Queensland Health

Capital Infrastructure Requirements

Volume 4 Engineering & Infrastructure

Section 4.2 Manual

Queensland Government

Capital Infrastructure Requirements - Volume 4 Engineering and infrastructure Section 2: Manual

Published by the State of Queensland (Queensland Health), August 2020

For more information contact:

Capital and Asset Services Branch, Corporate Service Division , Department of Health, Queensland Health, GPO Box 48, Brisbane QLD 4001,
email CAS_Correspondence@health.qld.gov.au.

An electronic version of this document is available at https://www.health.qld.gov.au/system-governance/policies-standards/doh-policy

Queensland Health disclaimer

Queensland Health has made every effort to ensure the Queensland Health Capital Infrastructure Requirements (CIR) are accurate. However, the CIR are provided solely on the basis that readers will be responsible for making their own assessment of the matters discussed. Queensland Health does not accept liability for the information or advice provided in this publication or incorporated into the CIR by reference or for loss or damages, monetary or otherwise, incurred as a result of reliance upon the material contained in the CIR.

The inclusion in the CIR of information and material provided by third parties does not necessarily constitute an endorsement by Queensland Health of any third party or its products and services.

Version	Author	Version description	Released date	Approved for release by
1.0	Health Planning and Infrastructure Division, Queensland Health	First public release	28 May 2012	DDG, Health Planning & Infrastructure Division
1.1	Health Infrastructure Branch	Name changed from Capital Infrastructure Minimum Requirements to CIR Approved	5 April 2013	DDG, System Support Services
2.0	Health Infrastructure Branch	Second public release. Updated information regarding Legionella, infection control and other minor edits.	3 September 2014	DDG, Office of the Director-General
3.0	Capital and Asset Services Branch	Updated to align with the new water risk management provisions under the Public Health Act 2005 (February 2017)	7 August 2017	DDG, Corporate Services Division
4.0	Capital and Asset Services Branch	Incorporation of BIM, updated references, refreshed layout, compliance statement and checklist process reviewed.	22 October 2020	DDG, Corporate Services Division

Contents

1 Mechanical

1.1 Introduction

The purpose of heating ventilation and air-conditioning (HVAC) systems in healthcare projects is to satisfy internal environmental conditions for comfort, safety and infection control.

The following items are considered part of the mechanical services:

- cooling and heating
- air conditioning
- ventilation
- heat recovery and rejection
- building management system (BMS)

Ancillary systems which may be part of mechanical services scope include:

- trigeneration/cogeneration
- refrigeration (cool rooms).

1.2 Planning context

Engineering masterplans are complimentary to site/clinical masterplans. Engineering masterplans, including HVAC, shall include 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 potential of and requirements for plantrooms
- serviceability of the site and implications of on-building or remote plant
- maintenance access.

1.3 Principles

1.3.1 Infection control

1.3.1.1 General

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

Design principles throughout the patient care areas shall, in addition to comfort requirements, comply with infection control requirements. To minimise the risk of infection the ventilation system shall be designed and balanced to provide directional airflow 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/or the CIR.

1.3.1.2 Pressure differentials and directional airflow

Pressure differentials and directional airflow between areas is one of the primary HVAC infection control measures. Refer to *HTM 03-01: Specialised ventilation for healthcare premises—Part A* for space classifications, air flow and pressure requirements.

Positive flow at adequate air flow rates is preferred to the defining of pressure differentials between areas. Defined pressure differentials usually require monitoring and, in many instances, active management or control, whereas designed and commissioned air flows due to static air balance are largely a 'set and forget' system. In some circumstances, airflow may be required only upon the opening of doors and the system shall have adequate flexibility to accommodate this requirement.

1.3.1.3 Environmental control

Uncontrolled environments (warm and humid) are more conducive to the growth of pathogens and increase the risk of nosocomial infection. These environments also encourage insect infestations and make infection control more difficult.

1.3.1.4 Filtration and infection control

Provision shall be made to ensure adequate air supply with varying filter resistances in areas requiring high levels of airborne contaminant control. This will include operating rooms, set-up rooms, isolation rooms, 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 shall be installed and additional cleaning procedures approved by the infection control committee shall be implemented. Additional air handling equipment will be required to achieve the necessary clean to less clean airflow patterns. Such areas include:

- Birthing and delivery rooms
- nurseries
- protective isolation rooms and units
- special care units
- treatment rooms
- emergency areas.

