The level of integration will be determined by the level of functional interaction required between these buildings. Existing buildings which will have direct pedestrian links with the new building may be required to operate or function in specific ways to aid in maintaining agreed fire safety levels and will therefore require some integration of systems to enable this to occur. Other existing buildings which are stand-alone may not require any integration.

6.5. Specific requirements and guidance

All fire services equipment will be located to ensure adequate space to be maintained and will be able to be cleaned and replaced without disruption to the building's day to day procedures.

Ceiling void sprinklers will be provided to sprinkler protected buildings unless exempt by AS 2118.1

The design of the sprinkler system should not preclude the use of innovative technologies such as extended coverage sprinklers or residential sprinklers in conjunction with fire engineered designs.

Flush mounted or concealed type sprinklers fitted off to false ceilings are to be avoided except in specific applications i.e. operating theatres, anaesthetic and adjoining sterile stock rooms and communications rooms (with false ceilings). In rooms where the air pressure within the room is to be controlled, flush mounted type sprinklers may be used. Sprinklers protection in communications and server and linen cupboards / rooms need to consider sprinkler head location and sprinkler guards to avoid impact damage. Sidewall sprinkler protection should be considered in such circumstances.

Minimise and preferably eliminate opportunity for ligature points in mental health facilities. Non-ligature sprinkler heads and door hardware to be used in mental health inpatient areas.

All water storage tanks will be accessible for draining and cleaning and be provided with sufficient overflow or automatic water inflow/ high level emergency shut off provisions so as not to cause flooding within the building. Water storage tanks for fire services will have a minimum design life of 30 years. All overflow drainage is to be coordinated with the hydraulic consultant or licenced plumber and ensure that full tank inflow can be drained.

Avoid the reticulation of mains pipework under buildings. Mains pipework should offset at the perimeter of the building into a riser shaft at the perimeter of the building where practicable.

Suitable valves are to be installed on all main services so that future connections can be made without disruption to existing hospital services. Flow switch zones shall be monitored and programmed to align with fire compartments or the mechanical smoke control measures, whichever the more onerous.

Communications rooms, server rooms and rooms containing electronic equipment will be sprinkler protected in sprinkler protected buildings unless unique circumstances exist including discernible cost savings to NSW Health and fire engineering solutions. Gaseous fire suppression systems are not required in communications rooms, server rooms and rooms with electronic equipment which will be sprinkler protected. Gaseous fire suppression systems are not to be used in place of sprinkler systems without fire engineering solutions and consideration to the ongoing maintenance cost of the asset.

FDCIE's are to be addressable systems and non-proprietary with open protocol.

Where a Fire Control Room is required by the NCC, then graphics systems shall be provided.

Every effort needs to be made in networking Fire Panels unless extenuating circumstances exist.

Fire equipment including tanks and fire pumps will be monitored at the fire indication panel and BMCS.

Smoke detectors in areas where patients stay overnight, including mental health inpatient units, will be configured so that the light-emitting diode (LED) indicator does not pole (flash) during normal operations.

EWCIE's will be configured to minimise patient trauma in inpatient areas. Where speakers are removed in these areas as part of an approved fire engineered solution, remote display units and mimic panels in the nurses' station together with visual indication with T3 strobe and audio annunciation with mute facilities at the mimic panel shall be provided.

Hydrant mains, fire pumps, FDCIE's and EWCIE's systems will incorporate a 25% additional service capacity for future expansion with this requirement clearly shown as such on fire services drawings and schematics and then to be clearly labelled as such upon completion.

Carbon dioxide fire extinguishers (3.5kg) will be used in patient care areas.

6.6. Design advice

6.6.1. Water supply

Ensure that appropriate supplies, storage and pumping facilities are negotiated with the fire authority early in the concept design phase and included in the scope and cost plan.

Refurbishment works need to consider existing capacity of the FDCIE and EWCIE to ensure any suitable allowance for future expansion for additional devices without the requirement to add additional loops or upgrade amplifiers.

All cabling and device spacing in refurbishment projects shall be installed in line with the applicable relevant standards.

All block plans shall be updated to suit newly refurbished area.

6.6.2. Monitoring of fire equipment

Consideration will be given to monitoring, via the main Fire Detection Control and Indicating Equipment (FDCIE) and in turn the BMCS, for the sprinkler and hydrant isolation valves, sprinkler and fire booster pumps and fire water storage tanks.

6.6.3. Integration with other services

Ensure the required interfaces are covered operation of other building services in fire mode must be carried out under the control of the fire systems to ensure that they operate in concert with the agreed fire safety strategy and the emergency procedures developed by the hospital. Interfaces will be provided between the fire detection system and other building services systems including:

- Mechanical ventilation used for smoke hazard management
- Specialised air conditioning or ventilation systems
- BMCS
- Security and access control systems
- Automatic door operators
- Door holders for doors in fire or smoke compartment walls
- Carpark boom gates (entry drive boom to ideally be fire tripped to close on fire alarm activation)
- Elevators (lifts) to assist in controlled vertical evacuation.

6.6.4. Integration with other hospital buildings

In planning a new building project or refurbishment, the fire response should be considered, not only in relation to the building in question, but also in relation to the entire site. The level of integration will be determined by the level of functional interaction required between these buildings. Existing buildings which will have direct pedestrian links with the new building may be required to operate or function in specific ways to aid in maintaining agreed fire safety levels and will therefore require some integration of systems to enable this to occur. Other existing buildings which are stand-alone may not require any integration.

The integration of the fire systems between other hospital buildings will be achieved via the appropriate infrastructure so that the integrity and performance of the fire systems is maintained i.e. via the common communications cabling infrastructure.

6.6.5. Water saving initiatives

Water saving initiatives will be addressed for the sprinkler and hydrant systems where cost-effective. For example:

- The installation of an on-floor isolation valve for each level or fire compartment of the sprinkler system so that each level can be drained and isolated only. This will prevent the entire installation being drained and avoid large sections of the building being isolated and unprotected during maintenance or alterations
- Water storage tanks connected to site irrigation systems capturing the flow from the hydrant/sprinkler testing. Tanks are to be designed to accommodate the volume of water discharged form sprinkler/hydrant pump annual activities.

6.6.6. Fire safety engineering

Fire safety engineering deals with strategic approaches to fire safety and the development of performance-based solutions which fall outside the deem-to-satisfy provisions of the NCC. Generally, deemed to satisfy (DTS) solutions with respect to fire and life safety is the preferred approach, however it is recognised that in larger multi building health facilities that this is not always possible. The benchmark for When used for a design to vary from the DTS parts of the performance-based fire solutions are to be based on establishing occupant safety (including adequate factors of safety).

The arrangement and size of internal fire and smoke compartments. Variation of the size of compartments can greatly assist the design of cost-effective and more operationally effective clinical spaces, particularly inpatient units and other large areas such as emergency and medical imaging departments.

7. Heating, ventilation, and air conditioning

7. Heating, ventilation, and air conditioning

7.1. Introduction

The purpose of HVAC systems in healthcare projects is to satisfy internal environmental conditions for comfort, safety and infection prevention and control.

7.2. Scope

The following services are considered as part of HVAC Systems:

- Cooling and heating
- Air conditioning
- Ventilation
- Heat recovery and rejection
- Energy management system
- Associated control systems
- Refrigeration (cool rooms)
- Medical gases (Chapter 11)
- Pneumatic tube systems (Chapter 14)
- BMCS (Chapter 16)

7.3. Planning and context

Site energy system masterplans are complimentary to architectural site masterplans and should provide a clear approach and direction for hospital developments which will allow projects and approaches to future work to benefit from a cohesive and coordinated plan.

Depending on the project size, such as new build verses existing, the analysis of benefits of decoupling the central energy plant from clinical facilities, decentralising or centralising services will be subject to a study that addresses issues such as:

- Location of plant space in the building or remote
- Freedom for space planning in buildings/ costs and architectural impacts
- Noise and vibration impact
- Future expansion needs of the plant room
- Maintenance access
- Sustainability and resilience
- Proximity to electrical, water and gas infrastructure and incoming supplies.

Projects with clearly identified future stages will have appropriate spare space allowance in central plant rooms, or strategy for future expansion, for installation of future chillers, boilers, heat rejection plant, and facilities to allow connections such as valves, space on headers for extensions to be completed with minimum and manageable interruption to existing systems.

Within new buildings, services risers must be designed to have spare capacity or the ability to add spare

capacity for future installation of services allocated in a practical manner. Space for at least one isolation room exhaust duct shall be provided per department per floor. Design and as-installed drawings will clearly identify such arrangement which has been provided and with access provisions to allow future fit-out.

7.4. Energy and sustainability

7.4.1. Passive energy efficient measures

The following passive measures will be addressed to reduce energy wastage:

- A ratio of external envelope to floor area that within the constraints of the site, and internal circulation results in an efficient building form
- A well-insulated and sealed external building envelope with thermal mass to dampen the effect of external environmental conditions
- Optimum fenestration ratios to achieve passive solar heating, good daylight factors for natural light penetration whilst minimising the effects of solar gain/ glare to perimeter spaces
- Room heights designed to achieve a sensible balance between functional need and economy.

7.4.2. Active energy efficient measures

These active measures will be addressed in the design to reduce energy wastage:

- Energy reclamation, run around coils or cross flow heat exchangers from extract ventilation systems should be incorporated into the system design where appropriate potential sources of heat recovery exist taking into account cross contamination issues
- The use of energy efficient motors including electronic commutator direct current (ECDC) motors, with variable speed drives where appropriate, for pumps and fans
- HVAC systems to be adaptable to respond to a range of environmental standards which can vary depending on room function. Systems will, where appropriate, make use of free cooling and differing operating modes in response to external climatic conditions
- Energy management systems integrated with a direct digitally controlled BMCS system to allow monitoring, targeting and load shedding capability of selected plant
- Control facilities via local and remote stations enabling plant usage to match occupancy patterns. Time and temperature-controlled zones should be designed to suit both thermal and functional characteristics, with each zone being independently temperature controlled
- The installation of centralised and modularised chiller and boiler plant with sequential control to maximise efficiency at reduced system demand, including the potential to utilise site and shared energy systems
- Separation of engineering systems to serve building zones with similar thermal and occupancy characteristics to allow differing requirements to be controlled separately and to achieve maximum turn down, i.e. night and weekend setbacks
- Engineering systems to be reasonably adaptable to respond to changes in planning and the likely changes in clinical needs, advancement in medical equipment and systems technology, in this respect, systems with modular configurations are encouraged
- Efficient insulation of distribution pipework and ductwork to minimise unwanted heat gains/ losses to meet NCC requirements.

7.5. General requirements

HVAC systems are generally required to follow the principles outlined in sections 2 and 3 of this document.

Air conditioning should be provided for each area used by staff and patients. Cooling and heating is not required in any bathroom or toilet area fitted with an exhaust system.

The choice of refrigeration systems should give due consideration to system capacity and the appropriate application of the various technologies. As a starting point, for systems below 200 kW, VRF systems can be considered, for systems between 200 to 500 kW, air cooled chillers should be considered, and for systems above 500 kW, water cooled chillers should be considered. Areas where water conservation is a key consideration (in regional areas), larger air-cooled systems may be considered.

The mechanical engineer shall seek confirmation from Health Infrastructure on the procurement strategy for cooling systems to support MME. If MME procurement includes standalone cooling plant, this is to be adequately planned and coordinated with other services for future installation. If no cooling plant is procured with MME, the mechanical engineer shall make suitable provision from the hospital central cooling plant.

Ventilation systems in critical patient care areas such as operating rooms, recovery, CCU, ICU, ED and infectious diseases inpatient units will operate on emergency power. The inclusion of chilled water should be considered to these areas where chiller sizing permits low load chillers to service cooling loads to such areas. Air cooled machines could be considered in these instances.

Access to any plant spaces in clinical departments must be from circulation spaces and not via patient treatment areas. All services in occupied areas are recommended to be concealed where possible, but if exposed then arranged to limit dust and dirt build-up.

A review of the building fabric and ceiling details will be undertaken to ensure minimum leakage of air into or out of the building.

All components such as temperature sensors and wall grilles within an occupied space will be suitable for swab down cleaning.

Rooms containing heat producing equipment, such as boiler or heater rooms or laundries, will be insulated and ventilated to prevent adverse impacts to the floor, ceiling and walls of adjacent occupied areas as per NCC requirements.

7.5.1. Outside air

Outside air will be provided according to AS 1668.2 and Table 7.1, where there is difference between the two documents, the higher quantity should apply.

All ventilation systems should be designed to control the higher level of odours often generated within healthcare facilities and ensures a high standard of indoor air quality.

If variable air volume (VAV) supply air systems are used, they will incorporate control devices to ensure minimum outdoor air supply to all areas is maintained at all times when system volume is turned down. VAV air diffusers should only be used in very isolated cases to overcome unique zoning situations.

In hospitals where helicopter operations occur, care will be taken to ensure that outside air inlets are clear of helicopter landing sites and the rotor air currents with entrained jet exhaust. Where this is unavoidable, considerations should be given to carbon filters and/ or temporary closing of outside air intakes through motorised dampers. If carbon filters are adopted, there should be a bypass for normal operation. If closing of outside intakes is adopted, measures should be taken to ensure that areas with pressure regime controls are maintained, one possible method maybe to increase the exhaust quantities in the more negatively pressured areas.

Full outside air systems should only be used after a comprehensive and informative study has been undertaken, (and to meet clinical and functional requirements) including initial capital cost implications,

ongoing energy cost implications and maintenance requirements. Selection will be based on value judgements of the additional costs and the benefits gained. Systems providing 100% outside air will be provided with heat recovery.

7.5.2. Exhaust air

Where back of house workshop areas need to be exhausted, fresh air ventilation and air conditioning systems should be provided in accordance with AS 1668. If the area is not listed in AS 1668 then a minimum supply air quantity of 20 litres per second per square metre of facility floor space should be provided.

For all other areas appropriate hoods and exhaust devices, for the removal of noxious gases, or chemical vapours, will be provided in accordance with AS1668.

Local exhaust ventilation will be localised as close as practicable to the sources of contamination. Exhausts will be suitably filtered and discharged in a manner that will not contaminate any adjacent area or system. Capture velocities at the point of localised extraction will designed to suit the function. Duct conveying velocities must also be maintained. This includes areas such as autopsy, plaster rooms, mould rooms and other areas where dust is created by process.

Consideration is also to be given to acoustics to prevent noise nuisance from high velocity systems.

The National Occupational Health and Safety Commission (NOHSC) criteria documents regarding occupational exposure to waste anaesthetic gases and vapours, and control of occupational exposure to nitrous oxide indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilised. Dedicated low-level exhaust systems shall not be required if it is demonstrated that the general ventilation of these areas provides adequate dilution of waste anaesthetic gases. Low-level exhausts shall be provided in areas mandated in other referenced documents.

7.5.3. Air conditioning heating and cooling loads

Cooling load calculations will be performed by internationally proven computer software. Care will be taken not to oversize plant as it will result in increased capital and recurrent costs.

7.5.4. Heat gain from lights and equipment

Heat gain from lights will be calculated from the lighting designers plans. Heat gain from electrically powered equipment will be based on the actual equipment to be used within the space. The gains noted in NCC Section J may be used for preliminary estimates to be verified when actual information becomes available, based on gross departmental areas for initial planning.

Additional allowances are required where equipment located in air conditioned space is heated by other means such as hot water or steam.

Designers shall always use the actual equipment gains for specified equipment where available, and this shall be verified as the design progresses. Where more detailed heat gain allowances for equipment are required prior to equipment selections (in refurbishments or fit-outs connecting to existing central plant) refer to Table 6 Recommended Heat Gain from Typical Medical Equipment, ASHRAE Fundamentals.

7.5.5. Air distribution

All air distribution devices will be selected to suit the specific needs of each room. Diffuser ‘throw’ will be carefully selected to assure no drafts over incapacitated patients.

As patients are often immobilised, air velocity is important to avoid drafts and discomfort. The throw of air diffusers should be selected such that there is no splash on walls above patients in beds or on trolleys.

Average air velocity in the room will be between 0.1 and 0.15 metres per second.

For patient spaces where privacy curtains are used care is to be taken in the selection and placement of supply air grilles and pathways for return and relief air.

7.5.6. Ductwork

Air handling duct systems will be designed to be accessible for duct cleaning, generally by the provision of access panels. Access panels will be fitted at each coil, fire and smoke damper and each turn in direction to allow annual essential services inspection.

Roof voids will not be used for air plenums for return air. Ceiling voids will not be used as air plenums for return air or introduce unwanted heat gain or heat loss to the system. Return air should be fully ducted. The ceiling void shall only be used in pandemic mode in inpatient units and as described for that option.

To reduce the extent of ductwork in ducted return air systems, consider transfer ducts between rooms and corridors; then ducted return from corridors, to minimise length of major ducts.

As a minimum, insulation will comply with the NCC section J; however, in addition, no internal insulation in clinical areas will have acoustic material lined with perforated foil or sheet steel without a membrane to prevent friable fibres entering the airstream. Acoustic silencers in these systems should be in accessible areas such as plant rooms such as they can be accessed and checked and cleaned.

The use of flexible ductwork shall be minimised, particularly on systems requiring regular cleaning for infection prevention and control. To facilitate replacement or cleaning of ductwork systems in clinical areas, the following maximum lengths are required as an improvement on the requirements noted in AS 4254.1. Lengths shall be less than 3000mm in clinical areas as described in the Table below.

Table 6: Maximum lengths of flexible ducts

Space	Maximum flexible duct length – supply systems	Maximum flexible duct length – return/ exhaust systems
General patient areas	3000mm	3000mm
Isolation rooms	3000mm	1000mm
Operating theatres	600mm	Not permitted
Connections to HEPA filters	Not permitted	Not permitted
Patient toilets	N/A	1000mm
Dirty utilities	3000mm	1000mm

7.5.7. Filters

Heating, ventilation and air conditioning systems will control the concentration of airborne particulates in high risk areas to minimise the risk of infection by means of air pressure, flow control and air filtration. The level of control will be proportional with the risk.

Filtration efficiencies will comply with AS1324.The first filter listed in the matrix of specific requirements is the pre-filter and if two filters are listed, the second is the main filter and the HEPA, if listed, is the final terminal filter. Manometers or differential pressure monitoring devices will be installed across filter banks with efficiencies greater than grade F6.

HEPA filters will always be installed at the air outlet and comply with AS4260 Type 1 class A grade A2 with minimum efficiency of 99.99%.

Designers are encouraged to consider UV filters and assess its application based on economics and benefits as this product becomes more commercially affordable.

7.5.8. Humidifiers

Reservoir type water humidifiers or evaporative pan-type humidifiers should not be used in ductwork or air handling units in health care facilities as they are known to leak, corrode and cause other maintenance problems as they age. Ideally, direct steam injection humidifiers are preferred. Humidifier steam control valves should be designed so that they remain OFF whenever the air handling unit is not in operation.

7.5.9. Pressure gradients

Where pressure gradients are specified to assure maintenance of sterile or containment conditions local pressure gauges, audible alarms and pressure monitoring devices should be installed.

Each pressure gradient step should be designed to 10 Pa.

If monitoring device alarms are installed, allowances will be made to prevent nuisance alarms. Short term excursions from required pressure relationships will be allowed while doors are moving or temporarily open. Simple visual methods such as smoke trail, ball-in-tube, or flutter-strip should be used when commissioning for verification of airflow direction.

7.6. Modularity, adaptability, integration and reliability

All efforts will be made to fully integrate all items of mechanical, electrical and ESD services with the architecture and landscape design.

All mechanical systems must be designed and installed to provide adequate and measurable reliability by providing plant items and systems that satisfy design requirements for critical areas, through standby, modular or load shedding arrangements that are clearly defined in operational instructions.

The susceptibility of hospital activities to departures from the optimal environmental conditions varies greatly. Most activities (other than where safety is paramount) can tolerate several hours of lost conditions without major damage other than areas such as sterile stock and some drug storage areas.

Stability in the internal environment by use of passive techniques and the building fabric will be assessed in principal and modelled.

Load shedding strategies will be developed to facilitate the maximum effectiveness of plant redundancy, in the event of a plant failure, so that operational building services systems will wherever possible give priority to critical spaces to maintain internal environmental conditions.

7.7. Design criteria

7.7.1. Outside design conditions

Outside design conditions will be based on the most accurate climatic data available for the location of the proposed project, considering recent weather data, and potential for future climate change leading to increased external temperatures.

Outside design conditions will be selected as follows:

- For the locations listed in AIRAH - ACS Design Aid DA9a: Air conditioning systems - design temperature data, the design conditions shall be reviewed against Bureau of Meteorology (BOM) data for the nearest listed location having similar climatic characteristics. If necessary, the design temperatures shall be adjusted to provide the same percentage exceedance values for critical and comfort temperatures based on the BOM data.

- For operating theatre plant and critical care areas, use the 'critical process', 24 hour data if available for the location
- For all other plants use the 'comfort or non-critical process installations' dataFor locations not listed in design temperature data or where conditions for ‘critical process’ does not exist, the designer will undertake an assessment based on review of BOM data for the nearest listed location having similar climatic characteristics
- For regional areas with higher dry bulb temperatures and where air cooled condensers are used, the selection of the condensers should be based on higher temperatures (based on recorded data) than the design conditions used for heat gain calculations
- Allowance shall be made for climate resilience.

7.7.2. Room air movement

The air velocity and temperatures within occupied zones will be provided to maintain accepted comfort limits. The temperature difference between rooms on the same zone will generally vary by not more than 3°C.

Care with the design of air distribution is required in operating rooms and rooms where patients are on beds and trolleys such as patient bedrooms, recovery units, ED and critical care units.

All rooms will generally be provided with sufficient air change rates for good air quality and scavenging as necessary.

In negative pressure (Class N) isolations rooms, care must be taken to ensure that air flow pattern sweeps away from the carer towards the bedhead and exhaust outlets.

7.8. Specific requirements and guidance

7.8.1. Air handling systems

The mechanical system for serving separate floors and departments should be able to be isolated without interrupting other areas. In this regard, each air handling system should serve either a floor or a department on a floor.

Variable control of air flow either by variable speed motor controls or step controls on smaller units may be used where deemed beneficial unless constant volume systems are preferable to serve areas to ensure that pressure regimes are maintained. In such cases, the interaction of varying pressure regimes between areas should be assessed.

Outside air economy cycles shall be included in all air handling systems and will be able to operate independent of other systems, unless detrimental to any pressure regimes or humidity control, in which case the details should be assessed and approved through formal project governance.

Air handling plant will employ air filters for improved air quality and reduction of mandatory minimum fresh air quantities where deemed appropriate such as in high population areas. Air filters will be made easily accessible for cleaning and will employ sensors and indicators to ensure adequate frequency of cleaning or renewal.

Isolation and operating rooms will each have separate air handling units and separate exhaust systems that are best located as close as practical to the areas served due to air leakage/ contamination/ decontamination issues.

Air cannot be recirculated to other areas from the following spaces; triage, ICU, recovery, operating rooms, birthing rooms, autopsy rooms and isolation rooms.

Separate localised air conditioning plant should be provided for rooms with unusually high heat gains or intermittent operation, i.e. meeting rooms, data rooms, control rooms and the like.

Separate clinical departments will have separate air handling plant. The same department on separate floors will have separate air handling plant. For health facilities with only a single inpatient unit, the air handling shall be further divided into two separate systems. Emergency departments will have a separate system provided for each major zone (e.g. acute, fast track).

Zoning of all air conditioning systems will acknowledge different dynamic loads and conditions likely to occur due to:

- External glazing and wall materials
- Roofs and suspended floors
- Hours of operation
- Clinical or process functions
- Internal heat gain from people, lights and equipment.

The size of each zone should take into consideration and commensurate with functional area sizes and planning grid dimensions.

The matching of air handling systems with functional floors and departments and fire compartments is required as it offers a matching of system to a department, thus offering matching flexibility in departmental functional patterns, potential full shutdown of department to eliminate cross infection with other areas, and any fire smoke control requirements which may be needed under NCC without additional fire rating of ductwork or elaborate dampening arrangements.

Good access for maintenance away from clinical and inpatient spaces.

Provisions for excluding dust from plant room areas and air intakes will be provided by seals around entry doors and roughing filters behind intake louvers and the like.

Due to costs and simplicity, the preference is for sprinklers to be provided and as such zone smoke control will not generally be required, unless the building exceeds the NCC requirements. This method of fire control allows the option for de-centralised air conditioning and ventilation plant rooms to be provided. The decentralised option is often the most economical, it is important however that the health planning is developed with the optimum location of the plant room in mind otherwise the economic benefits of the decentralised option can be lost.

Should sprinklers not be provided hence requiring a system of zone pressurisation smoke management, this lends itself to housing most of air handling systems in roof top plant rooms such that the return air ducts also act as smoke exhaust ducts. It would be ideal for the vertical risers and the associated areas served to coincide with fire compartments to facilitate the use of the air handling systems as smoke control systems in fire mode. This will also eliminate any ducts crossing fire compartments and the resultant fire rating.

7.8.2. Infection prevention and control

Air conditioning systems will maintain fresh air, temperature, humidity and contaminant control (dust, micro-organisms and gases) of the air.

Design principles across patient care areas will, in addition to comfort requirements, comply with infection prevention and control requirements. To minimise the risk of infection, ventilation system will be designed and balanced to provide directional air flow from clean to less clean areas. Maintaining required pressure regimes will frequently require air quantities more than the minimum scheduled in the Australian Standard, and these Guidelines. Positive flow at adequate rates is preferred to the defining of pressure differentials between areas. In some circumstances, flow may be required only on opening of doors and the system will have adequate flexibility to accommodate this requirement.

Provision will be made to ensure adequate air supply with varying filter resistances in areas requiring high levels of airborne contaminant control. Typically, this will be in operating theatre rooms, sterile stock rooms, isolation rooms and other high risk areas.

If individual room recirculation (unitary fan coil) units are to be used in high risk areas, high efficiency

filters will be installed, and additional cleaning procedures approved by the infection prevention and control team will be implemented. Additional air handling equipment will be required to achieve the necessary clean to less clean airflow patterns.

Such areas include:

- Birthing rooms
- NICU
- Negative pressure rooms (Class N)
- Specialised procedure rooms
- ED.

Systems incorporating central air supply and remote filter stations are recommended for these areas. Note that UV filtration may be appropriate in some cases such as high risk clinical departments. It is recommended that space be added in these areas so the health service can install if and when it is needed.

Fans in systems serving areas requiring airborne contaminant control will be operated 24 hours per day to maintain airflow patterns from clean to less clean areas.

Both the supply and exhaust ventilation systems to isolation rooms will be either separate independent systems for each room or will incorporate controls to prevent the possibility of cross contamination in the event of a fan failure. Additionally, supply air and extract air ventilation fans will be interlocked such that failure in either supply or extract will shut down the corresponding extract or supply to that room.

Provide pressure instrumentation, local alarms to the nurse station with a delay to prevent nuisance alarms, and monitor fan status.

Ensure that the rooms are built to prevent air leakage. This includes well sealed walls, ceiling and any penetrations for services installation and reticulation. For rooms that are designed to maintain pressure differentials this is an essential requirement for commissioning, subsequent functioning of the room and minimisation of excessive fan energy consumption.

Supply air and exhaust systems should be interlinked to prevent one system over or under pressurising in the event of a failure in the other system.

7.8.3. Pandemic mode - design changes in response to COVID-19

As a response to the COVID-19 pandemic, several design changes will occur in all subsequent projects. These are summarised in this subsection.

Intensive care units

Current design for adult and paediatric intensive care units (ICU) allows for a number of negative pressure rooms to suit current models of care. Additional capacity can be provided within an ICU during a pandemic by creating spaces with negative flow.

The negative flow capability in all scenarios is ‘switched’ to a pandemic mode as needed via the building management system (BMS).

The approach taken depends on the size, configuration and role delineation of the ICU and the following information details the recommended approach to design when considering these issues.

Level 6 ICUs

In all new Level 6 ICU with multiple ‘pods’, a pandemic pod is recommended. This will provide additional negative flow capacity in the event of a pandemic. When the area is ‘switched’ to a pandemic mode via the BMS, the room air will be drawn directly from each single bedroom space and vented to the outside. The corridor would be on a separate system and would be neutral or slightly positive compared to each bedroom. No additional Class N bedrooms are recommended within this pod, beyond the number

required to manage the caseload during normal operating periods. An airlock will be required at entry points to the pandemic pod. This will be a negative flow airlock and extract air from the entry corridor and ICU corridor.

Level 5 ICU

In all new level 5 ICU with multiple pods, a pandemic pod can be considered.

In all other level 5 ICU redevelopments pandemic/ isolatable pods should not be considered as this may introduce operational inefficiency as:

- During normal business as a pod arrangement will likely require additional staff
- During an outbreak, the pandemic pod will only be used to manage the infectious patient cohort, and this may affect total unit occupancy (i.e. pandemic pod with 50% occupancy). Instead, it is recommended that a proportion of these beds are fitted with negative flow capability, as an adjunct to Class N rooms (e.g. up to one quarter of the beds). When the area is 'switched' to a pandemic mode via the BMS, the room air will be drawn directly from each single bedroom space and vented to the outside. An airlock will be required at entry points to the pandemic pod. This will be a negatively flow airlock.

Level 4 ICUs

Pandemic/ isolatable pods should not be considered for the same reasons detailed for smaller Level 5 services. Instead, it is recommended that a proportion of ICU beds are fitted with negative flow capacity, as an adjunct to Class N rooms (e.g. up to one quarter of the beds). When the area is 'switched' to a pandemic mode via the BMS, the room air will be drawn directly from each single bedroom space and vented to the outside.

Operating theatres

A positive pressure environment is recommended in an operating theatre to protect the patient and reduce the risk of a surgical site infection. The following recommendations should be adopted including:

- Air handling arrangements in operating/ interventional procedural room are increased from a minimum of 20 to a minimum of 25 air changes per hour. This will further improve the ventilation within each room and reduce the time taken for airborne contaminants to be removed
- Management of AGP – using the operating theatre to undertake these procedures should continue as the air change regime will ensure there is sufficient and ongoing dilution of the air within the room. No further change recommended
- Single rooms to recover patients – the AusHFG currently shows an option to include single rooms within recovery areas of operating theatre services with six or more operating/ procedure rooms. The guidelines also show the option to supplement this approach with operational management such as leaving patients with infections to be last on the list and/or recovering the patient within the operating room. No change to current guidelines recommended given the restrictions in place regarding procedures and patients with suspected, probable or confirmed COVID.

Ideally, the care of patients undergoing interventional procedures is centralised within each LHD/ SHN.

Emergency Department

The approach taken depends on the size, configuration and role delineation of ED and the following information details the recommended approach to design when considering these issues.

Large emergency departments

It is recommended that ED with multiple resuscitation rooms (typically level 5 and 6 services or large level 4 services):

- Enclose one to two resuscitation rooms and provide a negative flow environment within these rooms. When the area is 'switched' to a pandemic mode via the BMS, the room air will be drawn directly from each enclosed resuscitation space and vented to the outside. Where this approach

cannot be achieved (e.g. design progressed, or the project involves refurbishment), the entire resus area may instead be designed to increase outdoor air changes from 15 to 20 per hour, to enhance ventilation and improve air quality

- Provide an additional storage room located close to any enclosed resus bay to enable this to be converted into a donning area in the event of an infectious patient.

