Guideline

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Engineering Services Guidelines

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GUIDELINE SUMMARY

ENGINEERING SERVICES GUIDELINES

PURPOSE

The purpose of this Guideline - *Engineering Services Guidelines* is to provide a performance based guide for the development of design and specification documentation for health care facilities.

KEY PRINCIPLES

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

- Contemporary approaches to design
- Practical and easy usage
- Fitness for purpose and
- Value for money.

Rather than providing engineering prescriptive details, these guidelines identify performance parameters and boundaries where innovations can be explored. This approach has been taken to discourage designers from using the *Engineering Services Guidelines* as default solutions, but encourage designers to apply their knowledge and skills to deliver the performance requirements within the defined parameters.

USE OF THE GUIDELINE

It is expected that all projects will be delivered in accordance with the requirements of all relevant codes and regulations, and all Capital 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 Capital Consultants will assess the provisions of Standards such as the *Australian Health Facility Guidelines* and determine an appropriate application of these to their particular project.

This document should be used as a guide rather than a mandatory directive. It does not

replace the need for the application of expert judgement in considering engineering design solutions for individual situations.

REVISION HISTORY

Version	Approved by	Amendment notes
August 2016 (GL2016_020)	Deputy Secretary, Strategy and Resources Division	Replaces Technical Series TS11 – Engineering Services and Sustainable Development Guidelines Updated guideline which provides a performance based guide

		for the development of design and specification documentation for health care facilities.
January 2008 (GL2008_002)	Deputy Secretary, Strategy and Resources Division	New Guideline

ATTACHMENTS

1. Engineering Services Guidelines – Guideline.

Engineering Services Guidelines

NSW GOVERNMENT Health

GUIDELINE

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CONTENTS

1 INTRODUCTION 1

2 PRINCIPLES 3

2.1 Fundamental Principles 3
2.2 Design Context and Appropriateness 3
2.3 Engineering Design Principles 4
2.4 Engineering Design Objectives 4
2.5 Targets 5

3 SPECIFICATION / INSTALLATION / COMMISSIONING / MAINTENANCE 12

3.1 Specification 12
3.2 Installation / Maintenance 12
3.3 Commissioning 13

4 RELATIONSHIP TO OTHER DOCUMENTS / GUIDELINES 14

5 ELECTRICAL 15

5.1 Introduction 15
5.2 Scope 15
5.3 General Requirements 16
5.4 Planning / Context 16
5.5 Design Criteria 16
5.6 Specific Requirements / Guidance 16

6 FIRE SERVICES 30

6.1 Introduction 30
6.2 Scope 30
6.3 General Requirements 30
6.4 Planning / Context 31
6.5 Specific Requirements / Guidance 32
6.6 Design Advice 33

7 HEATING VENTILATION AND AIR CONDITIONING 36

7.1 Introduction 36
7.2 Scope 36
7.3 Planning / Context 36
7.4 Energy / Sustainability 37
7.5 General Requirements 38
7.6 Modularity / Adaptability / Integration / Reliability 43
7.7 Design Criteria 44
7.8 Specific Requirements / Guidance 44
7.9 Thermal Modelling Guidelines 52

8 HYDRAULICS 59

8.1 Introduction 59
8.2 General 59

8.3 Scope 59
8.4 Design advice 59
8.5 Sanitary Plumbing and Drainage 60
8.6 Renal and RO Water Systems 62
8.7 General Material Selection 63
9 INFORMATION AND COMMUNICATOINS TECHNOLOGYSYSTEMS 64
9.1 Introduction 64
9.2 Planning / Context 64
9.3 Systems and Infrastructure 64
9.4 Specific Requirements / Guidance 67
9.5 ICT Applications for Healthcare Facilities 77
10 LIGHTING 78
10.1 Introduction 78
10.2 Scope 78
10.3 General Requirements 78
10.4 Planning / Context 79
10.5 Design Criteria 80
10.6 Specific Requirements / Guidance 80
10.7 Codes and Reference Documents 82
10.8 Equipment 83
10.9 Daylight 84
10.10 Lighting Control and Management 84
10.11 Emergency and Exit Lighting 85
10.12 Security Lighting 85
10.13 Design Advice 86
11 MEDICAL / SPECIALIST GASES 88
11.1 Introduction 88
11.2 Scope 88
11.3 General Requirements 88
11.4 Planning / Context 88
11.5 Design Criteria 88
12 SECURITY 92
12.1 Introduction 92
12.2 Scope 92
12.3 General Requirements 92
12.4 Planning / Context 93
12.5 Design Criteria 93
13 ACOUSITCS 94
13.1 Introduction 94
13.2 Scope 94
13.3 Design Strategy 94
13.4 Verification of the Design 95

13.5 Design Guideline Notes....95
14 PNEUMATIC TUBE SYSTEM....108
15 STEAM STERILISATION....109
16 BUILDING MANAGEMENT AND CONTROL SYSTEM....109
16.1 Introduction....109
16.2 Scope....110
16.3 General Requirements....111
16.4 Planning / Context....112
16.5 Design Criteria....112
17 VERTICAL TRANSPORTATION....116
17.1 Introduction....116
17.2 Scope....116
17.3 Code Requirements....116
17.4 Planning / Context....116
17.5 Vertical Transportation Assets....116
17.6 Design Criteria....117
17.7 Traffic analysis criteria....117
17.8 Lift Car Sizes....117
17.9 Design Considerations....119
17.10 Lift Features....119
18 AUTOMATED GUIDED VEHICLE SYSTEMS (AGVS)....120
19 RADIATION SHIELDING....121
20 APPENDIX 1: CHANGES FROM PILOT DRAFT TO FINAL VERSION....123

1 INTRODUCTION

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 Capital 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 provide for:

- Achievement of optimal patient care utilising a model of care for the patient
- Contemporary approaches to design
- Practical and easy usage
- Fitness for purpose and
- Value for money.

It is expected that all projects will be delivered in accordance with the requirements of all relevant codes and regulations, and all Capital 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 Capital Consultants will assess the provisions of Standards such as the Australian Health Facility Guidelines (AusHFGs) and determine an appropriate application of these to their particular project. In new, major hospital developments (generally role delineations level 4 and above) it is envisaged 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 Capital Consultants will critically evaluate the AusHFG to determine their applicability and suitability to the project during planning.

In all projects, it is envisaged all Capital 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 AusHFGs is expected, together with advice and progressive thinking on how this intent can be best achieved within the 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 Capital 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 clients, occupants and the environment
- 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 appropriate environmental solutions and
- Consistent design solutions across all projects.

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 principles, objectives and targets must be considered during design. Key Consideration Areas for Engineering Design Performance are outlined in Table 1 below.

Health Infrastructure Design Focus Areas								
	Functional Integration	**Security, Vandalism and Robustness**	**Infection Control and Cleaning**	**Disaster and Emergency Management**	**Sustainability Life-Cycle and Waste Management**	**Maintenance and Logistics Support**	**Emerging Technology**	**Certification and Compliance**
Electrical **Fire Services** **HVAC** **Hydraulics** **ICT** **Lighting** **Medical/Specialist Gases** **Security** **Acoustics** **Pneumatic Tube Systems** **Steam Sterilisation** **Building Management and Control** **Vertical Transportation**	Open and integrated systems with passive and active error detection, diagnostics and reporting	Consider security, vandalism and robustness considering spatial and temporal risk profile, and facility classification	Include infection control and cleaning protocols within designs.	Consider service delivery requirements along the emergency management continuum, systemic and random failures and the "All Hazards Approach".	A focus on energy, water and materials to improve environment and economically sustainable outcomes.	Consider location specific issues, alignment of reliability parameters, and aim to design innovation	Innovation is encouraged. A requirement for designers to provide a Business Case to support the adoption of design innovation.	Alternative standards acceptable if proven technically superior.

Table 1: Health Infrastructure Design Focus Areas

2.2 Design Context and Appropriateness

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 and practicality will also influence decisions.

- Size and type - will influence the choice and configuration of systems
- Location - the availability of support skills will influence the level of sophistication and technology in systems
- New / refurbished / extended - the age, conditions and relative size between new and old will influence design solutions on systems such as 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, and

- Economics and practicality - these Guidelines, whilst should be adhered to as far as possible, 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.

2.3 Engineering Design Principles

- The following principles must be considered:
- 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 master-plans 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 and
- 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 the following objectives:

- Design must be appropriate for the location in terms of climatic conditions, sophistication of services, availability of skills and support
- Design must be reasonably adaptable 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), 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
- 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:

- Functional Integration
- Security, Vandalism and Robustness
- Infection Control and Cleaning
- Disaster and Emergency Management
- Sustainability, Life-Cycle and Waste Management
- Maintenance and Logistical Support
- Emerging Technologies and
- Certification and Compliance.

2.5.1 Functional Integration

Designers must encourage 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) to ascertain that design features are appropriate, understood, and that the systems can and will be operated efficiently after commissioning and hand-over.

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 BIM

Design and documents are expected to be carried out using current BIM technology and systems. The system used is expected to be consistent across the whole design team and applied to achieve the full benefits available from BIM technology. BIM can be used as a tool for services co-ordination and whilst this is to be encouraged, its responsible application with diligent engineering effort is essential for its success.

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 control and cleaning

Optimum ventilation rates1 should be maintained in order 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 air-borne 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.

In particular, the use of non-porous materials, fixtures and fittings which are easily accessible and can be thoroughly cleaned should be considered.

Non-contact activation of systems should also be promoted to avoid infection transmissions.

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

Quarantine and isolation requirements must also be understood.

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, DISPLAN, and critical infrastructure risk assessments.

For the purpose of these Guidelines, the Westmead and Royal North Shore Hospitals should be considered as the two major hospitals for disaster and emergency management, and any new projects on these two hospitals should be provided with back up provisions over and above other hospitals in respect of the following:

- 24 hour water storage

[1] Air-change rate reduces the amount of pollutants, and reduces the rates of spread of airborne illnesses. This is of prime importance in hospitals. Ideally, the ventilation systems should be designed to achieve an Air Change Effectiveness (ACE) of >0.95 for at least 95% of the occupied area when measured in the breathing zone, in accordance with ASHRAE 129 1997: ‘Measuring Air Change Effectiveness’.

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

2.5.6 Sustainability, 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.

2.5.7 Energy

Hospitals are energy intensive due to the core occupant / functional / process requirements for the delivery of acceptable quality of care.

2.5.8 Sustainability and Energy Targets

To demonstrate Health Infrastructure commitment in delivering environmentally responsible projects the following criteria apply.

Green Star

All new facilities will target a Green Star Health Care 4 star equivalency rating, this has been and will continue to be considered as aspirational within the context of project location, scope and budgetary allowances, no documentation or certification is required.

Energy Targets

All new standalone buildings will have a mandatory requirement of delivering a 10% improvement on national construction code (NCC) section J. All design teams will be required to achieve this and demonstrate its compliance through JV3 modelling. The modelling will be undertaken and coordinated by the mechanical consultant; all design team members are required to proactively contribute. Architects will be responsible for the design of the building envelope and compliance with NCC parts J1, J2 and J3 regarding architecture, aesthetics and performance but must take advice from the mechanical engineer regarding thermal and energy implications.

Further Improvement

HI is committed to delivering projects which will deliver the best value energy performance, and will commit funding to implement initiatives and schemes which are economically responsible and deliver proven and significant energy improvements. This means achieving the optimum energy improvement return for capital investment. To demonstrate this approach and commitment, the current electronic data systems (ESD)

allowance in budget cost plans, which are 2% for projects over $100M and 4% for projects under $100M, will be renamed Energy Improvement Allowance. To identify a clear approach of how this allowance can be spent, the following guideline is provided. It can be spent on initiatives and systems if both conditions below can be met:

- A further 5% improvement on NCC Part J Performance, and
- With a 7 year payback period.

The initiatives and systems can take the form of either a single scheme or a combination of multiple schemes and components. Initiatives and schemes failing to meet these conditions will not proceed.

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:

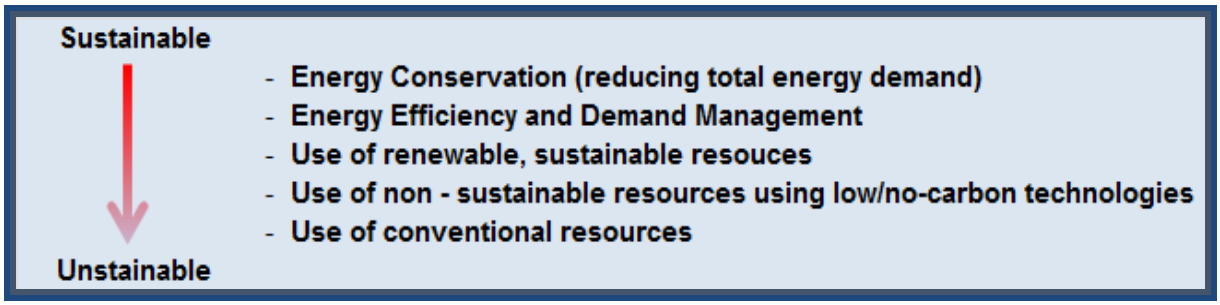


Table 2: Sustainable Energy Hierarchy

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

Energy design should 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 and
- Provide facility operations staff with site-specific training to minimise energy usage.

The following active measures could be incorporated into the design in order to reduce energy wastage:

- Consideration of 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 (building management system) 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
- Consideration of energy input for hot water systems including energy and heat recovery from mechanical plant heating systems including tri-generation where applicable
- System zoning and time control of reticulated services to enable maximum turn down during night and weekend off peak parameters and
- 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.

2.5.9 Water

Water-efficiency is of high importance. Design for hospital water quality and quantity, and satisfying the associated demand, require consideration 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
- Exploring 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 and
- Efficient irrigation systems (and using appropriate species).