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

1.3.1.5 Other considerations

Mechanical ventilation and air-conditioning systems shall 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.

Consideration should be given to the possibility of microbial contamination resulting from the hydraulic system being dispersed via the mechanical ventilation systems. For example, microbially contaminated aerosols produced from showers may be dispersed via the air-conditioning system. Consequently, the management of infection control should take a holistic approach with respect to engineering services.

All engineering components within an occupied space, such as temperature sensors and grilles, shall be suitable for swab down cleaning as part of infection control provisions.

1.3.2 Provisioning for Future

Projects with clearly identified future stages shall have appropriate spare space allowances in central plant rooms or strategy for future expansion. These projects shall have provision for installation of future plant (i.e. chillers/boilers/cooling towers etc) and/or facilities to allow future extension or connection. This shall include plant space, blanked or valved connections, and space on headers for extensions to be completed seamlessly and without interruption to existing systems.

1.3.2.1 Risers

Each riser should be designed to have 30 per cent spare capacity available for future installation of services with this requirement captured and clearly indicated as part of the building design within the project Building Information Modelling (BIM). Spare space shall be assessed at project handover at the completion of construction, not just during design. Designers shall ensure that all risers include allowance for installation tolerances, valves, flanges, supports etc such that the required spare capacity can actually be achieved.

1.3.2.2 Spare capacity for plant and equipment

All plant and equipment shall be sized to meet the required design load served with minor additional 'safety margin' for cooling. Diversity of load shall be considered when sizing plant to prevent unnecessary oversizing.

Safety margins shall not be less than 5 per cent of the calculated design load. Nominally 5-10 per cent shall apply as the normal safety margin unless project specific considerations warrant review of a higher margin. A design submission shall be provided to justify any increased safety margin.

No additional capacity in local plant or equipment shall be provided for future loads unless the required capital for the future plant and/or building has been committed.

Where an extension of the system is planned, the provision shall be made for future connection to the existing system but not as additional plant capacity. Future connections within piping systems shall be provided as blanked valves. Future connections for all systems shall be prepared to accept connection—cutting in via isolation of the operating system to create a new point of connection shall not be acceptable for systems where future extension is planned.

Any allowance for additional capacity shall not reduce the efficiency of the 'base' system below that if selected with no additional capacity when operating under the initial installed load.

1.3.3 Energy/sustainability

1.3.3.1 Passive measures

Passive measures shall be considered with designs in order to reduce energy wastage. Correct implementation of passive sustainability measures will require collaboration between engineers, architects and health planners to achieve good outcomes. Primary responsibility for

passive measures resides with the architects, but the engineers should be involved in reviewing design to advise on implications of various schemes with respect to energy performance and overall sustainability outcomes.

Measures to consider include:

- within the constraints of the site and planning requirements provide a high ratio of internal floor area to external façade (i.e. Reduce heat loss/gain to surrounding environment)
- provide a well-insulated and sealed external building envelope with thermal mass to dampen the effect of external environmental conditions
- optimise fenestration ratios to limit the effects of solar gain whilst maintaining good daylight factors for natural light penetration, views and visibility to outdoors for salutogenic benefits, but with consideration to passive gain potential in heating periods where applicable. In Queensland, managing solar gain will in most instances outweigh the more limited opportunities for passive heating benefits
- room heights designed to achieve a sensible balance between functional need and economy
- natural/hybrid ventilation to appropriate areas whilst maintaining the key consideration of pressure regimes, infection control, containment and safety.

1.3.3.2 Active measures

Active energy efficiency and sustainability measures shall be incorporated into designs in order to reduce energy wastage. These should include investigation and assessment of whole-of-life cost benefit *and* sustainability benefit of:

- energy reclamation—run around coils, cross flow heat exchangers or enthalpy wheels from extract ventilation systems should be incorporated into the system design where appropriate potential sources of heat recovery exist, with care regarding cross contamination issues
- the use of energy efficient motors with variable speed drives for pumps and fans
- HVAC systems which can, where appropriate, make use of free cooling and differing operating modes in response to external climatic conditions
- energy management systems integrated with a BMS to plant operation and staging optimisation
- occupant sensing and control of local plant and equipment for meeting rooms, amenities, stores, plant rooms
- control facilities via local and remote stations enabling plant usage to match occupancy patterns. Time and temperature-controlled zones shall be as small as practicable, with each zone being independently temperature controlled
- the installation of centralised and modularised chiller and boiler plant with sequential control to maximise efficiency at reduced system demand, including the potential to utilise site and shared energy systems
- separation of engineering systems to serve building zones with similar thermal and occupancy characteristics to allow differing requirements to be controlled separately and to achieve maximum turn down (i.e. night and weekend setbacks)

- increased insulation of distribution pipework and ductwork to minimise unwanted heat gains or losses.