In large ED with multiple pods, create one pod (e.g. acute zone) that has a separate air handling unit to become an isolatable pod so 'hot' and 'cold' zones are possible

Smaller emergency departments

In smaller ED where the design locates patient care in a single area, consider alternate use of Class N room instead of an enclosed resus bay or where the resus zone cannot be separated into a separate zone. The Class N room position should ideally be near the resus area and increased in size to accommodate a resus (i.e. the 14m2 room would ideally increase to 20m2).

Inpatient units – medical/ surgical

Recommendations include:

- No change to the current percentage of single bed rooms in selected clinical specialties such as respiratory and renal medicine as the current provision is between 50 to 60% single rooms in all inpatient units
- No change to the number of Class N rooms in overnight inpatient units. The current standards recommend one Class N room in general medical / surgical inpatient units
- Referring to AusHFG HPU340 Inpatient Unit for additional advice when planning specialty inpatient units e.g. respiratory (p. 17).

Small hospitals with a single inpatient unit will be designed to split the air handling so that the department is served by two air handling units.

Maternity units

Recommendations include:

- No change to the current design of maternity units as all rooms are currently designed with negative air flow
- One birthing room identify an area for donning PPE for those patients requiring airborne isolation precautions. A space of 3m2 is recommended. This may be provided as a dedicated bay, a dual use bay (e.g. mobile equipment) or a space at the end of a corridor that has no through traffic.

Medical imaging

Recommendations include:

- Interventional modalities identified as being used for interventional work (typically level 5 and 6 services) should be routinely equipped with air handling systems that achieve a minimum of 25 air changes per hour
- A single Class S isolation room with toilet, be considered for the main medical imaging department of new developments in the holding/ recovery zone. This approach may instead be managed operationally, especially where holding recovery zones have few spaces and minimal staff to monitor them
- No other changes to current medical imaging space design.

Office space/ staff areas

Recommendations include:

- No change to activity based working environments as they can be managed operationally to reduce the risk

- Staff rooms and staff kitchens serving large numbers of staff (e.g. large ICU, ED or theatres) will include an additional sink (or sinks, depending on the staff numbers) to support food and drink preparation. It is expected that clinical hand basins will be provided near, so staff can undertake hand hygiene prior to entering staff rooms.

Space provision for potential future filters

Space shall be provided in air handling systems for the possible future installation of additional filters such as HEPA or UV filters.

7.8.4. Operating theatres

Some operating theatres now incorporate extensive IT and medical imaging equipment. This equipment places a high heat load onto the room and the associated support structures take up a lot of the available ceiling area.

Designers need to understand the implications of this equipment on their systems and will work closely with imaging equipment suppliers to co-ordinate the set out of imaging equipment with the placement of ductwork, HEPA filters, access panels and lighting to obtain a satisfactory buildable design outcome.

Where equipment cabinets are incorporated into operating rooms consideration should be given to exhausting off the top of these cabinets to reject the heat load before it impacts on the room.

Operating theatre air supply solutions aim to reduce bacteria in the air, which may lead to post-operative wound infection.

In the past there has been a school of thought that for orthopaedic theatres, a laminar flow system must be employed to achieve the appropriate pattern of air flow and level of cleanliness required. It has since been accepted laminar flow is practically impossible to achieve in an operating theatre and this requirement has evolved to a call for an ultra-clean ventilation (UCV) system, which fundamentally requires the same engineering system components of what was termed the laminar flow system.

The provision of a UCV system is capital intensive and in its purest form requires certain clothing and hose connections to personnel which creates limitations in their movement.

Health Infrastructure form the view that irrespective of the nature of operating theatres, there is no need for the use of UCV systems, as it is costlier and does not provide proven improvements in its outcomes. A supply air ceiling solution offers better value for money, meets all codes and is supported by recent research it offers the best outcomes in terms of the lowest colony forming unit (CFU) counts within that research.

Designers need to seek careful briefing from users re the types of surgery to be carried out in each theatre. The design of the theatre HVAC systems should respond to the complexity and risk associated with the procedures. Modelling using computational fluid design (CFD) methods are useful in establishing the optimum arrangement of returns and exhaust outlet locations.

Airflow into the operating theatre will be by means of a distribution system that provides a flow of clean supply air over the operating area first then away. Entry of air will be from the ceiling to deliver a downward air movement with a minimum velocity 0.2 m/ s at the level of the operating table (0.3 m/ s max). To achieve this requirement a velocity of 0.5 m/ s is normally required at the filter face.

Air will be delivered at high level in a way that minimises turbulence and the recirculation of potentially contaminated room air and provides the cleanest practical air supply over the operating table area. i.e., the theatre supply HEPA filters or in a supply ceiling plenum arrangement with HEPA filters should be ceiling mounted over the surgical area in a configuration that ensures delivery of sterile air over the surgical site, with minimal interference from theatre lights, pendants and staff. This is a very important aspect of the theatre air supply to minimise turbulence and to ensure the supply covers the operating table. There have been examples where this has been compromised due to coordination issues between theatre lights, supply air ducts and pendants. This coordination must be undertaken early, and in a thorough manner, so that suitable equipment and products are selected, and optimal performance is achieved.

The directions of air flows within operating theatres will always be from the operating room and set-up room, through immediately adjacent inner anterooms, scrub-up and anaesthetic rooms to the entrance foyer, recovery, changing and post-operative clean-up rooms, from clean to less clean areas.

Graduated pressurisation relative to pressure in areas adjacent to the operating unit ranging from not less than 10 Pascal positive in the operating room(s) to slightly positive pressure in areas like entrance foyer, recovery and change rooms and slightly negative in clean-up room(s) can be achieved by using carefully balanced supply air and exhaust air systems. Designers need to coordinate the design with the architects and other disciplines to ensure that the building fabric, doors, pass-throughs etc. are sufficiently airtight to achieve the pressure gradient requirements.

Surplus supply air into the theatre is always required to assure correct flow direction.

Surgeons or surgical procedures may require room temperatures, ventilation rates, humidity ranges, and or air distribution methods that exceed the minimum indicated ranges.

Designers should seek project-specific advice from the users re the types of surgery and their specific humidity and temperature needs. Surgery, (involving burns, neonates and some other procedures) sometimes require a high range of temperature and humidity.

Exhaust registers will be located so that the whole room is effectively scavenged, particularly at floor level. The consultant should consider the adverse effect (turbulence) of the air flow pattern near the surgical field created by surgical lamps due to their shape, size location and the heat generated by the lamps. Some studies have shown that exhaust/ return air outlets at low level may not be optimum in reducing particle concentrations at the operating table. Some ceiling exhaust air slots can assist in improving purging of theatre extremities and reducing re-entrainment of ‘dirty’ air into the sterile flow from the HEPA filters.

Lint from operating theatre staff gowns can be a problem in the return / exhaust air path. Low level exhaust will be extracted at 200mm above floor level. Lint filters should be provided in low level extract outlets (easily replaceable from behind hinged grilles).

In the design of air conditioning and ventilation systems serving operating theatres suites, one of the key considerations is the maintenance of cleanliness of the sterile instruments until they reach the operating theatre. Another is the minimisation of cross contamination risk between rooms and/ or across theatres. The risks and thus design is different when there is a shared sterile stock store for multiple theatres and when there is a one to one relationship between the two. Additionally, if the CSSD is adjacent to the sterile stock store then the need to ensure that the clean area of the CSSD is also a clean environment is of importance. At present there are requirements contained in AusHFG and Australian Standards which addresses this topic.

The air handling system serving the sterile stock storage areas within an operating theatre complex will comply with AS/ NZS 4187. The table below illustrates various layout scenarios and the design consideration for each of the scenarios.

Table 7: Operating theatre scenarios

Layout arrangement	CSSD Clean Area	Sterile stock store	Operating theatres
CSSD adjacent to sterile stock store servicing multiple theatres	HEPA filtered air, highest pressure (+30 to 35 Pa)	HEPA filtered air, highest pressure (+30 to 35 Pa)	HEPA filtered air, higher pressure (+20 to 25 Pa)
Remote CSSD, sterile stock store servicing multiple theatres	HEPA filtered air, pressure higher than adjacent areas (minimum +10 Pa)	HEPA filtered air, highest pressure (+30 to 35 Pa)	HEPA filtered air, higher pressure (+20 to 25 Pa)
CSSD adjacent to sterile stock store servicing one theatre	HEPA filtered air, highest pressure (+30 to 35 Pa)	HEPA filtered air, highest pressure (+30 to 35 Pa)	HEPA filtered air, higher pressure (+20 to 25 Pa)
Remote CSSD, sterile stock store servicing one theatre	HEPA filtered air, pressure higher than adjacent areas (minimum +10 Pa)	HEPA filtered air, higher pressure (+25 Pa)	HEPA filtered air, highest pressure (+35 Pa)

Pressure differences between cascading spaces should not be less than 10Pa.

A further issue that needs attention is when a sterile stock store is shared between theatres, in this instance consideration should be given to providing a separate system to the sterile stock so that its operation and balancing is not dependent on other systems. Where several sterile stock stores are served from a separate system, the overall resilience provisions shall be agreed with Health Infrastructure – i.e. the loss of an air handling unit or other component of ventilation system should not render all operating theatres unusable.

7.8.5. CSSD and sterile stores

Air movement and ventilation will achieve a positive airflow from clean (packing and sterilisation) to contaminated, or dirty (receiving, cleaning and decontamination) work areas (minimum 5Pa pressure differential). Ventilation rates will be maintained when the zone is not occupied sufficient to ensure dilution rates are maintained. Air quality delivered to the clean zones will be equivalent to that delivered to operating theatres using HEPA filters.

7.8.6. Isolation rooms

There are four types of isolation rooms that can be used to accommodate patients. These room types are detailed in the Table below.

Table 8: Isolation room types

Isolation room type	Isolation room use
Class S – Standard	Standard isolation used for isolating patients capable of transmitting infection by droplet or contact routes.
Class P – Positive pressure	Protective isolation used to isolate immunocompromised patients.
Class N – Negative pressure	Respiratory isolation used to isolate patients capable of transmitting infection
Class Q – Quarantine	Quarantine isolation – a Class N room including an anteroom and fumigation facilities

Class N isolation rooms will provide a negative pressure gradient from the isolation room to the anteroom and corridor. The most negative pressure environment will be the patient bedroom.

Class P isolation rooms will provide positive pressure relative to the corridors.

The minimum differential pressure between the isolation room and adjacent ambient pressure areas should be 20 to 30 Pa if the isolation room has an anteroom and 10 to 15 Pa when there is no anteroom.

In both cases, the pressure gradient relates to the differential from the corridor. Barometric dampers will be needed to achieve these pressure gradients. These requirements are detailed in the Table below.

Table 9: Pressure gradients

	Class S (Standard)	Class N (Negative)	Class P (Positive)	Class Q (Quarantine)
Patient room	-	-20 to -30 Pa	+20 to +30 Pa	-20 to -30 Pa
Ensuite	-	-20 to -30 Pa	+20 to +30 Pa	-20 to -30 Pa
Anteroom	-	-10 to -15 Pa	+10 to +15 Pa	-10 to -15 Pa

Refer to AusHFG Isolation Rooms – Engineering and Design Requirements which contains a detailed description of requirements for isolation rooms.

The exhaust system for Class N isolation rooms shall be provided with duty and standby exhaust fans. The supply shall be either individual fan coil units, or a centralised supply unit for a group of Class N rooms, when a centralised supply is used, it shall include duty and standby air handling units. The supply shall be configured to shut off when there is loss of exhaust in the system. The airflow pattern inside a Class N room shall always be away from the staff towards to head of the patient bed.

7.8.7. Surgical diathermy and laser exhaust systems

Surgical diathermy and increasingly surgical laser equipment are used in operating theatres to cut tissue and cauterise the surrounding areas. Both types of equipment produce a smoke plume that is unpleasant and is harmful to health. Refer to NSW Health GL2015_002: Controlling Exposure to Surgical Plume.

Equipment to remove the plume can be divided into two types, i.e. self-contained smoke evacuators and central systems. The self-contained smoke evacuators are portable units which are often supplied by the surgical diathermy or laser manufacturer as companion units. They can be purchased at the same time as the surgical diathermy or laser and can be accommodated on the surgical equipment pendant in the operating theatre. They comprise a suction unit with a HEPA filter to remove all contaminants and the cleaned air is returned to the operating room.

Central systems are usually found in the ceiling space and comprise a suction pump, and HEPA filter with piping through the surgical equipment pendant to the point of use of the diathermy or laser, and an exhaust system which discharges the air outside the building. The point of discharge should be above roof level and well away from outside air intakes and open-able windows and be treated as an objectionable discharge as defined by AS 1668.2. The central system will be a group 1 or 2 item and planning for its installation is required before completion of the operating theatre.

Self-contained smoke evacuators are preferred to central systems.

7.8.8. Pharmacy aseptic and cytotoxic manufacturing areas

Laboratory and dispensing areas in pharmacy will be investigated for the necessity to control air flow and exhaust to avoid any possibility of contamination to any adjacent areas.

Pharmacy compounding areas may have additional air change and filtering requirements beyond the minimum of the matrix of specific requirements depending on the type of pharmacy, the regulatory requirements, the associated level of risk of the work, and the equipment utilised in the spaces.

Cytotoxic suites will be designed and constructed in accordance with AS 2639 Laminar flow cytotoxic drug safety cabinets - Installation and use, and AS 2252.5: Controlled environments Cytotoxic drug safety cabinets (CDSC) – Design, construction, installation, testing and use. The basic design will be of an ISO Class 7 Cleanroom (AS / NZS 14644) varied in accordance with the requirements of AS 2639.

Designers should note that the design, certification and approval of cytotoxic and aseptic suites may fall under the requirements of the Therapeutic Goods Administration (TGA) and will check in the concept phase if this approval is required.

7.8.9. Rooms used for tests for patients with Tuberculosis and in delivery of specific aerosolised medications

It is recommended that, if available, an existing Class N room is used for induced sputum and delivery of nebulised pentamidine.

If this is not possible:

- a single consult (or similar) room is identified as the place within the facility for performing the procedure
- the room is fitted out with its own fan coil so air from the system is not recirculated.

The room will have a dedicated exhaust fan that puts the room into negative flow. This exhaust system would be permanently activated so that the room is always under negative flow.

Operational procedures will be established to manage to indicate when room is in use and the room is ‘rested’ to ensure airborne contaminants are removed. Refer to link below for details:

https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html

7.8.10. Laboratories and clean rooms

Laboratories shall be designed to comply with AS 2243 ‘Safety in Laboratories’. Reference to AS 2252 Biological Safety Cabinets will also be needed as this will interface with the mechanical system.

Access to early information regarding pathology equipment is needed to ensure the heat load generating from it is understood.

Anatomic pathology laboratories have special requirements that need to be considered in the design and include:

- Management of fumes where high volumes of formaldehyde is used
- Minimising air turbulence in the cutting room where specimens are prepared and processed
- Different temperature set points depending on the activity. Refer to Table 10 for details
- Access to early information regarding pathology equipment is needed to ensure the heat load generating from it is understood
- Dedicated individual air conditioning system within the cut-up room with capacity to control temperature to 20oC as required. A control panel with digital display and temperature adjustment shall be provided at a location agreed with the users. Both monitoring and control functions shall be connected to the BMCS with override at the BMCS.

7.8.11. Hydrotherapy pools

The internal space conditions depend on pool water temperature and require that air temperature will be not more than 10ºC lower than pool water temperature and relative humidity not more than 75%. Pool water may be in the range 28ºC to 35ºC. Good air distribution is needed to avoid condensation on glazing and structure which contribute to the corrosive nature of pool space environments.

7.8.12. Mental health units

Consideration will be given to the type of heating and cooling units, ventilation outlets and equipment installed in areas occupied by patients in mental health units. Purpose designed equipment suitable for psychiatric or custodial use is needed, with anti-ligature designs will be used to minimise opportunities for self-harm.

Requirements include:

- All air grilles and diffusers will be of a type that prohibits the insertion of foreign objects. Air diffusers will be purpose designed with air flow performance data provided by the manufacturer to ensure correct air distribution
- All exposed fasteners will be tamper-resistant
- All convector or HVAC enclosures exposed in the room will be constructed with rounded corners and will have closures fastened with tamper-resistant screws
- HVAC equipment will be of a type that minimises the need for maintenance within the room
- In mental health patient bedrooms, ceiling-mounted air devices will be of a secure type such that removal cannot be affected without special tools. In addition, there will be no sharp projections or hanging points.

7.9. Thermal modelling guidelines

Thermal modelling will be undertaken for new buildings and extensions to existing buildings. For additions or alterations to existing buildings, model just the portions of the building affected by the changes.

The scope of thermal modelling will consider:

- Optimisation of the buildings thermal performance. Comparative analysis will be undertaken of various construction options to ensure the building envelope; fabric, glazing and shading provides a solution with reduced internal space loads
- Thermal comfort will be considered as part of the thermal analysis to ensure that glazing selection and solar shading systems not only are selected for improved thermal performance but improve occupant thermal comfort by minimising radiant loads
- Review of internal space loads for each zone and for the whole building. Options are to be considered to reduce those loads that present the highest proportion for each space. Space gains to be considered in the assessment include: lighting, equipment, external conduction and solar gain
- Where it is intended that spaces will be naturally ventilated for night purge and or mixed mode ventilation then dynamic thermal modelling is required to be undertaken to determine and identify the benefit through reduced energy loads.
- Determination of predicted HVAC energy usage for the building
- Thermal comfort modelling where required by the NCC.

7.9.1. Modelling software requirements

Software used for the purposes of thermal and energy modelling will perform dynamic modelling against recorded weather data. Software shall also be capable of accurately modelling building services controls and plant operation, including variance in part load efficiencies of plant and equipment. Where specific design solutions are being evaluated, the software used should be capable of accurately modelling and comparing different plant arrangements. Generic system profiles shall not be used.

Software shall as a minimum comply with the requirements of the NCC for JV3 analysis. Health services

will need to accurately understand the costs of energy in an ongoing way.

7.9.2. Internal loads and schedules

The internal loads and operating schedules will be either based on those prescribed in the NCC as used for JV modelling or via consultation with user groups through the briefing stage. The schedules used will include occupancy, equipment, lights, heating, cooling and ventilation. Schedules will reflect weekday and weekend profiles and areas of 24 hour use.

Table 10: Ventilation and service requirements

Area designation	Air movement relationship with adjacent area (s)	Pressure control, monitoring and alarm	Minimum outdoor air	Minimum total air changes per hour	All air directly exhausted directly to outdoors	Filtration efficiency	Humidity range/ setpoint (%RH)	Humidity control requirements	Temp control range (ºC)	Temp control requirements
Surgery & critical care										
Operating theatre	Out	Local gauges. BMCS controlled to set point.	50%, AS 1668.2 or as required to achieve pressure control.	25	Min. of 50% or as required to meet air balance calculations.	G4-F8 HEPA (1)	35-60	Local adjustable +/-5% from setpoint	18-27	Local adjustable +/- 1ºC from setpoint
Cardiac catheterisation laboratory	Out	Local gauges. BMCS controlled to set point.	50%, AS 1668.2 or as required to achieve pressure control. 50%	25	Min. of 50% or as required to meet air balance calculations	G4-F8 HEPA (1)	35-60	Local adjustable +/-5% from setpoint	18-27	Local adjustable +/- 1ºC from setpoint
Birthing room	In	No requirement	5	20		G4-F9	35-60	Expected range	20-23	Local adjustable +/- 1.5ºC from setpoint
Sterile stock store (Operating theatres)	Out	Local gauges, BMCS	AS 1668.2 or as required to achieve pressure control.	15		G4-F8 HEPA	35-60	Expected range	20-23	Local adjustable +/- 1ºC from setpoint
Recovery room	No requirement	No requirement	Higher of AS 1668.2 or 2	6		G4-F8	35-60	Expected range	21	BMCS +/- 1.5ºC from setpoint
Intensive care unit (excluding Class N and negative flow)	No requirement	No requirement	2	12		G4-F8	35-60	Expected range	21-24 21-32 (severe burns)	Local adjustable +/- 1.5ºC from setpoint
Neonatal care unit (excluding Class N rooms)	No requirement	No requirement	2	6		G4-F8	35-60	Expected range	24	Local adjustable +/- 1ºC from setpoint

Area designation	Air movement relationship with adjacent area (s)	Pressure control, monitoring and alarm	Minimum outdoor air	Minimum total air changes per hour	All air directly exhausted directly to outdoors	Filtration efficiency	Humidity range/ setpoint (%RH)	Humidity control requirements	Temp control range (ºC)	Temp control requirements
Surgery & critical care										
Burns inpatient unit	Out (10+ Pa)	Local gauges, local alarm, BMCS	3	10		G4-F8	35-95	Local adjustable +/-5% from setpoint	21-32	Local adjustable +/- 1ºC from setpoint
Treatment room	No requirement	No requirement	2	6		G4-F8			24	BMCS +/- 1.5ºC from setpoint
Resuscitation room	Out	No requirement	3	15		G4-F8	45-60	Expected range	21-24	Local adjustable +/- 1.5ºC from setpoint
Anaesthesia gas storage	In	No requirement	2	8	Yes	G4-F8	No			
Endoscopy procedure room	Out or no requirement	No requirement	2	6		G4-F8	35-60	Local adjustable +/-5% from setpoint	20-23	Local adjustable +/- 1.5ºC from setpoint
Bronchoscopy procedure room, sputum induction and Pentamidine	In	No requirement	3	12	Yes	G4-F8	35-60	Local adjustable +/-5% from setpoint	20-23	Local adjustable +/- 1.5ºC from setpoint
Emergency department and medical imaging - waiting rooms	In	No requirement	2	12	Yes	G4-F8	35-60	Local adjustable +/-1.5% from setpoint	20-23	Expected range
Emergency department - triage	In	No requirement	2	12	Yes	G4-F8	35-60	Local adjustable +/-1.5% from setpoint	20-23	Expected range
Nursing										
Toilet / ensuite	In	No requirement	N/A	AS1668.2	Yes	G4-F8				

Area designation	Air movement relationship with adjacent area (s)	Pressure control, monitoring and alarm	Minimum outdoor air	Minimum total air changes per hour	All air directly exhausted directly to outdoors	Filtration efficiency	Humidity range/ setpoint (%RH)	Humidity control requirements	Temp control range (ºC)	Temp control requirements
Nursing										
Class P isolation room	Out (AusHFG)	Local gauges, local alarm, BMCS	Higher of AS 1668.2 or 2	12		G4-F8 HEPA			24	BMCS +/- 1.5ºC from setpoint
Class N isolation room	In (AusHFG)	Local gauges, local alarm, BMCS	Higher of AS 1668.2 or 2	12	Yes	G4-F8	No		24	BMCS +/- 1.5ºC from setpoint
Patient corridor	No requirement	No requirement	2	6		G4-F8				
Diagnostic and treatment										
Consult room	No requirement		2	6		G4-F8			24	BMCS +/- 1.5ºC from setpoint
Medication room	No requirement	No requirement	2	6		G4-F8			24	BMCS +/- 1.5ºC from setpoint
Physiotherapy	In	No requirement	2	6		G4-F8			24	BMCS +/- 1.5ºC from setpoint
Dirty utility	In	No requirement	N/A	10	Yes	F4			24	BMCS +/- 1.5ºC from setpoint
Disposal room	In	No requirement	N/A	10	Yes	F4			24	BMCS +/- 1.5ºC from setpoint
Clean workroom or clean holding	Out		2	6		G4-F8				
Lung function testing rooms	In	No requirement	2	12	Yes	G4-F8			24	BMCS +/- 1.5ºC from setpoint

Area designation	Air movement relationship with adjacent area (s)	Pressure control, monitoring and alarm	Minimum outdoor air	Minimum total air changes per hour	All air directly exhausted directly to outdoors	Filtration efficiency	Humidity range/ setpoint (%RH)	Humidity control requirements	Temp control range (ºC)	Temp control requirements
Diagnostic and treatment										
Haemodialysis	No requirement	No requirement	2	6		G4-F8			20-25	BMCS +/- 1.5ºC from setpoint
Ancillary										
Radiology (interventional only)	Out	No requirement	3	25		G4-F9	30-60		21-27	BMCS +/- 1.5ºC from setpoint
Radiology (diagnostic & treatment)	No requirements	No requirement	2	6		G4-F8			21-24	BMCS +/- 1.5ºC from setpoint
Nuclear Medicine	Negative	No requirement	2	6	Yes	F7			24	BMCS +/- 1.5ºC from setpoint
Pharmacy (aseptic or cytotoxic)	AS 2639	AS2639	2 or AS2639	6 or AS2639		G4-F8			AS 2639	
Laboratory										
General	No requirement	No requirement	2	6		F7			24	BMCS +/- 1.5ºC from setpoint
Biochemistry	Out	No requirement	2	6	Yes	F7			24	BMCS +/- 1.5ºC from setpoint
Cytology	In	No requirement	2	6	Yes	F7			24	BMCS +/- 1.5ºC from setpoint
Glass washing	In	No requirement	2	10	Yes	F7			24	BMCS +/- 1.5ºC from setpoint

Area designation	Air movement relationship with adjacent area (s)	Pressure control, monitoring and alarm	Minimum outdoor air	Minimum total air changes per hour	All air directly exhausted directly to outdoors	Filtration efficiency	Humidity range/ setpoint (%RH)	Humidity control requirements	Temp control range (ºC)	Temp control requirements
Laboratory										
Anatomical pathology	In	No requirement	2	6	Yes	F7			20-22	BMCS +/- 1.5ºC from setpoint
Microbiology	In	No requirement	2	6	Yes	F7			22	BMCS +/- 1.5ºC from setpoint
Haematology/ Blood Bank	Out	No requirement	2	6	Yes	F7			22	BMCS +/- 1.5ºC from setpoint
Serology	Out	No requirement	2	6		F7			22	BMCS +/- 1.5ºC from setpoint
Autopsy Room	In	No requirement	AS 1668	12	Yes	F7			18-22	Locally adjustable +/-1.5ºC from setpoint
Sterilising services										
Clean areas – packing and sterilisation	Positive	No requirement	3	10		G4-F8 HEPA	30-60	Expected range	24	BMCS +/- 1.5ºC from setpoint
Dirty areas – receiving, cleaning and decontamination	Negative	No requirement	3	10	Yes	G4-F8	30-60	Expected range	24	BMCS +/- 1.5ºC from setpoint
Support services										
Kitchen – production or cook/chill	Out	No requirement	2	6		G4-E10				BMCS +/- 1.5ºC from setpoint

Notes:

1. *HEPA filters will be installed at the air outlet; the minimum air flow of 25 air changes to an operating theatre is the minimum stated in AS 1668.2, however the designer should assess the area of coverage over the operating table and air flow patterns to determine if this is adequate and increase if necessary*
2. *Filtration Efficiency: First filter listed is the pre-filter if two filters are listed, second is the main filter and the HEPA if listed is the final terminal filter*
3. *For VAV systems, the minimum total supply air flow stipulated in the above table should be considered the design air flow, its low load turn down minimum should be no less than 4 air changes per hour*
4. *The temperature and humidity are for guidance only. The exact temperature and humidity required in each area will be based on the requirements as determined from the completed room data sheets at detailed design stage. Where humidity is noted as 'expected range' active control is not required if the humidity is maintained in this range because of the air conditioning process. Active control would be required where this range cannot otherwise be maintained.*
5. *Where local control is noted, the setpoints should be adjustable with local controllers in the space or at the nearest appropriate staff station. Other control where required is remote via the BMCS. The range noted is the adjustable setpoint range, with a maximum permissible deviation from a setpoint.*
6. *For patient bedrooms, the 'out' flow relationship can be achieved either by a volumetric differential between supply and return/ exhaust air volumes, or via an air transfer system which induces air to move out of the room.*
7. *The table now refers to directional airflow as 'in' or 'out' to match the international approach. We often refer to a negative pressure regime that has no pressure target/ setting as a 'negative flow' room.*
8. *Where 'in' or 'out' directions are, directional airflow shall be maintained to/ from adjacent spaces by volumetric offset of supply and exhaust flowrates of 10L/s per square metre of the door opening.*
9. *All information in this table has been benchmarked against ANSI/ ASHRAE/ ASHE Standard 170-2021 Ventilation of Health Care Facilities (2021) and the equivalent information provided by the US Centre for Disease Control and Prevention (2017). In all cases, Table 10 either meets or exceeds these other sources. Any minor differences related to local requirements and arrangements. Air change rates are consistent with requirements detailed in the Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 (World Health Organisation, 2021).*

8. Hydraulics

8. Hydraulics

8.1. Introduction

The purpose of hydraulic services in a hospital is to provide adequate and reliable water, wastewater and specialty healthcare hydraulic services to meet the clinical needs and user requirements, including any controls to fail safe.

8.2. General

The consultant is to understand and apply all current applicable standards, guidelines and codes, (unless reference to earlier versions of standards and documents is specifically referenced). When healthcare facilities are not being covered by the deemed to satisfy provisions of the Plumbing Code of Australia the consultant should pursue performance solutions to ensure compliant best practice outcomes.

All systems shall be designed and installed with the ability to commission, fault find, maintain, and operate without the need for external measuring devices such as temperature, pressure sensors and the like to demonstrate quantifiable outcomes.

8.3. Scope

Hydraulics services covered under the design guidelines comprise:

- Cold water services
- Heated water services
- Non-drinking water services
- Sanitary plumbing systems
- Sanitary drainage systems
- Roof drainage systems (internal to the building)
- Surface and subsurface drainage systems (internal to the building)
- Suspended helicopter landing site stormwater drainage.
- On-site wastewater management systems
- On-site liquid trade waste systems including treatment systems for healthcare facilities
- Natural gas services
- Liquid petroleum gas services
- Renal dialysis reverse osmosis (RO) systems
- CSSD RO systems
- Endoscope RO systems
- Pathology RO systems
- Chlorine injection and water filtration.

8.4. Design advice

8.4.1. Water supply network utility operator

Very early investigations should be made with the local water network utility operator to confirm mains water supplies are available, their pressure and flow, and reliability. The degree of reliability needs to be determined on a project by project basis.

8.4.2. Water services general

Water services shall be designed in a manner to minimise the risk to public health and life safety, with general controls to generally limit organic material, generally limit microbial growth, and generally provide a mechanism to kill microorganisms within the water supply.

Suitable filters / treatment should be provided to the water service incoming to achieve the required water quality. The filters / treatment should be set up in a dual arrangement to provide redundancy that allows for the servicing of one filter / treatment while the other can be kept in operation. Filter / treatment equipment should not be oversized to the detriment of its design intent.