2.5.10 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 should focus on the following aspects:

- Use locally sourced materials
- Select low embodied energy materials (which may include materials with a high recycled content)
- Specify products and materials that are either reused or contain high-recycled content;
- Promote the specification of recyclable manufactured type materials and fittings
- Give preference to materials manufactured using renewable energy sources and
- Design to minimise materials.

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

- 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 and
- Design to material sizes and common packaging quantities, to avoid off-cut wastage and unnecessary consumption.

2.5.11 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 are encouraged to take every opportunity to design maintenance out of systems.

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

2.5.12 Emerging Technology

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

Whilst 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.

2.5.13 Certification and Compliance

It is required that:

- Designs to be appropriately certified 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 and
- 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 / 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 and
- 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 / Maintenance

Ease of installation and buildability 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. Whilst 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. The following are some key watch points in commissioning:

- 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. building monitoring and control systems (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 re-checking of results in the first year on a seasonal basis
- The appropriate programming allowance of time in the delivery and handover process and
- The emphasis of its importance in contractual terms.

4 RELATIONSHIP TO OTHER DOCUMENTS / GUIDELINES

This document refers to the latest applicable statutory requirements and other Standards. The Capital Consultant must verify and utilise the latest statutory requirements and other Standards available at the time work is to be carried out.

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

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

1. ***Section 3*** – Project specific requirements – outlines the scope, context and nature of the project; and,
2. ***Section 4*** – Scope of services - this document defines the capital consultants' scope of work and deliverables with respect to their engagement
3. ***Section 5*** – Conditions of agreement for the capital consultants' engagement.

Other documents that are also relevant include:

- Health Infrastructure design guidance notes that are issued as required and supplement the information within this Guideline
- NCC / Australian Standards / Legislation and Regulations and
- Australian Health Facilities Guidelines.

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 & Information Association (BSRIA)
- CIBSE and
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

For some of the larger projects, there may be helipads introduced either on the roof of buildings or externally on the hospital site. The Guidelines for Hospital Helicopter Landing Sites in NSW issued by NSW Health should be referred to and complied with for these installations.

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

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 / ANZ 3000 Electrical Installations
- AS / ANZ 3003 Electrical Installations – Patient areas and
- AS / ANZ 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 and
- 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
- Emergency power generation system
- UPS
- Sub-mains
- Distribution switchboards
- Earthing
- Lighting and power sub circuit wiring including protected wiring systems in patient areas
- Socket outlets
- Luminaires (internal, external, security), lighting control and functionally specialised lighting

- Emergency and Exit lighting system and
- 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 / Context

All projects must consider and document the impacts of the project on existing and future planning on the site taking into account any master plans 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 and
- 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

Refer to the AusHFG for the requirement of services provisions in rooms as the initial basis of 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 / 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 should 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 capital consultant should 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 taken into account:

- 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 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 their individual supply demand and
- Reference should be made to actual demands from similar existing hospitals as a final sanity check.

Spare Capacity

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

Substation and High Voltage Capacity

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

The choice between a kiosk or chamber substations will to 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 use of land use on site and
- Maintainability.

Cogeneration

Cogeneration and tri-generation may be suitable for some projects. Where cogeneration or tri-generation is proposed, the consultant will include the following considerations in the feasibility stage analysis:

- Life cycle costing
- Cost of built plant room areas

- Potential energy trends and
- Skills availability for operation and maintenance.

Should cogeneration be seen as a viable option, consideration should also be given into ways of making use of the cogeneration plant for standby power purposes.

Section 2.5.6 provides a clear criteria and target on the viability of these systems.

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 will be provided.

In some circumstances the provision of dual supplies to improve electricity supply reliability may be considered. In this case and where practical, feeders should emanate from two independent network circuits and from two different street reticulation routes. Preference should 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 single HV site connections (spur connection); and,

Due to improved reliability, underground HV supply cable reticulation should be adopted in lieu of overhead cables where possible and cost effective.

Power Factor Correction

Power Factor Correction (PFC) equipment to comply with authority requirements will be incorporated into the design to improve the power factor of the electrical installation to 0.99 to minimise the energy authority demand charge and improve energy efficiency.

PFC systems will be interfaced to disconnect under generator operation.

Harmonics

The total maximum harmonic distortion of 5% current (THDi) at point of common coupling for the facility.

5.6.2 Standby Power

Standby electrical power will be provided, and guided by the recommendations of AS 3009 and the subsequent paragraphs of this section.

Standby power will 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

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 ICT communications room active equipment
- Pneumatic tube, Medical air and suction equipment
- Renal Dialysis equipment
- Approximately 30% of lighting and power in all areas. This can vary depending on the number of light fittings and power outlets used in any particular room
- Full lighting and power in critical areas, which include emergency department, operating theatres, sterile stock, recovery unit, coronary care unit (CCU), intensive care unit (ICU), neonatal intensive care unit (NICU), cardiac catheterisation laboratory, burns unit and mortuary. All air handling fans and exhaust fans serving these areas
- All air handling and exhaust fans serving isolation rooms, central sterile services department (CSSD) and pathology
- Selected Imaging areas required for emergency departments only
- Critical storage such as -80ºC fridges and blood fridge
- Sewage pumping stations if these were used and
- 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.

- 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 and
- 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 number of smaller generators if required to ensure that they are loaded appropriately.

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

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

Connection of loads to the standby supply system will be designed to avoid stalling of the generator engines.

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 should 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 needs 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 should be considered.

Uninterruptible Power Supply (UPS)

UPS systems will be required for specific critical loads. This includes ICT equipment, theatre equipment 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's are best suited. As some equipment may be provided with inbuilt UPS; they should be accounted for in any design and capacity calculations.

Purpose and application of UPS

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 uninterruptible power supply (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 in-built 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.

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 Resilience

A resilient system can be defined as one that can withstand a number of 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 on-going maintenance.

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 through two separate UPS systems, each loaded at 50%, but both capable of supplying 100% in the event of a single UPS system failure.

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 cabinets. 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.

- 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
- hot swappable UPS modules
- 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.
- standby GPOs installed adjacent to UPS GPOs 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 and
- Monitored UPS alarms.

UPS batteries to be specified in multiple parallel strings such that a single string failure or planned maintenance does not affect the specified UPS system battery autonomy.

Requirements for major medical equipment

MME Category	Stand-by Power Reqd?	UPS Reqd?	Capacity	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		
Fluoroscopy rooms with	Yes	Yes	2 -10	UPS to power computing

MME Category	Stand-by Power Reqd?	UPS Reqd?	Capacity	Notes
fixed screening or multi-purpose equipment			kVA	equipment. Table, monitoring and fluoro 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	
MRI scanners	Yes	Yes	10 -15 kVA	
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		
Orthopantomograph machines	Yes	No		
Ultrasonic Scanners	Yes	No		
Gamma Cameras	Yes	Yes	3 - 15 kVA	
Spect-CT Scanners	Yes	Yes	3 - 15 kVA	
PET 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 equipment. Table, monitoring and fluoro functionality may require a 40kVA 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.

MME Category	Stand-by Power Reqd?	UPS Reqd?	Capacity	Notes
Superficial orthovoltage devices	Yes	Yes	3 -15 kVA	Many of these devices have UPS supplied with them at purchase.
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 & monitors,	Yes	Yes	8 – 10 kVA	The operating theatres will have UPS power supplied from a central UPS to a number of GPOs per pendant. Allowance per room.
Operating theatre integration products	Yes	Yes	10 kVA	
Integrated imaging systems	Yes	Yes	3 – 15 kVA	
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 (similar to the Neptune Rover and docking station product)	Yes	No		
Ultrasound scanners	Yes	No		
Infection control (CSSD / SSU) equipment				
Ultrasonic cleaners	Yes	No		
Washer / disinfectors (cart washers, batch washers, tunnel washers, etc.)	Yes	No		
Pre-vacuum steam sterilisers	Yes	No		
Low temperature sterilisers	Yes	No		
Flash sterilisers	Yes	No		
Drying cabinets	Yes	No		

MME Category	Stand-by Power Reqd?	UPS Reqd?	Capacity	Notes
Endoscope washers / disinfectors (re-processors)	Yes	No		
Endoscope drying & storage cabinets	Yes	No		
Bulk detergent dispensing plant	Yes	No		
Reverse osmosis treatment units	Yes	No		
Instrument tracking systems	Yes	Yes	5 kVA	
Dental equipment				
Dental chairs	Yes	No		
Dental units	Yes	No		
Dental lights (if separate from the chair and dental unit)	Yes	No		
Dental x-ray units	Yes	No		
Dental sterilisers	Yes	No		
Dental plate scanners	Yes	No		
Pendants				
ICU / HDU / NICU and ED Resus Bay Pendants	Yes	Yes	2.5 – 3kVA per bed	The pendants will have UPS power supplied from the central UPS to a number of GPOs per pendant.
Major clinical equipment				
Hospital-wide cardiac monitoring equipment including telemetry and wireless monitors	Yes	No		
Hospital-wide central monitors at the Staff Stations	Yes	Yes	5 kVA	UPS at each central monitoring station and for ADT & 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	5 kVA	
Medication dispensing systems (similar to Pyxis)	Yes	No		

MME Category	Stand-by Power Reqd?	UPS Reqd?	Capacity	Notes
Ophthalmological diagnostic equipment	Yes	No		

5.6.3 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 – Emergency / safety services (AS3000 defined)
- Group B - Critical care services and
- Group C - General services (remainder).

Group A – Emergency Services

AS / NZS 3000 defines emergency services, some or all of which will be required in the hospital design. Sub-mains for the emergency 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:

- Resuscitation bays in the emergency department
- Treatment bays in the emergency department in Level 5 and 6 facilities
- Operating rooms, anaesthetic bays and recovery area
- Day procedures rooms
- Coronary care unit
- Intensive care unit
- NICU
- Angiography and cardiac catheterisation rooms and
- Selected areas of medical imaging unit.

AS / NZS 3009 requires that 100% of all power outlets in the ‘surgical suite’ be connected to the emergency supply, or a UPS supply which is fed from the emergency supply.

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

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 should be a direct feed from an EPG switchboard rather than the main switchboard.

Critical care sub-mains cables are not required to be fire rated, however protection against mechanical damage will be provided.

Group C – General Services

The remaining sub-mains for non-critical services and equipment will be wired in accordance with AS3000 and will comprise the following:

- General light and power throughout the buildings
- Mechanical services systems
- Medical imaging system
- Computer (IT servers) system and
- Hydraulic services system.

Sub-mains Capacities

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

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

Neutrals should be sized the same as the active conductors or the maximum current generated by harmonics: whichever is greater.

General Cable Insulation

Insulation materials for cables will 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 will have a minimum form of separation of at least Form 3b.

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

- The main switchboard will be housed in a separate, accessible room, suitably ventilated and not subject to flooding
- Divide the busbar system 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
- 25% spare capacity on all busbar sections, but no need to install spare breakers
- Provide complete grading and discrimination of all switchgear throughout the installation with the utility and standby generation system and
- Power factor correction equipment to be installed.

Distribution Boards

Boards will be 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 will be fitted with circuit breakers and RCDs 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 also in the 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 services building monitoring and control system (BMCS).

5.6.4 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.

5.6.5 Electro Magnetic 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 / 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, an 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.

5.6.6 Lightning Protection

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

5.6.7 Patient Electrical Protection Systems (Body & Cardiac Patient Areas)

Electrical installations will be designed to comply with AS / NZS 3003 'Electrical installations - patient areas' and follow the guiding principles below:

1. Compliance with AS / NZS 3003 is a statutory requirement in all NSW hospitals and healthcare facilities
2. All patient areas in hospitals and healthcare facilities must be wired at least as body-protected electrical areas and protected with 10mA RCDs
3. Patient safety is not increased by the installation of cardiac-protected electrical areas when performing body-protected procedures
4. Cardiac-type procedures are defined by AS / NZS 2500 and are limited to those which make direct contact with cardiac tissue
5. 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
6. Defined areas for cardiac-protected electrical wiring include:
    - Cardiac catheter laboratories (CCL) and control rooms
    - Cardiac intensive care unit (CICU)
    - Coronary care unit (CCU)
    - ICU with regular thermo-dilution Swann-Ganz monitoring
    - NICU (Level 3) and
    - Operating theatres used for cardiac / thoracic surgery or interventional radiological procedures.
7. All other areas should be wired as body-protected electrical areas and
8. If an uninterrupted power supply 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 AusHFGs.

Labelling & 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, nurseries and children's inpatient units should be fitted with safety shutters.

5.6.8 Medical Services Panels (MSP's)

The different MSP configurations will be documented on the RDS.

Attention should be paid to ensure that the provision of MSPs is included in either the electrical or mechanical services, and not lost between the two trades.

Designers should 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.

5.6.9 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 and
- Extended UPS autonomy for security systems.

6 FIRE SERVICES

6.1 Introduction

The purpose of fire services in healthcare buildings is to provide means by one or a combination of methods to achieve the following:

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

6.2 Scope

The following services / systems will be considered as part of fire services:

- Fire detection, warning control and intercom systems
- Sound systems and intercom systems for emergency purposes (SSISEP)
- Fire sprinkler systems
- Fire extinguishers and fire blankets and
- Gaseous fire suppression systems.

Health Infrastructure prefers to have 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 and
- 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 and
- Fire Services are required to achieve compliance with NCC and referenced standards.

6.4 Planning / Context

Fire services master-plans 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 vs existing refurbishments, a planning strategy should address the following issues:

- Existing authorities infrastructure regarding water mains and fire mains
- Existing internal site services relating to refurbishment and extensions
- Location of plant and equipment
- Cost and budget impacts
- Future expansion of services and master-plan analysis
- Architectural and building impacts
- Maintenance access and replacement of services and plant without interruption to critical Hospital Services
- Noise and vibration impact and
- Valving and zoning of services so as to allow minimal disruption should maintenance be required.

Projects with clearly identified future stages and master-plans 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.

The level of integration of fire alarm signals and the details of the alarm messages to be sent to Fire and Rescue NSW will require discussion with the Fire and Rescue NSW.