1.3.4 Modularity, adaptability, integration and reliability

The susceptibility of health facility activities to variation from the optimal environmental conditions varies greatly. Many activities can tolerate a period of lost conditions without major damage or risk to patients, but this varies by climate. Some activities require critical environmental control and any loss of control represents significant risk to patients, staff or the public.

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

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

Stability in the internal environment by use of passive techniques and the building fabric shall be assessed in principal and modelled. Refer also to section 1.3.3.1 above.

A multidisciplinary approach may be required when considering legionella risks, including the possibility of microbial contamination from a hydraulic system being dispersed via a mechanical ventilation system.

1.3.5 Patient, public and staff safety

In addition to safety through infection control, HVAC systems are important in creating environmental control to encourage safer facilities. In some areas, a controlled environment reduces stress on patients and permits observation of them with only limited bed covering. Uncontrolled environments (heat and humidity) can exacerbate the risk of violence, such as mental health units, waiting rooms, and emergency departments (ED).

Consideration for environmental control provisions to provide patient, public and staff safety shall be provided through the user consultation process and holistic review of design for HVAC systems.

1.3.6 Acoustics

The location of plant in proximity to staff and patients shall be considered to ensure noise and vibration levels are maintained within the recommended levels as per AS/NZS 2107 and any project specific acoustic design requirements. The mechanical services design shall consider:

- transfer of noise where services or ductwork penetrate acoustically rated partitions
- transfer of noise between acoustically rated rooms via air conditioning grilles/openings
- noise generated through air movement, moving parts (such as fans) and vibration associated with the mechanical services system
- control of noise transfer through the building structure from plant rooms to adjacent spaces

- noise emission to on-site and off-site receptors, to be reviewed in accordance with local authority and/or state-based legislation as appropriate.

1.4 Mechanical services systems

1.4.1 Introduction

Heating, ventilation and air-conditioning systems provide a variety of processes, including but not limited to, maintaining comfortable internal environmental conditions, maintaining internal air quality, mitigating airborne infections, control of odour and smoke management. In facilities such as hospitals, requirements for ventilation rates, temperature and humidity ranges, and air filtration exceed that of what is required in buildings not classified as hospitals. This section focuses on the requirements of these systems.

1.4.2 Major plant

1.4.2.1 General

Major mechanical plant includes chilled water infrastructure, such as chillers, cooling towers and pumps, heating hot water infrastructure and steam plant.

The selection of major plant is influenced by several factors:

- existing plant and infrastructure
- geographical location and ability to receive support
- market and commercial opportunities.

Projects should aim to provide a single manufacturer solution to one site to allow for the most efficient maintenance contracting.

Major plant selections shall not be solely driven by capital cost decisions. A whole-of-life analysis shall be provided to assess the most suitable plant options. A weighted decision matrix shall be applied to enable appropriate plant selection, considering:

- whole-of-life cost
- capital cost
- availability of maintenance and service
- operational efficiency.

1.4.2.2 Cooling system

Central cooling plant chiller sets shall be selected to ensure that in the event of compressor failure, adequate standby capacity is available for selected critical areas. Select chillers that maintain reliable and energy-efficient low-load operation. Chiller plant shall be sized to provide efficient and stable part-load operation.

Chillers shall be selected to meet the integrated part-load value as defined per the current version of the National Construction Code (NCC) Section J.

1.4.2.3 Cooling towers and evaporative condensers

Cooling tower and evaporative condenser systems shall be designed and installed in accordance with Australian Standards, in particular the requirements for water quality control. Heat rejection equipment shall comply with or exceed the minimum requirements of NCC Section J for energy efficiency.