The designer should consider the water service systems ability to flush, disinfect, and sterilise where applicable to remediate water quality. Large bore manual or automatic end of line water service main reticulation supply flushing points shall be provided based on the intent of drawing and flushing water from the system at a high velocity in its entirety to assist with water hygiene and flushing debris from the system, (note this does not include branch fixture or minor supply pipes i.e. rough-in pipework or external site pipework). The flushing points shall be no smaller than 32mm and sized to achieve a velocity as high a practically possible within the system and in all locations that are required to adequately flush the system. The provision of ‘daisy chain’ branch fixture minor supply pipes arrangements to improve water quality are also recommended to be considered.

The design of water system valving arrangements should provide for isolation valves from the main supply pipe to local groups of fixtures, these valves should be in an accessible location without the use of a ladder. Multiple ring-main isolation valves should be located to ensure that the minimum number of fixtures is isolated at any time while the system is under maintenance. Additionally, this approach also considers the flexibility of the system and aids in simplifying any future expansion or refurbishment works that may take place later in the hospital’s life.

Isolation valves should also be provided at the branch take off from the ring main / main supply pipe to facilitate servicing or modification of local branch distribution pipe work.

The inclusion of ring mains should be considered as part of the design process. The ring-mains will perform both performance and maintenance roles. Due to duplicate pathways within ring mains considerations should be given to diversified flows to avoid over sizing of the ring main.

The design of water piping systems shall achieve 200kPa minimum static water pressure at any outlet, for general sanitary fixtures and fittings with a maximum static water pressure of 500kPa at any outlet. For major medical equipment, and other specialty equipment, the minimum and maximum dynamic and static water pressures shall be obtained from the equipment manufacturer and accommodated within the design. Pressure reduction valves shall be used to ensure pressures do not exceed 500kPa static pressure at any outlet and shall not be sized based on the connected pipe size. Pressure reduction stations shall be provided with multiple valves to allow for staged pressure control and avoid operating outside of the valves best performance operating zone. Due to limitations of the current deemed to satisfy provisions of the Plumbing Code of Australia, the probable simultaneous demands shall be determined using DIN1988-300 or another method suitable for healthcare buildings.

Water meters shall be provided to all main water users such as cooling towers, central hot water systems and external landscape irrigation, floor by floor and to comply with NCC requirements.

All fixtures shall be provided with heated water no hotter than warm water unless specified by the NSW Health Policy Directive for “Water – Requirements for the Provision of Cold and Heated Water” or

defined as part of the user consultation process and/ or equipment manufacturers requirements.

Fixtures for personal hygiene requirements shall not be installed downstream of zone or individual backflow prevention devices in combination with fixtures not used for personal hygiene.

Each Class N isolation room shall be provided with adequate backflow prevention prior to providing any of the fixtures within the isolation room and or ante room with water.

All water services outlets and pipes down stream of either an individual or zone backflow prevention device shall be identified as follows.

- All Outlets shall have a sign using words to the effect of 'WARNING NOT FOR DRINKING'
- All pipes shall be identified by a purple colour, with lettering on the pipe at approximately 3m distances using words to the effect of "DO NOT DRINK"

Consideration should be given to the provision of integrated variable speed drivers (VSD) and controllers fitted to cold, heated and specialty water service pumps. It is preferable that the pump set for large probable simultaneous demands (PSD) over 2L / second be constructed from multiple smaller pumps that when all running together deliver the total flow rate / PSD.

It is highly recommended that water services are not installed within the ceiling or exposed in operating theatres, server rooms, building distributor rooms, distributed antenna system rooms, switch rooms, substation rooms and other sensitive areas defined by the project team.

The architect should ensure that the flexible shower heads and toilets are located so as the flexible shower head hose is not long enough for the shower head to enter and reach below the flood level of the toilet.

8.4.1. Cold water services

Cold water storage should be provided only in instances where the network utility operator main is inadequate to supply the hospital complex or it is known to be unreliable and the hospital is required to deliver service continuity in the event of civil emergencies.

Where site water supplies are proved to be unreliable by past records, 24 hour storage for domestic consumption should be provided. The water storage tank should be divided to allow for cleaning and be designed to comply with AS/NZS 3666 (Parts 1 and 2). The designer should critically assess the water storage requirements for other supplies such as cooling towers. Generally, most facilities the provide clinical services and are not stand-alone buildings for administration, general clinical consulting, mental health or the like, shall be provided with three hours of drinking and cooling tower water supply for business continuity.

Consideration to water truck/ cart connection should be given for extended civil emergencies, to ensure business continuity in relation to water supply.

Water storage in fill points and draw off points shall be of opposing sides of the tank to encourage water turn over and movement within the tank to assist with water quality. All tank draws off points shall be manifolded in equal flow manifold arrangements to reduce the risk of stagnation and assist with water quality.

Continuous BMCS monitoring and identification of network utility operator watermain failures shall be provided, to identify the facility users if the water main supply has failed, so they can engage their management plan. This may be achieved by the provision of a pressure monitoring probe connected to the water service incoming upstream of any water storage, exposed to the Network Utility Operators water main pressure.

The maximum velocity of water within pipework will be limited to 1.5m/ seconds for all main supply pipework irrespective of the piping material in the cold-water service. Branch fixture minor supply pipes cold water service pipework may have velocities up to 3m/ second subject to the manufactures engineer and project acoustic engineer's acceptance.

8.4.2. Heated water services

Heated water plant shall be sized to cater for the peak hour with flow rate capacity at the design temperature for the probable simultaneous demand. Central heated water plant shall be modular and not reliant on a single critical component. The design of central heated water plants shall consider removal of their components and ease of transport within the facilities vertical transportation system.

The maximum velocity of water within pipework will be limited to 1.2m/ seconds for all main supply pipework irrespective of the piping material in the heated water service. Branch fixture minor supply pipes heated water service pipework may have velocities up to 3m/ second subject to the manufactures engineer and project acoustic engineer's acceptance.

The velocity for the circulation in hot water systems will be in the range of 0.6 to 1.0m/ second. Controls shall be provided to ensure the primary or secondary circulation pump cannot cause the velocity to exceed this range.

Temperature sensitive automatic balancing valves should be avoided as they do not provide a constant flow and even temperature outcome. Constant volume (flow) variable pressure balancing valves are preferable as each circuit can be balanced independently of other circuits.

Where the system incorporates a flow and return layout the ΔT (change in temperature) shall not exceed 5°C. All balancing valves shall be installed within the central accessible riser cupboards while being accessible without the use of a ladder. The flow and return system layout shall be on a floor by floor basis maximising central risers and utilising effective and efficient floor by floor loop layouts. The loops or pipework layouts shall not cause undue complexity or potential future balancing or operational issues.

Dead legs are defined as a branch pipe in a water service containing dead water. Dead water is the cold water drawn off before heated water commences to discharge from a heated water outlet, should be kept to a minimum (less than 2L) to ensure that sufficient water is flushed out of the pipe system at every use. The oversizing of dead leg pipes, by use of 22mm pipes or greater when not hydraulically needed to suit the flow demand, is strictly prohibited. The use of cast in slab conduits for small 15mm rough-in pipes can be considered if needed to limit dead legs.

Some areas such as the CSSD, food services and other very large departments may require larger dead legs. These shall be identified within the project departure register.

The use of thermostatic mixing valves (TMV) shall be the preferred method of delivering warm water. Remote monitoring of the TMV shall be provided. This provides a more reliable method of controlling legionella and will minimise the affected area in case of any issues arising.

Should a situation arise where the recommendation of this Guideline needs to be departed from, and a central warm water reticulation system provided, the designer shall:

- Install additional filters/ treatment on the cold, hot and warm water system(s) to maximise the control mechanisms for microbial growth by means of removal of organic material, introduction of a microorganism growth inhibitor and a kill mechanism
- Ensure the secondary hot water circulator is sized for the heat loss or the required continued flow through the central warm water system TMV, whichever is greater.
- Ensure that all warm water pipework can be heat sanitised at least at 82°C with controls provided to prevent scalding, and
- Ensure that system flushing valves are provided to facilitate high velocity flushing of the system to assist with water hygiene.

8.4.3. Specific water services

The emergency department decontamination showers should not add additional load onto the domestic hot water plant. (i.e. do not include additional capacity within the peak hour should the buildings demand be greater than the decontamination shower(s) load).

Alternate piping options may be considered where highly corrosive products are used. In addition,

pipping delivering RO should not use copper products.

8.4.4. Water services backflow prevention

Backflow prevention is an important aspect of the water service within a hospital campus to protect public health. Risk that existing in a general environment that might form a low hazard rating, as defined by the Plumbing Code of Australia, are exacerbated due to the large quantity of immunosuppressed people within a healthcare facility and therefore give a higher hazard rating, given the greater risk. Therefore, backflow prevention devices are required to be provided to connections and appliances that would give rise to a high hazard rating.

8.4.5. Wastewater supply network utility operator

Very early investigations should be made with the local water network utility operator to confirm wastewater discharge mains are available, and reliability. The degree of reliability needs to be determined on a project by project basis.

8.4.6. Sanitary plumbing and drainage - general

Gravity sanitary plumbing and drainage systems should be installed wherever possible.

Wastewater pipes should be of a suitable material and designed and installed to suit the type of waste or wastes carried and the temperature and corrosion characteristics of the waste.

It is recommended that drainage services are not installed within the ceiling or exposed in operating theatres, communication rooms, building distributor rooms, distributed antenna system rooms, switch rooms, substation rooms and other sensitive areas as defined by the project team. Where overhead drainage piping in these areas is unavoidable, special provisions should be made to protect the space below from leakage. Should this include the use of drip trays, the drip trays shall be drained with leak detection devices and shall be linked back to the BMCS.

Inspection and cleaning openings shall not be positioned in ceiling spaces, as access to the ceiling spaces for access to inspection of cleaning is strictly prohibited. Inspection and cleaning openings in the form of clear-outs shall be located next to each toilet or group of toilets to allow inspection and cleaning. The deemed to satisfy (DTS) provisions for AS/NZS3500.2 shall not be followed in relation to permanent inspection and cleaning openings. Maintenance holes shall be used external to the building for Inspection and cleaning located to suit best practice, the constraints of cleaning equipment, and ease of access, with maintenance shafts using pipes raised to surface for non-critical services. Inspection and cleaning opening should be provided at each change of direction on any major service to facilitate service pathway identification from the surface.

Maintenance openings for cleaning and pumping out are recommended to be in service areas. All access pits are to have airtight covers when within a building, however it is recommended to avoid providing access pits within buildings.

Generally, pipe sizes less than 100mm for sanitary plumbing and draining above ground should be avoided to promote future flexibility for connections, however where it is not practicable, compliant pipe sizes with the Plumbing Code of Australia shall be used. All sanitary drainage pipework below ground (within the dirt) shall not be less than 100mm in size.

For external site wastewater drainage sizing, the use of the Water Supply Code of Australia WSA 02 Sewerage Code of Australia should be considered to ensure drains are not excessively oversized based on the DTS provisions AS/NZS3500.2.

8.4.7. Sanitary pump-out pits and wastewater pump stations

If sanitary pump-out pits and wastewater pump stations are installed, they will be installed in locations which will not impede operational continuity of the hospital while maintenance procedures are carried out.

The pumps shall be duplicate and will be connected to the hospital standby generator power supply to operate as duty/ assist/ standby, all pumps are to be linked to the BMCS for fault, electrical breaker trip / power failure, low and high level alarms.

The emergency storage volume of a pump-out system will ensure a minimum of four hours storage and up to 24 hours subject to a risk analysis. Consideration, in consultation with the electrical engineer, should be given to redundant power supplies from different distribution boards within disaster critical facilities.

All level sensors should be wired to the BMCS system and a local audible and visual alarm be provided near the pit or outside the door if the pit is in a room. An alarm should be raised in case of power failure or a breaker trip.

Rising main velocities shall be not less than 0.8m/ second, the designer should consider the velocities for transporting solids in both vertical and horizontal pipes.

Independent pump station pipe inlet grinders shall be considered for pump-out pits where there might be a risk of a pump blockage from wipes and other matter that is present within a hospital wastewater system.

The pumps shall be sized based on the peak inlet flow, with the well capacity responding to either the pump run time volume for minor pump-out pits or for wastewater pump stations the average dry weather flow. The Water Supply Code of Australia WSA 02 Sewerage Code of Australia and WSA 04 Sewage Pumping Station Code of Australia should be considered when designing precinct or entire building wastewater pump stations.

8.4.8. Trade waste and high temperature wastewater

The designer should consult with the users to determine the nature of all temperature, chemical and biological discharges to ascertain the project requirements for trade waste retention and treatment.

Trade waste substances intended to be disposed via sanitary drainage systems should be reviewed to determine if there are alternative ways of removal from buildings or if on site treatment is required before discharge.

Grease traps should be located on site in a position accessible from outside of the building without need to interrupt any clinical services and which is easily accessible for tanker vehicle access. Should the grease arrestor be located internally to the building, a suitably sized and ventilated room should be provided above the arrestor to allow cleaning and to ensure objectionable odours do not escape into other areas. Through wall cleaning pipes/hose(s) connections shall be provided to avoid internal doors to grease arrestor rooms being held open by cleaning pipes/hoses.

The direct pumping of grease waste should be avoided; where provision for pumping of the grease arrestor for maintenance purposes only, then a permanent pump-out pipe link to a disposal point should be provided if no alternative exists. Grease waste pumps should be a positive displacement helical screw type.

High temperature wastewater more than 65°C from areas which include, but not limited to CSSD, steam boilers, endoscope reprocessing, renal dialysis RO units, heat sanitisation processes and other areas shall be piped using metallic pipes that are corrosion resistant to mineral hungry water. These pipes must discharge into a cooling pit or cooling device that can cool the wastewater discharged over the hours of operation for the area or device(s) to below 50°C. The use of probable pipe flow steam mixing of wastewater more than 65°C with other waste water in a pipe stream shall not be utilised. All innovations provided to cool wastewater more than 65°C shall have adequate fail safes for mechanical, electrical and the like components and should fail safe in all conditions.

The emergency department decontamination shower pit shall be designed as a blind pit and not connected to the network utility operator sewer. The size of the pit shall be determined based on the numbers of showers, shower head flow rates, usage durations, and usages in an event before the pit is pumped out. The effective capacity shall be below the overflow level of the decontamination drainage system inlet. The inlet grated drains shall be sized using no more than 25mm of head above the grate.

There are legislated requirements with respect to the disposal of radioactive waste to the sewer system.

No radioactive substance as defined in Schedule 1 of the Radiation Control Regulation can be disposed to sewer without consent from the EPA in accordance with Clause 34 of the Radiation Control Regulation 2013. This requires the submission of calculated evidence that the radioactive substance released to the sewer will be less than 100 Bq/gram and considers water contaminated from the dedicated patient suite via the toilet, shower, hand basin or beverage bar area.

Compliance with the Australian Standard AS 2243.4 – 1998 Safety in Laboratories Part 4 Ionising Radiation Section 8, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Series 14.2 Radiation Protection in Nuclear Medicine and water authority acceptance standards 2018-19 is required. Network Utility Operators may have specific requirements.

A suitably qualified radiation consultant shall be engaged by the project to undertake the radioactive waste calculations and potential radiation exposure to any member of the public or occupational workers near the wastewater streams either within a pipe or post an overflow incident.

The radiation consultant shall negotiate the right to discharge with the wastewater network utility operator and seek approval from the wastewater network utility operator and the NSW EPA Radiation Control branch.

Wastewater containing radioactive substances shall drain within the building in an isolated pipe system that is appropriately labelled ‘RADIOACTIVE WASTEWATER CONTACT THE NUCLEAR MEDICINE PHYSICIST BEFORE COMMENCING WORK’.

All trade waste treatment devices shall be provided with reflux valves on the outlet of the devices to prevent under a surcharge or blockage situation sewer entering the trade waste treatment devices and creating a septic situation.

The hot waste sanitary pipe should exit the building and be provided with a gully inspection opening, external to the building, which will be marked identifying the service. This inspection opening will allow the network utility operator to sample the discharge if required and facilitate and overflow point that will not enter the building.

The maintenance access points to the pipe(s) carrying potentially radioactive waste on site shall also be labelled ‘RADIOACTIVE WASTEWATER CONTACT THE NUCLEAR MEDICINE PHYSICIST BEFORE COMMENCING WORK’.

All private wastewater design parameters shall be worked through with the radiation consultant and accepted within their report for the project. As part of the design work the project team in conjunction with the radiation consultant shall consider the following and modify/ adopt as applicable, with due consideration given to:

- Public areas where the hot waste WC flush quantity could be increased by simply removing all half flush buttons. The removal of the half flush and increasing the flush quantity in turn reduces the exposure risk to other users of the WC
- The dedicated hot waste pipe system should not hold any wastewater for any period of time. The only locations where wastewater can / and will be held will be hand wash basin traps, sink traps, floor waste traps, and toilet bowl traps. The wastewater in the toilet bowl traps will generally be replaced during flushing.
- As the wastewater in basin traps sink traps and floor waste traps are only trickle fixtures, they will generally not be replaced during operation. To meet the radiation physicist intent, it might be required that the hospital cleaning staff should carry out manual flushing of the trickle fixtures within the dedicated patient ensuite or nuclear medicine unit. This could be as simple as tipping a full bucket or two of water into the traps through the fixtures waste outlet grate to replace the water in the trap

- Where water less traps can be fitted to the selected basin or sink, they should be utilised to avoid the holding of waste water. Waterless floor wastes, should they be available on the market, would be desirable for use.

8.4.9. Stormwater and roof water drainage

Gutters and downpipes should be designed to 1% average annual exceedance probability (AEP) rainfall intensity with overflows to cater for blocked outlets at the maximum flow, considering wall catchment, and overflows from upper catchments. From time to time, the stormwater and roof water drainage systems will need to consider fire test water flow, this should not be added on top of any rain event scenario.

The use of external eave gutters is preferred given the roof layout and catchment area falls within the parameters outlined in AS/NZS3500.3.Where warranted by the architectural layout, gutters should be placed on the perimeter of catchments rather than internal to the catchment. The designer should demonstrate an effective overflow strategy such that overflows should be located to avoid discharge onto lower catchments and should instead discharge to the external building perimeter, where possible. Catchments receiving overflows from higher catchments should have their primary and overflow systems sized to cater for this scenario.

Gravity downpipes should be used where possible. If a siphonic drainage system is proposed, the design and installation responsibility should be with a single company with a demonstrated track record. Siphonic drainage system shall not be used to drain planter boxes and other planted areas. Where the stormwater and roof water drainage system deviates from or there is no prescribed method contained within AS/NZS3500.3 a performance solution shall be provided as part contract documentation.

8.4.10. Stormwater drainage

Roof outlets in concrete roofs should be located to allow for visual inspection and be kept clear of any plant installed on the roof. The roof outlets should be provided with domed grates to allow for a higher water level should debris build up around the outlet.

Courtyards and other exposed areas that are public and patient trafficable shall be provided with flat grate rainwater outlets or pits where in ground. All flat concrete exposed areas should have overflow provisions that match 1% AEP rainfall intensity. The system should be designed such that water ponding depth over the outlets and the overflow slots/ pipes top water level do not lead to water ingress via doorways. A freeboard of at least 25mm over the primary system and 25mm over the overflow system should be allowed for. Trench drains are to be provided at door entry thresholds should be provided. Courtyards and winter gardens with openings on the façade may be subject to wind-blown rain hence must be treated as wet areas and provided with primary and overflow stormwater drainage systems.

8.4.11. Metal roof - roof water drainage

Drainage systems for metal roofs should be designed to a 1% AEP rainfall intensity. The drainage system may comprise of either box gutters or eaves gutters. For metal roofs over walkways, it is preferred to have gutters on the edges of the roof rather than centrally. For metal roofs that form an awning on the building façade, it is preferred to have the gutter located on the outer edge of the awning away from the building façade. For box gutters, overflow slots are the preferred secondary system. A freeboard of at least 25mm over the primary system and 50mm over the overflow system should be allowed for. Where piped overflows are used, these must terminate in a suitable location that is visible when activated. Overflows and spreaders from higher catchments must not discharge onto metal roofs to avoid overwhelming the discharge capacity of roof sheet pans, unless detailed analysis is undertaken.

8.4.12. Subsoil drainage

Subsoil drainage should be provided to all building retaining walls, planters and areas where potential ground water ingress could occur. Subsoil drainage should gravitate where possible to the stormwater drainage system, however consideration should be given to backflow into the subsoil system during a heavy rain event to avoid additional dampness within the building retaining wall systems. The structural engineer shall provide all subsoil details for the building retaining walls subsoil system to be documented by the hydraulic engineer.

Where subsoil drainage water is pumped, the pits should have sufficient size to allow for the proper operation and maintenance of the pumps, with access hatches and ladder rungs provided to facilitate this. Pumps should be installed in a dual configuration with at least one pump on standby. A control panel for pump operation should be provided in an accessible location near the pit.

All level sensors and pumps should be wired to the BMCS system and a local audible and visual alarm be provided near the pit of outside the door if the pit is in a room. An alarm should be raised in case of power failure or a breaker trip.

8.4.13. Stormwater pump-out stations

The building stormwater systems should gravitate to the site civil stormwater system. Where this is not possible, a stormwater pumping station may be used. Only catchments that cannot be gravitated to the site civil stormwater system should drain to the pump out pit. Stormwater pump out pits should be sized to provide emergency storage of at least the first two hours of a 1% AEP storm event, this shall be measured between the high-level alarm and overflow level or based on a risk assessment. Access hatches and ladder rungs shall be provided for maintainability. Pumps should be installed in a dual or triplex configuration with at least one pump on standby. A control panel for pump operation should be provided in an accessible location near the pit.

The pumps shall be duplicate and shall be connected to the hospital standby generator power supply to operate as duty / assist/ standby, all pumps are to be linked to the BMCS for fault, electrical breaker trip / power failure, low and high level alarms. Consideration, in consultation with the electrical engineer, should be given to redundant power supplies from different distribution boards within disaster critical facilities.

The emergency storage volume of a pump-out system will ensure a minimum of two hours storage and up to 24 hours subject to a risk analysis.

All level sensors should be wired to the BMCS system and a local audible and visual alarm be provided near the pit or outside the door if the pit is in a room. An alarm should be raised in case of power failure or a breaker trip.

8.4.14. Suspended helipad stormwater drainage.

The suspended helicopter landing site stormwater system should drain via a metallic pipe to a hydrocarbon trap (fuel puraceptor) to account for fuel spillages on the helipad and any adjacent surfaces on the same level e.g. walkway leading to the helipad. Puraceptors should incorporate a flame trap to extinguish flames. The puraceptor should be in ground where possible, as the handling of hydrocarbons within the building will not be acceptable.

The helipad drainage system and puraceptor should be sized to a 1% AEP rainfall intensity or a storm event as agreed with the aviation consultant, whereby there will be no helicopter movements during greater storm events. Siphonic systems should be avoided due to the aversion to high flow rate velocities at the puraceptor inlet. Stainless steel is the preferred pipe material until the puraceptor inlet. The project BCA consultant is to advise on any fire-rating requirements, or service separation for the pipework within the building.

The design and management of any fuel spillages shall ensure compliance with Section 120 of the NSW

PoEO Act 1997 (NSW) – “A person who pollutes any waters is guilty of an offence.” in relation to receiving waters concentrating specifically on hydrocarbons and the guidelines that govern their environmental impact from discharging to receiving waters all the NSW state-based regulations (OE&H) refer back to the ANZECC Guidelines 2000 (Commonwealth) Section 5 - “Oil and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odour.” It is generally accepted that visibility occurs >10ppm (mg/L).

8.4.15. Gas supply network utility operator

Very early investigations should be made with the local gas network utility operator to confirm gas mains are available, and reliability. The degree of reliability needs to be determined on a project by project basis. To ensure flexibility and minimise private infrastructure pipe sizes gas supplies should be connected to 1050kPa gas mains and provide for a metering pressure of 100kPa, where appropriate and cost efficient. Network utility operator gas meter/regulator sets should be located external to the building where possible, to avoid complex room access, ventilation and fire rating requirements.

Very early investigations should be made with the local liquid petroleum gas supply agency to confirm gas supply deliveries are available, and reliability. The degree of reliability needs to be determined on a project by project basis. The consultant should also gain an understanding of the supply chain and local filling process.

8.4.16. Natural and liquid petroleum gas services - general

Gas services should comply with the relevant AS/NZS 5601.1. Gas distribution pressures inside a building should comply with AS/NZS 5601.1, it is recommended where possible to keep the pressure at 7kPa or below within the facility.

Area isolation valves for plant rooms and kitchens should be installed at a height that does not require ladder access and located at the exit/entrance to the space and available for emergency use.

Consideration should be given to avoiding complex internal service ventilation of gas appliances, meters, regulators, pipework and other gas equipment. Generally, mechanical ventilation adds operational as well as construction cost.

Gas service pipework above ground should not be constructed from non-metallic pipes and fittings.

Regulators shall always be installed directly upstream of gas meters to ensure metering accuracy.

When over pressure shut off regulators are used, a downstream regulator able to cater for the trip pressure shall be provided. Over pressure shut off regulators shall not be provided in the absence of a regulator directly downstream of them.

For pipe sizing based on the probable simultaneous demand a total maximum pressure drop should be used based on the below service pressures:

- Up to 30kPa for 100kPa services
- Up to 4kPa for 7kPa services
- Suitably determined drops for all lower pressures.

Should the pressure drops above be exceeded, a maximum velocity of 20m/second should be adhered to.

8.4.17. Natural gas services

Natural gas services system setups shall consider future connection to hydrogen or other similar innovative fuel gases.

8.4.18. Liquid petroleum gas services

When determining the duration of liquid petroleum gas storage, the peak daily and daily average usage needs to be understood. Careful consideration of the State Environmental Planning Policy (SEPP) for bulk storage should be given in consultation with the dangerous goods consultant.

The duration of storage should also be determined by the user supply needs and the local liquid petroleum gas supply agency supply ability. Supply safety factors should be considered should the supply agency supply ability be unreliable.

The liquid petroleum gas storage should also be sized to ensure adequate ability to vaporise based on the lowest expected ambient temperature around the storage and the probable simultaneous demand.

The liquid petroleum gas service shall be designed to carry liquefied petroleum gas in vapour phase only at pressures not exceeding 150kPa post the primary storage regulators.

8.4.19. Renal dialysis systems

Special consideration should be given to the design of the renal reverse osmosis water systems regarding the water quality requirements, pipe loop design, material and plant selection. The design should be undertaken in collaboration with the equipment supplier to ensure system compatibility. All renal reverse osmosis units shall be registered under the Therapeutic Goods Administration (TGA) and shall hold a valid Australian Register of Therapeutic Goods (ARTG) number.

Pre-treatment equipment to the reverse osmosis unit shall incorporate sediment filtration, water softeners (where applicable), auto backwash carbon media filters (filters installed in series to achieve a minimum empty bed contact time of 10 minutes). Due to the requirement for the frequent replacement of carbon media in the carbon filters (typically annual replacement), for occupational health, safety and environment requirements, the diameter of each carbon filter should be restricted to be less than 457.2mm where possible.

Reverse osmosis plant design shall incorporate operational redundancy and automatic chemical free sanitisation / disinfection of the entire reverse osmosis unit including the membranes and the reverse osmosis water distribution loop / ring main.

The design shall focus on water and energy saving features. The reverse osmosis unit recovery shall be duly considered when using municipally treated feed water. A recovery of less than 75% should be considered a best practice target.

The reverse osmosis unit shall be designed to continuously operate even in the event of equipment failure. Controllers shall be designed with a key switch to activate the emergency control operation where the system switches over to a second controller to offer 100% control redundancy.

A panel indicating the operational status of the reverse osmosis unit should be installed at the staff station where required by the users. Although traffic light type indicator panels are cost-effective, a touch screen Nurse's panel displaying basic operational information is the preferred approach. A button or switch to abort the automatic disinfection process shall be available at the panel installed at the Nurse's station.

The haemodialysis RO plant shall not be shared with any other RO system.

The following document provides guidance on the scale of intermittent renal dialysis needed to support a fixed RO system:

https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0007/306088/water-for-dialysis2018.pdf

This document shall be considered in conjunction and be supplemented by the following paragraphs.

Where renal dialysis is required within ICU, HDU or other departments that operate 24 hours a day, central renal reticulated dialysis systems shall be avoided to avoid the risk of dialysing a patient during the heat sanitation process. Single patient / portable reverse osmosis units with appropriate pre-treatment/treatment mounted on trolleys should be used. These areas shall be provided with drinking water connection points, with appropriate backflow and previsions for flushing to ensure stagnant water

can be removed before usage. Central pre-treatment systems for point of use dialysis should be avoided due to water quality, and microorganism risks, however, should sound controls be able to be engineered and guaranteed, this approach could be proposed for consideration.

Where the number of renal dialysis points in a dedicated renal unit is less than six, single patient / portable RO units with appropriate pre-treatment mounted on trolleys maybe considered based on the usage profile and best value for money, while considering water quality and microorganism risks. When this approach is used these areas shall be provided with drinking water, with appropriate backflow and previsions for flushing to ensure stagnant water can be removed before usage.

The designer should confirm with the pipe and fitting material manufacturer that the material is suitable and is ISO or Australian Standard certified with renal reverse osmosis water and that the use in these systems does not void the warranty.

Where fittings are manufactured to be used in renal water systems, these fittings will need to have traceability of material and manufacturing processes to an accepted pharmaceutical component manufacturing process.

For ring main reverse osmosis systems, the pipe loops should not allow for stagnant water. Fittings that allow water circulation up to the connection point should be incorporated in the installation. (p. 24).

8.4.20. Reprocessing of reusable medical devices

AS4187 *Reprocessing of reusable medical devices* in health service organisations details that the quality of the water used at all stages in the cleaning process is critical to the successful outcome of the process. Softened, filtered, demineralized, distilled or RO water can be required for various stages of the cleaning process.

If the local water supply is not of a suitable quality, then tests shall be conducted prior to equipment installation to demonstrate the water supplied to equipment is in accordance with the manufacturers specification and the results recorded.

Central sterile services department (CSSD) and/ or dental sterile services department (DSSU) water quality

A dedicated purified water plant incorporating suitably designed pre-treatment equipment (i.e. sediment filters, water softeners and carbon filters reverse osmosis and/ or ultra-endotoxin filter unit) shall be provided to the CSSD in compliance with the water requirements of the latest AS/NZS 4187 standard.

The pre-treatment should not consist of chemical additives injected into a system based on flow volumes. The plant should be located close to the CSSD where possible. Where redundancy is provided, the reverse osmosis water plant shall be designed with a central control panel which controls the entire operation of the plant. The controller shall log all critical operational data and conditions for traceability. Controls should be provided to ensure water quality compliance outcomes with AS/NZS 4187.

The ring main, tank and all associated equipment and pipework shall be capable of being heat disinfected using temperatures between 80oC and 90oC for a set time for performance validation and qualification. Sanitisation processes using the A0 principle shall not be deemed acceptable.