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.

6.5 Specific Requirements / Guidance

All Fire Services equipment will be located so as 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 where the ceiling void space is greater than 200mm as nominated by AS 2118.1 to enable future flexibility for reticulation of services that may be considered combustible.

The design of the sprinkler system should not preclude the use of innovative technologies such as extended coverage sprinkler.

Areas ancillary to patient care should be defined in terms of the nearest NCC and AS 2118 categories. Large areas of the hospital, particularly administration, may be suitable for the installation of light hazard sprinklers.

Consideration should be given to proving combined sprinkler, hydrant and hose reel systems.

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 with rubber gaskets may be used. Sprinklers in communications and server rooms without ceilings will consider placement of the sprinklers to avoid mechanical damage from ladders etc. provide heavy duty sprinkler guards.

Sprinkler system remote test points will be provided with drainage to enable testing.

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.

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.

Backflow prevention devices will be installed in locations that allow testing and draining to occur.

Communications rooms, server rooms and rooms containing electronic equipment will be sprinkler protected in sprinkler protected Buildings. Gaseous fire suppression systems are not required in communications rooms, server rooms and rooms with electronic equipment which will be sprinkler protected.

Fire panels are to be of the non-proprietary type with open protocol.

Fire panels will be networked where practicable.

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

Smoke detectors in ward sleeping areas and in mental health will be configured so that the light-emitting diode (LED) indicator does not pole (flash) during normal operations.

Sound systems and intercom systems for emergency purposes will be configured to minimise patient trauma in inpatient areas. Where speakers are removed from inpatient areas as part of a fire engineered alternate solution to minimise patient trauma, provide 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.

Minimum opportunity for ligature points in mental health facilities.

Suitable valves are to be installed on all main services so that future connections can be made without disruption to existing hospital services.

Internal mains, risers and fire detection warning control intercom and SSISEP systems within multi-storey buildings 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 should 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.

Ensure that the water supply flow and pressure is provided for both hydrant and sprinkler systems to operate simultaneously.

6.6.2 Monitoring of Fire Equipment

Consideration will be given to monitoring, via the main fire indicator panel (FIP) 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 the following other building services systems:

- Mechanical ventilation used for smoke hazard management
- General air conditioning systems
- Specialised air conditioning or ventilation systems
- Building Management Systems
- Security and access control systems
- Automatic door operators
- Door holders for doors in fire or smoke compartment walls and
- Elevators (lifts) to assist in controlled vertical evacuation.

Consider the use of the latest convergent technology in fire detection systems allows the integration of other equipment and technologies to provide enhanced response and occupant notification. This may include the provision of graphic displays on colour monitors, text messages to pocket pagers and mobile telephones, interfaces to security and access control systems to initiate pre-programmed functions.

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 my 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 considered for the sprinkler and hydrant systems where cost effective. For example:

- The installation of an on-floor isolation valve for each level 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 and
- The installation of sprinkler and hydrant system annubar flow test lines that discharge either back into the respective system storage tanks.

6.6.6 Fire Safety Engineering

The fire safety engineering deals with the strategic approaches to fire safety and the development of performance-based solutions which fall outside the prescriptive requirements of the NCC. Generally deemed to satisfy 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.

When used for a design to vary from the Deemed-to-Satisfy (DTS) parts of the NCC, a performance based fire engineered solutions should optimise:

- 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 wards and other large areas such as emergency and medical imaging departments
- Egress provisions in the building including the number, location and aggregate width of exits, horizontal exits to adjacent fire compartments and vertical exits using stairs

- The use of elevators (lifts) for emergency evacuation
- Emergency response strategy including staff response and the use of safe havens and horizontal evacuation to allow ‘defend in place’ strategies for occupants with severely restricted mobility
- Fire resistance levels of construction including the use of unprotected steel, glazing and environmentally sustainable materials
- Coordinated smoke hazard management systems including the use of advanced smoke detection equipment and complementary active smoke management systems
- Descriptive emergency warning systems which provide sufficient information to emergency management teams to enable a coordinated response
- Development of a coordinated and holistic fire safety strategy that complements the project-specific architectural planning, building functionality and sustainable design initiatives
- Where specific facility-related fire risks are not covered adequately in the NCC and other relevant regulations, the risk should be analysed and a suitable engineering solution be developed and implemented to maintain an acceptable risk level. The need for additional measures for a specific facility and the suitable solution will be established during the design process and
- Where fire engineered solutions are adopted, the rationale, design details and authority approvals should fully documented for future reference and ensure appropriate future testing and certification.

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 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)
- BMCS
- Medical Gases, and
- Pneumatic Tube.

7.3 Planning / Context

Site energy system master-plans are seen as complimentary to architectural site master-plans 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, new build verses existing and the like, 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
- Resilience and
- 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 should be designed to have spare capacity or the ability to add spare capacity for future installation of services allocated in a practical manner. 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 / Sustainability

7.4.1 Passive Energy Efficient Measures

The following passive measures will be considered in order 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 and
- Room heights designed to achieve a sensible balance between functional need and economy.

7.4.2 Active Energy Efficient Measures

The following active measures should be considered in the design in order 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 ECDC, 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 utilize 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 and
- Efficient insulation of distribution pipework and ductwork to minimise unwanted heat gains / losses to meet NCC requirements.

7.4.3 Sustainability and Energy Targets

To demonstrate Health Infrastructure commitment in delivering environmentally responsible projects, section 2.5 provides clear targets for all projects.

7.5 General Requirements

HVAC systems are generally required to deliver:

- Energy conservation and efficiency
- Healthy environments
- Comfort control
- Infection control
- Reliability
- Flexibility / adaptability
- Maintainability
- Commissionability
- Fire/ smoke/ life safety
- Whole of life efficacy and
- Acoustic integrity.

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.

Ducted air-conditioning systems should be capable of providing sufficient outside air.

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.

Ventilation systems in critical patient care areas such as operating rooms, recovery, CCU, ICU, emergency department and infectious diseases 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 plant rooms should not be via 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.

Mechanical ventilation and air conditioning systems will be fully ducted or be provided with air paths that are contained, not subject to contamination, accessible and cleanable. 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 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 health care 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 helipads 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 are required to be exhausted, fresh air, ventilation and air-conditioning systems should be provided (and if the area is not listed is AS1668 than) with a minimum supply air quantity of 20 litres per second per square metre of facility floor space.

When required, 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 particular 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.

National Occupational Health and Safety Commission (NOHSC) criteria documents regarding occupational exposure to waste aesthetic gases and vapours, and control of occupational exposure to nitrous oxide (7) indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilised.

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 results 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 following may be used for preliminary estimates to be verified when actual information becomes available, based on gross departmental areas for initial planning:

Heat Gain from Equipment		
Department	**Lighting W/m2**	**Power W/m2**
Medical/Surgical Wards	12	5
Orthopaedic	12	5
Paediatric	12	5
On-call accommodation	12	5
Rehabilitation	12	5
Allied health	12	5
Psychiatric	12	5
Psychogeriatric	12	5
Oncology	12	5
Bio-medical Engineering	12	10
Medical Imaging - an assessment is also required of point loads that may be generated by specialist medical imaging equipment. These loads can be high and need supplementary cooling.	12	10
Emergency	15	10
Medical Records	12	5
Pharmacy	12	10
Nuclear Medicine	12	10
Pathology	15	10
Blood Donor Unit	12	5
Medical Library	12	5
Day procedures	12	10
Operating Suite	35	40
Intensive Care Unit	15	10
Coronary Care Unit	15	10
Mortuary	10	5
Linen Handling	10	5
Regional store	8	2
Engineering & Maintenance	8	5
Kitchen	10	-
Staff Cafeteria	12	10
Education	8	5
Main Entrance & Foyer	8	5
Admission/Discharge	12	15
General Administration	12	15
Staff Amenities	8	-

Table 3: Heat gained from equipment

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

7.5.5 Temperature Control

The control tolerance for temperature will be + / - 1.5ºC from set point. Closer control of + / - 1ºC will apply to operating theatres.

7.5.6 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.

Because 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.

7.5.7 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 for air plenums for return air, or introduce unwanted heat gain or heat loss to the system. Return air should be fully ducted.

In order 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 located in accessible areas such as plant rooms such as they can be accessed and checked and cleaned.

7.5.8 Filters

Heating, ventilation and air-conditioning systems will control the concentration of air-borne 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 Efficiency: The first filter listed in the matrix of specific requirements is the pre-filter if 2 filters are listed, second is the main filter and the HEPA if listed is the final terminal filter. Filtration efficiencies will comply with AS1324. 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.

7.5.9 Humidifiers

Reservoir type water humidifiers or evaporative-pan-type humidifiers should not be used in ductwork or air-handling units in health care facilities – 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.

7.5.10 Pressure Gradients

Where pressure gradients are specified to assure maintenance of sterile conditions in areas such as isolation rooms and operating theatres, 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 / 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 in order 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.

Outside design conditions will be selected as follows:

- For the locations listed in AIRAH - ACS Design Aid DA9a: Air conditioning systems - design temperature 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' data
- For 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 Bureau of Meteorological data for the nearest listed location having similar climatic characteristics and
- 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.

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.

Particular care with the design of air distribution is required in operating rooms and rooms where patients are on beds and trolleys such as: patient bed rooms, recovery, emergency departments and critical care.

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

In negative pressure (Type 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 / 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 will be included on all significantly sized air handling plant as per NCC requirements, unless detrimental to pressure regimes or humidity control.

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, delivery rooms, autopsy 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 generally have separate air handling plant. The same department on separate floors will have separate air handling plant. A pragmatic assessment of transcending these boundaries should take place depending on relative departmental sizes and inter-relationships for individual projects.

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 and
- Internal heat gain from people, lights, 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 preferred 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 in-patient 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 the majority 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 Control

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

Design principles throughout the patient care areas will, in addition to comfort requirements, comply with infection control requirements. To minimise the risk of infection the 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 in excess of 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 rooms, set-up rooms, isolation rooms and high infection risk areas and the like.

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 control committee will be implemented. Additional air handling equipment will be required to achieve the necessary clean to less clean airflow patterns.

Such areas include:

- Birthing / delivery rooms
- Neonatal intensive care
- Negative Pressure rooms
- Special care units
- Procedure rooms and
- Emergency departments.

Systems incorporating central air supply and remote filter stations are recommended for these areas. Note that UV filtration may be appropriate in some cases.

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 rooms are well sealed, including all services penetrations, to enable the pressure differentials to be maintained. This usually requires briefing of all the building and other services trades to ensure a workman like result of the HVAC fans cannot sustain the required pressures and flows.

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 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 in order to get 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 a 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 from the view that irrespective of the nature of operating theatres, there is no need for the use of UCV systems, as it is more costly 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 CFU count 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. 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 co-ordinate the design with the architects and other disciplines to ensure that the building fabric, doors, pass-throughs etc. are sufficiently air tight 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 are different when there is a shared sterile stock store for multiple theatres and also 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 table below illustrates various layout scenarios and the design consideration for each of the scenarios:

Layout Arrangement	CSSD Clean Area	Sterile Stock Store	Operating Theatres
CSSD adjacent to sterile stock store serving multiple theatres	HEPA filtered air, highest pressure (3+)	HEPA filtered air, highest pressure (3+)	HEPA filtered air, higher pressure (2+)
Remote CSSD, sterile stock store serving multiple theatres	HEPA filtered air, pressure higher than adjacent areas	HEPA filtered air, highest pressure (3+)	HEPA filtered air, higher pressure (2+)
CSSD/TSSU adjacent to sterile stock store serving one theatre	HEPA filtered air, highest pressure (3+)	HEPA filtered air, highest pressure (3+)	HEPA filtered air, higher pressure (2+)
Remote CSSD, sterile stock store serving one theatre	HEPA filtered air, pressure higher than adjacent areas	HEPA filtered air, higher pressure (2+)	HEPA filtered air, highest pressure (3+)

Table 4: Operating Theatre scenarios

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.

7.8.4 CSSD and Sterile stores

Air movement and ventilation will achieve a positive airflow from clean to contaminated work areas. 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 and sterile storage spaces will be equivalent to that delivered to operating theatres using HEPA filters.

7.8.5 Isolation Rooms

There are four types of isolation rooms that can be used to accommodate patients. These room types are as follows:

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

Pressure Gradient

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.

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 which contains a detailed description of requirements for isolation rooms.

7.8.6 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 considered to be harmful to health.

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.

7.8.7 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’. 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.

7.8.8 Laboratories and Clean Rooms

Physical Containment (PC) laboratories will be designed and constructed according to the requirements of the Genetic Manipulation Advisory Committee publication 'Guidelines for Small Scale Genetic Manipulation Work' when any work involving genetic manipulation is undertaken.

7.8.9 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. Be aware of good air distribution and the need to avoid condensation on glazing and structure and the corrosive nature of pool space environments.

7.8.10 Mental Health Units

Consideration will be given to the type of heating and cooling units, ventilation outlets and equipment installed in patient-occupied areas of mental health units. Special purpose equipment designed for psychiatric or prison use with anti-ligature designs will be used to minimise opportunities for self-harm.

The following will apply:

- 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 and
- In mental health patient bedrooms, ceiling-mounted air devices will be of a secure type such that removal cannot be effected without special tools. In addition there will be no sharp projections or hanging points where cord / string etc. can be fixed.

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 the following activities:

- Optimisation of the building 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 the purpose of 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 and

- Determination of predicted HVAC energy usage for the building.

7.9.1 Modelling Software Requirements

Software used for the purpose of thermal and energy modelling will be capable of performing dynamic modelling against recorded weather data.

Weather Data

The energy and thermal modelling simulations must be undertaken using recorded annual hourly weather file such as test reference year (TRY) data or TMY2 data.

The annual weather file must represent a typical weather year for the building location and should be selected from the climate zone that most closely represents the typical weather conditions at the location of the building. This may not be the weather file that is located closest to the building site.

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.

Building Services and Environmental Design
SERVICES REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES

AREA DESIGNATION	AIR PRESSURE RELATIONSHIP TO ADJACENT AREA	MINIMUM AIR CHANGES OF OUTDOOR AIR PER HOUR	MINIMUM TOTAL AIR CHANGES / HOUR	ALL AIR EXHAUSTED DIRECTLY TO OUTDOORS	FILTRATION EFFICIENCY	RE-CIRCULATED BY MEANS OF ROOM UNITS	RELATIVE HUMIDITY (%)	DESIGN TEMP (DEGREES C)
SURGERY & CRITICAL CARE								
Operating Theatre	Positive	AS 1668.2	20	50%	G4-F8 HEPA (1)	No	35-60	16-27
Birthing Room or Delivery Suite	Negative	5	20		G4-F9	No	35-60	20-23
Setup Room & Sterile Store	Positive	AS 1668.2	15		G4-F8 HEPA	No	35-60	20-23
Recovery Room	Positive	AS 1668.2	10		G4-F8	No	35-60	21
Intensive Care	Positive	2	6		G4-F8	No	35-60	21-24
Neonatal Intensive Care	Positive	2	6		G4-F8	No	35-60	22-26
Burns	Positive	3	10		G4-F8	No	35-95	21-32

Building Services and Environmental Design
SERVICES REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES

AREA DESIGNATION	AIR PRESSURE RELATIONSHIP TO ADJACENT AREA	MINIMUM AIR CHANGES OF OUTDOOR AIR PER HOUR	MINIMUM TOTAL AIR CHANGES / HOUR	ALL AIR EXHAUSTED DIRECTLY TO OUTDOORS	FILTRATION EFFICIENCY	RE-CIRCULATED BY MEANS OF ROOM UNITS	RELATIVE HUMIDITY (%)	DESIGN TEMP (DEGREES C)

Treatment Room	Positive	2	6		G4-F8			24
Resuscitation Room	Positive	3	15		G4-F8	No	45-60	21-24
Anaesthesia gas storage	Negative	2	8	Yes	G4-F8	No		
Endoscopy Room	Positive or no requirement	2	6		G4-F8	No	35-60	20-23
Bronchoscopy, Sputum Induction & Pentamidine	Negative	3	12	Yes	G4-F8	No	35-60	20-23
Emergency Department and Medical Imaging Waiting Room	Negative	2	12	Yes	G4-F8	No	35-60	20-23
Emergency Unit Triage	Negative	2	12	Yes	G4-F8	No	35-60	20-23
NURSING								
Patient Room	Positive	2	6		G4-F8			21-24
Toilet Room / En-suite	Negative	N / A	AS1668.2		G4-F8			
Newborn Nursery Suite	Positive	2	6		G4-F8			24
Protective Environment Room	Positive	AS 1668.2	12		G4-F8 HEPA			24
Building Services and Environmental Design								
SERVICES REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES								
AREA DESIGNATION	**AIR PRESSURE RELATIONSHIP TO ADJACENT AREA**	**MINIMUM AIR CHANGES OF OUTDOOR AIR PER HOUR**	**MINIMUM TOTAL AIR CHANGES/HOUR**	**ALL AIR EXHAUSTED DIRECTLY TO OUTDOORS**	**FILTRATION EFFICIENCY**	**RE-CIRCULATED BY MEANS OF ROOM UNITS**	**RELATIVE HUMIDITY (%)**	**DESIGN TEMP (DEGREES C)**
Class N Isolation Room	Negative	AS 1668.2	10	Yes	G4-F8	No		24

Isolation alcove or anteroom	Neg or Pos	AS 1668.2	10		G4-F8	No		
Patient Corridor		2	6		G4-F8			
DIAGNOSTIC AND TREATMENT								
Consult Room		2	6		G4-F8			24
Medication Room		2	6		G4-F8			
Treatment Room		2	6		G4-F8			24
Physiotherapy & Hydrotherapy	Negative	2	6		G4-F8			24
Disposal Room	Negative		10	Yes	F4	No		
Clean Workroom or Clean Holding		2	6		G4-F8			
Haemodialysis		2	6		G4-F8	No		20-25
ANCILLARY ***Radiology***								
Radiology (surgical / critical care & catheterisation)	Positive	3	15		G4-F9	No	30-60	21-27
Radiology (diagnostic & treatment)		2	6		G4-F8			21-24
Darkroom	Negative	3	10	Yes	F7	No		
Ventilation Requirements **VENTILATION REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES**								
AREA DESIGNATION	**AIR PRESSURERELATIONSHIP TO ADJACENT AREA**	**MINIMUM IR CHANGES OF OUTDOOR AIR PER HOUR**	**MINIMUM TOTAL AIR CHANGES / HOUR**	**ALL AIREXHAUSTED DIRECTLY TOOUTDOORS**	**FILTRATION EFFICIENCY**	**RE-CIRCULATED BY MEANS OF ROOM UNITS**	**RELATIVE HUMIDITY (%)**	**DESIGN TEMP (DEGREES C)**

Laboratory								
General		2	6		F7			24
Biochemistry	Positive	2	6	Yes	F7	NO		24
Cytology	Negative	2	6	Yes	F7	NO		24
Glass Washing	Negative	2	10	Yes	F7	NO		
Histology	Negative	2	6	Yes	F7	NO		24
Microbiology	Negative	2	6	Yes	F7	NO		24
Nuclear Medicine	Negative	2	6	Yes	F7	NO		24
Pathology	Negative	2	6	Yes	F7	NO		24
Serology		2	6		F7	NO		24
Sterilising	Negative	3	10	Yes	F7	NO		24
Autopsy Room	Negative	AS1668	12	Yes	F7	NO		
Non-Refrigerated Body Holding Room	Negative	3	10	Yes	F7	NO		21
Pharmacy		2	6		G4-F8			
STERILISING & SUPPLY								
Sterilising Room	Negative	3	10	Yes	G4-F8	NO		24
Steriliser Equipment Room	Negative	3	10	Yes	G4-F8	NO		
Central Medical & Surgical Supply		2	6		G4-F8			
Disposal Room	Negative		6	Yes	F4	NO		20-23
Clean Workroom	Positive	2	6		G4-F8	NO	30-60	
Ventilation Requirements **VENTILATION REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES**								

Table 5: Matrix of specific requirements

Notes:

1. HEPA filters will be installed at the air outlet; the minimum air flow of 20 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
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 is 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
5. For operating theatres and burns units, the temperature and humidity should be adjustable and
6. Load figures are for planning / modelling purposes only and may be ratified through the briefing process.

8 HYDRAULICS

8.1 Introduction

The purpose of hydraulic services in a hospital is to provide adequate and reliable water and drainage services.

8.2 General

Codes and standards – the consultant is to understand and apply all current applicable standards, guidelines and codes, (unless reference to earlier versions of standards is specifically referenced).

8.3 Scope

Hydraulics services covered under the design guidelines comprise the following:

- Sanitary drainage
- Sanitary plumbing
- Trade waste plumbing and drainage
- Trade waste pre-treatment
- Stormwater systems including gravity or siphonic principles
- Rising mains and pumps
- Fixtures and fittings
- Water services (hot and cold and warm water systems)
- Gas services (natural and LPG)
- Fire hydrant systems and fire hose reel system
- Hydrotherapy pools
- Water recycling systems including RW collection and reuse systems with associated treatment systems subject to cost and benefit analysis
- Renal dialysis or RO water plant design and
- Helipad drainage.

8.4 Design advice

8.4.1 Water Systems

Very early investigations should be made with the local supply authorities to confirm mains water supplies are available and reliable. Cold water storage should be provided only in those instances where the public utility 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 main supplies are proved to be unreliable by past records, 24 hour storage for domestic consumption should be provided. The storage tank should be divided to allow for cleaning. The designer should critically assess the storage requirements for other supply such as cooling towers.

The design of water piping systems will achieve 200kPa minimum static water pressure at any outlet and a maximum water pressure of 500kPa at any outlet. The maximum velocity of water within pipework will be limited to 1.5 m / seconds irrespective of the piping material in the water supply system. The velocity for the circulation in hot water systems will be in the range of 0.6 to 1.0 m / second.

Dead legs should be kept to a minimum (less than 10 metres) to ensure that sufficient water is flushed out of the pipe system at every use.

The design of water system isolation valve should provide for isolation valves to local groups of fixtures, or where the architectural layout is such that group isolation to basins is not economical, individual mini taps will be used for hot and cold service flow control where required. Multiple ring-main isolation valves should be located to ensure that during maintenance the minimum number of fixtures is isolated at any time.

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

The inclusion of ring mains will be considered as part of the design process. The ring-mains will perform both performance and maintenance roles.

Water meters should be provided to all main water users such as cooling towers, hot water systems, CSSD, kitchens and laundries.

Suitable filters / treatment should be provided to the domestic cold water main incoming water service downstream of the water meter. The filters / treatment should be set up in dual to allow for servicing of one filter / treatment at the time.

For warm water systems, the use of thermostatic mixing valves with remote monitoring is the preferred method of delivering warm water. This provides a more reliable method of controlling legionella, and will minimise the affected area in case of any issues arising.

8.5 Sanitary Plumbing and Drainage

Very early investigations should be made with the local supply authorities to confirm adequate sewer mains are available and reliable.

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

Gravity drain systems will be installed wherever possible. If pumping systems for the disposal of sewerage or effluent are installed they will be installed in 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, low and high level alarms.

The storage volume of a pump-out system will be as AS3500 or local authorities' requirements; however the system will ensure a minimum of 4 hours storage 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 of outside the door if the pit is in a room. An alarm should be raised in case of power failure.

Drain pipes should be of a suitable material and designed and installed to suit the type of waste or wastes carried and the temperature of same waste. Where possible, it is highly recommended that pipework is concealed and vents are interconnected in roof or ceiling spaces to reduce the number of roof penetrations.

It is highly recommended that drainage piping is not installed within the ceiling or exposed in operating and delivery rooms, nurseries, food preparation areas, food serving facilities, food storage areas, computer centres and other sensitive areas. Where overhead drainage piping in these areas is unavoidable, special provisions should be made to protect the space below from leakage. This is to include the use of drip trays and leak detection devices linked back to the BMCS.

Inspection and cleaning openings should be positioned external to the building fabric. Where this is not possible, inspection and cleaning openings will be positioned in ducts or within the wet areas it serves. Inspection and cleaning openings will not be positioned in ceiling spaces.

Access pits suitable for cleaning and pumping out are recommended in service areas rather than cleanout openings within pipes and junctions. All access pits are to have airtight covers.

Grease traps should be located on site in a position accessible from outside of the building without need to interrupt any services and which is easily accessible for tanker vehicle access. Should the grease arrestor be located internally of 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 of the health care facility. Grease arrestors should be sealed and provided with a chamber vent that extends to the roof.

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. Pumps should be a positive displacement helical screw type. Where practicable, above stainless steel traps should be considered.

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

8.5.1 Storm, Subsoil and Roof Water Drainage

Gutters and downpipes should be designed to 1 in 100 year rainfall intensity with overflows to cater for blocked outlets at the maximum flow.

External eaves gutters should be considered instead of internal box gutters. Where internal box gutters are designed the designer should demonstrate the effective overflow strategy.

Gravity downpipes should be used where possible. If a syfonic drainage system is proposed, the design and installation responsibility should be with a single company with a demonstrated track record.

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 outlets should be provided with domed grates to allow for a higher water level should debris build up around the outlet. All flat concrete roofs should have overflow provisions that match 1 in 100 year rainfall intensity.

Subsoil drainage should be provided to all retaining walls, planters and areas where potential ground water ingress could occur. Sub soil drainage should gravitate where possible to the stormwater drainage system.

Where subsoil drainage water is pumped, the pits should have sufficient size to allow for the proper operation and maintenance of the pumps. Pumps should be installed in a dual or triplex configuration with at least one pump on standby.

All level sensors 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.

8.5.2 Natural and LPG

Gas systems should comply with the relevant Australian Standards and local supply authority. Authority gas meter sets are should be located external to the building where possible and gas distribution pressure inside a building should comply with AS5601.

Zone isolation valves for plant rooms and kitchens should be installed at a height that does not require ladder access.

The above items will provide and improved serviceability, reduce maintenance and allow for maximum future flexibility.

- Internal gas meter rooms generally require mechanical ventilation and add operational as well as construction cost
- Isolation valves usually end up at high level in plant rooms or ceilings and cannot be access quickly and
- Internal pipe work should not be plastic. This does not provide sufficient mechanical damage protection and will require special tools and fittings for future modification.

8.6 Renal and RO Water Systems

Special consideration should be given to the design of the renal and RO water systems in regard to the water quality requirements, pipe loop design, material and plant selection.

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

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

The pipe loops should have minimal dead legs that do not allow for stagnant water. Fittings that allow water circulation up to the isolation valve should be considered in the installation.

For RO water systems serving renal dialysis equipment, the design should be undertaken in collaboration with the equipment supplier to ensure system compatibility.

A separate RO waters system should be provided to the CSSD in compliance with AS4187.

8.7 General Material Selection

The designer should carefully consider all impacting and contributing environmental factors which affect the 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 zero degrees, 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
- Chemical waste – e.g. from laboratories, cleaning chemicals
- RO water in dialysis suites and
- Acoustic treatment of downpipes etc.

9 INFORMATION AND COMMUNICATOINS TECHNOLOGYSYSTEMS

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 run on the ICT Infrastructure that may be found in a hospital. ICT systems will be designed in accordance with NSW eHealth Standards including the ICT Cabling Standard, NSW Health Campus Blueprint, ICT Wireless Standard and associated guidance notes.

The guidelines below are provided as a guide and are not meant to be prescriptive. The need and extent of ICT systems will be determined on a project by project basis.

9.2 Planning / Context

All projects will consider the master-plan for the hospital campus. The site-wide infrastructure needs must be assessed and balanced with the needs of the project, including future land acquisition and divestment opportunities.