The design features should eradicate dead legs as much as possible to comply with AS/NZS 4187. The purified water plant (pre-treatment and the RO unit) shall be designed to ensure that any process / component within the purified water plant will not remain idle for extended periods of time where the risks of microbial growth / contamination is increased. It is preferable to reticulate the reverse osmosis water at a temperature between 60 and 65oC to reduce the risk of endotoxins. Inline plate heat exchanges provided to reduce RO water temperatures to equipment requiring lower temperatures are prohibited. Individual systems shall be provided to suit varying equipment temperature needs.

Designs incorporating low water production rates with large tanks where water resides for extended shall be avoided due to the increased risks of biofilm growth and contamination of the CSSD equipment (i.e. washer-disinfectors, sterilisers etc.) can occur.

The design shall focus on water and energy saving features. The reverse osmosis unit recovery shall be duly considered when using municipally treated feed water. A recovery of > 75% should be considered a best practice mark.

Two or more filters/ treatment trains should be set up in parallel to allow for servicing of one filter / treatment train at a time. Filter/ treatment equipment should not be oversized to the detriment of the intent.

Careful consideration to the peak flow compared with the peak hour flow should be given when sizing the RO unit, the storage tank and the ring main pumps. The ring main pump shall be sized for both usage flow and return flow, controlled by a variable speed drive. The constant circulating flow velocity shall not be less than 0.9m/ second even during the peak draw off condition. This minimum velocity shall be maintained at the return line to the storage tank.

The pipe network should be set up in a flow and return ring main configuration with the ring main to offset downwards as close as practically possible to the equipment and points of connection to minimise dead legs as much as practically possible and follow the. World Health Organization (WHO) document TRS 970, which states dead legs shall not exceed three times the branch diameter as measured from the internal diameter (ID) pipe wall to centre line of the point-of-use valve.

Pipework shall be selected to minimise microbial growth, be metallic or PVDF pipes that are corrosion resistant to mineral hungry water and capable of conveying water more than 80°C. It is critical that incompatibility of material be avoided to stop galvanic corrosion which can not only introduce sediments back into the process but can also increase biofilm growth. The reverse osmosis water storage and the distribution system shall be manufactured using sanitary piping system such as stainless steel with non-threaded components where possible.

It is acknowledged that very small sterile services departments might not be able to accommodate a heat sterilisation system and therefore compliance with AS/NZS 4187 by other controlled engineered solutions will be required.

Where bench top RO points are required for final rinse, confirmation with the users as to the outlet temperature being more than 60oC should be obtained. It should be noted that the personal protective equipment (PPE) required by the CSSD technicians should facilitate the use of outlet temperatures more than 60oC.

In some areas where the hot and cold pre-rinse water quality does not meet the requirements of AS/NZS 4187, pre-treatment of the pre rinse water will be required such as a softening plant and active carbon plant.

Endoscope water quality

In the instance where compliance with AS/NZS 4187 is demonstrated to be possible, post water quality testing during the design phase in accordance with AS/NZS 4187, without the use of high-pressure membrane processes, other proven controlled measures/ controlled engineering solutions shall be required. This process shall be validated during the defects liability period (DLP) to prove its robustness and resilience in reference to variation in town water quality.

A dedicated purified water plant incorporating suitably designed pre-treatment equipment (i.e. sediment filters, water softeners and carbon filters RO unit, ultraviolet filtration, and ultra-endotoxin filter), shall be provided to the automated endoscope reprocessors (AER) in compliance with the water requirements of the latest AS/NZS 4187 standard. This plant should be located close to the scope reprocessing area where possible. Where possible the pre-treatment equipment can be shared with the CSSD reverse osmosis system. Endoscope and CSSD RO membranes and ring mains shall not be shared. Inline plate heat exchanges provided to reduce RO water temperatures to equipment requiring lower temperatures are prohibited. Individual systems shall be provided to suit varying equipment temperature needs.

Where redundancy is provided, the RO water plant shall be designed with a central control panel which controls the entire operation of the plant. The controller shall log all critical operational data and conditions for traceability. Controls should be provided to ensure water quality compliance outcomes with AS/NZS 4187.

The ring main, tank and all associated equipment and pipework shall be capable of being heat

disinfected using temperatures between 80 and 90oC for a set time for performance validation and qualification. Sanitisation processes using the A0 principle shall not be deemed acceptable.

The design features should eradicate dead legs as much as possible to comply with AS/NZS 4187. The purified water plant (pre-treatment and the RO unit) shall be designed to ensure that any process/ component within the purified water plant will not remain idle for extended periods of time where the risks of microbial growth/ contamination is increased. Careful consideration and consultation with the users and AER suppliers is needed to confirm the reticulated water temperature(s). Generally, the water should be circulated at either 35°C or 44°C, but this needs to be confirmed as AER tolerances can be within 2°C.

Designs incorporating low water production rates with large tanks where water resides for extended shall be avoided due to the increased risks of biofilm growth and contamination of the CSSD equipment (i.e. washer-disinfectors, sterilisers etc.) can occur.

The design shall focus on water and energy saving features. The RO unit recovery shall be duly considered when using municipally treated feed water. A recovery of less than 75% should be considered a best practice target.

Where possible, based on flow rate demands, two or more filters/ treatment trains should be set up in parallel to allow for servicing of one filter/ treatment train at a time. Filter/ treatment equipment should not be oversized to the detriment of the intent.

Careful consideration to the peak flow vs the peak hour flow should be given when sizing the RO unit, the storage tank and the ring main pumps. The ring main pump shall be sized for both usage flow and return flow, controlled by a variable speed drive. The constant circulating flow velocity shall not be less than 0.9m/ second even during the peak draw off condition. This minimum velocity shall be maintained at the return line to the storage tank.

The pipe network should be setup in a flow and return ring main configuration with the ring main to offset downwards as close as practically possible to the equipment and points of connection to minimise dead legs as much as practically possible and follow the. World Health Organization (WHO) document TRS 970, which states dead legs shall not exceed three times the branch diameter as measured from the ID pipe wall to centre line of the point-of-use valve.

Pipework shall be selected to minimise microbial growth, be metallic or PVDF pipes that are corrosion resistant to mineral hungry water and capable of conveying water more than 80°C. It is critical that incompatibility of material be avoided to stop galvanic corrosion which can not only introduce sediments back into the process but can also increase biofilm growth. The RO water storage and the distribution system shall be manufactured using sanitary piping system such as stainless steel with non-threaded components where possible.

It is acknowledged that very small scope reprocessing departments might not be able to accommodate a heat sterilisation system and therefore compliance with AS/NZS 4187 by other controlled engineered solutions will be required.

AS/NZS 4187:2014 stipulates water of chemical purity as generated by RO technology is not required and that water of low salt content is not requested by all suppliers of AER. However, it should be emphasised that water of purity as stipulated in the latest version of AS/NZS 4187, as well as other applicable standards/ guidelines, in respect to microbial purity / quality is more stringent than that stipulated for the reprocessing of thermolabile reusable medical devices. As thermolabile instruments, such as endoscopes, are reprocessed using chemical disinfectants, the use of water of low microbial purity for the final rinse cycles is critical for good patient outcomes. The use of poor microbial purity/ quality water for final rinsing following high level disinfection defeats the purpose of disinfection as it may result in the recontamination of thermolabile endoscopes with pathogens that may be present in the drinking water supply or is growing within the hospital pipe network.

8.4.21. Pathology

General issues

Early information regarding pathology equipment will be needed to ensure the drainage is located and sized to manage waste being generated by large analysers. In some larger services, the waste generated is 100L per hour.

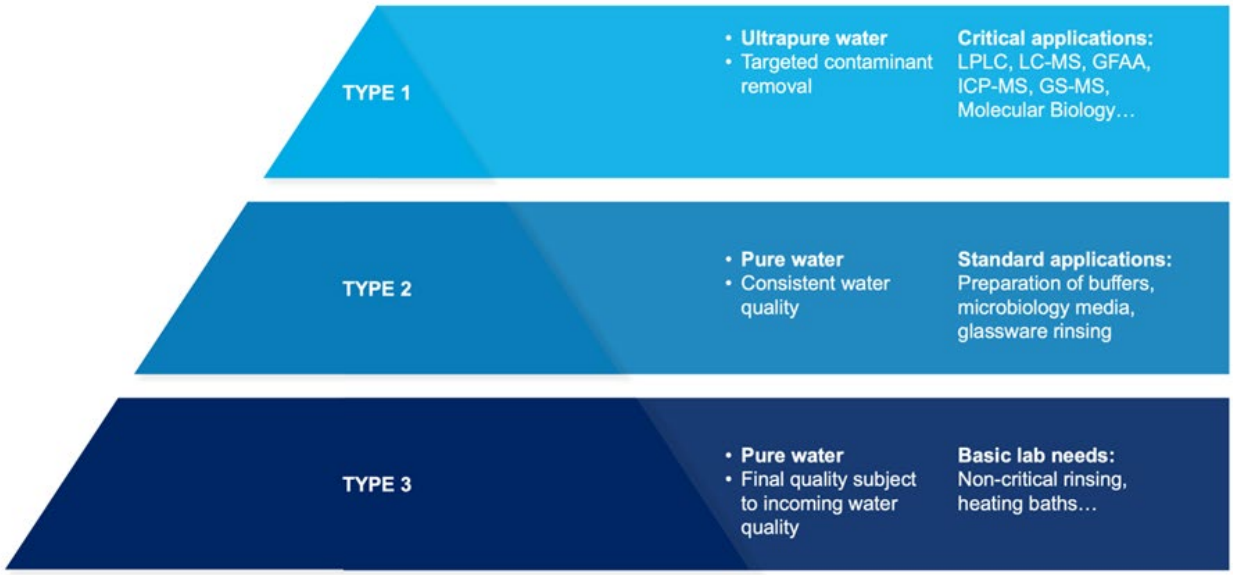
Reverse osmosis systems

Generally, a type of purified water is used in pathology. The type / purity of the water used is dependent on its use/ the process undertaken within the pathology.

There are several voluntary water quality standards released by several organisations such as Clinical and Laboratories Standards Institute (CLSI) and ASTM International. In general, the overall water quality is determined by assessing its ionic purity, organic purity, bacteria level and its particulate concentration.

The quality of water used in pathology depends on the application. The figure below identifies some common applications based on the water purity level.

Figure 2: Water purity levels



Detailed consultation is required to understand the water requirements (i.e. the quality as well as the quantity) within the pathology unit. The designer will need to carefully consider the plant types and reticulation configurations and will need to assess the options dependant on the needs of the different qualities and flow rates to determine the best value for money approach.

International Organization for Standardization (ISO) specification ISO 3696:1987 specifies three grades of water: Grade 1, Grade 2 and Grade 3, where Grade 1 is the purest (see Table below):

Table 11: Water quality parameters for ISO grades

Parameter	Grade 1	Grade 2	Grade 3
pH value at 25°C	–	–	5.0 – 7.0
Conductivity (µS/cm) at 25°C, max	0.1	1.0	5.0
Oxidisable matter Oxygen content (mg/l), max	–	0.08	0.4
Absorbance at 254 nm and 1 cm optical path length, absorbance units, max.	0.001	0.01	–
Residue after evaporation on heating at 110ºC (mg/kg), max	–	1	2
Silica (SiO2) content (mg/l), max	0.01	0.02	–

Source: American Society for Testing and Materials (ASTM)

The ASTM uses D1193-06 and has four grades of water (see table below).

Table 12: Water quality parameters for ASTM types

Parameter	Type I*	Type II**	Type III***	Type IV
Conductivity (µS/cm) at 25°C, max	0.056	1.0	0.25	5.0
Resistivity (MΩ-cm) at 25°C, max	18.0	1.0	4.0	0.2
pH at 25°C	–	–	–	5.0 – 8.0
TOC (µg/l), max	50	50	200	No limit
Sodium (µg/l), max	1	5	10	50
Silica (µg/l), max	3	3	500	No limit
Chloride (µg/l), max	1	5	10	50

*Requires use of 0.2 µm membrane filter; **Prepared by distillation; ***Requires the use of 0.45 µm membrane filter.

Pipework within the pathology unit should attempt achieve a seamless joint outcome. PVDF is a preferred option for large reticulated pipework systems. Where required by the users, resistivity meters should be located within the pathology unit area, so local staff can monitor the water quality and record statutory information.

8.5. General material selection

The designer should carefully consider all impacting and contributing environmental factors which affect materials used in the hydraulic systems. Materials will be selected that are suitable for both the specific environmental characteristics of the locality of the facility and the service being installed. Issues such as water quality and hardness, piping materials in locations which experience temperatures below 0oC, exposure to sunlight, proximity to coastal waterways (exposure to salt water spray) etc. will all be considered prior to the final selection of materials.

Materials should be specifically suitable for:

- Temperature – e.g. drains from CSSD sterilisers and washers, steam boilers blow down, humidifiers, and AEF
- Chemical waste – e.g. from laboratories, cleaning chemicals
- The pressure exerted upon them, and have a rating of at least PN16
- RO water in haemodialysis units
- The acoustic treatment of downpipes etc.

9. Information and communication technology

9. Information and communication technology

9.1. Introduction

ICT systems are key enablers for patient-centred care, providing the infrastructure and integration to support a digital hospital.

This section offers a brief overview of some of the ICT infrastructure and engineering systems which operate from the ICT infrastructure that is provided in a new hospital.

The guidelines below are based on learnings from recent projects and changes the way ICT infrastructure is provided. The need and extent of ICT systems will be determined on a project by project basis with overall requirements based on the complexity, size and criticality of the facility as described in Section 3.4 of the NSW Health Campus LAN Wired and Wi-Fi Standard. A conceptual view of infrastructure-related ICT in a health facility redevelopment is shown at Figure 3.

9.2. Guidelines and standards

Service consultants should refer to relevant documents to inform the ICT design including:

Relevant Australian Standards

- AusHFG
- NSW Health ICT Cabling Standard
- NSW Health ICT Rooms Standard
- NSW Health Campus LAN Wired and Wi-Fi Standard
- NSW Health Managed Meeting Rooms Standard
- Relevant standards/ guidelines from LHD and Health Entities.

Conflicting information shall be governed by reference to the latest editions / replacements of the following standards documents in descending rank order:

1. Relevant Australian Government Legislation and Regulations that are mandated (for example, Telecommunications Act 1997)
2. Relevant NSW Government Legislation and Regulation (for example, NSW Work cover regulations)
3. Australian Standards
4. NSW Health Standards
5. AusHFG
6. LHD/ SHN and related health entity standards

9.3. Planning and context

All projects will consider the masterplan for the hospital campus. The site-wide infrastructure needs must be assessed and balanced with the needs of the project.

Key considerations include:

- Proposed cabling routes to connect new or refurbished facilities
- Site location in context to the existing ICT infrastructure (e.g. PABX room)
- Cost and service impacts.

Cabling routes should be chosen to minimise the need for future relocation. In-ground cabling infrastructure will be carefully planned to not reduce flexibility of the site.

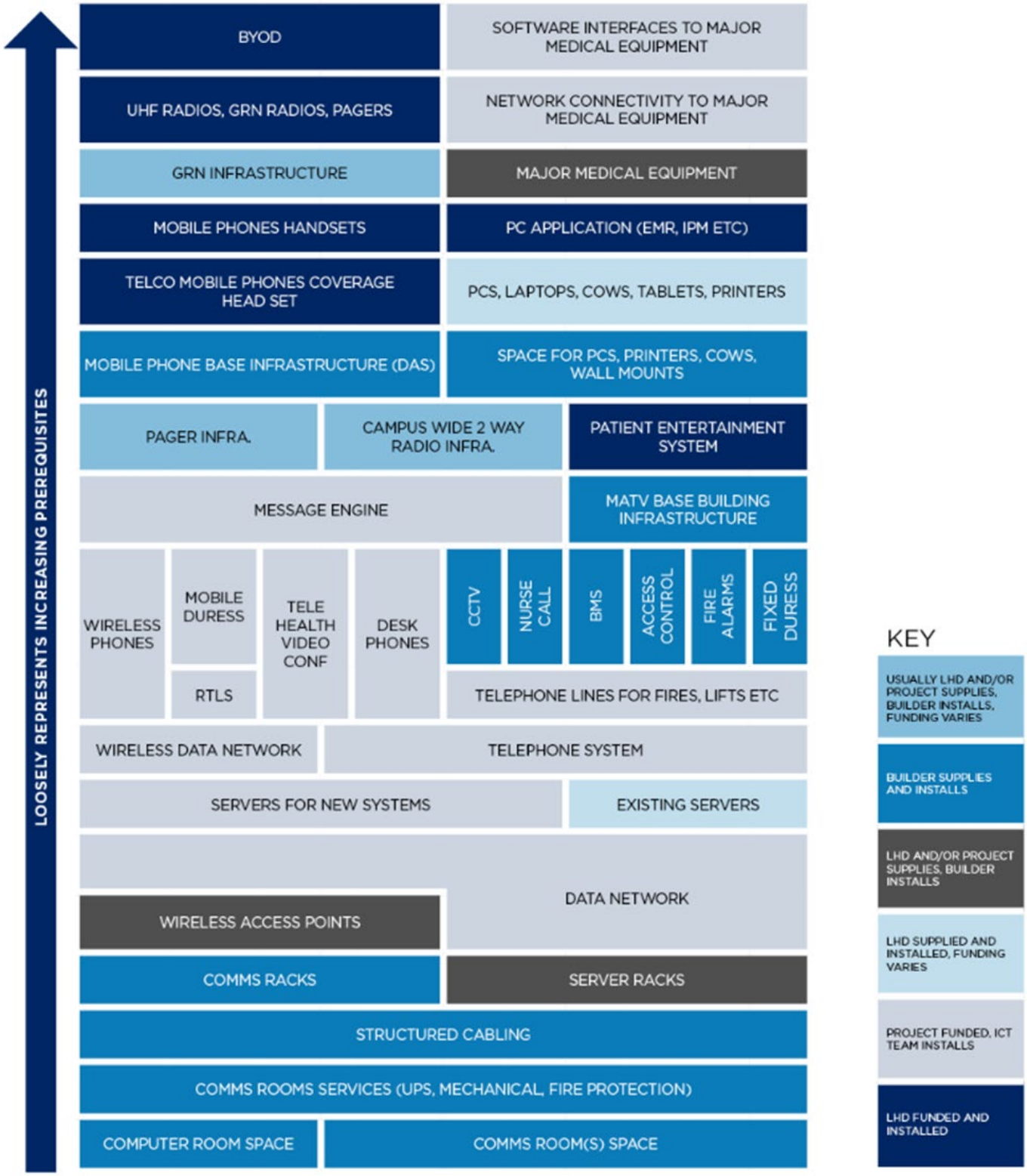
The ICT system will also be influenced by:

- New technologies that offer significant benefits to service delivery
- Specific requirements identified during the hospital briefing process
- Best practice from similar projects.

Where there is a requirement to implement new services into existing ICT environments, such as existing communication rooms or the expansion of existing systems, it is not a requirement to retrofit or upgrade the environment to the latest standards provided the environment has the additional capacity to accept the uplift in services.

Although the implementation of the new services to existing environments must adhere to any relevant standards

Figure 3: A conceptual view of infrastructure-related ICT in a health facility redevelopment



9.4. Physical Infrastructure

9.4.1. Data cabling – horizontal structured cabling to all technical outlets

Refer to NSW Health Cabling standard for detailed requirement.

9.4.2. Communications rooms

Communication rooms are vital components in the physical infrastructure of the ICT environment. ICT communication rooms may host the following functions to support the networking topology for the facility. These functions include:

- Campus distribution (CD) function – CDs are the central and key distributor for a large campus or large premises with multiple buildings on a large geographical plot of land. The CD structured cabling system will feed the building distributors located in other buildings. The carrier or public network cables and other services are also found in CDs
- Building distribution (BD) function– BDs feed cables to floor distributors and also interconnect with a CD. The BD may act as a local floor distributor, double up as a CD and have carrier cables/services terminated within it. The BD is most simply defined as the primary distributor in a single physical building
- Floor distribution (FD) function – FDs are typically located on each floor of a building to service local IT clients or devices. The FDs terminate the horizontal cabling that is run to each client end point. The floor distributor also have building backbone cables connecting the FD to the BD or from the FD to other FDs
- Server room function - A server room is a room used to store, power and operate computer servers and their associated components. A server room provides the operational and environmental components and services necessary to operate enterprise class servers.
- Distributed antennae system (DAS) / carrier room function – is a central communications rooms where the DAS would aggregate and terminate into. Telecommunication carriers (such as Telstra, Optus and Vodafone) would terminate their lead in services into the DAS/ carrier room and would also host any carrier equipment in this area.

Communications rooms will comply with the NSW Health ICT Rooms Standard.

Combined Communications Rooms

Communication rooms can host a number of distribution functions.

Where possible, communications room functions should be combined into the same room while still meeting all other requirements to host that function.

If the communications room functions are combined, then each function should be accommodated in separate racks.

For multistorey buildings, communications rooms should be stacked on top of each other to assist with riser access. Alternatively, there should be careful consideration towards the design for common vertical risers for cable access to communications rooms between floors.

Campus Distributor (CD) Functions

Larger critical health facilities will have two separate communications rooms that host the CD function. There will be a primary and secondary CD room on the campus to provide a level of redundancy and availability.

For smaller, less critical facilities (e.g., fewer than four buildings on a campus), only one CD room will be needed.

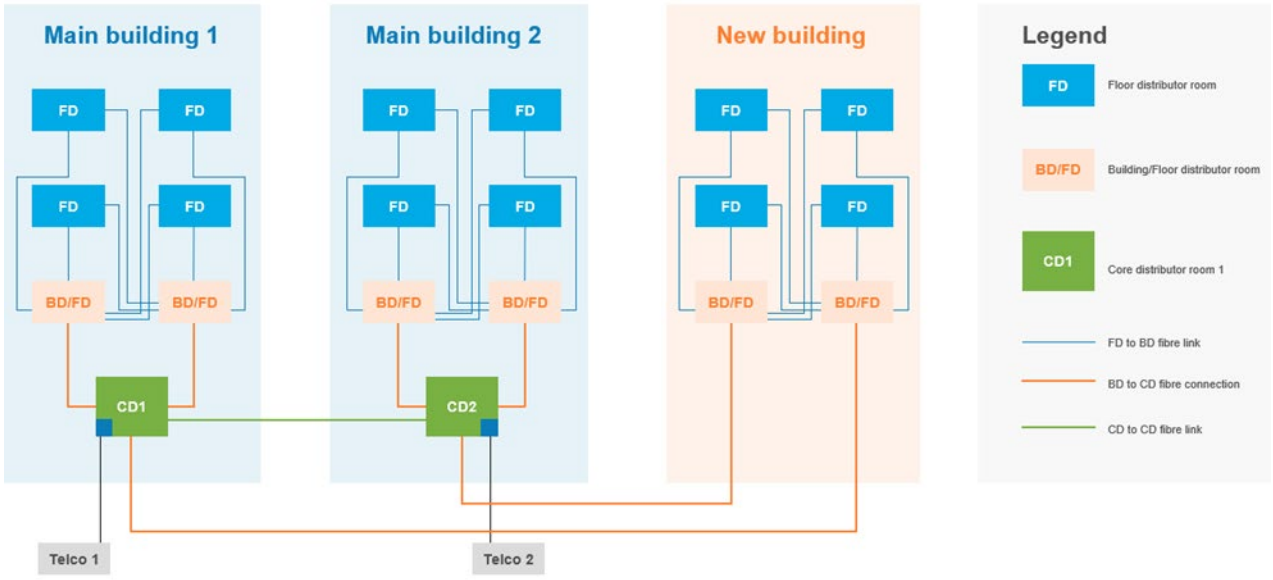
The CDs will be physically separated in two different buildings on the campus

Communications rooms with CD functions shall be connected with two physically diverse fibre connections.

Each fibre connections shall be a minimum of 24 core fibre strands.]

To support CD functions, in communication rooms, a minimum of two racks will be required. One rack will be required for passive termination of CD functions and one rack will be allocated for active equipment for CD functions. A third rack may be considered for future growth.

Figure 4: Campus distribution room configuration



Building Distributor (BD) Functions

Each new substantial and critical building on the hospital campus will have two communications rooms, operationally functioning as a BD.

Smaller, or less critical buildings, shall only require a communications room with a single BD. This may include multi-purpose services (MPS), community health centres, HealthOne facilities or buildings less than 10,000m2.

There will be a primary and secondary BD communications rooms to provide a level of redundancy and availability for the building.

The BD communications rooms will be located in physically separate rooms within the building.

A BD communications room may also act as a FD communications room.

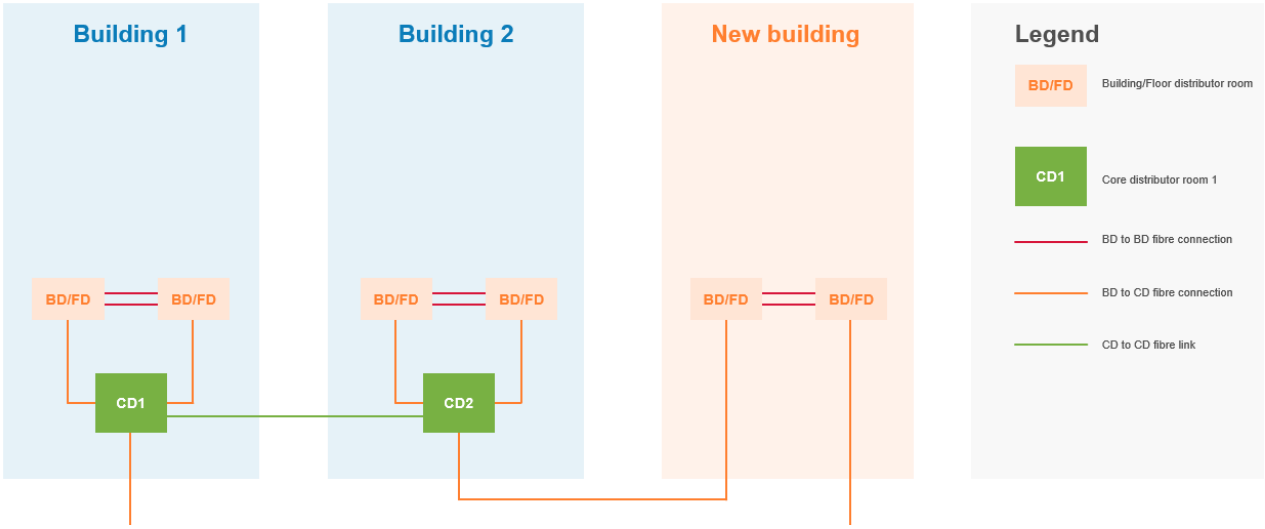
BD communication rooms may reside on different floors of the building.

BD communication rooms must be connected to each CD communication rooms via physically diverse fibre pathways.

Fibre connections to each CD communication room should be a minimum of 12 fibre core strands.

To support CD functions, in BD rooms a minimum of two racks will be required. One rack will be required for passive termination of BD functions and one rack will be allocated for active equipment for BD functions. A third rack may be considered for future growth.

Figure 5: Building distribution room configuration



Floor Distributor (FD) Functions

FD communications rooms will be strategically placed to ensure all horizontal cables meet NSW Health cabling standards i.e. horizontal cable runs will not exceed 90m in length.

For field ports and horizontal cable runs that exceed the 90m distance, a FD room will be provisioned to cater for these ports.

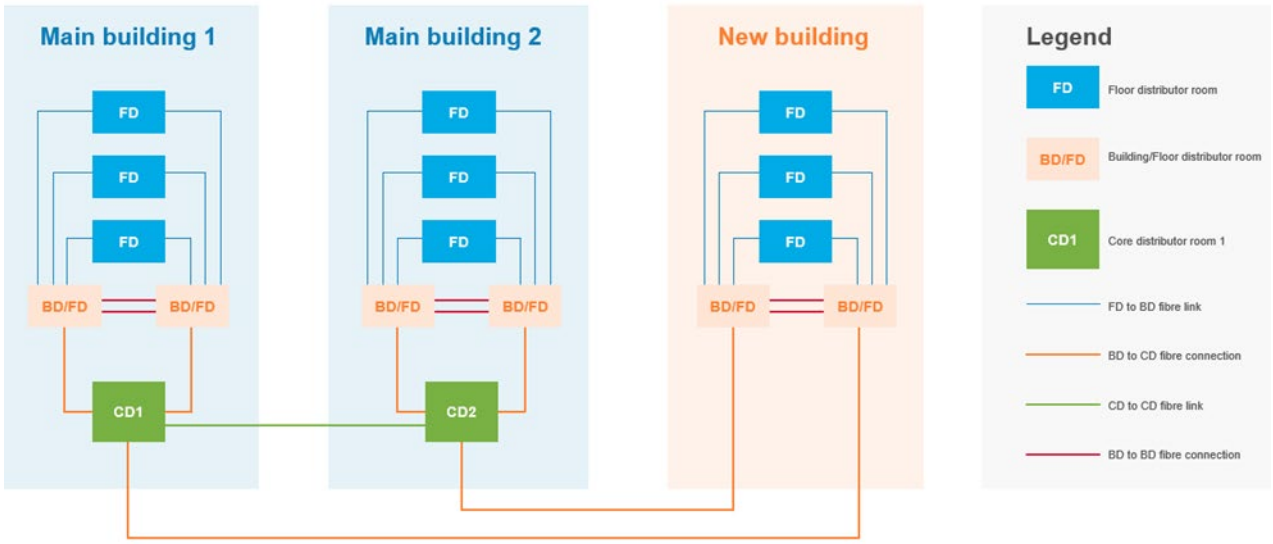
FD communication rooms must be connected to each of the BD communication rooms via physically diverse fibre pathways and fibre connections to each DB rooms should be a minimum of 12 fibre core strands.

A BD room may share the same functions as a FD room.

To support FD functions, in FD rooms, a minimum of three racks will be required. The number of racks will be dependent on the FD functions it is servicing. Rack requirements will be dependent on allocation of technical outlets and support:

- Passive termination
- Active equipment
- Hosting of on-premises local systems (such as nurse call, security and access control systems and patient entertainment systems).

Figure 6: Floor distribution room configuration



Server room

A dedicated server room will not be provisioned on the hospital campus as the NSW Government Data Centre Reform strategy seeks to migrate all local service infrastructure to the 'all of government data centre'.

Servers identified unsuitable to be relocated to the government data centre will be hosted in the campus distribution rooms.

The CD rooms will be of sufficient size to host limited local server infrastructure, with future additional racks, where required.

DAS \ Carrier Room

A DAS / carrier room function will be provisioned in every new or redeveloped building. Spatial allowances shall be large enough to host four racks per telecommunications carrier connecting to the DAS. In addition, the DAS room will:

- Be located on the ground floor of the building to ensure floor load requirements can be met
- Have a cooling system provisioned to meeting heat load requirement of the equipment
- Have three phase power available to telecommunications carriers
- Not routinely require UPS power as the telecommunications carriers will supply their own battery banks for UPS power.

Redevelopment projects will ensure they collaborate with the hospital's lead carrier in developing the DAS design, building facilities and coverage.

The DAS / carrier room function may be combined within other functional communications rooms such as a CD or BD. However, consideration into the physical separation of functional services between externally delivered services (such as Telco lead-in services) and internal hospital services in combined rooms.