Key considerations include:

- Proposed cabling routes to connect new or refurbished facilities
- Site location in context to the major data centre(s)
- Site location in context to the legacy PABX Room and
- Cost and service impacts.

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

Where the needs require a local data centre to be established, it will be viewed as a permanent fixture on campus, and positioned in the best location for the overall future of the site.

NSW Health, eHealth, HealthShare, Local Health Districts and NSW Health Infrastructure all have standards that will influence the ICT related works for a health facility.

- There are other areas ICT will be influenced by the following criteria
- Recommendations of Australian Standards
- New technologies that offer significant benefits to a health facility
- Specific Project Briefing process and,
- Best practice from similar projects.

9.3 Systems and Infrastructure

The ICT system span across a development is large, these include:

- Structured cabling
- Fly leads and patch leads
- Technical Outlets (TO) including wireless access point cabling and outlets for which equipment, such as a computer on wheels
- Mobile telephone Distributed Antenna System (DAS) and mobile phone macro tower(s)
- Radio based communication including for use by facility staff as well as Emergency Service providers such as Police, Fire & Rescue, Ambulance, Government Radio Network (GRN)
- Telecommunication lead in(s) to the campus, terrestrial or aerial
- UPS to servers, network equipment and other key equipment
- Communication and computer rooms including redundant air conditioning, racks, power rails in racks, UPS, generator backed up power, cable management, fire protection, environmental monitoring and physical security
- Telecommunication panels including MDF and IDF
- MATV / Patient Entertainment System cabling but not usually active equipment
- Equipment and cabling to support Video conferencing / TeleHealth but not usually the codec itself. This may include fixed speakers, microphones, screens, projectors, matrix switchers, cabling to floor boxes, cabling between a table and display / projectors / screens
- External and / or internal intercom, except where it is agreed this will be provided the telephone system
- Pager Infrastructure
- Public Address System, except where it is agreed this will be provided the telephone system or EWIS
- The following are particular engineering systems that may run on the ICT Infrastructure
- CCTV
- Security (Access Control)
- Building Management and Control System (BMCS)
- Electronic Way Finding and
- Nurses Call.

The interconnection of systems into the Message Integration Engine, of the following systems shall be conducted on a case by case bases, depending on the size and nature of the project:

- Nurse Call
- Building Management and Control System (BMCS)

- Security (Access Control and CCTV)
- Fire Indicator Panel
- Fixed Duress and
- Intercom.

Figure 9.1 below provides a conceptual view of infrastructure related ICT in a health facility redevelopment. This should be used as a guide only.

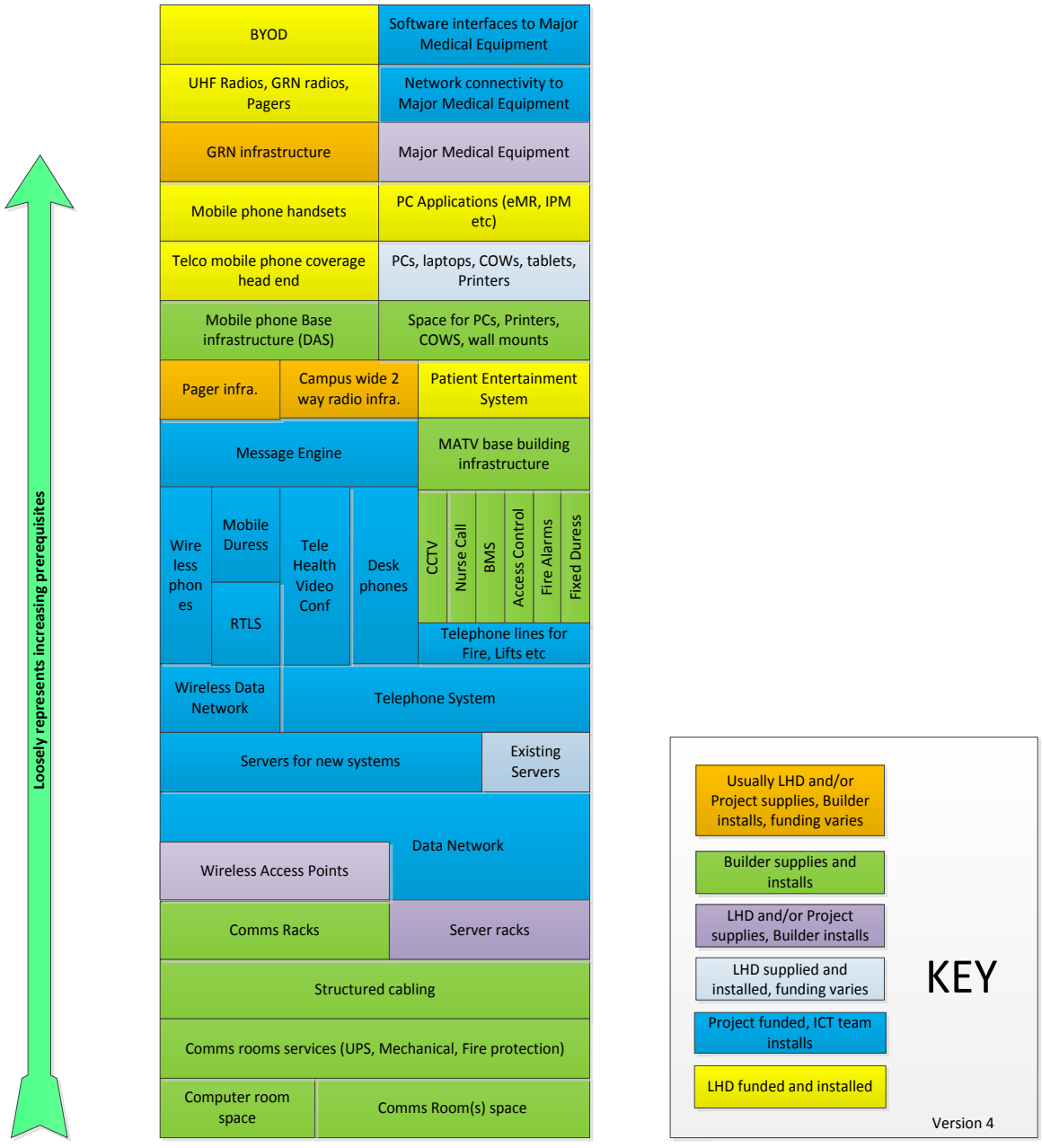


FIGURE 9.1 – A CONCEPTUAL VIEW OF INFRASTRUCTURE RELATED ICT IN A HEALTH FACILITY REDEVELOPMENT

9.4 Specific Requirements / Guidance

9.4.1 Data Cabling - Structured Cabling

Due to the longer life expectancy of cabling, is expected to be used by the facility for 25 year or more, and will limit functionality if done poorly over that 25 + year period. Of all of the ICT elements in a redevelopment, data cabling is the element that is most static over the life of the health facility and thus should be most carefully planned in order to “future proof” the health facility.

NSW Health cabling standards, Local Health District cabling standards, NSW Health LAN * WLAN Campus Design Guidelines and Local Health District network design standards must all be considered in the data cabling of a health facility.

9.4.2 Communication Rooms

The communication room hierarchy is: Campus distributor(s) (CD) feed Building Distributors (BD) that feed Floor Distributors (FD) that feed Technical Outlets (TO).

Refer to State and local Health District cabling standards.

All active equipment in communications rooms should have UPS power. Most active equipment has redundant power supplies and each power supply should be connected on diverse electricity circuits.

Communication rooms should have environmental monitoring with the ability to create an auditable record of events and notify a range of people, via a variety of means, when events occur.

9.4.3 Campus Distributor(s)

Where practical, appropriate and not subject to excessive costs dual CDs will be constructed with each providing a level of redundancy over the other. This may include each CD having:

- Its own telecommunications data lead in via a physically diverse path possibly with diversity of carrier and possibly with diversity of telecommunications exchange
- MDF / IDF and
- Redundant core active equipment housed in it such as core data network, wireless LAN controllers, telephone system and other high availability systems.

In addition, CDs should be considered hybrid ICT rooms that house not only telecommunication equipment, but also active network equipment, DAS equipment and are also the campus computer room(s). This precludes constructing other computer / server rooms or DAS rooms. The benefit of the hybrid use approach is that it provides the most flexibility for the future as space requirements for networking, servers or other equipment fluctuates over time.

CDs should be interconnected with fibre and copper cabling.

9.4.4 Building Distributor(s)

Logically BDs always exist but in practice they may be physically in the same room as a CD or a FD i.e. CD / BD or BD / FD combination.

9.4.5 Floor Distributor(s)

FDs have non-redundant copper cabling paths to Technical Outlets (TO) and Wireless Access Points (WAPs).

9.4.6 Communication Lead-ins

Where practical, appropriate and not subject to excessive costs, n+1 incoming copper and fibre lead-in communications services will be provided along diverse routes, terminating in separate incoming communications rooms. Where the hospital area is fed from a single utility exchange, then n+1 incoming services may not offer a suitable level of redundancy to be an attractive solution.

Wireless communications may be considered as a secondary, redundant communication link in some facilities.

9.4.7 Communication Outlet Quantity

Refer to the NSW Health ICT cabling standard and Local Health District cabling standards for guidance. These requirements must be considered in conjunction with the current AusHFGs.

The final number must be presented and agreed to by Health Infrastructure. Cabling Redundancy - where practical, appropriate and not subject to excessive costs, horizontal fibre cabling should be designed with redundant paths from campus distributors (CD), via building distributors (BD), to floor distributors (FD). Copper cabling is generally not designed with the same level of redundancy. Cabling from floor distributors to technical outlets (TOs) is not usually made redundant.

9.4.8 Mobile Phone Coverage

The need for mobile telephone coverage is increasing in importance in health facilities. Where practical, and not subject to excessive costs, planning should consider mobile phone coverage throughout a health facility. This may require the installation of a Distributed Antenna System (DAS) for in-building coverage and / or a macro tower installed outdoors. How this is funded and the best options for a facility is a matter for consultation at the project, facility, Local Health District and State levels.

9.4.9 Radio and Paging reception

Radio reception includes consideration for:

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

9.4.10 Mobile Duress

Duress systems in a health facility are either Fixed Duress or Mobile Duress. The former is described below in “Building Specific Systems”. This section describes Mobile Duress.

Mobile duress systems can be based on WiFi infrastructure or other technologies. WiFi based mobile duress systems are most commonly out of scope of the capital consultant because of the significant interdependencies with system provided by the ICT team. This includes, for example, the WiFi network itself, Real Time Location Services (RTLS), Message Integration Engine, WiFi devices, Smart Phone apps and, PC based apps.

In some redevelopments, it may be decided to use a mobile duress system based on non WiFi technology. In those cases the Capital Consultant will most likely be responsible for the implementation of the mobile duress system in the redeveloped areas.

A mobile duress solution must, regardless of who provides it or how it is provided, always:

- Comply with NSW Health “Protecting People and Property” policy
- Have coverage in areas of the facility deemed necessary by a formal risk assessment
- 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
- Consider bi-directional integration to a Message Integration Engine to allow alerts and resets to be passed to other end points and systems
- Consider the need for communication to an external monitoring company when duress events occur
- Uniquely identify the device triggering the duress
- Identify the location of the event with a message consistent with way finding and room naming standards across the facility
- Minimise false alarms
- Minimise alarm fatigue and
- Support the duress response process of the facility.

9.4.11 Building Specific Systems

A number of building specific systems may be provided by the capital consultant. This includes but is not limited to the following are engineering systems that will run on the ICT infrastructure:

- Nurse Call
- (BMCS)
- Close Circuit Television (CCTV)
- Security / Access Control
- Fixed Duress
- Public Address System

- Intercom
- Electronic Way Finding and
- Baby Location.

Planning for each of these systems must always take into account:

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

9.4.12 Data Cabling for Building Specific Systems

Data cabling for Building Specific Systems should, where practical and cost effective, make use of structured cabling. This gives the best chance of reuse of that cabling when the initial building specific system is inevitably replaced in the future.

This may or may not mean that the Building Specific System is on the campus' data network. That is a matter for detailed planning with the LHD ICT team.

9.4.13 Enterprise Design and Quality of Equipment

ICT equipment that makes up building specific systems should be designed according to enterprise grade standards and equipment. The LHD ICT team should be consulted. This included, but is not limited to:

- Use of enterprise grade equipment and systems
- Highly reliable equipment with Mean Time Between Failure (MTBF) equivalent to industry standards
- The ability to monitor and manage equipment remotely
- Best practice security standards including hardening, remote patch management, anti-virus, firewalls, access control, encryption and
- Power supply redundancy.

9.4.14 Nurse Call Systems

Exiting sites will consider the extension of their 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 Message Integration Engine 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 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 and
- Each Nurse Call alert text message must uniquely identify the location consistent with way finding and room naming standards across the facility.

Issues of security, duress, and location specific and / or context specific information will also be considered.

9.4.15 Building Management and Control Systems (BMCS)

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

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

9.4.16 CCTV

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

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

9.4.17 Security / Access Control

Exiting sites will consider the extension of their existing Security / Access Control system. Where extensive new facilities are planned, Security / Access Control system will allow for:

- Bi-directional integration to a Message Integration Engine to allow alerts and rests to be passed and
- 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.

9.4.18 Fixed Duress

Fixed duress may or may not be a component of the Security / Access Control system. Fixed duress 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 system must comply with NSW Health “Protecting People and Property” policy. That policy must be considered in depth for any duress planning. For example, that policy states that fixed duress is only appropriate in locations where the aggressor is unable to get between the staff member and the duress button. That precludes fixed duress in meeting rooms for example. That policy also states determination of the need for duress should be made via a risk assessment.

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

- Bi-directional integration to a Message Integration Engine 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 and
- 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.

9.4.19 Public Address Systems

Where public address systems are required, the following will be considered as part of the design:

- Integration with Emergency Warning Intercommunications Systems (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 and
- Allow announcements from the Unified Communication System / PABX.

9.4.20 Intercom

Intercom may be required at entry points into a building or into a department within a building. Where intercom is required, the following will be considered as part of the design:

- Voice integration with Unified Communication System / PABX including to configurable telephone handsets, either wired or wireless
- Video integration with Unified Communication System / PABX 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 and

- Bi-directional integration to a Message Integration Engine to allow text, audio and / or video to be passed.

9.4.21 Electronic Way Finding

Where practical, appropriate and not subject to excessive costs, Electronic Way Finding be required. Where it is required, the following will be considered as part of the design:

- The use of Way Finding Consoles at key locations in the facility and
- The use of Smart Phone apps to direct a visitor, patient or staff member.

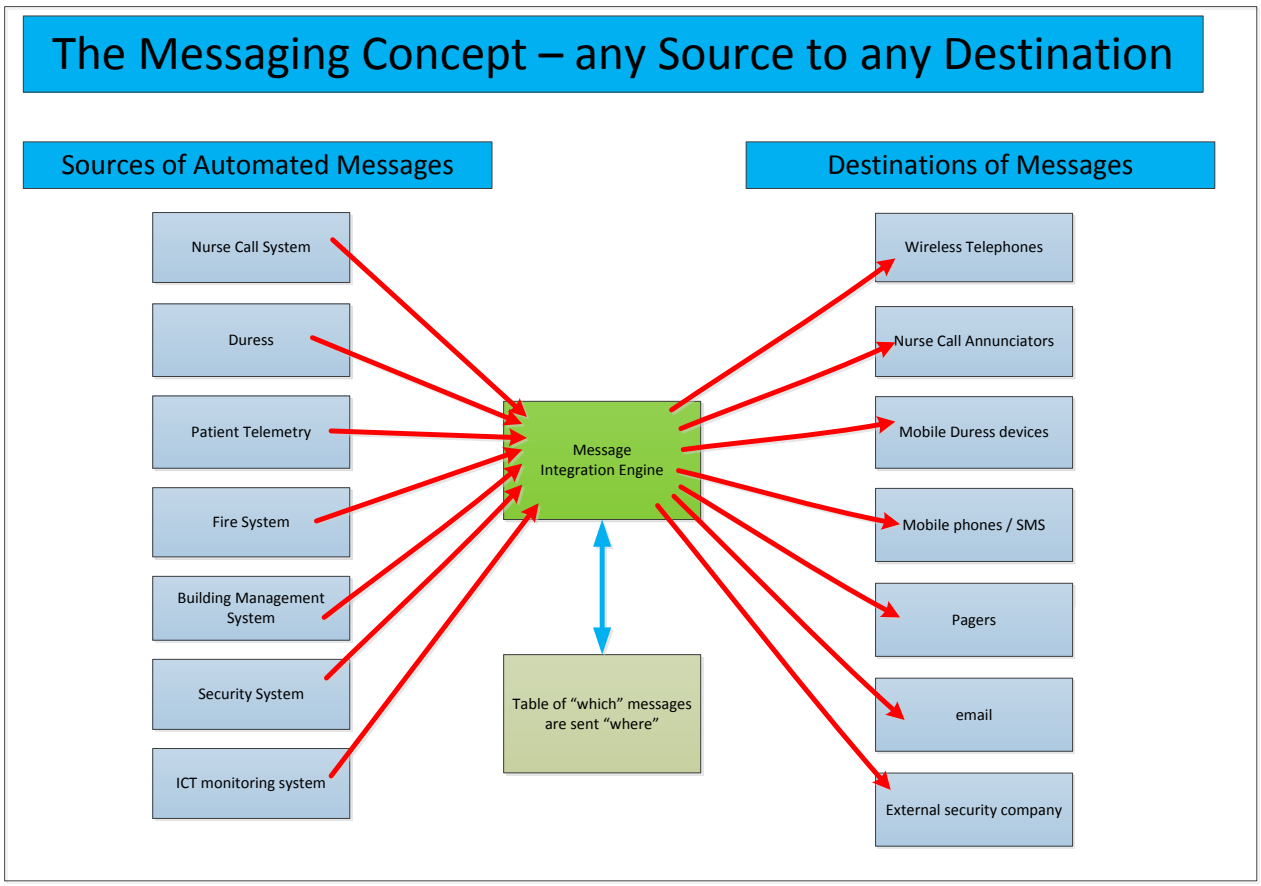
9.4.22 Baby Location

Where practical, appropriate and not subject to excessive costs, baby location monitoring may be required. This system alerts staff if a baby leaves a ward. Where it is required, the following will be considered as part of the design:

- The baby location system may be part of another system
- The device attached to the baby must be appropriate in terms of
- Cost
- Size
- Discretion and
- Water proof
- The device attached to the baby must cause an alert if it is removed from the baby.

9.4.23 Message Integration Engine (MIE)

A Message Integration Engine is a system to allow messages generated by disparate systems to be sent to a range of receiving devices and / or systems. The figure below shows the concept.



The supply and commissioning of the MIE is not in the scope of the Capital Consultant. However the Capital Consultant is required to provision a range of systems to integrate to the MIE. Examples are shown in the section "Building Specific Systems". Refer to the HI Design Guidance note. Key considerations for the Capital Consultant, with respect to the MIE are:

- 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 and
- The MIE is supplied and commissioned by the ICT team due to its interdependencies with other ICT systems; Telephone System (PABX) and Facsimile Machines.

It is standard project arrangement that all active equipment in PABX systems are procured separately from the building contract, but as part of the overall project delivery. Therefore, the project design must cater for the appropriate infrastructure and outlets to meet this requirement including spatial allocation of PABX equipment. In existing hospitals where existing PABX system of various age and technology may exist, appropriate assessment must be made to evaluate the optimal arrangement of extending, separate system or system replacement arrangements, giving due consideration to practical problems and budget considerations.

Despite the availability of digital technology, the use of facsimile in hospitals is still required. The method of providing for the communication to these machines should be considered, as to whether dedicated analogue connection or otherwise.

9.4.24 Wireless Telephony

Wireless telephony on a campus is provided by any or all of:

- WiFi technologies
- DECT technologies and
- Mobile phone technologies.

Either WiFi or DECT infrastructure that support voice calls should be provided in a redevelopment, but not both.

DECT infrastructure, if provided, will normally fall within the scope of the Capital Consultant.

WiFi infrastructure, if provided, will normally fall outside of the scope of the Capital Consultant. The location of the Wireless Access Points will be determined by a suitably qualified expert in the field. See WiFi network design below.

9.4.25 WiFi network Design

WiFi networks are generally provided with ubiquitous coverage within the redevelopment buildings and limited locations outside. That coverage is usually designed to performance criteria that provides high quality Voice over Wireless LAN (VoWLAN) and Real Time Location Services (RTLS).

WiFi network design will normally fall outside of the scope of the Capital Consultant. The location of the Wireless Access Points will be determined by a suitably qualified expert in the field, and be engaged by the ICT team. That design will inform the Capital Consultant as to the placement of WAP cabling.

WAPs should be expected to be installed throughout the redevelopment including:

- In lift cars
- In stairwells used to move between floors (fire stairs or other)
- In enclosed courtyards
- In external areas used to move between buildings and
- In rooms whose walls have high attenuation of WiFi signal, for example lead lined rooms.

The Capital Consultant must ensure there is no system installed, within their scope, that installs any WAPs or other WiFi infrastructure, if the main WiFi network is designed and installed by the ICT team.

9.4.26 Provisions for other services

There are many engineering systems which may run on the IT infrastructure, these include: Nurse Call, security, lifts (including AGV if applicable), BMCS, medical equipment alarms and fire alarms systems. The ICT system should facilitate and provided for all necessary connections for such systems. The management and co-ordination with appropriate hospital stakeholders on details such as allocation of

addresses for various points and systems are important when these systems run on the hospital IT network.

9.4.27 Patient Entertainment System (PES)

The infrastructure cabling for a Patient Entertainment System is within the Capital Consultant's scope, however the active equipment is not.

The Capital Consultant should design cabling for a PES considering:

- The use of CAT6A cabling to "future proof" the PES infrastructure
- Coordination with the facility and others who will provide the active equipment
- Integration into the Nurse Call pendant to allow control of the PES from the bed
- Provision for the placement of TV Antenna, satellite dish and similar equipment in a suitable location
- A location for the installation of head end equipment and
- Means to fit TVs at the patients' bed.

9.4.28 Installation and Equipment Quality

It is important for ICT designs to specify equipment of appropriate quality for hospital applications out by appropriate experienced and qualified ICT contractors.

9.4.29 Campus Considerations

The work of HI changes the physical nature of the health campus, and can impact existing network coverage. The following is the policy position of NSW Health Infrastructure:

- Before any works commence on a Healthcare Campus, a network coverage assessment of the campus must be undertaken / obtained
- HI is not responsible for providing infrastructure to 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, HI can assist in establishing a dialogue between the hospital / LHD and WSPs to negotiate improved mobile wireless device network coverage
- Similarly, HI can facilitate dialogue between the hospital / LHD and the GRN operator to negotiate improved GRN coverage if required, noting that GRN coverage is required within the emergency department, ambulance bays and main hospital entrances. For clarity, there is no expectation that GRN coverage be achieved throughout an entire facility. Such negotiations will consider both existing and new demand associated with the capital works being undertaken by HI
- 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. The HIRPN maintenance provider is British Aerospace Engineering Australia (BAE) and

- After works are completed, the network coverage assessment must be confirmed.

9.5 ICT Applications for Healthcare Facilities

The designer should maximise the opportunities for current and future ICT needs of the specific project.

Consultants should address the opportunities to achieve better health outcomes and efficiencies by providing an infrastructure system that will facilitate, within practical and economic limits, emerging ICT technology. Some examples of emerging applications may include may include:

- Patient management optimization
- Patient management - integrated and complete patient health management for whole of life
- Application of Smart Cards and new approach to ICT at various settings including bedside and staff base functions
- Patient education - assist in self-diagnosis and care after discharge
- Integrated patient care across all modalities
- Access to health informatics
- Collaboration of health providers and researchers at all levels to provide optimum diagnosis and individual treatment planning for each patient
- Integrated and complete patient monitoring systems
- Improved infection management and patient outcomes and
- Telemedicine.

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 OT lighting
- Exit and emergency lighting
- Security lighting and
- Associated control systems.

10.3 General Requirements

Lighting systems are generally required to deliver:

- User comfort
- Healthy environments
- Task visibility and good visual performance
- Orientation and way finding
- Safety
- Energy conservation and efficiency
- Comfort control
- Reliability
- Flexibility/ adaptability
- Maintainability
- Commissionability and

- Whole of life efficacy.

10.4 Planning / 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.

10.4.5 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.

10.4.6 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 lamp types across the project and the campus and
- 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 a number of issues, including functional and medical requirements, the comfort of patients, staff and visitors, the architectural space and design intent, security requirements, access and way finding and other considerations such as maintenance, 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 / Guidance

10.6.1 Illuminance Guidelines for Visual Tasks

The Australian Standards, in particular 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 Service Colour’ i.e. visual task requiring discrimination of colours. The standard gives three examples:

- Examination of patient’s skin condition to detect conditions such as cyanosis and jaundice
- General examination for dermatological conditions and
- 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:

1. Install energy efficient high quality LED or T5 type lights of the appropriate colour temperature in all general areas of the hospital to provide a high level of

illumination, it ought to be noted that LED is preferred as the cost of LED and T5 lamps are becoming similar

2. Provide a limited number of mobile LED type Ra 90 lamps for areas that do not have adequate natural lighting or examination / procedure lights and
3. 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 in order 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) and
- 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 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

- Luminaires and their positions should be assessed in regards to 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 and
- Inpatient units and corridor applications care has to be taken in designing and placing lighting in order 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:

- The 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 and
- 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

It needs to be ensured that the lighting designer has an understanding of 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 4282 - Control of the obtrusive effects of outdoor lighting;
- AS4485 - Security for health care facilities; and,
- AS2293.1 - 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) and
- AS 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 fluorescent and / or 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, lamps 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) and
- 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 lamp 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 located 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 and
- 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 particular in patient 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 in regards to its contribution 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 might need to be utilised for predicting the distribution of visible radiation in day lit spaces, for identifying instances of direct solar penetration entering a space and for assessing daylight control mechanisms in regards 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 particular 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 in order to maximise natural daylight whilst minimising energy gains.

To minimize 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 have the ability to provide a platform to accommodate new technologies as they emerge without the need for major reconfiguration.

Open control protocols such as KNX 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 health care buildings will be provided in accordance with the requirements of the National Construction Code and AS2293.1. The emergency and exit lighting system will be designed to considering the following:

- Existing health campus emergency system (if in existence)
- Integration with architecture and overall lighting design philosophy
- Single point or central battery system
- Energy efficiency and
- 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 car parks
- To illuminate areas with CCTV coverage to sufficient levels for the effective operation of CCTV cameras
- Be considered with crime prevention through environmental design document;
- Design advice (see below) and
- Protecting people and property requirements.

10.13 Design Advice

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 J6 – energy efficiency, artificial lighting. The Design Illumination Power Density must be calculated in accordance with Section J 6.2.

Space	Maximum illumination power density (W/m2)
Board room and conference room	8
Carpark - general	6
Carpark - entry zone (first 20 m of travel)	25
Circulation space and corridor	8
Control room, switch room and the like	10
Entry lobby	15
Factory, industrial tasks and processes	17
Health-care - examination room	20
Health-care - patient ward	10
Health-care - children's ward	15
Kitchen and food preparation area	8
Laboratory	15
Office - artificially lit to an ambient level of 200 lx or more	10
Office - artificially lit to an ambient level of less than 200 lx	7
Plant room	5
Public toilet	5
Restaurant, cafe, bar, spaces for the serving and consumption of food 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 lx, 13 W/m1
	B	For an illuminance of 160 to 600 lx, 16 W/m1
	C	For an illuminance of more than 600 lx, 20 W/m1
2	For illuminance levels greater than 600 lx, the maximum illumination power density can only apply to the location where that level is needed.	
3	The maximum illumination power density my be increased by dividing it by the illumination power density adjustment factor in Table J6.2c where applicable.	