Physical security separation measures may include wire cage separation of services, security and access control, alternate door access or security locked communications racks.

Where DAS / carrier rooms are not combined with CD functions, DAS / carrier rooms should be located relatively close to the campus main communications rooms.

Communication lead-ins

The campus will require two communication lead ins via diverse pathways to each CD room. Where the hospital area is fed from a single utility exchange, then dual incoming services may not offer a suitable level of redundancy. Wireless communications may be considered as a secondary, redundant communication link in some facilities.

Each lead in service will require a minimum of two x P100 conduits terminated to a pit at the boundary of the campus.

Other considerations

Specific services are required to support communication rooms as detailed below.

Power

Power that services the racks with active equipment shall be fed by two power sources installed on separate electrical circuits. One power feed will be UPS power and the other power source essential power.

Each power circuit will be installed with a 20A power rating.

The UPS will be fed by a centralised UPS providing UPS power to all ICT communications rooms. However, a standalone unit may supply UPS power if a centralised system is not practical. Refer to Section 5.6.3 for further details.

Active equipment will be configured to shutdown in an orderly manner in the event of extended operations on UPS power after a complete power failure event.

Air handling

Refer to Section 7 of this guideline.

Building services

Building hydraulic and waste services, such as main water lines and sewage, will be diverted around communications rooms. Where hydraulic services cannot be diverted around communications rooms, hydraulic services shall be diverted around active racks with imbedded risk mitigation strategies in place to manage the risk of leaks. These mitigations should include drip trays with leak detection or other targeted solutions.

Water suppression systems will not be installed in communications rooms.

All communications rooms will require restricted access to authorised staff with access control for security.

Fire services

All communications rooms shall be two-hour fire rated. Gaseous fire suppression system is not required for communications rooms.

Very Early Smoke Detection Apparatus (VESDA) monitoring should be installed only in the main CD communications room.

All other communications rooms will have standard fire detection and alarm systems.

9.4.3. Communication outlet quantity

Refer to the NSW Health ICT Cabling Standard for guidance. These requirements must be considered in conjunction with the current AusHFGs with the higher of the two adopted where they do not align.

The final number must be presented and agreed to by NSW Health Infrastructure.

9.4.4. Telephony and unified communications

A VoIP telephony phone system will be implemented. Traditional analogue based PABX telephony solutions should not be installed or expanded.

A VoIP telephony system has a major dependency on the communications network, therefore the associated network infrastructure MUST be designed to facilitate voice services technology.

The wireless network will be designed to facilitate complete coverage for voice services.

While traditional copper telephony cabling is slowly becoming redundant with the move towards VoIP solutions, there is still a requirement to deploy limited amount of traditional copper based analogue telephony services to provide communications functions (e.g. fail-safe phones, dedicated fixed service lines for elevator emergency lifts, fire and security communication services, EFTPOS and fax service). Traditional copper telephony cabling may also be required for backward compatibility with legacy systems.

New buildings will have limited infrastructure supporting traditional analogue based telephony communications.

The main communications room for the building will host the main distribution frame (MDF) for the copper structure cabling system for the building.

A single 20 pair copper tie will be run to each communications room.

Within each communications room, there is no requirement for an intermediate distribution frame (IDF).

The copper pairs shall be terminated directly into the bottom row of the passive rack, terminated to an RJ45 patch panel.

If the campus has an existing central MDF for copper reticulation, 100 pair copper tie will connect the MDF in the new building to campus MDF.

Refer to NSW Health ICT Cabling standards for further specifications.

9.5. Core ICT systems

9.5.1. Single converged network

The campus will only have a single converged shared data network i.e. separate isolated networks will not be created or exist on the campus.

All IP enabled devices should connect to the hospital's shared data network. Logical separation of data networks should be achieved through the configuration of virtual networks (VLANs).

The data network should be designed to cater for the following network data traffic and systems:

- Client access data (General client data access, PC, printers)
- VoIP telephony
- Wireless access data traffic
- Videoconference and telehealth traffic
- Biomedical equipment
- Medical imaging equipment
- Major medical equipment and systems
- Service management systems such as BMCS, CCTV, security and access control systems and nurse call systems.

Specific networking requirements should be discussed in detail with LHD/ SHN support and operational teams.

9.5.2. Wireless usage

The wireless environment will be designed to cater for the following wireless systems and applications:

- Mobile computing (laptops, tablets, mobile phone)
- BYOD devices
- Wi-Fi telephony (VoIP over Wi-Fi)
- Mobile duress
- Asset tracking (e.g. RFID)
- Wireless mobile telemetry.

9.5.3. Wireless network design and coverage

A wireless network design shall comply with the NSW Health Campus LAN Wired and Wi-Fi standards. A predictive survey must be prepared to ensure the adequate coverage for the wireless environment.

The wireless environment shall be limited to the perimeter of the building and critical areas outlined below.

Areas of coverage will include:

- Transit ways and locations that staff use during their working day and may be using a Wi-Fi device in that location
- Lift cars
- Internal courtyards
- Ambulance bays
- Helicopter landing sites (HLS), including travel paths to the hospital
- Stairwells used by staff to move between floors
- Plant rooms – wireless density in plants rooms is limited to data grade performance. Plants rooms will not require Real Time Location Services (RTLS) level performance density.

Area of coverage should not be included:

- Stairwells used only for emergency egress
- Lift cars that do not transport people e.g. dumb waiters
- On-grade or multistorey carparks.

9.5.4. Wireless access point placement

As a general guide for the purposes of estimation, wireless coverage is based on one access point per 70m2. A wireless site survey will be conducted to determine the exact wireless placement and coverage. There should be 5m of excess cable for each WAP data outlet to allow the access points to be relocated.

Wi-Fi design will be done in accordance with the NSW Health Campus LAN Wired and Wi-Fi Standard to support RTLS.

An accurate wireless survey will be conducted to determine the exact access location and coverage for an RTLS implementation.

Design considerations will include environmental conditions such as varying wall construction types and any other potential radiofrequency interferences.

Wireless survey's must be conducted by a qualified independent IT engineer / consultant.

9.5.5. Message integration engine

There are multiple systems in a modern health facility that generate ‘messages’. Typically, operational systems are installed as independent systems with no integration with other systems. Modern operational systems are now becoming more computerised and digitised allowing for greater integration with other systems through standard industry interfaces.

A message integration engine (MIE) is a system that allows messages generated by disparate systems to be sent to a range of receiving devices and/or systems.

An integrated system environment within a hospital environment can provide effective and efficient operational benefits by complementing the operational processes and supporting the limited workforce resources within a facility. It will be designed for high availability and redundancy.

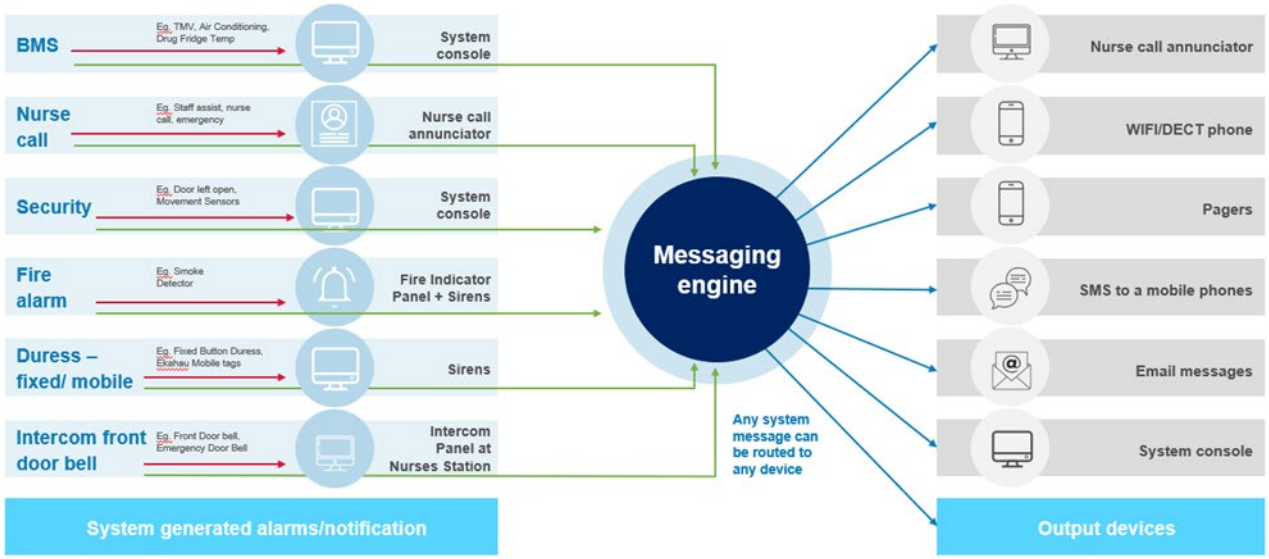
The interconnection of systems into the message integration engine (MIE), of the selected systems shall be conducted on a case by case bases, depending on the size and nature of the project. The messaging engine should be capable of interfacing with a range of system including, but not limited to:

- Nurse call
- BMCS
- Security and access control system

- Duress (fixed and mobile)
- CCTV systems
- Fire systems and fire indicator panel
- Intercom.
- Lighting systems.

The figure below provides a conceptual view of infrastructure related ICT in a health facility redevelopment. This should be used as a guide only.

Figure 7: The messaging concept - any source to any destination



Note: The above table includes examples and the extent of integration is limited to these systems and services.

Detailed discussion will be undertaken with the hospital's operational teams to identify what systems may require integration and the extend of the level of integration.

- The MIE is not intended to replace messaging self-contained within a system
- The MIE is not intended to be relied upon for the operation of discrete systems such as BMCS, nurse call, security/ access control
- The MIE shall be a Group 1 item to be procured within the building contract.
- As part of the design process, the design team shall commence the process of establishing the scope of the system, the various systems that need to be part of the inputs to be received and outputs required at a concept and scheme design level. This shall include consultations with the LHD, to agree on principles on systems that the messages need to be integrated, the levels of messages and alarms that need to be sent, recipients of alarms, acknowledgement process, and escalation protocols.
- The appointed building contractor and their team shall be responsible for the finalisation of the process mentioned above, to arrive at the final configuration of inputs and outputs, to the approval of Health Infrastructure. The actual product shall be proposed and submitted to Health Infrastructure for approval prior to implementation.

9.6. Service delivery system platforms

9.6.1. Overview

Several building specific systems may be provided by the Services Consultant. Planning for each of these systems must always consider:

- Interoperability with existing equivalent systems, especially those that will not be replaced as part of the redevelopment
- Operational issues of disparate systems
- Ongoing support and maintenance, including skills required and responsibility.

9.6.2. Building management and control systems (BMCS)

The facility's asset and operational maintenance team are responsible for determining the requirements of the BMCS.

Where appropriate, the hospital's BMCS devices should be connected to a district wide system. The building services can be managed remotely over the wide area network and the facility should consider utilising a district wide system where possible.

IP based controllers that are required to communicate on a data network should utilise the facility's data communications network. A dedicated Virtual LAN (VLAN) will be utilised to provide network isolation from the hospital's data network.

Independent/ isolated networks to support the data communications for BMCS devices should not be installed by vendors.

Structured cabling required to support IP based devices communicating on the network must adhere to the specifications as outlined in the NSW Health ICT cabling standard.

Existing sites will consider the extension of their existing BMCS. Where extensive new facilities are planned, BMCS will allow for:

- Integration to a MIE to allow BMCS to be pass alerts to other end points (devices) or systems.
- Single point of administration of multiple BMCS, cost permitting.
- Each BMCS text message must uniquely identify the location of the alert consistent with way finding and room naming standards across the facility.

9.6.3. Mobile duress

Duress systems in a health facility are either fixed duress or mobile duress. This section describes mobile duress. A mobile duress solution:

- Should utilise the facilities network
- Should employ RTLS to accurately locate a person in duress and uniquely identify the device triggering the duress
- Will identified the coverage of the system through a formal risk assessment
- Will adhere to the standards as define in the NSW Health Protecting People and Property policy

Will have capability to integrate with a MIE using industry standard messaging interfaces

- Will integrate with the MIE for messaging and alert notification
- Will complement clinical and operational procedures to minimise and mitigate the risk of a duress event, by being the last line of defence, not the first line of defence

- Will consider the need for communication to an external monitoring company when duress events occur
- Minimise false alarms
- Minimise alarm fatigue.

9.6.4. Radio and paging systems and reception

Radio reception includes consideration for:

- Health Interior Radio Paging Network (HIRPN)
- Campus specific paging solutions
- Campus specific radio infrastructure requirements.

A paging system plays a pivotal role in sending out messaging and alerting notices to defined recipients. The hospital should have an operational paging service that is integrated / interfaced as a core function of the MIE, where provided.

9.6.5. Security and access control systems

Existing sites shall consider the extension of the existing district wide security management system. Security controllers can communicate and be managed by the district solution over the wide area network. This strategy will provide:

- A standardised security access solution across the district
- The integration of security access systems with other facilities within the district
- A consolidated security system
- Centralised management and administration.

Where extensive new facilities are planned, security/ access control system will allow for:

- Bi-directional integration to a MIE to allow alerts and notifications to be passed
- Use of current technology for all new buildings. For refurbishment of existing buildings, careful consideration should be given to the choice of existing expansion or replacement, depending on age of technology and relative size of new and refurbished areas.

Where it is not possible to expand on a district wide solution, design requirements to be considered will include:

- Data communications between the system components such as the controllers and management server, must communicate over the hospital's data communication network. A separate data network must not be deployed to support the security system.
- A dedicated Virtual LAN (VLAN) will be configured to logically separate the data communications for the security system from the rest of the hospital's data communications.
- The management server for the security system should be able to run on a virtual platform. It must support virtual operation.
- ICT structured cabling (where applicable) will comply with the NSW Health ICT Cabling Standard.
- The system should integrate with third party systems for message alerting and notifications using standard industry integration interfaces.
- The system should be capable of being managed, administered and configured remotely if remote access capabilities are provided.

9.6.6. Nurse call systems

Existing sites will consider the extension of the existing nurse call system. Where extensive new facilities are planned, nurse call will allow for:

- Annunciators that allow multiple text alerts to be displayed simultaneously with colour coding, and different tones
- Bi-directional integration to a MIE to allow nurse call system alerts to be passed to other end points (devices) and for other systems to have select alerts displayed on nurse call system annunciators
- Possible full two-way communications between patients and nurses
- Provide the facility to have multifunctional monitoring interface for nurses
- Allow nurses to monitor patient status with medical alarm status
- Enable integration into bed management systems
- Use of current technology for all new buildings. For refurbishment of existing buildings, careful consideration should be given to the choice of existing expansion or replacement, depending on age of technology and relative size of new and refurbished areas
- Each nurse call alert text message must uniquely identify the location consistent with wayfinding and room naming standards across the facility.
- Where possible, nurse call system components such as annunciators, nurse call handsets etc. should be an IP based solution.
- Data communications between nurse call system components shall communicate on the facilities data communication network. A separate data network should not be deployed to support the nurse call system.
- A dedicated Virtual LAN (VLAN) will be configured to logically separate the data communications for the nurse call system from the rest of the hospital's data communications
- Where applicable, the management server for the nurse call system should run on a virtual platform. It must support virtual operation.
- The system will be capable of being managed, administered and configured remotely if remote access capabilities are provided.
- ICT structured cabling (where applicable) will comply with the NSW Health ICT Cabling Standard.
- Head end system components will be installed and housed in the closest ICT floor distribution communications room to the zone that the head end is servicing.
- All nurse-call active equipment will be rack mounted in the communications room.
- Head end system units will be installed in a separate rack to the hospital's ICT active equipment in the communications room.
- Nurse call system components will be supplied by UPS and essential power.
- Nurse call structure cabling will adhere to the cable colour regime define by the LHD.

9.6.7. Fixed duress

Fixed duress, where provided, is supplied separately to the mobile duress system. However, they are required to behave in an equivalent manner, from an operational point of view, when a duress event occurs.

Fixed duress requirements will be designed, installed and configured in accordance to the standards as define in the NSW Health Protecting People And Property policy.

Where extensive new facilities are planned, Fixed duress will allow for:

- Bi-directional integration to a MIE to allow alerts and resets to be passed
- Communication to an external monitoring company when duress events occur
- Use current technology for all new buildings. For refurbishment of existing buildings, careful consideration should be given to the choice of existing expansion or replacement, depending on age of technology and relative size of new and refurbished areas
- Each fixed duress alarm must uniquely identify the button pressed and produce a location consistent with way finding and room naming standards across the facility.

9.6.8. Fire system and fire indicator panel

The fire system and fire indicator panel:

- Will be a standalone system / platform
- Will operate independently to the hospitals ICT data communications network
- May interface with other site management systems such as BMCS, message integration engine or nurse call systems for messaging and alerting notifications.

These systems are supplementary notification systems and will not form part of the primary notification procedures for the fire system

9.6.9. Mobile phone coverage within buildings

New buildings require mobile phone coverage. If an adequate mobile signal is not available from external macro towers, an in-building coverage solution must be designed to allow for adequate coverage to delivery clinical and support services.

Adequate mobile coverage shall cover all clinical and critical areas of the facility.

In-building coverage shall include coverage for all major telecommunications carriers, Telstra, Optus and Vodafone, with Telstra service being the priority service.

A desktop or predictive assessment should be conducted to determine the expected level of coverage generated from external macro towers.

Should the assessment identify expected poor internal coverage, the design consultant shall propose the most appropriate in-building coverage solution for the facility considering coverage and cost.

In building coverage solution may include DAS based solutions or repeater-based solutions.

DAS based solutions shall be designed to the latest mobile carriers forum (MCF) specification

The DAS designer is responsible for ensuring the DAS design is ratified and endorsed by the nominated lead carrier

The lead carrier for the facility will be nominated by NSW Health to the health service.

It is the responsibility of the health service to engage and enter into service contracts with the telecommunications carriers to connect to the DAS upon approved completion of the DAS system.

9.6.10. Close circuit television (CCTV)

Existing sites will consider the extension of their existing CCTV. Where extensive new facilities are planned, CCTV will allow for:

- IP based cameras and hardware on the health facility’s data network. Careful performance and capacity planning must be undertaken to ensure the hospital’s network is not compromised
- Robust security of all elements of the CCTV system to prohibit unauthorised access

- The system to communicate over the facilities local data communication network
- A locally based system and will not form part of a district or global system i.e. CCTV recordings will not be recorded over the wide area network
- A dedicated VLAN should be provisioned for the communications of CCTV equipment. This VLAN will segregate CCTV communications data from the rest of the facilities data traffic
- The CCTV head end and recording equipment to be housed in the campus distribution room
- The CCTV head end recording server will be installed on dedicated physical hardware and storage. It will not be installed on the facility's virtual infrastructure.
- Camera placement to be installed in accordance with the NSW Health Protecting People and Property policy
- Structured cabling associated with CCTV deployments will adhere to the NSW Health ICT cabling standard.

9.6.11. Intercom systems

Intercom systems may be required at entry points into a building or a department within a building. Where intercom is required, the design will consider:

- Voice integration with unified communication / telephony system including to configurable telephone handsets, either wired or wireless
- Video integration with unified communication system including to configurable telephone handsets, either wired or wireless
- The ability of a staff member to remotely open the entry door from the telephone handset and/ or an intercom console
- An IP based intercom system
- That the system should integrate with other site management systems for messaging and alerting such as the MIE, BMCS or nurse call system using standard industry interfaces. The integration will allow notifications of an intercom event to other systems within the facility
- The system must communicate over the facility's local data communication network
- A dedicated VLAN should be provisioned for the communications of intercom equipment. This VLAN will segregate intercom communications data from the rest of the facility's data traffic
- The intercom system may be integrated with the VoIP telephony system.

9.6.12. Patient entertainment system

MATV system should be provisioned in new redevelopments. However, the MATV solution will not be designed for the provisions of pay TV services such as 'Foxtel'.

Ethernet based Cat6A structured cabling will be provisioned to support a patient entertainment solution.

In general, coaxial based cabling shall not be installed. However, this must be discussed with the local health entities to understand the strategy for providing Patient entertainment to patients.

Cabling provisions shall be made for the television unit to integrate with the nurse call system and nurse call pendant.

Television and patient entertainment system (PES) devices in inpatient units shall be controlled through the nurse call system.

MATV termination equipment such as splitters and head units will be housed and terminated in the facility's data communications room.

The Services Consultant should design cabling for a PES considering:

- Coordination with the facility and others who will provide the active equipment
- Provision for the placement of TV antenna, satellite dish and similar equipment in a suitable location
- Means to fit TVs at the patients' bed.

9.6.13. Public address systems

Where public address systems are required, the following will be considered as part of the design:

- Integration with EWIS
- Digital system to allow scalability and flexibly to add additional zones and announcement consoles as required
- A discrete zone will be provided for each department
- Flexibility to allow announcements to all zones, a single zone, or group of zones as required
- Allow announcements from the unified communication system / Telephony system.

9.6.14. Electronic wayfinding

Where practical, appropriate and not subject to excessive costs, electronic wayfinding be required. Where it is required, the design will consider:

- The use of wayfinding consoles at key locations in the facility
- The use of smart phone apps to direct a visitor, patient or staff member.

9.6.15. Tracking

Health care facilities may seek to implement tracking solutions that may include tracking of:

- Critical equipment Patients such as newborns
- Staff using mobiles duress
- Beds to map the patient journey
- Visitors using interactive wayfinding

Tracking systems may include

- Passive tracking with the use of RFID and perimeter "choke points"
- Active tracking with real time location tracking.

The services consultant should understand the strategy for tracking services and propose a design for the most appropriate solution. A return on investment should be sought while considering the adoption of these systems.

Active system will utilise the hospital's Wi-Fi network and RTLS tracking service for locations services.

9.6.16. Campus considerations

Redevelopment projects can change the physical nature of a healthcare campus, and this can impact existing network coverage. The following information details scope that is included in a redevelopment project:

- Before any works commence on a healthcare campus, a network coverage assessment of the campus must be undertaken/ obtained
- The redevelopment project budget will not address existing campus-wide network coverage issues
- If mobile network coverage is deemed inadequate for either current campus needs, or the needs of the combined development, the redevelopment project team can assist in establishing a dialogue between the hospital/ LHD and the design team to negotiate improved mobile wireless device network coverage
- Similarly, the redevelopment project team can facilitate dialogue between the hospital/ LHD and the Public Safety Network (PSN) operator to negotiate improved PSN coverage if required, noting that PSN coverage is required within the emergency department, ambulance bays, main hospital entrances and fire stairs. For clarity, there is no expectation that PSN coverage be achieved throughout an entire facility. Such negotiations will consider both existing and new demand associated with the capital works being undertaken by the redevelopment project team
- The HIRPN network utilises high-powered transmitters operating in the VHF band on 148MHz. One transmitter generally covers an entire campus and surrounding areas and does not rely on any form of in building reticulation for the signal to penetrate structures.
- After works are completed, the network coverage assessment must be confirmed.

10. Lighting

10. Lighting

10.1. Introduction

Light, both daylight and electric light, has direct influence on the perception of the space and the visual performance and comfort of its users. There has been considerable research on lighting and its impact on the visual comfort, and health for people within the built environment.

An important issue that should be considered in designing lighting is the visual comfort of patients, visitors and staff. Light should create a comfortable, varied, inviting and interesting atmosphere and support the intention of the architectural design and the functional requirements of the health facility.

10.2. Scope

The following elements are considered as part of lighting systems:

- External lighting
- Internal lighting
- Feature and architectural lighting
- Medical examination, procedure and operating theatre lighting
- Exit and emergency lighting
- Security lighting
- Associated control systems.

10.3. General requirements

Lighting systems are generally required to deliver:

- User comfort
- Healthy environments (e.g. circadian systems)
- Task visibility and good visual performance
- Orientation and wayfinding
- Safety
- Energy conservation and efficiency
- Comfort control
- Reliability
- Flexibility/ adaptability
- Maintainability
- Commissionability
- Whole of life efficacy.

10.4. Planning and context

10.4.1. Lighting quality

Lighting needs to provide operational and functional lighting to the various spaces to fulfil visual task requirements without glare or discomfort. In addition to the functional requirements, one of the key goals of the lighting design is the creation of a healthy and comfortable environment.

Hereby, the following issues need to be considered and form part of the design:

10.4.2. Light distribution

Light distribution of a luminaire determines how the light output is utilised and distributed into the space or onto an object and plays a key role on the visual results. It is also a determinant in how efficiently the space is illuminated, how the items are enhanced or subdued, as well as in how well glare is reduced or eliminated.

10.4.3. Direction of light and modelling

Light should be used to define qualities of surfaces (colour, form and texture) and to draw people to particular areas or down certain routes, facilitating orientation and way finding.

10.4.4 Visual comfort and sense of wellbeing

A qualitative lighting approach needs to be aimed at, rather than a quantitative approach which considers illuminance levels on the horizontal surface only. The creation of a healthy environment without visual discomfort should be aimed for. In this regard, circadian lighting shall be considered.

10.4.4. Architectural lighting and integration

The lighting approach should also consider the enhancement and reinforcement of the architect's vision and identity of the building and be fully integrated into the architectural design.

10.4.5. Coherence

Lighting needs to be addressed with a coherent approach that takes the following issues into consideration:

- Existing lighting, lighting control systems and emergency lighting control systems in existing buildings or within other parts of the campus
- Consistency of architectural lighting concepts within the building
- External and internal lighting and relevant interfaces
- Standardisation of light fitting types across the project and the campus
- Maintenance access.

The design should allow for flexibility and future adaptability of the lighting concepts and approaches, considering and allowing for the technology to advance.

10.5. Design criteria

The design needs to take into consideration several issues, including functional and clinical requirements, the comfort of patients, staff and visitors, the architectural space and design intent, security requirements, access and wayfinding. Other considerations include maintenance, sustainability, access and coordination.

The specific criteria below are to be used as guidance but should be verified with the project team and user groups to ensure specific project needs and requirements are met.

10.6. Specific requirements and guidance

10.6.1. Illuminance guidelines for visual tasks

The Australian Standards, AS/NZS 1680.2.5, should be referred to for general guidelines on illuminance levels.

The appearance of colour, both in terms of chromaticity (correlated colour temperature) and colour rendition (colour rendering index) are important for the overall comfort and visual performance within the space.

Correlated colour temperature

Correlated colour temperature of a light source is a measure of the hue of the light output of that source. It is denoted in kelvin degrees (K) that refer to the temperature of a theoretical black body radiator emitting the hue equivalent to that of the light source in question.

For medical areas, a neutral white colour of approximately 4000K is recommended; also, as cyanosis lamps and high colour rendering lamps are typically supplied in a 4000K version.

Colour rendering

The colour rendering index (CRI) describes the effect of a light source on the colour appearance of objects by comparison with their colour appearance under a reference source. Daylight and similarly incandescent light sources have a continuous spectrum and attain a CRI value of 100.

Australian Standard AS / NZS 1680.2.5 deals with ‘light source colour’ i.e., visual task requiring discrimination of colours. The standard gives three examples:

- Examination of patient’s skin colourtaion to detect conditions such as cyanosis and jaundice
- General examination for dermatological conditions
- Colour based diagnostic tests.

For cyanosis observation, based on current lamp technology, requirements of the most current international standards, it is considered that the following will be considered appropriate:

- Install energy efficient high quality LED lights of the appropriate colour temperature in all general areas of the hospital to provide a high level of illumination.
- Provide a limited number of mobile LED type Ra 90 lamps for areas that do not have adequate natural lighting or examination/ procedure lights
- Utilise oxygen saturation monitoring via fixed or mobile pulse oximeters in all areas for continuous monitoring or for regular observations as required by clinical need.

For the other areas and usual tasks, the standard recommends a colour measuring index of at least 85 with continuous spectral energy distribution. All patient remedial or diagnostic treatment and accommodation should be illuminated with light source having a high colour rendering index.

Glare limitation

Glare can occur when the luminance or luminance ratios are too high; both of which occasions can cause a feeling of discomfort and reduced visual performance.

The following factors which can contribute to glare should be considered as part of the lighting scheme to avoid and minimise glare:

- Luminance of the source and size of luminous opening
- Position of lighting within the field of view (angle of light)

- Background luminance in comparison to light source.

Glare assessment

For electric lighting systems, the unified glare rating systems (UGR) as developed by the Commission International de l'Eclairage (CIE) should be used to predict the level of discomfort produced by the applied light sources. In addition, consider AS/NZS 1680.

In day-lit environments, the most cited model for predicting discomfort or reduction in visibility is the daylight glare index (DGI). Day-lighting and lighting will be designed to achieve DGI values of less than 22 as glare starts to become uncomfortable above 24.

High luminance contrasts between the glazing and surrounding surfaces can also cause glare. The luminance contrast ratios should generally not be higher than 20:1.

Glare minimisation

The following factors which can contribute to glare should be considered as part of the lighting scheme to avoid and minimise glare:

- Luminaires and their positions should be assessed against glare ratings and cut-off angles
- Lighting the room surfaces (vertical surfaces and ceilings) can reduce contrasts and possible glare
- Window treatments and daylight controls should be investigated to limit daylight glare
- Within inpatient units and corridor applications, care must be taken in designing and placing lighting to minimise glare and disturbance to patients lying on their backs (looking up at the ceiling).

Task lighting

The following areas may require specific task lighting, in addition to general or architectural lighting. These requirements need to be assessed for each individual project and in collaboration with user groups:

- Beds in the inpatient areas might require a task light which should enable comfortable and glare free reading tasks. The light should be separately controllable with controls easy to reach and operate by the patient
- Medical procedure lighting in areas where clinical procedures are taking place (e.g. operating theatres)
- Clinical observation light/ examination lighting in areas where clinical observation is required
- In patient care areas, the lighting used at night-time is required to enable nursing staff to move around safely and monitor the patients whilst minimising any light spill and ensuring that the lighting is not interfering with the patients' sleep
- This might require special night-time lighting in some areas which could be achieved with luminaires mounted at low level, directed at the floor in low intensity. To avoid interrupting the patients' sleep, warm white lighting or long wavelength lighting (e.g. amber) are considered most appropriate
- Staffing stations, operation at night time might require task lighting within the counters or receptions desks. Any lighting of this nature should provide sufficient task lighting for the nursing staff whilst not causing unwanted spill-light into other areas
- Overhead cupboards and shelves in office or staff areas should be considered as part of the lighting scheme. Shadows could be eliminated by means of task lighting to the affected areas.

10.6.2. Space and surface characteristics

The lighting designer needs to understand the room surface characteristics and finishes to enable the assessment of brightness and lighting distribution within the space and to ensure the compliance with illuminance and colour rendering requirements is maintained.

10.7. Codes and reference documents

The following codes and standards should be considered as general guidelines:

- AS / NZS 1680.0 - Safe movement
- AS / NZS 1680.1 - General principles and recommendations
- AS / NZS 1680.2.5 - Hospital and medical tasks
- AS / NZS 4282 - Control of the obtrusive effects of outdoor lighting
- AS4485 - Security for health care facilities
- AS / NZS 2293.1 - Emergency escape lighting and exit signs for buildings.