Table 7: Power Density

11 MEDICAL / SPECIALIST GASES

11.1 Introduction

The purpose of the medical gases is to provide life support and for use in patient procedures and patient care.

11.2 Scope

Medical gases generally include:

- Oxygen
- Medical breathing air
- Suction including scavenging
- Nitrous oxide
- Tool air
- Dental air
- Dental suction
- Carbon dioxide and
- 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 / 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.

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 3 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 2 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.

Note – these regulator and indicator panels are quite large and need to be carefully co-ordinated with other wall mounted services and equipment.

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 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.

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 AusHFGs.

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 AS 1210 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.

12 SECURITY

12.1 Introduction

The purpose Security systems is to provide a secure environment to ensure safety for all 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 and
- 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
- IT facilities, central rooms and data centres
- Risers
- Hazardous bulk storage and
- Campus wide areas.

12.4 Planning / 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 the all of the 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 Australian Standards - Security for health facilities (AS4485).

13 ACOUSITCS

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, theatre 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 and
- Building services noise and vibration.

13.2 Scope

In the development of the acoustic design for a health care building the design team and builder 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 and
- Vibration and structure borne noise.

13.3 Design Strategy

This document outlines the design strategy for each acoustic consideration in the sections that follow, and includes:

- Design outcomes – provides direction for the design team by outlining the design targets and outcomes, and promotes consistency in acoustic design by setting a benchmark for all future and updated healthcare buildings and
- Design guidelines – provides guidance for the design team on issues to consider in achieving the design targets, including information on important elements for each acoustic design aspect.

13.4 Verification of the Design

The acoustic design should be documented at key stages of the work, typically including:

- Development assessment stage
- Return brief and concept design and
- Detailed design.

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 client, 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.

13.5 Design Guideline Notes

13.5.1 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 and
- Noise from emergency helicopter flights associated with the facility.

The assessment will also consider characteristics that influence the impact of a particular 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 louvers 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 particular development location.

13.5.2 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.

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.

Environmental noise intrusion should be considered in aggregate with the noise from mechanical services to satisfy the maximum noise levels in Column A of Table 12.

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 achieve the maximum allowable internal noise levels as given in Column A of Table 12:

The environmental noise intrusion should be considered in aggregate with the noise from mechanical services to satisfy the maximum noise levels in Column A of Table 12.

Intermittent Noise

Infrequent and short duration noise sources such as aircraft; trains and emergency vehicles 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.

The design should limit intermittent noise to achieve the maximum internal noise levels outlined in Column B of Table 12.

Helicopters Associated with Hospital Operations

Helicopter operations can exhibit similar noise characteristics to fixed wing aircraft pass-bys and also generate high levels of short period steady noise levels hovering or idling.

However, emergency medical helicopter operations differ from fixed wing aircraft as follows:

- 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 and
- 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 wind aircraft. Column C of Table 12 provides recommended design noise levels applicable to frequent operations (1 or more missions per day, on average). These criteria may be adjusted, in consultation with the client, to account for the frequency of emergency operations, using a risk-based approach as follows:

- Up to 10dBA less stringent if helicopter operations are less than 1 mission per day, but more than 2 missions per week, on average
- Up to 20dBA less stringent if helicopter operations are very infrequent (less than 2 missions per week, on average) and

  subject to:

- an absolute limit of 80dBL_{Amax} for any occupied room and
- consideration being 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.

The design will achieve and internal noise level (from rain noise) equal to Column A of Table 12 + 10 dB based on the estimated maximum rainfall intensity for a 1 hour duration in a year, as given by the Bureau of Meteorology for that location.

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.

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. Therefore, at the operation of the emergency generation plant, small increase from the normal design level by + 5 dB should be considered acceptable. Note that this 5 dB allowance does not apply to continuous generation plant.

Sleep Arousal

Short duration noises may comply with the "Intermittent Noise" criteria above, and yet be undesirable because of the sleep arousal effect at night.

Therefore, noise intrusion from intermittent noise that occurs between 10.00pm and 7.00am will also be controlled in accordance with the relevant standards and guidelines on sleep disturbance.

Building Services Noise

Mechanical Services

The internal noise levels due to mechanical plant should be designed to meet the internal noise criteria as per Column A of Table 12 in aggregate with other sources of continuous noise.

The internal noise levels 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 and,
- 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.

The maximum noise level from mechanical services should be considered in aggregate with the environmental noise intrusion to satisfy the maximum noise levels in Column A of Table 12.

Vertical Transportation

Noise from lifts will to be controlled to achieve the following noise levels as shown on table 9:

Occupancy	Maximum Sound Level Lmax
Habitable	30 dB(A), free of tonal components
Wet Areas	40 dB(A), free of tonal components
Lift Call Bells	
(measured within sleeping areas)	25 dB(A)
Lift Lobbies (including lift by-pass)	50 dB(A)
Lift Lobbies (during doors open / close)	60 dB(A)

TABLE 9: VERTICAL TRANSPORTATION

In general, noise sensitive spaces should not be located adjacent to, above or below, or in close proximity to 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 plant room for attenuators and other control measures and

- 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).

13.5.3 Acoustic Isolation

In summary, 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 internal noise levels as per the requirements of Column A of Table 12
- Speech privacy requirements as per column D of Table 12
- 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.) and
- 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 of the 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 take into account 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 and
- The background noise level in the receiving room.

The airborne sound isolation of separating constructions, will achieve whichever the greater requirement is of:

- The speech privacy requirements for each room in Column D of Table 12 and
- Control of noise from any adjacent noise generating room (such as a plant room) so that the resulting noise level in an adjacent receiving room achieves the nominated levels in Column A of Table 12.

The speech privacy levels are defined as shown in Table 10.

Level of Speech Privacy	*Description*	*Required outcome (sound insulation, Dw plus background noise, dBA)*
Confidential	Raised speech would be audible but not intelligible, and normal speech would be inaudible	80 to 85
Private	Raised speech would be audible and could be intelligible. Normal speech would be audible but not intelligible	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

TABLE 10: SPEECH PRIVACY LEVELS

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 greatest rating of the two assessments takes precedence and should be used as the final sound isolation rating.

Speech Privacy

The table below illustrates the important dependence of speech privacy on both sound insulation and background noise levels.

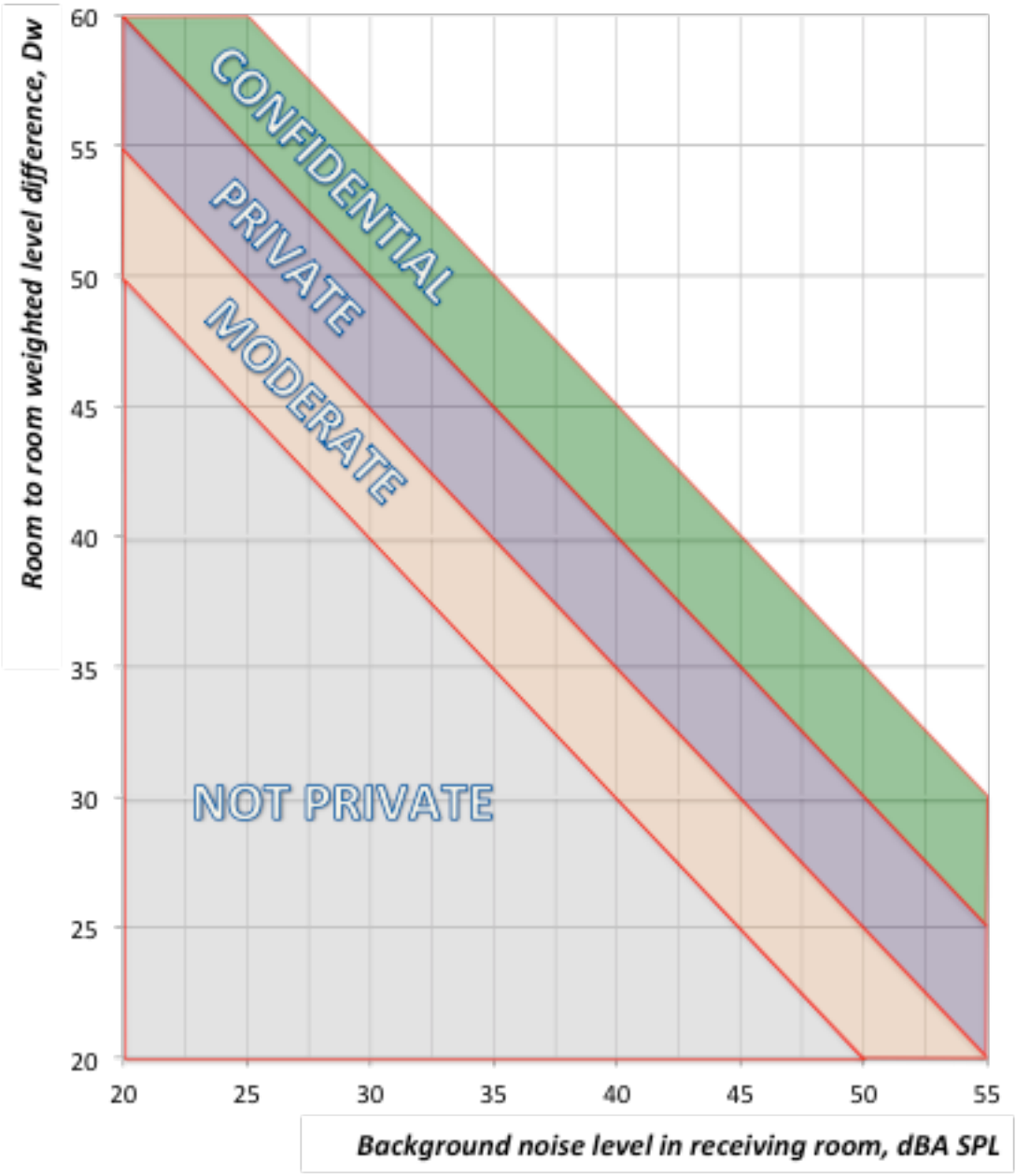


TABLE 11: SPEECH PRIVACY

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. 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 so as to arrive at the most cost-effective solution for the project.

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 so as 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. This requires:

- Air conditioning noise levels to be in the range between “Satisfactory” and “Maximum” in Column A of Table 12. In other words, the “satisfactory” criterion should be interpreted as a “minimum” value for rooms that require a degree of acoustic privacy and
- Consideration of 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, strategic planning and 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 and
- A door specified within a partition should have a performance of not less than 10 dB below the partition performance.

When considering doors in healthcare buildings including cost, practicality and usability, there are generally two standard door types that can be implemented:

- General doors with no acoustic performance and
- Acoustic doors to provide a higher level of sound isolation typically achieved with a thick solid core doors with full perimeter and threshold seals.

Column E of Table 12 indicates which room types typically require an acoustic door.

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.

Walls – Impact Noise

Where partitions are expected to receive 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 discontinuous. A discontinuous construction is satisfied when two separate leaves of a partition are separated by a minimum of 20 mm. Examples of partition that should be considered for discontinuous construction when adjacent to a noise sensitive space are:

- Bathrooms
- Kitchens
- Laundries
- Workshops and
- High traffic corridors.

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

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, which have high foot traffic.

Column F of Table 12 provides the design impact noise requirements for the floor situated above the designated room type. Typically, vinyl floor or carpet tile floor coverings with a polyethylene foam underlay are sufficient to control impact noise through concrete floor structures. Resilient floor coverings need to be considered in conjunction with wear and rolling resistance needs of the surface.

13.5.4 Room Acoustics

Each room and area should have an internal room acoustic that suits 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. The room reverberation time (RT) is the most reliable descriptor of room acoustic performance although good room acoustics is not solely dependent on RT. The reverberation times in the spaces must be controlled to satisfy the times given in Column G of Table 12.

To achieve the nominated reverberation times, and to provide a room acoustic to allow good communication in key spaces, sound absorptive room acoustic finishes will be

required on the ceilings and / or walls and floors. These finishes will be integrated with the architecture and furnishings wherever possible.

Generally, where absorptive finishes such as carpet and / or suspended ceilings with mineral fibre ceiling tiles (minimum NRC 0.7 to 0.75) are provided, the recommended reverberation times will be achieved.

In many rooms within a healthcare building, there are conflicts with providing sterile and hygienic surfaces and providing absorptive finishes (such acoustic ceiling tiles). Where possible and practical, the design team will aim to provide acoustic absorption and investigate alternative materials that can satisfy both acoustic and functional requirements. For example, ceiling tile products exist in the market, which provide a sound absorptive finish and also meet the sterile and hygienic surface requirements for rooms such as operating rooms or birthing rooms.

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 as follows:

- 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 room's 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 2 seconds and
- 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 only effectively controlled at the source (relative to airborne noise). 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 MRI's can cause significant vibration issues, from both operational and installation perspectives.

Structure borne noise from plant and equipment must be considered in aggregate with building services, services noise and environmental noise intrusion to satisfy Column A of Table 12. Generally, generators or plant with high levels of vibration should not be located on suspended slabs. Where possible these plant items should be placed on grade to avoid costly vibration mitigation measures.

13.5.5 Energy / Sustainability

Acoustic design offers some opportunities for sustainable design. All of the materials specified as part of the acoustic design should be considered against products, which offer sustainability benefits. The following should be considered when selecting products:

- Recyclable products
- Products made with recycled materials
- Low embodied energy construction methodologies and materials
- Reduce the use of loaded vinyl products where possible and
- Selection of low-pressure loss acoustic attenuation components for the HVAC system.