Other reference documents include:

- AS / NZS 1680.2 - Interior Lighting for other non-medical spaces
- AS / NZS 1158.3 - Pedestrian Area Lighting (for external lighting applications)
- AS / NZS 1428 - Design for Access and Mobility (where applicable).

Where the above listed standards or other building services standards referencing illuminance levels conflict with each other, the design team and user group need to establish which standard takes precedent.

10.8. Equipment

10.8.1. Light sources

Generally, lighting will consist of LED fittings. Metal Halide luminaires can be considered where appropriate in areas with high ceilings, directed light and where no dimming or regular switching is required (e.g. foyer areas). The use of incandescent/ halogen lamps should be avoided.

Generally, light fittings should have a colour rendering index of 85 or higher.

10.8.2. Luminaires

The following selection criteria should inform the luminaire selection:

- Performance (photo-metrics, light output ratio / luminaire efficiency, operating temperatures and heat management, size uniformity of luminous surfaces and openings, glare ratings)
- Quality (workmanship, quality of manufacture and components, Ingress protection ratings, class of material)
- Compliance with the relevant standards (evidence / certificate to be provided)
- Architectural quality and aesthetics (including shape, dimensions and finish)
- Track records of lighting / luminaire companies
- Local availability and representation of supplying company (for future maintenance)
- Environmental impact of production, transportation, operation.

10.8.3. Maintenance of equipment

Well maintained lighting equipment is a prerequisite for an effective lighting system.

Maintenance should be simplified by standardising lamp types and minimising variations throughout a project. Where possible, within the same area or type of area, only one lamp type should be used.

A luminaire maintenance and bulk light fitting replacement schedule should be used for maintenance. This schedule should incorporate information on recommended lamp burning hours prior to lamp replacement.

Periodic lamp replacements should be targeted at not more than 80% of the total lamp life stated by the lamp manufacturer.

Education of staff plays an important part in a well maintained lighting installation. Not only to fully understand the technical aspects of the lighting system operation, but to also be informed of the lighting design principles and objectives.

10.8.4. Location of equipment

All lighting equipment needs to be in positions that are safely accessible for maintenance. Positioning of lighting and related access will be coordinated with other services:

- To achieve an integrated services approach
- To minimise and share access panels and locations
- To achieve the required offsets and distances.

Lighting in plant areas and areas with services equipment should be coordinated and positioned to adequately light the equipment and to be accessible for maintenance.

Operating theatres incorporating medical imaging technology, need special consideration for the placement of luminaires as the support structure for the medical imaging equipment can take up much of the available ceiling area. Designers need to co-ordinate with medical imaging equipment suppliers as well as the placement of items such as HEPA filters, pendants and access panels.

10.9. Daylight

The use of natural light is encouraged, in overnight inpatient care areas as the perceptual contact with natural light is a key factor of comfort in terms of physiology and psychology.

Daylight should be also considered as it contributes to the illumination of the space which might provide the possibility to reduce the use of electrical power.

However, direct visual contact with daylight may cause disabling and discomfort glare. The amount of daylight, especially direct sunlight entering to staff stations and examination areas should be kept under control by employing appropriate controlling mechanisms to avoid glare and discomfort. The details and level of control may vary depending on the space and its use.

Where daylight control is critical, lighting visualisation software packages may need to be utilised for:

- Predicting the distribution of visible radiation in day lit spaces
- Identifying instances of direct solar penetration entering a space
- Assessing daylight control mechanisms in regard to their effectiveness and suitability.

In addition to appropriate daylight control mechanisms, the internal lighting should be designed to balance daylight and reduce high contrasts.

10.10. Lighting control and management

The lighting control strategies and systems should be developed in conjunction with the users to suit their operational procedures and requirements.

The use of daylight sensors for area adjacent to glazing/ daylight access should be considered and is encouraged. This requires a collaborative design approach with the architect and HVAC engineer to maximise natural daylight whilst minimising energy gains.

To minimise energy use, occupancy-based lighting control is to be considered in staff areas and particularly for infrequently used spaces such as store rooms. The delay settings need to be agreed with the relevant user group.

Subject to thorough investigation and satisfying user and clinical needs, the use of automated control of lighting in both administrative and patient areas could be considered, allowing for mode selection, time clock control and pre-programmed lighting settings (e.g. day and night time modes).

Using an intelligent hospital technology infrastructure that connects and integrates the various systems and services within the hospital environment will be considered, subject to the system satisfying the clinical requirements of the various spaces and to considerations of budget and availability of local support and maintenance.

Such infrastructure has the possibility to make the healthcare environment in medical areas more adaptive and sensitive to the needs of the patients, staff, and the environment. An intelligent integrated infrastructure can also provide a platform to accommodate new technologies as they emerge without the need for major reconfiguration.

Open control protocols can be considered as integrating data infrastructure if suitable and relevant to the specific project requirements.

10.11. Emergency and exit lighting

Emergency lighting to healthcare buildings will be provided in accordance with the requirements of the National Construction Code and AS/NZS 2293.1. The emergency and exit lighting system will be designed to consider:

- Existing health campus emergency system (if in existence)
- Integration with architecture and overall lighting design philosophy
- Single point or central battery system
- Energy efficiency
- Maintenance (monitored or non-monitored system).

Based on industry trends, the use of single point monitored systems is to be considered.

10.12. Security lighting

Security lighting is to be considered for both internal and external areas of the building. The lighting designer is to meet with health security personnel to discuss the security lighting requirements for the building and external areas. Items to consider associated with security lighting are:

- To deter unauthorised entry
- To assist security staff conducting patrols
- Provide an increased level of safety to and from car parks and outlying buildings

- To illuminate areas with CCTV coverage to sufficient levels for the effective operation of the cameras
- Be considered with crime prevention through environmental design considerations
- Design advice (see below)
- Requirements as detailed in ‘Protecting people and property’.

10.13. Design advice

10.13.1. Power density- minimum energy performance requirements

The selection of lighting sources, luminaires and their control gear should comply with the regulatory limits prescribed in the BCA Section J6 – energy efficiency, artificial lighting. The Design Illumination Power Density must be calculated in accordance with Section J 6.2.

Table 13: Power Density

Space	Maximum illumination power density (W/m2)
Board room and conference room	8
Carpark - general	6
Carpark – entry zone (first 20m of travel)	25
Circulation space and corridor	8
Control room, switch and the like	10
Entry lobby	15
Factory, industrial tasks and processes	17
Health-care – consult room	20
Health-care – patient inpatient unit	10
Health-care – children’s inpatient unit	15
Kitchen and food preparation area	8
Laboratory	15
Office – artificially lit to an ambient level of 200 1x or more	10
Office - artificially lit to an ambient level of less than 200 1x	7
Plant room	5
Public toilet	5
Restaurant, café, bar, spaces of the serving and consumption of foods or drinks	20
Storage with shelving no higher than 75% of the height of the aisle lighting	8
Storage with shelving higher than 75% of the height of the aisle lighting	10
Service area, locker room, staff room, cleaner’s room, rest room and the like	3

Notes		
1	In areas not listed above, the maximum illumination power density is:	
	A	For an illuminance of less than 160 1x, 13 W/m 1

	B	For an illuminance of 160 to 600 1x, 16 W/m 1
	C	For an illuminance of more than 600 1x, 16 W/m 1
2	For illuminance levels greater than 600 1x, the maximum illumination power density can only apply to the location where that level is needed.	
3	The maximum illumination power density may be increased by dividing it by the illumination power density adjustment factor in Table J6.2 where applicable.	

11. Medical and specialist gases

11. Medical and specialist gases

11.1. Introduction

The purpose of the medical gases is to provide life support and for use in a range of patient treatments.

11.2. Scope

Medical gases generally include:

- Oxygen
- Medical breathing air
- Suction including scavenging
- Nitrous oxide
- Tool air
- Dental air
- Dental suction
- Carbon dioxide
- Other special gases.

11.3. General requirements

Medical gases are a critical part of hospitals in their ability to support life and to provide patient care. The design and installation of these systems is governed by Australian Standard AS2896, designers and installers must adhere to the requirements of this standard. The critical nature of these services demands a high level of knowledge of the standards by both designers and installers.

11.4. Planning and context

The location of medical gas equipment and gas storage as well as the route and size of main pipework runs should account for the future expansion potential of a hospital. Plant layouts should be arranged to account for additional future plant or larger capacity gas storage vessels. Headers used as central distribution points should include spare valved take offs for future use.

11.5. Design criteria

The capacity of plant and pipework will be based on as a minimum the requirements as set out in AS2896. The capacity of gas storage installations will be based on the agreed period for filling or replacing cylinders. A two week delivery period is considered reasonable.

The essential nature of these services demands that there is a level of redundancy, this is achieved by having duty standby cylinders and standby compressor and vacuum plant.

In reticulation of medical gases, the use of a ring main system is encouraged to improve reliability, especially is larger installations. The designer should assess its viability subject to the size of each

project, the associated benefits, and whether it should be on a system level or in the floors or departments.

11.5.1. Oxygen

Oxygen will be supplied from either gas cylinders or from a bulk liquid gas storage vessel.

In larger hospitals, the demand is such that a bulk liquid gas storage vessel is necessary. Each gas or bulk store also needs a standby source of oxygen and this may be in the form of gas cylinders or in the case of a bulk store a second smaller bulk liquid gas storage vessel.

The change over from the duty to the standby source of oxygen must be automatic with a warning raised to indicate that the supply is now operating on the standby source.

Tanker truck deliver access needs to be considered and suppliers should be consulted for comment on access. Delivery bays should be constructed from a non-bitumen surface, concrete hard standings are recommended.

Storage compounds will be secure but well ventilated. There are stringent requirements for the separation distance of liquid oxygen vessels to other plant, structures, boundaries, public roads etc. Separation distances will comply with the requirements of AS 1894.

Bulk gas compounds will generally require a mains hose tap water supply, a three phase power outlet and a communication outlet.

11.5.2. Medical breathing air

Medical air generally generated by oil free compressor plant. Medical air compressors will be served from the standby power supply together with any associated plant such as driers and compressor cooling pumps and fans.

Medical air systems used to serve life support systems will be used for medical purposes only. Separate compressed air systems will be used for non-medical purposes.

Plant sizing will be in accordance with AS 2896.

11.5.3. Suction

Two systems of medical suction are in use within hospitals, venturi suction and vacuum pump suction.

The venturi suction systems are generally used within the older hospitals, this system uses the medical breathing air to produce the suction; the outlets include an air flow valve that adjusts the suction pressure produced at the outlet. The air flow of medical breathing air is relieved via a pipe to outside; this relief pipe is not filtered and can cause infection control issues. It is important that the discharge point for this relief is located away from any outside air intakes and open-able windows. This type of system has an impact on the capacity of the medical air compressor system. Where hospitals are being refurbished consideration should be given to the replacement of venturi suction to vacuum pump suction.

The vacuum pump suction system is the preferred system for new hospitals; this system comprises vacuum pumps that are often mounted on the top of a horizontal vacuum cylinder. Plant should be located within a ventilated plant room. The discharge from the vacuum pumps should be located away from outside air intakes and open-able windows.

Hospitals must be consulted if it is proposed to introduce vacuum suction into an existing venturi suction served facility. Although a staged gradual change over from venturi suction to vacuum pump suction can be achieved, the co-existence of the two systems within one facility requires understanding and appropriate operational and safety regimes.

Vacuum plant should be served with standby power.

Vacuum plant sizing will be in accordance with AS 2896.

11.5.4. Nitrous oxide

Nitrous oxide is generally provided from gas cylinders arranged to provide a duty and standby source of the gas. The changeover from duty to standby cylinders will be automatic.

Nitrous oxide is used within specialist areas. The location of the cylinders will be as close as practical to the areas of use. High usage areas are operating theatres, maternity and dental units as well as some procedure rooms. The location of the cylinders will be a well-ventilated area and will allow for easy cylinder delivery.

Scavenging outlets must be provided adjacent to nitrous oxide outlets. These can be provided as part of a venturi suction system or as part of a vacuum pump suction system.

11.5.5. Tool air

Tool air is generally provided from gas cylinders arranged to provide a duty and standby source of the gas. The changeover from duty to standby cylinders will be automatic.

Tool air is used within specialist areas; the location of the cylinders will be as close as practical to the areas of use. The location of the cylinders will be a well-ventilated area and will allow for easy cylinder delivery.

Where the demand for tool air is extremely high consideration will be given to the use of high pressure compressor sets to produce the tool air.

Tool air pressure regulator and indicator panels will be provided at the point of use. The regulator and indicator panels are quite large and need to be carefully co-ordinated with other wall mounted services and equipment.

Increasingly, powered tools are instead used and tool air is not needed.

11.5.6. Dental air

Dental air is required at the dental chairs to drive the pneumatic dental tools. Dental air compressors will be oil free units, the installation will include air driers, a dental air vessel and regulators. The Dental Air compressors shall be separate from the Medical Air system compressors. The distribution pipework is usually installed beneath the floor slab to serve the dental chairs. A separately pressure regulated compressed air line may be required to serve such areas as dental laboratories.

Air dryers will be designed to account for the ambient conditions of the installation to ensure that the correct compressed air dew point condition is achieved.

11.5.7. Dental suction

Dental suction is required at each dental chair, for single dental surgery rooms small local suction plant may be employed but for installations serving multiple dental rooms, central plant will be provided. Suction can be provided as either dry or semi-dry, semi-dry system are the more common designers will consult with the dental chair suppliers to ensure that the system that is specified matches the chair requirements.

11.5.8. Isolation valve panels and alarms

Designers will agree with the Hospital on the locations of department emergency isolation valve and

alarm panels as well as the location of central alarm panels. Each operating theatre will include an emergency isolation valve and alarm panel. A standby power supply will be needed for each medical alarm panel, The alarm will be connected to the BMCS. A single valve isolation panel and alarm shall not serve more than one department.

11.5.9. Reticulation

Pipework will generally be in copper, oxygen cleaned where appropriate. Where pipework is installed underground it will be protected against corrosion.

Underground distribution routes will be accurately recorded with in ground markers installed to identify service routes and changes in direction. Pipework sizing will be calculated using the flow rates as set out in AS2896.

Valving will be provided within the hospital to allow isolation of sections of the installation with the remainder of the installation operating normally. In the case of intensive care units, maintenance isolation valves will be included to allow for the isolation of individual bed positions or pairs of beds.

Access panels will be provided to give access to above ceiling isolation valves and pendant NIST fittings.

11.5.10. Medical service panels

Medical service panels will be provided to group services at a patient care location. They can comprise combinations of electrical, communications, nurse call and medical gas services and in some cases only medical gas services.

The numbers of medical gas outlets to each location will comply as a minimum with the AusHFG.

Where ever possible, medical service panels will be installed flush in a single panel. Where installed in fire walls, the installation will be detailed to maintain the integrity of the fire wall.

Back to back installation within common walls cannot always be achieved, in which case the height of the panels will have to be staggered.

11.5.11. Medical gas pipeline systems

Bulk storage of liquid oxygen and (other gases if appropriate) should be selected for refills as agreed with the gas supplier or a maximum of two weeks.

Automatic manifolds are generally recommended to hold a minimum of one days' supply on each bank. Sufficient spare cylinders for changing one complete bank should be stored in the manifold room for all gases except nitrous oxide/ oxygen mixture, for which two complete changes should be stored in the manifold room. Sufficient additional cylinders should be held in the medical gas store to ensure continuous supply for one week.

One or more medical air receivers complying with the design requirements of AS1210 will be installed in the compressed air system. Receiver capacity will be such that each compressor starts less than 10 times per hour during normal working conditions.

The nominal volume of the receiver and pipework should approximate the design flow rate volume per minute of the system. Receiver capacity will be such that no pump starts more than 10 times per hour during normal working conditions.

11.6. Special care locations

The Australian Standard AS2896 now details additional requirements for 'special care locations'. For the

purposes of new developments, these locations include:

- Intensive care units (medical air and oxygen)
- Neonatal intensive care units, excluding low dependency cots (medical air and oxygen)
- Close observation units – stand alone, co-located with ICU or within a speciality inpatient units. This will include a CCU beds (medical air and oxygen)
- Operating theatres (medical air only as back-up for oxygen is available on anaesthetic machine)

12. Security

12. Security

12.1. Introduction

Security systems seek to provide a secure environment to ensure safety for staff, patients and public and to ensure that the ongoing operation of the facility and equipment is not compromised by theft or damage.

12.2. Scope

The following services are considered as part of security systems:

- Integrated security management systems and integration
- Access control
- CCTV
- Intrusion detection
- Credential management systems
- Duress alarm systems
- Electronic key management systems
- Audio and video intercoms systems.

12.3. General requirements

The design will utilise the following principles to maximise the architectural elements that enhance a secure facility:

- Crime Prevention Through Environmental Design (CPTED) and
- Defence in Depth (DiD).

Electronic measures will be planned as part of each facility to manage the following elements:

- Main perimeter
- Entrances and drop off points
- Main entrance(s) and foyers
- Lifts
- Lift foyer
- Stairs
- Reception areas
- Intensive care units
- Inpatient units
- Emergency department
- Research facilities
- Safes

- ATMs and cash in transit routes
- Administration areas
- Laboratories
- Pharmacies
- Loading docks
- Car parks
- Cahiers desks
- ICT facilities, central rooms and data centres
- Risers
- Hazardous bulk storage
- Campus wide areas.

12.4. Planning and context

A risk based approach will be utilised for the identification of threats and evaluation of risks and identification of management strategies to reduce those risks to an as low as reasonably practical level.

12.5. Design criteria

The design will comply with all relevant Australian and International Standards.

The designs should follow the NSW Health ‘Protecting People and Property’ policy and applied after a risk assessment of the project to determine the extent and details of the systems. This applies to access control, monitoring and lighting systems.

Security strategy and resultant electrical security designs should be in accordance with AS4485 Security for health facilities.

13. Acoustics

13. Acoustics

13.1. Introduction

Acoustic design is fundamental to the quality of healthcare buildings. There is a growing body of clinical research that shows that better acoustics leads to improved health outcomes. Well designed, high quality spaces have been shown to facilitate a reduction in the use of analgesics, improved patient recovery times, increased staff efficiency and reduced staff turnover. Further, poor acoustic design of clinical, procedural and consultation areas can negatively impact the performance, communication and concentration levels of staff.

This document provides a basis for the incorporation of all aspects of acoustic design considerations into the detailed design of future and redeveloped healthcare buildings, covering:

- Environmental noise
- Architectural acoustics
- Building services noise and vibration.

13.2. Scope

In the development of the acoustic design for a health care building both the design team and the delivery team, which includes a design (finalisation) responsibility, must consider the following items:

- Environmental noise emission
- Internal design noise and vibration levels
- Environmental noise intrusion
- Building services noise and vibration
- Internal acoustic isolation
- Room acoustics
- Vibration and structure borne noise.

It is important to note that the acoustic design requires coordination and cooperation amongst different disciples, including architecture, clinical planning, building services and structural engineering. Furthermore, there are medical and other equipment that may contribute to issues such as room acoustics, e.g. refrigerators, photocopier/printers, monitoring systems and annunciators. The design team, especially the acoustic consultant, should provide the project acoustic design intent and parameters to the Project Director for onward communication with the FF & E procurement process.

13.3. Design strategy and verification

This document includes:

- Design guidelines to provide the design team with guidance on issues to consider in achieving the design targets, including information on important elements for each acoustic design aspect
- Design outcomes by providing direction to the design team by outlining typical design targets and outcomes
- Promotes consistency in acoustic design by setting a benchmark for all future and updated healthcare buildings.

It is recognised that these outcomes may not apply to all situations. The consultant should critically

review the outcomes and propose departures if necessary for HI consideration, providing reasons as to why these typical outcomes should not be applied. Whenever possible, departures should be identified and resolved prior to the issue of the project enters delivery stage. The objective is to provide a well-defined basis for subsequent tendering and design development. Additional departures may need to occur during the implementation phase, however the objective is to minimise these.

The acoustic design should be documented at key stages of the work, typically not less than at the:

- Planning phase (‘schematic design report’)
- Implementation phase (‘design finalisation report’).

The documentation will clearly define the scope of the project that has been assessed, the acoustic issues considered, the acoustic criteria and design targets adopted and the recommended acoustic design measures. The documentation will be suitable for review by the health service, project manager and design team to ensure that the acoustic requirements are integrated in the design of the works. The documents should also be formatted to assist the project manager in planning the supervision and verification of the acoustic design during the construction and commissioning stages.

13.4. Design guidelines and objectives

13.4.1. Noise emissions from use

All new or redeveloped facilities will be designed so that operational noise emissions and impacts on neighbouring noise sensitive receivers comply with project specific criteria established in accordance with the requirements of the NSW planning and development assessment process.

The design team will also consider the amenity of open external areas within the proposed development such as patient or staff courtyards and other existing healthcare buildings surrounding the development.

All operational noise sources associated with the healthcare building must be assessed against the project specific criteria established for the development in accordance with the relevant guidelines and standards.

Noise generating sources and activities that should be assessed include (but are not limited to):

- All external mechanical plant (including emergency/ standby plant)
- Workshop areas
- Loading dock areas
- Car park noise
- Noise from road traffic generated by the facility
- Noise from emergency helicopter flights associated with the facility, and
- Medical imaging (and associated) equipment.

The assessment will also consider characteristics that influence the impact of a noise source (such as intermittency, tonality, low frequency noise etc.).

General design considerations that may be incorporated in the design include:

- Strategic location of noise generating areas (i.e. plant areas, car park areas, helipad location etc.)
- Consideration of proximity to neighbouring noise sensitive receivers and the cumulative impact from noise generating sources and/ or activities
- Strategic selection of plant (i.e. quiet plant options), and
- Noise control measures to minimise impacts on the proposed building and surrounding environment (this may include enclosures, barriers / screening, sound absorptive panels, acoustic louvres etc.).

In addition to the above general use noise emissions, the relevant NSW planning and assessment processes applicable to each health care project may also require specific assessment and consideration of sleep arousal and disturbance. Noise emissions that occur between 10.00pm and 7.00am (intermittent or impulsive noise in particular) may also require assessment for sleep arousal during the design process in accordance with relevant standards and guidelines applicable to a healthcare development and the development location.

13.4.2. Internal design noise levels

Environmental noise intrusion

All elements of the building façade will need to be constructed to control external noise entering the building. Sound insulation performance requirements for each element should be nominated based on external noise levels from all noise sources that surround the building (as well as predicted levels from any known future noise source).

External elements including, glazing, doors and ventilation openings are generally the weakest elements in an external façade and therefore careful consideration is required in the design and specification to ensure that sufficient sound insulation is provided by the combined performance of a façade.

Internal noise requirements of relevant State planning policies, guidelines and regulations, etc should also be considered when determining project internal noise limits.

Steady state / continuous noise

When assessing environmental noise intrusion from relatively continuous noise sources, such as free flowing road traffic, the facade should be designed to not exceed the maximum allowable internal noise levels, considered in aggregate with noise from mechanical services.

Intermittent noise

External noise sources producing short duration noise events will have varying impacts on the amenity of internal spaces relative to steady state/ continuous noise and therefore should not be assessed using the same criteria.

Intermittent events should be considered according to room function and would typically considered where sleep occurs (to prevent adverse sleep arousal) or in functionally noise sensitive spaces.

Therefore, for sleeping areas, noise intrusion from intermittent noise that occurs between 10.00pm and 7.00am should be controlled to prevent adverse impact on sleep.

Impacts produced by short term noise events will vary depending on the frequency of the events, time of day and maximum level and these factors should be considered when setting performance targets.

Short duration noise sources that should be considered include: aircraft including emergency helicopters; trains, internal and external driveways, loading docks, nearby industry, etc.

Noise sources that would not normally be assessed include emergency vehicle sirens, one off and atypical events, construction noise, etc.

Helicopter noise

Helicopter operations can exhibit similar noise characteristics to fixed wing aircraft pass-bys and generate high levels of short period steady noise levels hovering or idling. However, emergency medical helicopter operations differ from fixed wing aircraft as:

- They can occur at any time of day or night
- They are generally much less frequent than fixed wing aircraft operations near a typical airport
- They are directly associated with the hospital facility.

Criteria for managing noise from emergency medical helicopter operations therefore differ from

standards that apply to noise from fixed wing aircraft.

Impacts produced by helicopters will vary depending on several factors. Generally, helicopter noise should not exceed the internal noise levels in Table 12(a). However, the expected frequency of events, event duration (e.g. approach, engine shut down/warm up, departure), building façade requirements and sensitivity of the affected occupancy should be considered when setting performance targets. Helipad landing statistics may be obtained from NSW HI.

https://www1.health.nsw.gov.au/pds/Pages/doc.aspx?dn=GL2020_014

Preliminary assessment of the above factors should be presented to NSW HI, including a comparison between the building facade requirements necessary to achieve:

- Internal noise level requirements in Table 12(a)
- Any proposed alternative performance targets.

For most hospitals, the average daily frequency of helicopter movements is very low, and /or the helipad is located away from sensitive buildings. Therefore, typically, specific helicopter intrusive noise limits will not apply to new hospital buildings. However, there are a limited number of major hospitals (John Hunter and Royal North Shore hospitals) that have a higher number of movements and, therefore, should be considered different to the typical case. New buildings with a rooftop helicopter landing site should also be atypical and limiting helicopter noise levels should be investigated and direction sought from NSW Health Infrastructure on a case-by-case basis.

In addition to the above, direction should be sought from NSW Health Infrastructure as to whether consideration should be given to 'future-proofing' the building so that, if helicopter operations were to significantly increase in the future, it would be practical to retrofit suitable acoustic treatment to manage noise impacts to an acceptable standard. For example, this may necessitate additional layers of plasterboard in the façade construction so that, if secondary glazing were to be added in the future, the rest of the façade would provide sufficient sound insulation so as not to compromise the glazing performance.

Rain noise

The roof and ceiling construction will be designed so that rain on roofing (particularly metal roofing) does not significantly raise the noise level within internal spaces. This may require additional insulation to control drumming where bedrooms are located at building setbacks.

Emergency generation

The internal noise levels within a healthcare building resulting from the operation of emergency plant should be designed so that undue disturbance does not occur during maintenance / testing procedures and during emergencies, and that statutory requirements are met.

Given the infrequent use of emergency and standby plant, it would be unduly stringent to apply the same noise criteria typically reserved for continuous operation and / or frequent noise generating activities/ sources.

13.4.3. Building services noise

Mechanical and hydraulic services

The internal noise levels due to mechanical plant and hydraulics should be designed to not exceed the maximum allowable internal noise levels, considered in aggregate with the noise from steady state/continuous external noise sources.

The internal noise levels in occupied spaces are to be free of tonality and should not include annoying characteristics including tones and distinctive low or high frequency components described as rumbly or hissy. Nor should the noise contain amplitude or frequency modulation components referred to as hunting or beating.

Tonality will be deemed to apply where the noise in any one-third octave band exceeds the level of the

adjacent bands on both sides by:

- 5 dB or more if the centre frequency of the band containing the tone is above 400Hz
- 8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive
- 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.

In general, noise sensitive spaces should not be located adjacent to, above or below, or near main plant rooms. Where plant areas are located directly adjacent to noise sensitive spaces, high levels of acoustic control will be required.

The following items should be considered during the design (but not limited to):

- Plant noise levels
- Down duct noise transmission
- Aerodynamic noise and air velocities (regenerated noise)
- Duct breakout noise
- Duct break-in noise
- Reverberation minimisation inside plant rooms
- Cross talk (i.e. the design sound insulation performance of the wall, ceilings and doors system must not be compromised)
- Mechanical penetrations (i.e. the design sound insulation performance of the wall and ceilings must not be compromised)
- Strategic locating of plant and ductwork (such as fan coil units to be installed in corridors not inside rooms, and main ductwork to be installed in corridors and not between rooms)
- Ducts, pipes or hydraulic services that pass through sensitive spaces should be sufficiently separated from the space by a construction with a sound insulation rating that will achieve the internal noise levels nominated for that room
- Adequate space should be allowed in plantroom for attenuators and other control measures.

Vertical transportation

Noise from lifts should be controlled in noise sensitive spaces.

Escalator noise should also be considered in addition to lift noise to minimise impacts as best possible (such as quieter selections and/ or energy saving measures to slow movement when not in use).

13.4.4. Acoustic isolation

Designing the sound isolation rating of the partition must consider:

- Adjacency of any noise generating spaces (e.g. plant rooms) to noise sensitive rooms, and achieving services internal noise levels
- Speech privacy requirements (e.g. confidential, private, moderate, not private)
- The reduction in achieved performance from laboratory to the field (flanking paths etc.)
- The composite sound isolation performance of the partition (i.e. reductions in performance resulting from weaknesses in the partition including, doors, glazing, ceilings etc.)
- The background noise level within the receiver room.

Where practical, the building layout should minimise the adjacency of noisy and sensitive spaces. The design sound isolation rating, expressed as Rw, of all partitions must be documented and verified as part of the design process.

Walls and floors – airborne noise

The acoustic design of walls and floors will be specified to provide a level of acoustic separation appropriate to the intended use of adjacent spaces.

The adjacency of different room types will influence the sound isolation rating required for a construction. The final sound isolation rating should consider the adjacency of the different room types with consideration of the following:

- The speech privacy requirements of a noise source room
- The noise sensitivity of the receiving room
- The background noise level in the receiving room, and
- Whether there is a door to a corridor (or the like) in the partition that would otherwise limit the potential performance of the partition as a whole.

Table 14 describes the levels of privacy and the subjective outcome for the end users.

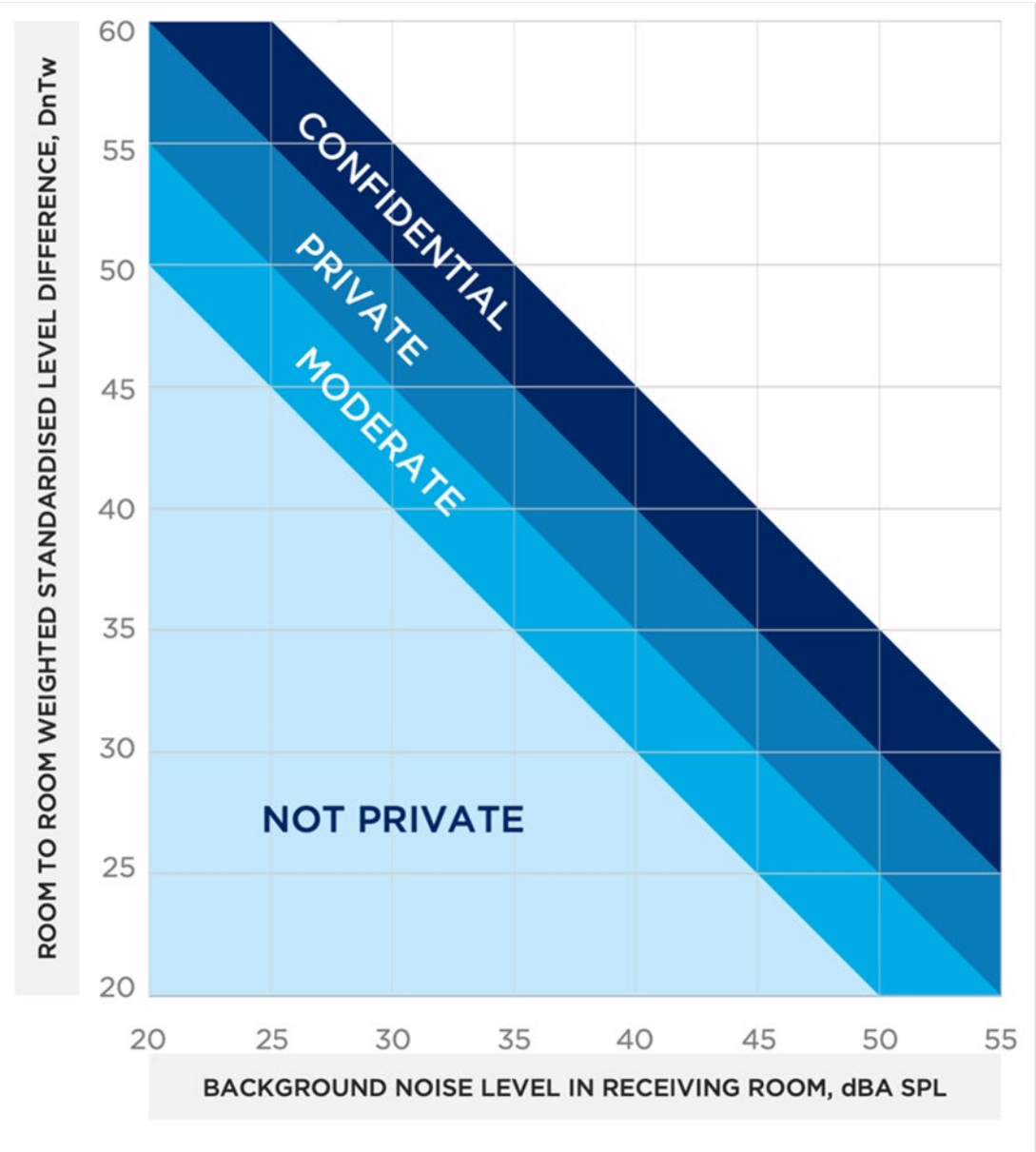
Level of speech privacy	Description	Required outcome (sound insulation, Dw plus background noise, dBA)
Confidential	Raised speech would be audible but not intelligible. Normal speech would be audible.	80 to 85
Private	Raised speech would be audible and could be intelligible. Normal speech would be audible.	75 to 80
Moderate	Normal speech would be audible and intelligible but not intrusive.	70 to 75
Not private	Normal speech would be clearly audible and intelligible.	Less than 70

When assessing the sound isolation rating of a construction to achieve internal noise levels (from adjacent noisy areas) and to achieve the speech privacy requirements, the higher rating of the two assessments takes precedence and should be used as the final sound isolation rating.

Speech privacy

The Figure below illustrates the important dependence of speech privacy on both sound insulation and background noise levels.

Figure 8: Dependencies of speech privacy



There are two approaches to achieving the required levels of sound insulation between rooms, namely full height (slab to slab) constructions or partial height (floor to ceiling) constructions. Full height (slab to slab) constructions are generally considered to be a reliable way to achieve good sound insulation performance but necessitate sealing of services penetrations above the ceiling void. This can be labour-intensive, costly and difficult to inspect and verify, and inhibit flexibility. The use of partial height (floor to ceiling) constructions avoids the need for sealing of services penetrations above the ceiling void but the overall sound insulation is limited by the performance of the ceiling construction. It is recommended that these options be considered in the design to arrive at the most cost-effective solution for the project. There is preference to limiting the use of slab to slab partitioning where possible, unless they are required to achieve privacy requirements for more noise sensitive spaces.

It must also be emphasised that unnecessarily low background noise levels can significantly undermine speech privacy. It would be possible to account for this at the design stage by selecting higher partition performance to maintain privacy standards, but this is likely to be costly and may not be practical. Careful consideration should therefore be given to the design of the air conditioning system to avoid unnecessarily low background noise levels. Consider air conditioning noise in all affected rooms, not just those closest to the main plant, which normally dictate the extent of noise control required

Where necessary, sound conditioning should be considered as an alternative means of ensuring sufficient levels of background noise. This would be reviewed in conjunction with the design team to

determine the most cost-effective way to achieve the acoustic privacy requirements.

Doors and internal glazing

Partitions with doors will always achieve a lower performance than a partition of the same construction without a door. Doors will limit the overall performance as they are generally of a much lighter construction and they are difficult to seal. Therefore, locating of doors is important where the following should be considered:

- Maximising the distance between doors of neighbouring spaces, rather than directly side by side
- Doors along corridors should be offset where possible, rather than opposite one another
- Sliding doors and/ or pivot doors should be avoided where any degree of acoustic separation is required
- Doors should be avoided between noise generating/ sensitive rooms and rather installed in partitions facing corridors.
- There are generally two standard door types that are used in healthcare building including:
- General doors with no specific acoustic performance
- Acoustic doors to provide a higher level of sound isolation typically achieved with a thick solid core door with full perimeter and threshold seals.

Additionally, there may also be in some instances critical spaces/ adjacencies where proprietary acoustic door sets should be provided.

Table 12(b) indicates door types required for various room types and adjacencies.

While higher performance doors can be provided, they are likely to be heavy, more difficult to operate with functionality that may conflict with healthcare environments, require greater maintenance and be relatively expensive.

Where glazing is included within a partition, it should be appropriately specified to ensure that the overall performance of the partition is not degraded significantly.

Walls – impact noise

Where partitions are expected to receive a significant number of impacts e.g. from moving trolleys / equipment or from services / machinery and the partition is adjacent to a noise sensitive space, then the partition must be a double leaf wall without connection between the leaves except at the periphery e.g. ‘staggered stud’ partitions.

Examples of partitions that should be considered for double leaf construction when adjacent to a noise sensitive space are:

- Bathrooms
- Kitchens
- Laundries
- Workshops.

It also important for the design team to consider structure borne noise that can be generated via direct mounting of equipment such as TVs and other audio vibration generating devices which may require some form of additional separation between two sides of a partition.

Floors – impact noise

When required, sources of impact noise should be controlled at the source wherever possible i.e. at the surface of the floor with a soft pliable material such as vinyl with underlay. The objective is to attenuate impact sound (e.g. footsteps) transmitted into a space via the floor. Sources of impact noise must be separated from sensitive spaces such as wards and operating rooms. Impact isolation treatments must be provided where noise sensitive spaces are located below corridors that have high foot traffic.

Resilient floor coverings need to be considered in conjunction with wear and rolling resistance needs of the surface, and where resilient floor coverings are not suitable, resiliently suspended ceilings should be considered.

13.4.5. Room acoustics

Each room and area should be designed to have room acoustic design that supports the function of the space. The spaces should be comfortable to occupy, speech should sound natural, and the typical activities carried out within each space and environment should not be tiring over long periods.

Acoustic absorptive treatment is recommended in all areas (including corridors) with a Reverberation Time (RT) criterion in Column E of Table 15. Where it is determined to be impractical to achieve the RT criteria due to conflicting requirements such as cleaning, infection-control, patient-safety, clinical and maintenance requirements, the RT shall be reduced to as far as practicable.

The acoustic absorptive treatment will normally be applied to the ceiling. However, floor or wall finishes may also be considered. Where speech intelligibility is critical or where speech reinforcement or audio conferencing systems or activities occur (e.g. telemedicine), the acoustic design must consider treatment to other surfaces to reduce negative acoustic effects such as flutter echoes.

For rooms requiring optimum acoustic conditions such as lecture theatres, specialist advice should be sought.

Vibration

Internal vibration within a healthcare facility is a critical issue for sensitive equipment and the amenity of building occupants.

Vibration levels will comply with applicable international standards for human comfort and structural damage. The criteria for vibration-sensitive equipment or processes will be determined by reference to the manufacturer’s specifications and/ or derived from sensitivity testing of existing or equivalent equipment or processes.

Guidance on the assessment vibration and design of vibration control measures should be obtained from relevant Australian Standards and environmental guidelines.

The assessment and design of vibration controls will consider the type of vibration source including:

- Continuous vibration continues uninterrupted for a defined period (usually throughout daytime and / or night-time). This type of vibration is assessed on the basis of weighted acceleration values
- Impulsive vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than two seconds
- Intermittent vibration can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

Vibration sources are best controlled and most effectively controlled at the source. Treating vibration issues following the installation of equipment can require more effort, is costly and often not practical. Therefore, when considering vibration in healthcare buildings, proper planning is a critical component in the design. An acoustic consultant should be involved from the early planning stages so that potential vibration issues can be raised early on. This is most important for allowances of future changes or new equipment. Without early advice and proper planning from the design team, future installations of equipment such as MRs can cause significant vibration issues, from both operational and installation perspectives.

Structure borne noise from plant and equipment must be considered (in addition to tactile vibration) in aggregate with building services, services noise and environmental noise intrusion.

Generally, generators or plant with high levels of vibration should not be located on suspended slabs where possible. Where possible these plant items should be placed on grade to avoid costly vibration mitigation measures.

13.4.6. Special areas

There are some special areas where the clinical and infection control requirements may create conflicting design requirements and thus pose design challenges.

Mental health units

A higher sound isolation/speech privacy performance is typically warranted for certain rooms in the mental health units (e.g. bed, seclusion, sensory, de-escalation, etc.). This is particularly relevant for ‘Adult Acute’ and ‘Older Peoples Acute’ mental health units. It is recommended to identify this acoustic design consideration the sound isolation/speech privacy strategy for these rooms/spaces should be adjusted from the standard approach to inpatient units to suit

Acoustically absorptive surface finishes may be limited in mental health rooms/spaces due to conflicting design requirements (e.g. anti-ligature, security, tamper proof, etc.). For example, to satisfy tamper proof requirements, perforated material hole diameters need to be limited to approximately 6-8 mm. This can limit the acoustic absorption performance of some perforated systems. Notwithstanding these potential constraints, the design team must endeavour to optimise the acoustic design of the spaces. The design team should work with all stakeholders to arrive at agreements regarding aspects of acoustic privacy and reverberation times taking into consideration the above challenges.

Operating rooms

Operating Rooms present a similar set of challenges in respect of reverberation time, as wall and ceiling surface areas available for acoustic absorptive materials will be limited, or at times unavailable. The design team should undertake design discussions with all stakeholders to arrive at agreements regarding aspects of acoustic privacy and reverberation times taking into consideration the above challenges.

13.4.7. Sound masking

The adoption of sound masking has increased as the technology matures and becomes commercially more affordable. This initiative may be able to assist and/or offset the need for some building elements (e.g. full height walls) in achieving sound isolation or privacy and provide a reasonable level of background noise to overcome sometimes environment which may be too quiet. This can be explored on projects where there may be specific needs for this technology, with a full cost benefit assessment to inform any decisions made by HI.

13.4.8. Energy and sustainability

Acoustic design offers some opportunities for sustainable design. Materials specified as part of the acoustic design should be considered against products, which offer sustainability benefits. When selecting products, consider:

- Recyclable products
- Products made with recycled materials
- Low embodied energy construction methodologies and materials
- Reduce the use of loaded vinyl products where possible

- Selection of low-pressure loss acoustic attenuation components for the HVAC system.

13.5. Design outcomes

Typical design/performance outcomes have been developed using the design principles outlined above.

Notwithstanding, there will be situations that are non-typical or may not be covered by these typical outcomes. In these cases, the designers/consultants should develop and document appropriate alternative or additional assessment criteria.

Table 15 summarises the typical design performance outcomes.

Table 15: Acoustic requirements for areas affecting patient care hospitals and outpatient facilities

Acoustic requirements for areas affecting patient care hospitals and outpatient facilities							
Area designation	**A**		**B**	**C**	**D**	**E**	**F**
	Continuous internal noise levels l_{aeq} db		**Intermittent internal noise level l_{amax} db [9]**	**Internal noise level helicopter $l_{amax\ (slow)}$ db [7]**	**Floor impact sound isolation l_{nw} db**	**Reverberation time (s) (fully furnished)[4]**	**Emergency generator internal noise level l_{amax} db [11]**
	Satisfactory	**Maximum**					
Clinical							
Operating theatre	40	45	55	65	50	Note 12	+ 5
Birthing room	45	50	65	75	60	Note 12	+ 5
Intensive care	40	45	60	65	55	Note 12	+ 5
Single patient bed room	35	40	55 [10]	68	50	0.4 - 0.7[13]	+ 5
Multi bed room	35	40	55 [10]	68	55	0.4 - 0.7[13]	+ 5
Toilet / ensuite	50	55	–	75	60	-	+10
Patient corridor	40	50	–	80	60	Note 8	+ 10
Counselling / interview room	40	45	60	65	55	0.4 - 0.6	+ 5
Consultation room	40	45	60	65	55	0.4 - 0.6	+ 5
Speech therapy	35	40	60 [6]	65	55	0.4 - 0.6	+ 5
Treatment / medication / examination room	40	45	60	65	60	0.4 - 0.6	+ 5
Public areas							
Corridors and lobby spaces	40	50	–	80	60	Note 8	+ 10
Cafeterias / dining	45	50	–	80	60	Note 8	+ 10
Toilets	45	55	–	70 -	–	–	+ 10
Waiting rooms, reception areas	40	50	–	80	60	0.4 - 0.6	+ 10

Acoustic requirements for areas affecting patient care hospitals and outpatient facilities							
Area designation	**A**		**B**	**C**	**D**	**E**	**F**
	Continuous internal noise levels l_{aeq} db		**Intermittent internal noise level l_{amax} db (9)**	**Internal noise level helicopter $l_{amax\ (slow)}$ db (7)**	**Floor impact sound isolation l_{nw} db**	**Reverberation time (s) (fully furnished)[4]**	**Emergency generator internal noise level l_{amax} db (11)**
	Satisfactory	**Maximum**					
Multi faith / chapel	30	35	–	65	50	0.4 - 0.6	+ 5
Staff / back-of-house areas							
Meeting room	35	40	–	70	55	0.6 - 0.8	+ 5
Board / conference room (large)	30	35	–	70	55	0.6 - 0.8	+ 5
Open plan office space	40	45	–	75	60	0.4 - 0.6	+ 5
Single person offices	35	40	–	70	55	0.6 - 0.8	+ 5
Multiple person offices	40	45	–	75	55	0.4 - 0.6	+ 5
Change/ locker room	50	55	–	-	-	-	+ 10
Staff room	40	45	–	75		Note 8	+ 5
Classrooms, training rooms	35	40	–	75	55	0.5 - 0.6	+ 5
Lecture theatre	30	35	–	75	55	Curve 1 of as2107	+ 5
Library	40	45	–	80	55	0.4 - 0.6	+ 5
Workshops	45	50	–	–	–	Note 8	+ 10
Plant rooms	N/a	<85	–	–	–		–
Laboratories	45	50	–	75	60	0.4 – 0.7(12)	+ 10

Notes:

1. *All sound pressure levels referenced to 20 micro-Pascals (dB re 20 µPa).*
2. *For Column A, Leq noise levels should be measured over a repeatable, worst-case one hour period. A one hour averaging period has been selected to best represent impacts from continuous noise sources, and any frequently occurring intermittent noise sources.*
3. *The repeatable maximum noise level generated by lift operations should not exceed the maximum Leq noise level specified for that space (excluding lift lobbies).*
4. *Reverberation times are the arithmetic average of the middle frequencies in the octave bands of 500 Hz and 1 kHz.*
5. *Where rooms have a "confidential" or "private" speech privacy requirement (Refer to Table 16 for speech privacy requirements), the ambient noise levels in adjoining rooms are to be in the range between "satisfactory" and "maximum" in Column A . In other words, the "satisfactory" criterion should be interpreted as a "minimum" value for rooms adjoining those that require a degree of acoustic privacy, unless partition ratings have been otherwise determined using lower background noise levels. In this case the design basis should be nominated.*
6. *Speech and language therapy excludes audiometric rooms and specialist test and measurement rooms that require more controlled ambient noise conditions.*
7. *Noise levels apply to Westmead and Royal North Shore hospitals. For new buildings with a rooftop helipad, specific consideration should be given to controlling helicopter noise levels, in agreement with NSW HI on a case-by-case basis.*

Direction should be sought from NSW HI on a project-by-project basis as to whether consideration should be given to 'future-proofing' the building against future increases to helicopter movements on the rooftop helipad.

8. *Reverberation time should be minimized as much as practicable for noise control. Acoustic treatment should have a minimum acoustic performance equivalent to NRC 0.7 covering at least 80% of the area of the ceiling. If acoustic materials with a higher NRC performance are proposed, the coverage area can be reduced proportionally.*
9. *The acceptability of any intrusive noise depends on the frequency of occurrence, the intrusive noise level and character, plus the sensitivity of the space. The intermittent internal noise levels shown are intended to apply to any frequently occurring intermittent noise sources including rail, internal and external driveways, loading docks, nearby industry, etc. and where the frequency of occurrence of the noise source is sufficiently high or low that adequate control of the intrusive noise level is not achieved via the Column A, Leq noise levels. The project acoustic engineer is required to apply professional judgement in assessing the frequency of occurrence of the intrusive noise, the intrusive noise level and character, plus the sensitivity of the space to apply the intrusive noise limits in Column B. Justification of the basis of the design needs to be reported for HI review. The intrusive noise limits in Column B do not apply to noise from commercial aircraft (which is to be assessed in accordance with AS2021).*
10. Where a significant, intermittent and intrusive noise source is prevalent, a sleep disturbance assessment is required. The outcome of this assessment shall be included with the acoustic design.
11. *Noise levels are set relative to the 'maximum' continuous internal noise levels from Column A.*
12. *For spaces where sound absorptive finishes may have critical implications for infection control, hygiene or sterility requirements, the design team should investigate suitable acoustic treatment options from manufacturers that can satisfy the functional requirements.*
13. *For mental health units, while good room acoustic design is desired, achieving the reverberation time targets will be challenging given conflicting requirements (e.g. anti-ligature, security, tamper proof, etc.). The design team should justify any instances where sound absorptive finishes may not be possible.*

Table 16 Acoustic speech privacy requirements

Speech privacy requirements for areas affecting patient care hospitals and outpatient facilities				
Area designation	**A**	**B**		
	Speech privacy requirement (for walls with no doors)	**Door type [1] / adjacency**		
		Room to room	**Room to reception / waiting**	**Room to corridor**
Clinical				
Operating theatre	Private	Type 1	-	–
Birthing room	Confidential [2]	Type 2	Type 1	–
Intensive care	Moderate	–	–	–
Patient room / single bed room	Minimum rw42 partition	–	–	–
Clinical				
Multi bed room	Moderate	–	–	–
Toilet / ensuite	Moderate	–	Type 1	–
Patient corridor	–	–	–	–
Counselling / interview room	Confidential [2]	Type 2	Type 1	Type 1
Consultation room	Confidential [2]	Type 2	Type 1	–
Speech and language therapy [4]	Moderate	Type 1	Type 1	–

Speech privacy requirements for areas affecting patient care hospitals and outpatient facilities				
Area designation	**A**	**B**		
	Speech privacy requirement (for walls with no doors)	**Door type [1] / adjacency**		
		Room to room	**Room to reception / Room to corridor waiting**	
Treatment / medication room	Private	Type 2	Type 1	Type 1
Public areas				
Corridors and lobby spaces	–	–	–	–
Cafeterias / dining	–	–	–	–
Toilets	–	–	Type 1	–
Waiting rooms, reception areas	–	–	–	–
Multi faith / chapel	Confidential [2]	Type 2	Type 1	–
Staff / back-of-house areas				
Meeting room	Private	Type 2	Type 1	–
Board / conference room (large)	Private	Type 2	Type 1	Type 1
Open plan offices	Moderate	–	–	–
Private offices	Private	Type 1	Type 1	–
Multi person offices	Moderate	–	–	–
Locker room	Moderate	–	–	–
Rest room	–	–	–	–
Classrooms, training rooms	Private	Type 2	Type 1	–
Lecture theatre	Private	–	Type 1	Type 1
Library	–	–	–	–
Staff / back-of-house areas				
Workshops	–	–	– [3]	– [3]
Plant rooms	–	–	– [3]	– [3]
Laboratories	Moderate	–	–	–

Notes:

1. *Door Types*
    - Type 1 – Solid core door with perimeter and threshold acoustic seals
    - Type 2 – Specialist acoustic door set (the use of Type 2 doors should be minimised by appropriate planning)

2. *Confidential privacy requirements can be difficult to achieve in practice with cost-effective solutions. These spaces should be reviewed and agreed on a case-by-case basis.*
3. *As required to control noise break-out from plant, equipment or machinery to adjacent areas.*
4. *Excluding audiometric rooms and specialist test and measurement rooms that require specific sound insulation and intrusive noise requirements.*
5. *For lecture theatres, meeting rooms, etc where use of AV, assisted speech or teleconferencing is used extensively, ratings for separating constructions should be increased by five points.*

14. Pheumatic tube system

14. Pneumatic tube system

14.1. User briefing requirements

Pneumatic tube systems are commonly used within hospitals to transport:

- Bloods, blood culture tubes, blood culture bottles but not suitable to support mass transfusion protocols
- Urine samples
- Blood packs, critical blood products, plasma, albumin
- Swabs
- Tissue samples
- Samples in fixative
- Glass sides
- Cerebrospinal fluid (CSF)
- Medication, prescriptions
- Documents.

The design team shall obtain briefing information from the Project User Groups during the Schematic Design phase to determine the optimal arrangement of the system. The briefing process must determine:

- Specimens/ items to be transported, and their sensitivity to temperature, maximum speeds of transport, susceptibility to shaking and breakage
- Criticality of wait times, maximum transfer times between departments
- Priority links between departments, and any requirement to prioritise urgent traffic in the system
- System certification requirements (typically for blood products)
- Security and access control requirements for stations and carriers
- Required integration with other pneumatic tube systems on the precinct (if present)
- Required integration with (or future proofing for) other automated systems such as but not limited to automated core laboratories, automatic guided vehicles, Automated pharmacy dispensing.

The design of the new system, the tube diameter, zoning, and plant locations shall be required to meet the performance requirements identified during the briefing process. Locations of stations within each department shall be coordinated by the Architect based on operational and clinical workflows.

In some cases, point-to-point systems and dedicated zones may be the most cost-effective means of meeting the performance requirements for high traffic department linkages.

Pneumatic tube systems shall generally not be designed for bulk transfer of blood products for mass transfusion protocols. This is considered impractical due to the high quantity of products required to manage severe traumas.

14.2. General design requirements

When adequately supported, pneumatic tubing can be installed externally. There is however a risk of physical damage and excessive expansion of pipework due to temperature fluctuations. Temperature fluctuations can also adversely affect contents of the carriers, hence wherever possible external

installations should be avoided.

Hospitals place high level of reliance on pneumatic tube systems in the delivery of patient care. Systems should therefore be placed on standby power supplies to ensure system operation during power outages. This should include the controls systems to ensure carrier positions are not ‘lost’ during changeover to standby power.

Air tube conveyor systems can have significant impacts on the efficiency of logistics for small and urgent deliveries within a healthcare facility. Several suppliers have systems available in Australia. The key points are:

- Tube carriers – carriers should be leak proof and tamperproof
- Systems should be able to track and locate carriers in the system via RFID
- Ideally, systems should be able to vary the transport of carriers according to its contents and priority
- System installation – designers should note that the tubes require a minimum bending radius to allow carriers to pass freely. This requires special co-ordination with services in the ceiling, joinery, walls etc
- System cleanout – the design of the system should allow for a special carrier to be inserted which will clean and disinfect the inside of the system
- The engineering services masterplan should consider and detail how a pneumatic tube system would be expanded to subsequent future stages while maintaining the required system performance.

The PTS should be connected to the local facility network to ensure that any blockages or issues are identified immediately, and specimen loss is avoided.

15. Steam sterilisation

15. Steam sterilisation

Sterilisation is carried out on reusable medical devices to eliminate cross infection. Sterilisation is achieved using processes of washing, steam autoclaving, drying, packing and storage within a suitable environment.

Two methods of generating steam are commonly used, central steam generation and local steam generation. The most important factor is in producing the correct dryness of steam at the point of use. If the steam is too wet then effective sterilisation will not be achieved.

The central plant is generally gas operated and comprises steam boilers or more commonly steam generators. These units are usually located within a plant room and steam is distributed to the sterilisers via pipework. Distribution pipework must include pressure regulation, moisture separators, be adequately insulated and drained with steam condensation traps provided at the point of connection into the autoclave to ensure that steam dryness is achieved.

The local steam generation is usually electrically operated and can be provided as part of the sterilising RO plant requirement equipment. Although steam dryness can be more reliably achieved when produced locally, the electrical demand can become a significant load on the electrical supply and this needs to be considered.

The location of smoke detectors should be coordinated so the steam does not trigger the alarm.

16. Building management and control system

16. Building management and control system

16.1. Introduction

The purpose of this document is to set out the functions of a BMCS and the standards to be applied.

This document sets out proposals for achieving a system that gives sufficient information to enable the functions of the hospital to be carried out in a cost effective manner.

The provisions of the document are to be applied to all new BMCS and to all extensions or enhancements of existing systems.

The implementation of BMCS with digital technology and open communication standards will provide a unified approach to automation systems throughout healthcare projects for seamless integration, energy monitoring and intelligent automation of the building services.

The BMCS should be an open building control system using Lon Mark, Lon Works, Modbus or BACnet standards with full interoperability. Selection of a BMCS system will be appropriate to the size, nature and location of the project. Where economically and technically appropriate, it is preferable to extend on an existing BMCS system on small to medium size projects, rather than to duplicate systems. Life cycle analysis is will be undertaken to inform a decision in this regard.

Alternatively, systems should be selected for high level interface compatibility. Where this is not possible, low level interface between systems may be considered to achieve a degree of system integration. This should always be considered a last choice.

Also, of significance, is the degree of sophistication appropriate to the project and location. Overly sophisticated systems requiring a high level of computer skills are not appropriate to remote locations.

16.2. Scope

The new BMCS will be consist of a high speed, peer to peer network of digital controllers, run and standby servers and operator workstations. The operator workstation will provide for overall system supervision and configuration, graphical user interface, management report generation and alarm annunciation. Scope of BMS provision will include but not be limited to:

- Mechanical services digital controls
- Electrical services monitoring
- Communications network (unless part of an Integrated Communications Network (ICN)
- Open communications capability such as BACnet, LON, Modbus Connectivity
- All associated field devices such as; sensors, control valves, etc.
- All associated hardware including computer workstation
- All associated software
- Graphical User Interface (GUI)
- Remote access via web pages
- Energy management and reporting
- Historical data logging
- 12 months preventative maintenance and warranty.

The new system will use open IP/ Ethernet based protocol for communication to the operator workstation or web server; and for communication between control modules. System will conform to the following minimum standards over network connections. Systems will be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).

- Graphic display – a graphic with 20 dynamic points will display with current data within 10 seconds
- Graphic refresh – a graphic with 20 dynamic points will update with current data within eight seconds and will automatically refresh every 15 seconds
- Configuration and tuning screens – screens used for configuring, calibrating or tuning points, PID loops, and similar control logic will automatically refresh with six seconds
- Object Command – devices will react to command of an analogue object within two seconds
- Alarm response time – an object that goes into alarm will be enunciated at the workstation within 45 seconds
- Program execution frequency – custom and standard applications will be capable of running as often as once every five seconds. Select execution times consistent with the mechanical process under control
- Multiple alarm annunciations – each workstation on the network will receive alarms within five seconds of other workstations.

16.3. General requirements

BMCS will be proven reliable systems with components which have been in commercial or industrial use for two years prior to any project delivery. The system architecture will be flexible, expandable and backward compatible throughout the given life expectancy of the project.

Systems will be configured to maximise energy efficiency without detriment to environmental conditions with all proposed control strategies pre-approved and tested.

Operator workstations will be engineered to provide clear three dimensional animated graphics for all connected plant and systems with summary information of operational profiles such as times, conditions and energy usage. The operator interface will include energy dashboards and building performance information.

Alarms will be clearly identified in plain English with all point identifiers / references labelled without acronyms and in accordance with any existing identification convention or as directed by the facility engineer. Projects with an existing BMCS will consider the life cycle of the existing system, integration of legacy technology and migration options onto a single open communications platform. Life cycle costs inclusive an ongoing maintenance will be factored into proposed upgrade options and compared to replacement costs where a competitive tender may provide a more cost-effective solution.

BACnet Systems will have BACnet test lab certification inclusive of operator work stations and all field devices.

BMCS software will enable interrogation of stored historical data. Additionally, BMCS must be capable of output to database. Databases will use an open standard such as SQL for operator queries integration to enterprise systems for seamless data transfer for a digital hospital.

Systems will be configured and commissioned with operational trend logs for all sensor points at 15 minute intervals. Remote access will be provided via a web-based application using a thin client with secure login. Users will be provided with individual privileges for levels of access and area control. Levels of access will be as agreed with the facilities engineer.

Systems will provide event management with audit reporting of all system user activities.

16.4. Planning and context

All projects will consider and document:

- Compliance with any master planning such as site expansion
- Integration with existing systems
- Proposed site communications infrastructure (dedicated network or ICN)
- Detailed control sequences specification for energy efficient control
- Detailed points schedules nominating trends and alarms
- Commissioning planning
- Minimum standard commissioning requirements
- Building tuning requirements
- Operator training schedule
- Energy efficiency targets
- Procurement methods for small projects and large projects.

Where integration is required, the BMCS specialist will be responsible for all interfacing documentation for compatibility of equipment.

16.5. Design criteria

The design will comply with all relevant Australian and International Standards.

Work, materials and equipment will comply with the most restrictive of local, state and federal authorities' codes and ordinances, or these plans and specifications. As a minimum, the installation will comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:

- ANSI / ASHRAE Standard 135, BAC net – A Data Communication
- Electrical work – To AS/ NZS 3000 Wiring Rules
- Fire and smoke control – to AS 1668:1, Fire and smoke control in multi-compartment buildings
- AS/ NZS 1367: Coaxial cable and optical fibre systems for the RF distribution of analogy and digital television and sound signals in single and multiple dwelling installations
- Australian Communications Media Authority (ACMA) installation requirement for Customer Wiring AS3080, AS3084, AS/ NZS 3085, AS/ NZS 3087
- AS/ ACIF S008 and AS/ ACIF S009.

16.5.1. Required functions

Subject to the conditions set out below the following functions will be provided by the BMCS system as a minimum. All functions will be represented graphically at the front end and on remote stations as required.

- Plant control (temperature, humidity, pressure, etc.)
- Optimum and scheduled start and stop plant
- Electrical load shedding
- Outside air economy cycle control
- Alarm annunciation

- Data gathering and logging.

Given the high cost of providing BMCS, the limited life of the technology (currently about 10 years) and the large volumes of information generated, the objective in installing a system is to include only those monitor and control points and functions that can be demonstrated to indices (Green Star or similar) for the project will also be considered when determining control and monitoring point provision.