ACOUSTIC REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES								
AREA DESIGNATION	A		B	C	D	E	F	G
	Continuous Internal Noise Levels L_{Aeq} dB		Intermittent Internal Noise Level L_{Aeq} dB	Internal Noise Levels Helicopter L_{Amax} dB	Speech Privacy Requirement	Acoustic door(s) likely required?	Impact Sound Isolation L_{nw} dB	Reverberation Time (s) (fully finished)
	Satisfactory	Maximum						
CLINICAL								
Operating Theatre	40	45	50	55	Private	-	55	0.4 - 0.7
Birthing Room or Delivery Suite	45	50	65	65	Confidential	Y	60	0.4 - 0.6
Intensive Care	40	45	50	55	Moderate	-	55	0.4 - 0.7
Patient Room / Single Bed Ward	35	40	50	55	Private	-	50	0.4 - 0.7
Multi Bed Ward	35	40	50	55	Moderate	-	55	0.4 - 0.7
Toilet / En-suite	50	55	75	70	Moderate	-	60	-
Patient Corridor	40	50	65	70	-	-	60	0.4 - 0.6
Counselling / Bereavement / Interview Room	40	45	50	55	Confidential	Y	55	0.4 - 0.6
Consultation Room	40	45	50	55	Confidential	Y	55	0.4 - 0.6
Speech and Language Therapy	35	40	50	55	Moderate	-	55	0.4 - 0.6
Treatment / Medication / Examination Room	40	45	50	55	Confidential	Y	60	0.4 - 0.6
PUBLIC AREAS								
Corridors and Lobby Spaces	40	50	65	70	-	-	60	0.4 - 0.6
Cafeterias / Dining	45	50	70	70	-	-	60	Practicable Reduction
Toilets	45	55	75	70	-	-	-	-
Waiting Rooms, Reception Areas	40	50	65	70	-	-	60	0.4 - 0.6
Multi Faith / Chapel	30	35	50	55	Confidential	Y	50	0.4 - 0.6
STAFF / BACK-OF-HOUSE AREAS								
Meeting Room	35	40	55	60	Private	Y	55	0.6 - 0.8
Board / Conference Room (Large)	30	35	55	60	Private	Y	55	0.6 - 0.8
Open Plan Offices	40	45	65	70	Moderate	-	60	0.4 - 0.6
Private Offices	35	40	55	60	Private	Y	55	0.6 - 0.8
Multi Person Offices	40	45	65	70	Moderate	-	55	0.4 - 0.6
Locker Room	50	55	75	-	Moderate	-	-	-
Rest Room	40	45	65	70	-	-		0.4 - 0.6
Classrooms, Training Rooms	35	40	55	60	Private	Y	55	0.5 - 0.6
Lecture theatre	30	35	55	60	Private	Y	55	Curve 1 of AS2107:2000
Library	40	45	50	60	-	-	55	0.4 - 0.6
Workshops	45	50	75	-	-	-	-	Practicable reduction
Plant Rooms	N/A	<85	75	-	-	-	-	Practicable reduction
Laboratories	45	50	65	65	Moderate	-	60	0.4 - 0.7

TABLE 12: ACOUSTIC REQUIREMENTS

Notes:

1. All sound pressure levels referenced to 20micro-Pascals (dB re 20 µPa);
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. Reverberation times are the spatial average in fully finished rooms, generally for full octave bands with centre frequencies of 500 Hz and 1 kHz; and,

14 PNEUMATIC TUBE SYSTEM

Pneumatic tube systems are commonly used within hospitals to transport specimens between inpatient units, operating theatres and pathology labs. These systems reduce the manpower and the time taken to get samples to pathology and results back to the medical staff and hence they enhance patient care. There are limited suppliers of these systems within Australia and the current systems comprise mainly of two suppliers.

Systems should be designed for the most direct route of the tubing runs to keep specimen travel times to a minimum with care being taken to allow for the tubing large turning radius bends that the systems demand.

Tubing is generally PVC and hence when crossing fire compartment fire collars must be employed.

With large systems and when extending systems, specimen travel times can become excessive. Many systems are designed with a single blower which can compound delays in specimen delivery. A second blower and transfer station is often required to keep travel times within acceptable limits.

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, 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.

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:

- System size – generally there are two pipe diameters available – 100mm nom and 160mm nom. In general, the larger system provides
- System configuration – point to point systems are suitable for specific individual traffic routes. For general use a looped system will be required with multiple stations
- System performance – large and complex systems will have an impact on service frequencies. Designers should consult with stakeholders and system suppliers to assess the traffic and resultant system performance
- Tube carriers – carriers should be leak proof and tamperproof

- 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 and,
- Departments which see significant benefit include:
    - ❖ Medical imaging
    - ❖ Operating theatres
    - ❖ Inpatient units
    - ❖ Pathology
    - ❖ Pharmacy – subject to use of approved spill-secure containers and
    - ❖ Emergency departments.

15 STEAM STERILISATION58

Sterilisation is carried out on instruments, tubing and equipment in order to eliminate 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 them 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.

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 system s 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 DDC 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 and,
- 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 8 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 6 seconds
- Object Command – devices will react to command of an analogue object within 2 seconds
- Alarm response time – an object that goes into alarm will be annunciated at the workstation within 45 seconds
- Program execution frequency – custom and standard applications will be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control and,
- Multiple alarm annunciations – each workstation on the network will receive alarms within 5 seconds of other workstations.

16.3 General Requirements

Building Management and Control Systems 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 / Context

All projects will consider and document the following:

- 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 and,
- 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 the all of the 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 Australia / New Zealand Writing 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 and
- 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 and
- 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 would include:

Energy Management

- Energy metering form supplier including (as appropriate) KWH and KVA
- Chiller and boiler KW output
- Power to major submains (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 and
- Emergency power mode operation.

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) and
- Pressure control for rooms with such requirements.

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 and
- 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) and
- 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 has the ability to 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 5 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 and
- Documentation.

17 VERTICAL TRANSPORTATION

17.1 Introduction

The following 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 all 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) and
- Escalators and moving walks.

17.3 Code Requirements

The Design will comply with relevant Australian and International Standards. Particular consideration is to be made with reference to the Building Code of Australia and meeting the Disability Discrimination Act.

17.4 Planning / 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 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 in the planning / context phase.

17.5.2 Escalators & 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 in close proximity to offer a choice for those passengers who are unable, or not comfortable using escalators and moving walks.

Note that a stationary escalator is not safe for use as a stairway as it does not meet stairway code requirements.

17.6 Design Criteria

Vertical Transportation design criteria is made up of a number of 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 and
- Distribution of food, goods, and waste disposal.

17.7 Traffic analysis criteria

Passenger lifts – traffic analysis required to determine number of lifts; analysis to be based on 2 way traffic demand for a 5 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 5 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.

Total population – Design population can generally be based on between 3 and 5 persons per bed. Where peak hours or routes differ between staff and visitors, these populations can be separated into 1 and 2 visitors per bed and 2 and 3 staff per bed.

Populations for non-patient ward departments should be determined based on a person per square meter or person's per room basis depending on the type of use.

17.8 Lift Car Sizes

Lift car sizes are to be fit for purpose. Consideration is to be made with respect to the lift use and size of beds / equipment to be transported.

The following table gives some typical bed / equipment sizes that may need to use the lifts.

Bed/Equipment	Width	Length
Critical Care Bed	1100mm	2400mm
Standard Bed	1080mm	2370mm
Bariatric Bed	1370mm	2540mm
Ambulance Stretcher	750mm	2200mm
Electric Bed Tug		580mm

TABLE 13: BED EQUIPMENT

Minimum bed lift size recommended to suit a Critical Care Bed is 1800 w x 2700 d. The below image illustrates indicative spatial allowances.

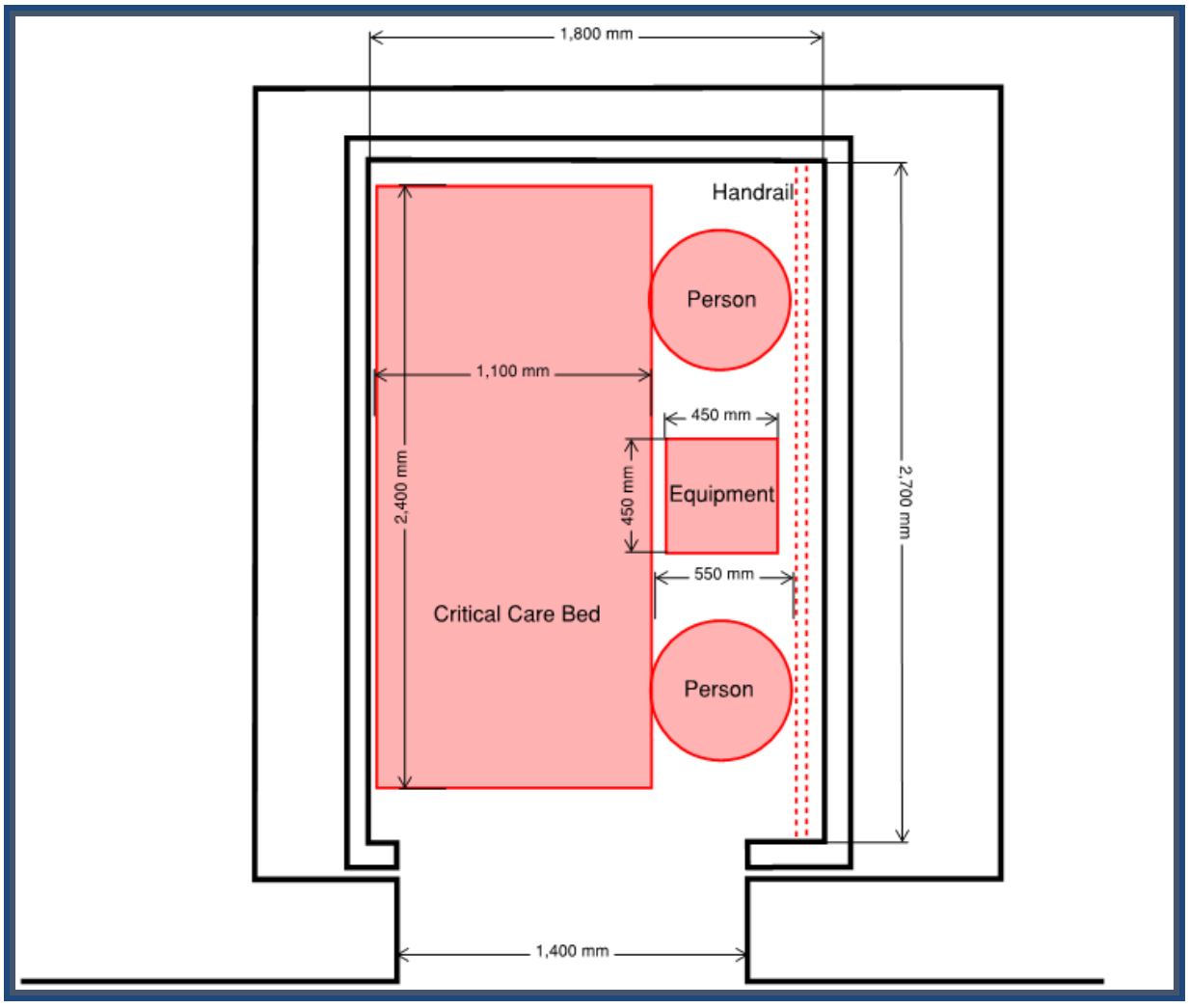


Table 14: Minimum Bed Lift Recommendation

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 & 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.

17.9 Design Considerations

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 50m travel distance from any point on the floor plate.

Staff / Patient & Public lifts to be separated where possible. This is considered to be essential for larger developments, but may not be practical for low rise developments of 4 levels or less.

Lift use for clean and dirty goods should be separated. Service lifts (dumbwaiters) may be considered as a cost saving option as oppose 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.

17.10 Lift Features

17.10.1 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) and
- Emergency rescue system (incorporated in the lift design).

Coordination with the lift supplier and electrical design engineer is required in order 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.

17.10.2 Priority control

In emergency situations lifts may be required to cease normal operation and operate in an exclusive manner in order 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 and

- 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.

17.10.3 Finishes

Vertical transport systems within health facilities will be designed with finishes that provide the following attributes:

- Robustness
- Corrosion resistance
- Vandal resistance
- Biological resistance and
- Ease of cleaning.

Consideration should also be made in the joining detail of finishes in order to reduce gaps and areas where cleaning will be hindered.

18 AUTOMATED GUIDED VEHICLE SYSTEMS (AGVS)

For consideration in larger facilities, the use of AGVs are appropriate 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 & AGVs
- Corridor and walkway floor covering, gradient, level changes
- AGV parking / storage / recharge area
- Electrical services interface
- Lift services interface and
- Automated door interface.

An individual needs assessment and business case for AGVs must be carried out, and if carried beyond the preliminary concept planning phase, specialist design input must be sought.

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, Orthopantomograph rooms, Mammography rooms, Angiography laboratories, and Cardiac Catheter laboratories. Nuclear Medicine equipment including 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 above that in X-ray departments.

Radiation Guideline 7, entitled “Radiation shielding design assessment and verification requirements”, produced 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) adorn 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 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 and
- 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.

20 APPENDIX 1: CHANGES FROM PILOT DRAFT TO FINAL VERSION

1. Identification of Westmead and RNSH as the two major hospitals where additional backup systems are required
2. The standard requirement of 25% spare capacity updated
3. Updates on supplies to DBs
4. Updates on standby power and UPS requirements
5. Update on power factor correction
6. Update on the application of PVC products
7. The strong preference of an Independent Commissioning Agent included
8. Updated to include reference to the Guidelines for Helicopter Landing Sites in NSW
9. The preference of TMVs with monitoring included
10. Water pipe work velocity updated
11. The need for separate RO water system for Renal and CSSD added
12. The consideration of air on condition for air cooled condensers in regional areas added
13. Details on Isolation Rooms added
14. Details on operating theatres HVAC with minor edits
15. Table 7.1 in HVAC updated
16. The preference of LED over T5 lamps added
17. Other minor edits