Typical functions are detailed below.

Energy Management

- Energy metering from supplier including (as appropriate) kWh and kVA
- Chiller and boiler KW output
- Power to major sub-mains (the cut off between ‘major’ and minor needs to be viewed by weighing the cost of monitoring against the benefits of allocating costs to departments and some other basis such as floor areas)
- Data logging of plant run hours
- Electrical load shedding
- Emergency power mode operation
- Water monitoring and usage.

Control

- Start and stop plant
- Optimise plant operation to reduce energy consumption
- Switch off lights and plant for areas not in use – use of BMCS for this function is to be justified by economic comparison with alternatives
- Chiller and boiler optimisation
- Temperature control (subject to need to have this centrally controlled)
- Pressure control for rooms with such requirements
- Positive sensing and supply air sensing.

Alarm functions

- Fault alarms from critical items – normally a common alarm for each item of plant will suffice
- Alarms from items of non-mechanical equipment such as blood refrigerators, body holding, kitchen cool rooms, medical gas plants, lifts, diesel generator, hydraulic pumps etc. where fault condition could be life threatening or lead to major financial loss
- Fire alarm indication with ability to allocate priorities.

Maintenance functions

- Hours run log of plant items
- Scheduled maintenance
- Operating hours logging
- Performance logging (e.g. temperature profiles)
- Fault / alarms logging and analysis.

16.5.2. Operator training and capacity

A modern direct digital control BMCS represents a high level of technical complexity and requires an equivalent level of mechanical contractor, operators and maintenance staff.

It is essential that any system installed is capable of being understood and operated by relevant hospital staff. Experience has shown that it will rapidly fall into disuse for all but the most basic functions. The system must, as well as being suitable for the staff that it will use and maintain it, be provided with technical back-up in the form of comprehensive, usable documentation and a formal training structure for initial and subsequent users.

16.5.3. Maintenance arrangements

Consideration should be given on large or complex BMCS to incorporating a long-term maintenance agreement into the installation contract.

Such long-term contract needs to be carefully prepared. In addition to setting out requirements for maintenance of hardware, software upgrades and the like; it must also cover issues such as the training of new operators over the years, modification of software and extension of the system.

16.5.4. Local support

The system which is installed and commissioned must be provided by a vendor which can provide 24-hour support and periodic performance maintenance for the life of the system software and hardware. As a part of the specification and contract, the new system provider will be required to submit the option price to undertake comprehensive maintenance for a period of five years.

16.5.5. Redundant equipment

All equipment and services made redundant through a project and required to be removed from its existing place of installation will be stripped out and removed. All effort will be made to recycle redundant equipment.

Redundant control services will be stripped back to source. All redundant materials including those containing hazardous must be disposed of in accordance with the EPA, Worksafe and all relevant authority requirements.

16.5.6. Ownership of proprietary material

Project specific software and documentation will become the end users' property. This includes, but not limited to:

- Graphics
- Record drawings
- Database
- Application programming code
- Software
- Documentation.

17. Vertical transportation

17. Vertical transportation

17.1. Introduction

The following information provides general guidelines for vertical transportation services within multilevel hospitals and health care facilities. This information has been derived from industry best practices and is not to be taken as a design solution for projects, as the individual requirements for each hospital must be considered and incorporated within the design for each specific site.

17.2. Scope

The scope of this design guide covers vertical transportation services inclusive of:

- Bed/ passenger lifts
- Passenger lifts
- Goods lifts
- Service lifts (dumbwaiters)
- Escalators and moving walks.

17.3. Code requirements

The design will comply with relevant Australian and International Standards. Consideration is to be made to the NCC and meeting AS1428.1 Design for Access and Mobility.

17.4. Planning and context

This document provides preliminary planning guidance for vertical transportation services however the specific requirements for each project must be assessed and an agreed design brief must be documented after consultation with relevant stakeholders.

Preliminary planning for lifts, escalators and moving walks must be based on generic spatial details to assist in providing a design on which competitive tenders can be received from multiple suppliers within the local market.

Where specialist equipment or products are identified as being required, and such are available from a limited number of suppliers, or a sole supplier, these suppliers must be invited to become an active partner in the design development process.

Specialist advice should be sought for lift traffic design.

17.5. Vertical transportation assets

17.5.1. Lifts

Lifts are to be used for transportation of passengers and goods. An assessment of the number, type, speed and size of the lifts must be made based on the agreed site-specific design brief as developed.

17.5.2. Escalators and moving walks

Careful consideration must be given prior to incorporating escalators or moving walks into any project, as although ideal for moving large numbers of people very quickly, they are generally not suitable for use by disabled, elderly or infirm passengers. Use in locations where there is a through site link, or link to a transport hub may be appropriate, however lifts and stairways must also be provided nearby to offer a choice for those passengers who are unable, or not comfortable using escalators and moving walks.

It should be noted that a stationary escalator is not safe for use as a stairway as it does not meet stairway code requirements.

17.6. Traffic analysis criteria

Passenger lifts analysis criteria include:

- Traffic analysis to determine number of lifts; analysis to be based on two-way traffic demand for a five minute interval
- Waiting interval required within the range of 30-50 seconds
- Handling capacity is required within the range of 8-12% of total population for the five minute interval, where 8% should be used for very light use buildings and 12% is used for heavy use buildings. Handling capacity is not usually an issue due to use of large capacity bed / passenger lifts, but needs to be assessed with waiting interval
- The total population. The design population can generally be based on between three and five persons per bed. Where peak hours or routes differ between staff and visitors, these populations can be separated into one and two visitors per bed and two and three staff per bed
- Populations for non-inpatient units should be determined based on a person per square metre or persons per room basis depending on the type of use.

17.7. Design considerations

Vertical transportation design criteria consider several factors including, but not limited to, the following:

- The number of floors in the building, main entry floors and floors served
- The number of beds in the hospital
- Types of departments proposed to be accommodated within the building
- The amount of inter-departmental traffic within the building likely to be generated
- The number of staff, shift patterns, visitors and visiting hours
- Distribution of food, goods

17.8. Requirements when transporting patients and related equipment

17.8.1. Transporting equipment

A list of items required in patient transport scenarios, including dimensions of clinical equipment and technical lift car and shaft data from lift manufacturers are shown in tables below.

Table 17: Required equipment for ICU bed transport.

Bed / Equipment	Width (mm)	Length (mm)	Comments
Standard patient bed	1020	2210	
ICU bed	1100	2400	
Bariatric bed - Arjo Huntleigh: Citadel Plus - *retracted for transport* - Position 1	1030	2300	Shown in Figure 7
Bariatric bed - Arjo Huntleigh: Citadel Plus - *fully extended* – Position 3	1340	2500	Shown in Figure 8
NSW Ambulance stretcher (helicopter transport)	750	2200	Used in layout sketch
NSWA stretcher - standard (vehicle)	580	2060	
NSWA stretcher - bariatric (vehicle)	750	2000	
ED stretcher	920	2200	Noting many ED use a standard patient bed
ECMO machine and trolley	600	550	
Balloon pump	650	1200	Used in layout sketch
Electric bed tug – beyond bed	-	300	Used in layout sketch
Ventilator	400	400	Used in layout sketch

Table 18: Lift manufacturers advice

Bed type	Lift car (mm)	Door opening CTR 4 panel (mm)	Shaft size single entrance (mm)	Shaft size through entrance (mm) (Note 2)	Weight (kg)	Travel speed (m/s) (Note 1)	Head-room (mm)	Pit depth (mm)
Standard patient bed	1800 w x 2700 d x 2400 h	1600 w x 2100 h	3200 w x 3150 d	3200 w x 3310 d	Up to 2500	1	4350	1850
ICU	2400 w x 3000 d x 2500	1600 w x 2100 h	3600 w x 3450 d	3600 w x 3600 d	4000	0.8	4450	1850

Note 1: Lift travel speed to be selected to suit the building height and lift traffic analysis criteria. Higher speeds will be possible in buildings higher than 3 levels.

Note 2: Measurements relating to shaft sizes is notional only and reflects the biggest, or worse-case scenario, dimensions when a range of manufacturers were consulted. Project teams should finalise the shaft size when the dimensions of the actual lift car are known.

Note 3: It is a balance between achieving the optimal lift car size without compromising the travel speed of the lift.

17.8.2. Routine patient movements

Standard patient bed lifts are used to transfer a range of acutely ill patients using a NSW Ambulance stretcher (including those used in vehicles and helicopters) standard patient beds, bariatric beds and ICU beds.

The space allowance in the lift car can accommodate staff and equipment positioned beside the hospital bed. In addition, space is available to allow for a staff member to be positioned at the head of the bed.

Lifts will ideally be located where there is a requirement for the movement of patients. Where there is a requirement for high cross traffic of patients across large floor plates, lift nodes should ideally be within 50 metre travel distance from any point on the floor plate.

17.8.3. Transporting critically ill patients

The Agency of Clinical Innovation (ACI) was consulted to inform the functional requirements needed to support the patient care of critically ill patients (i.e. ICU and trauma). These patient transfers involve the use of lifts in a range of emergency situations (i.e. arriving from the Helipad into ED, from the hospital to be moved / transferred to another hospital) or intensive care transfers (i.e. from ICU to operating theatres or medical imaging).

Patients transferred from a helicopter landing site will require space to accommodate:

- a stretcher which is smaller at 750mm wide and 2200mm long
- depending on injuries, one person may be located at head end
- ECMO, when needed, will require a staff member to be positioned at both sides of the stretcher.

The transfer of a range of intensive care patients may require additional space in the lift car to accommodate:

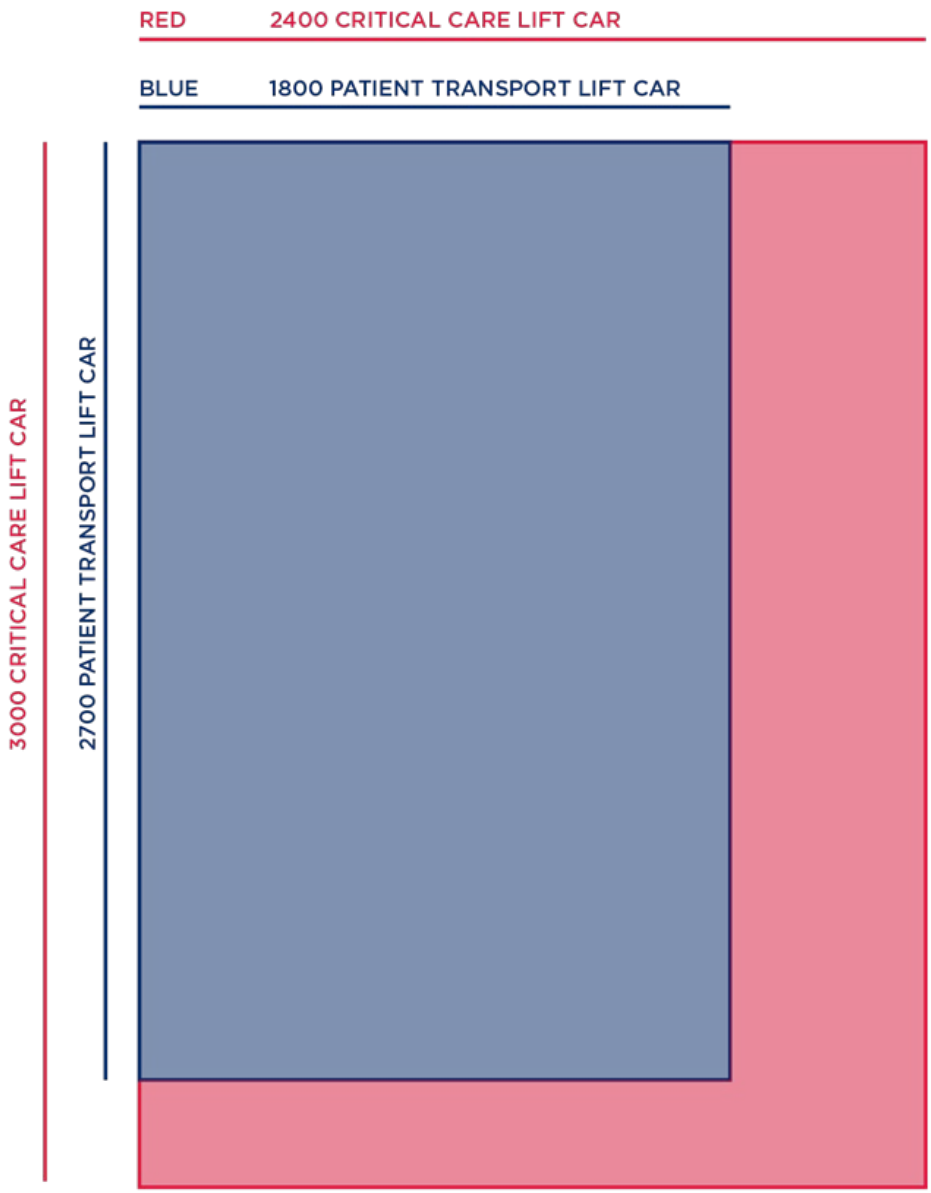
- up to four staff to assist with the patient transport. For critically ill patients, this may include one person on either side of the bed, additional help at one side and one person at the bed head managing an airway
- equipment such as monitor / chest drain / ventilator / ECMO on trolley / small arrest trolley
- a critical care bed sized at 1100mm x 2400mm (this will be retracted for transfers and attached equipment will be positioned in / over the bed).

17.9. Lift car sizes

In many acute hospitals, the standard lift will be used for all patient transport. These hospitals may receive critically ill patients, but they will typically be transferred to another site for ongoing treatment owing to complexity.

The Figure demonstrates the different lift car sizes recommended for standard (patient transport) and oversized (critical care) lift cars.

Figure 9: Lift car sizes



17.9.1. Patient bed lift – standard

Table 19: Patient Bed Lift – standard size

Car size	1800mm x 2700 mm Refer to Figures 6, 7 and 8 for details.
Door opening	1600mm clear which will require four central opening panels.
Shaft size	Refer to Table 18: Lift manufacturers advice. These dimensions vary according to lift manufacturer; however, designers should note that lift shaft sizes required to accommodate a four panel door size are slightly larger than lift shaft sizes that accommodate two opening panels. Designers should consult with lift manufacturers early in the design process.
Purpose	This size lift can be used to transport patients in: Standard hospital beds Bariatric beds Standard ICU beds where staff and equipment are only required at one side of the bed A bariatric ICU bed fully retracted for transport. Transfers to/ from a helicopter landing site, including roof top locations.
Other considerations	Assumes handrail on one side of lift car only which reduces clear width by 100mm. Assumes 25 mm bump rail to all internal walls of the lift car. Assumes a 300mm zone for bed tugs.

The following layouts show findings from consultation with ACI and NSW Ambulance.

Figure 10: Patient bed lift – standard size - transport set up for general patient transport (N.T.S.)

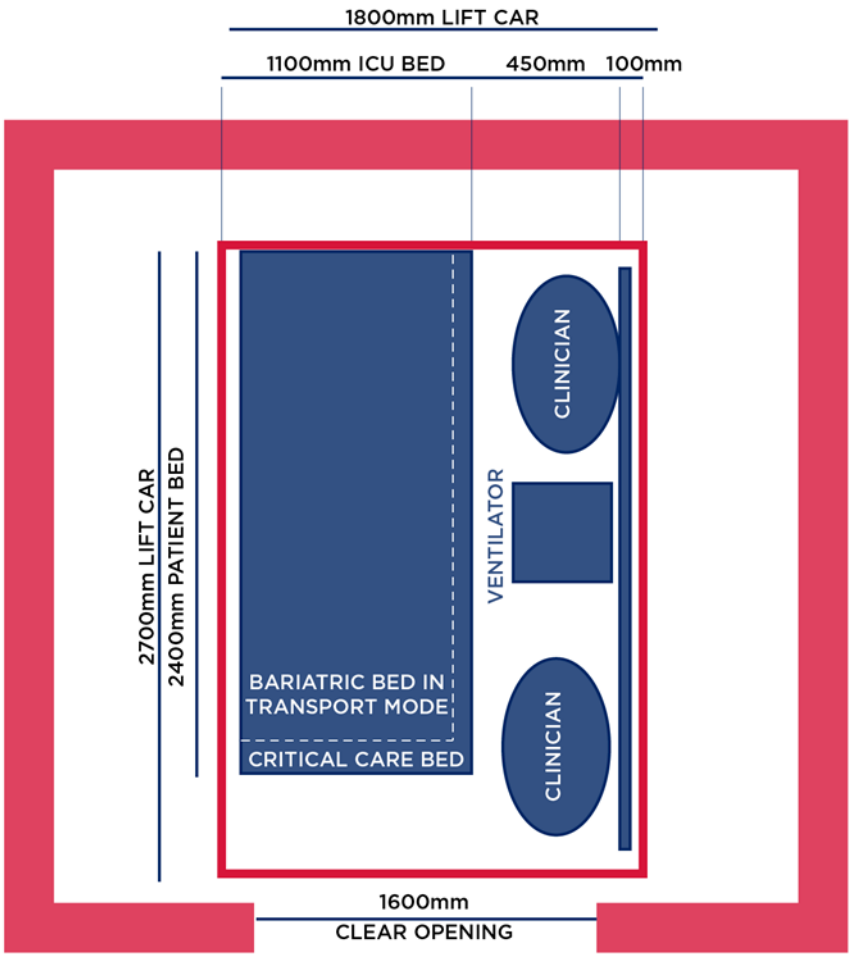
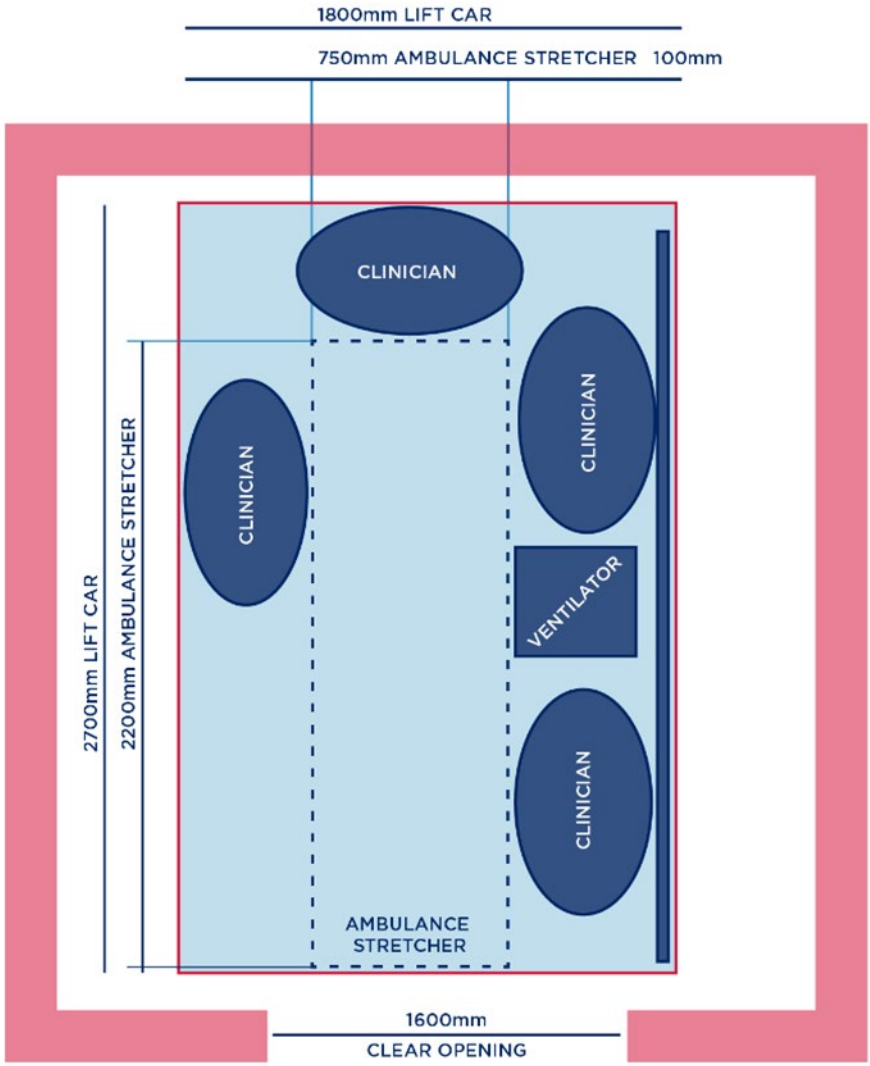


Figure 11: Patient bed lift - standard -transport set up by NSW Ambulance Retrieval Service (N.T.S.)

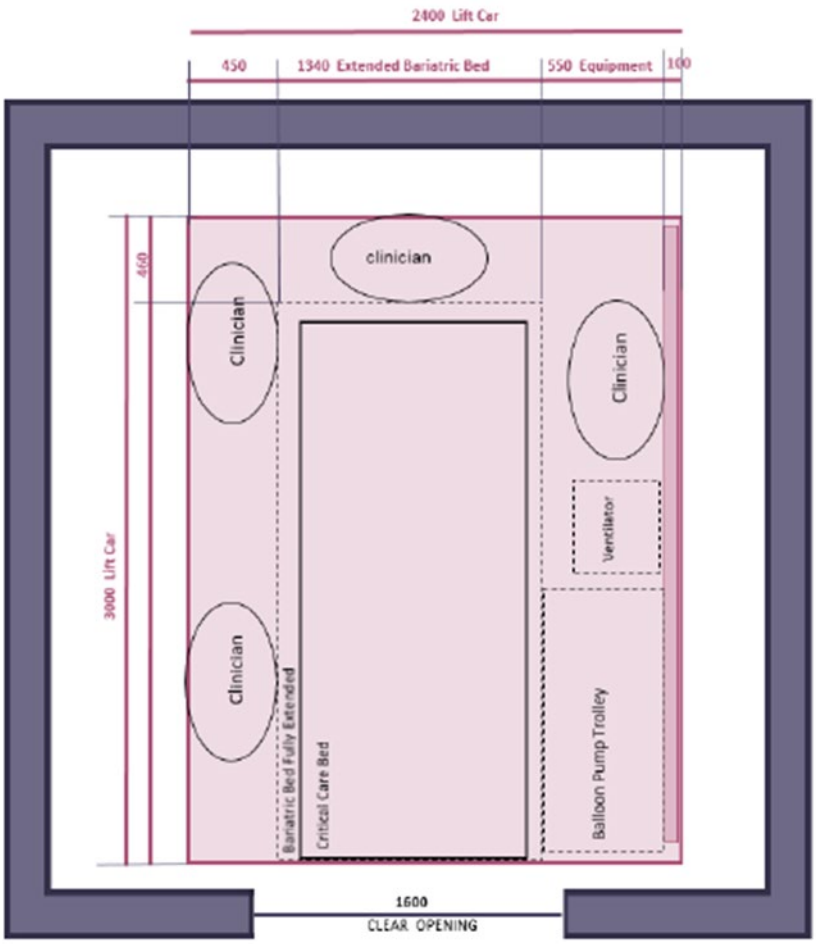


17.9.2. Patient bed lift – ICU

Table 20: Patient bed lift – ICU (oversized)

Car size	2400mm x 3000mm Refer to Figures 6 and 9 for details. For Design Dimensions, refer to Table 20: Required equipment for ICU bed transport.
Door opening	1600mm clear which will require four central opening panels.
Shaft size	Please refer to Table 18: Lift Manufacturers Advice in this DGN. These dimensions vary according to lift manufacturer; however, designers should note that lift shaft sizes required to accommodate a four panel door size are slightly larger than lift shaft sizes that accommodate two opening panels. Designers should consult with lift manufacturers early in the design process.
Purpose	This size lift can be used to transport patients: That are critically ill and ventilated (ICU and trauma patients) and require a configuration of staff and equipment as shown in Figure 9 That are ventilated and in a fully extended bariatric ICU bed will need to be transferred using this lift type.
Other considerations	Assumes handrail on one side of the lift car only which reduces clear width by 100mm. Assumes 25 mm bump rail to all internal walls of the lift car. Where this lift type is needed, only one will typically be provided however this will need to be assessed in terms of the hospital size and alternatives. The project team needs to consider a management plan for fully extended ICU bariatric bed movements. Equipment maintenance needs to be considered by the project team.

Figure 12: Patient bed lift – intensive care lift - oversized (N.T.S.)



17.10. Design considerations

Staff/ patient and public lifts to be separated where possible. This is essential for larger developments but may not be practical for low rise developments of four levels or less.

Public/ visitor lifts sizes need to consider use by elderly, disabled and users in wheelchairs. A wide/ willow car shape should be employed to intentionally not accommodate a bed and deter staff use of these lifts.

Goods lifts can be provided as single lifts subject to specific needs, with a recommended minimum capacity of 2000kg. Consideration for lift use and equipment to be transported should be taken into consideration.

Lift use for clean and dirty goods may be separated or managed operationally. Service lifts (dumbwaiters) may be considered as a cost saving option as opposed to using passenger lifts.

Where the lifts provide access for critical services, redundancy should be provided by grouping at least two lifts together. The result of an impact assessment to determine the consequences of the failure of a single lift will aid in the decision for redundancy in other areas.

17.11. Lift features

17.11.1. Emergency power

Consideration should be made for lifts in the event of loss of power. Typical methods used to ensure power to the lifts is maintained include:

- Emergency generator power (base building)
- Emergency rescue system (incorporated in the lift design).

Coordination with the lift supplier and electrical design engineer is required to select the most appropriate method of emergency power supply. Cost and functionality considerations will apply however standard practice is to select one option only.

17.11.2. Priority control

In emergency situations lifts may be required to cease normal operation and operate in an exclusive manner to provide priority functions for hospital staff. Planning of these operations with all relevant stakeholders is essential to determine:

- Selection of the lifts
- Method of activation
- Audio and visual communication within the lift
- Audio and visual communication on the landing
- Operation within the lift car
- Operation of other lifts not used in the priority control mode.

When planning for the use of priority control designers should endeavour to limit the usage of the function to only the highest levels of need. Overuse of priority control will severely degrade the capacity of the lift group to handle other vertical transport needs.

17.11.3. Finishes

Vertical transport systems within health facilities will be designed with finishes that provide the following attributes:

- Robustness
- Corrosion resistance
- Vandal resistance
- Biological resistance
- Ease of cleaning.

Consideration should also be made in the joining detail of finishes to reduce gaps and areas where cleaning will be hindered.

17.12. Regenerative braking lifts and standby generators

Lifts with regenerative braking will be more commonly used in commercial setting owing to better energy performance and the drive towards net zero emissions. This type of lift performs well under normal operations, but issues may arise when the use of a standby generator is triggered, following a normal

power failure. As the power recovered from the regenerative braking feeds back into the standby generator supply this may cause problems for the generator, either causing it to trip or create damage.

Ensure the electrical distribution system within the building remains safe during routine maintenance operations. This may involve inhibiting the regeneration function on manual supply isolations, additional signage on distributions boards, and providing procedural guidance as part of the design works. Refer to the Safe Work Australia, safe design requirements.

The key points to be considered when selecting this lift type include:

- 1. Assess the percentage of the lift load on the generator capacity. Most generators may be able to handle 10% of regenerative loads. In the design of the system, the sizing of the generator and the allocation of loads in the case of multiple generator and loads, will need to be considered.
- 2. Explore the possibility of deactivating the regenerative braking feature upon power failure via the BMCS or other automated means. This possible solution will need to be explored and tested for each lift manufacturers and their specific designs.

If this is not possible, then consider the following options.

- 3. The sequence of switching on loads onto the standby generator upon generator activation, and the sequence of switching off loads as normal power comes back on. The purpose of this initiative is to keep the lift load to be less than 10% of the generator load if possible.
- 4. Consider using a load bank to absorb the regenerative load.

18. Automated guided vehicle systems

18. Automated guided vehicle systems

In larger facilities, the use of automated guided vehicles (AGV) may be considered to reduce staffing demand in the supply chain process for containerised transport of general goods, linen, meals, rubbish, etc.

Such systems can provide an automated container transfer service for scheduled transport needs and for specific demands as they arise.

These systems are ideally suited to new developments where spatial and services interface can co-ordinated at during the design phase. Issues for coordination are:

- Environment – internal use only
- Corridor and walkway width suitable for both pedestrians and AGV
- Corridor and walkway floor covering, gradient, level changes
- AGV parking/ storage/ recharge area
- Electrical services interface
- Lift services interface
- Automated door interface.

An individual needs assessment and business case for AGV must be carried out, and if carried beyond the preliminary concept planning phase, specialist design input must be sought.

19. Radiation shielding

19. Radiation shielding

Lead shielding should be considered for all areas of the health facility where ionising radiation is produced by x-ray equipment. These areas include general x-ray rooms, fluoroscopy/ screening rooms, CT scanning rooms, orthopantomography (OPG) rooms, mammography rooms, angiography laboratories, cardiac catheter laboratories. gamma cameras, PET scanners, SPECT scanners and combination units.

Special purpose screening, including magnetic and radio frequency screening, is required for MR scanning rooms.

Radiation therapy bunkers require special shielding that is of a higher rating than is provided in medical imaging departments.

Radiation Guideline 7, entitled ‘Radiation shielding design assessment and verification requirements’, published by the Department of Environment, Climate Change and Water, NSW, outlines the classifications for different types of facility and the requirements for assessing the degree of shielding required.

In all cases a shielding assessment must carried out by a consulting radiation expert (CRE) and a report produced for the facility, detailing the extent and details of the shielding required.

Imaging equipment is increasingly used in operating theatres. fixed fluoroscopy units (with single plane or bi-plane, floor or ceiling mounted C-arms) interventional imaging theatres, and fixed and mobile CT scanners, MR scanners and nuclear medicine scanners are planned for so-called multimodality theatres. Radiation shielding is required for these operating theatres.

General operating theatres will not feature fixed imaging equipment but will have mobile x-ray or mobile fluoroscopy units wheeled in as required. In this case there may be no need for radiation shielding as the amount of ionising radiation may be low and the operating theatre may be classified as a low-risk. Again, a shielding assessment must be carried out to determine the likely radiation exposures. The factors to consider include:

- Whether the maximum weekly workload in mA-minutes is less than 20mA minutes in one week. This can be derived from the formula E x F x N / 60, where E is the typical exposure per film (mAs), F is the number of films per examination, and N is the number of examinations per week
- Type of radiation – primary or secondary. In the operating theatre, the staff will need to be protected from primary radiation while staff and / or patients in adjacent operating theatres, sterile cores, utility rooms, anaesthetic induction rooms, etc. may be subject to secondary radiation

The distance from the radiation source or scatter to occupied areas – in a 55m2 operating theatre which may measure 7000mm x 7900mm, with the operating table in the middle of the room, the distance between the mobile x-ray or fluoroscopy unit and any wall, will be in the order of 3000mm

- The area irradiated by secondary radiation will be the ceiling, walls and floor of the operating theatre in which mobile imaging equipment is being used. Primary radiation will to a large extent be absorbed by the patient and supporting structures, while scattered radiation will be dispersed across the operating theatre.

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