Wherever possible consider design strategies to minimise water consumption. Where whole-of-life cost studies and climatic conditions demonstrate feasibility, consideration shall be given to the adoption of hybrid cooling towers which incorporate both evaporative and dry cooler components.

Cooling towers and evaporative condensers shall include a side stream filter system or a cyclonic separator system to provide solids removals from the circulating water systems. Plant operation shall remain unaffected during the cleaning process.

Cooling towers shall be constructed of stainless steel to maximise operational life, subject to whole-of-life cost analysis for alternate material choices.

Condenser water pipework shall be stainless steel. Spiral wound pipework shall not be used for condenser water.

1.4.2.4 Central heating plant

Central boiler, steam and heating water plant shall be fully unattended.

All heating systems shall be thermostatically controlled. Systems that rely on opening windows to compensate for over-heating are not acceptable.

The selection of central heating systems (heating hot water) or local heating (electric, reverse cycle DX etc) shall be subject to a whole-of-life cost analysis.

1.4.3 Air handling systems

1.4.3.1 Zoning

Separate clinical departments shall generally have separate air handling plant. The same department on separate floors shall 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.

The mechanical systems serving separate departments should be able to be isolated without interrupting other areas.

Isolation rooms and operating suites shall each have separate air handling units (AHU) and separate exhaust systems that are best located as close as practical to the areas served due to air leakage, contamination or decontamination issues.

Zoning of all air conditioning systems shall acknowledge different dynamic loads, conditions and functional parameters likely to occur due to:

- external glazing and wall materials
- roofs and suspended floors
- hours of operation

- clinical or process functions
- internal heat gain from people, lights, equipment
- fire and smoke compartments.

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

1.4.3.2 Filtration

Air handling plant shall 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 shall be made easily accessible for cleaning.

Refer also to section 1.6.5 for further discussion of filtration requirements, and to Table 1 for details of required minimum filtration by space function.

1.4.3.3 Tropical and marine environments

Tropical environments: special consideration is required for humidity control in ceiling voids, under floors and void spaces adjacent to occupied areas to avoid condensation. Particular attention should be paid to operating theatres, pharmacy, sterile storage and medical records.

Marine environments: all intake louvers and exposed metalwork shall be 316 stainless steel. All duct connections for outside air shall be stainless steel.

Tropical and marine environments: consideration shall be given to provision of tempered plantrooms to control dust, humidity, heat and salt for prolongation of life of plant and equipment, and for maintenance purposes.

1.4.3.4 Fire and life safety implications

Due to costs and simplicity, the preference is for sprinklers to be provided where this obviates the necessity for a smoke hazard management system.

Should sprinklers not be provided, and a zone pressurisation smoke management therefore is required, this lends itself to housing the majority of air handling systems in rooftop plant rooms so that the return air ducts also act as smoke exhaust ducts.

Vertical risers and horizontal plant zoning should match the required fire compartments to minimise requirements for fire-rated ductwork, fire mode controls and fire and smoke dampers.

1.4.3.5 Air handling unit plant rooms

For reasons of maintenance, centralised systems with major air handling plant components located in dedicated plant rooms and spaces are preferred over systems with distributed components. However, distributed on-floor plantrooms for air handling plant can provide simplicity for servicing of fire and smoke compartments with minimal dampers and associated long-term maintenance challenges.

Should on-floor plantrooms be provided, these must be sized and located to allow all necessary maintenance to occur within the plantroom with doors closed to prevent any disturbance to the clinical areas. Ideally, access to plantrooms shall be from non-clinical spaces where feasible.

The most appropriate plant room configuration to suit the building form and function should be reviewed depending upon the site and the functional requirements. Discussion of the plantroom and AHU strategy for the site shall be provided in the concept and schematic design reports.

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

1.4.3.6 Air handing unit and air distribution system types

The most appropriate air handling system type depends on the functional requirements of the area served, the scale of facility development or redevelopment, and climatic considerations. Discussion of requirements for mechanical services for clinical areas is provided in section 1.5 below.

The following provides an overview of various system options and general applicability to use within a healthcare context. A whole-of-life cost assessment should be provided to justify the proposed air handling system selection, with detailed discussion provided in the concept and schematic design reports.

1.4.3.6.1 Constant volume systems

Constant volume air handling systems are suitable for all areas of the health facility and are essential for areas where airflow and temperature control are critical. Areas of critical control, include but are not limited to:

- operating theatres
- mortuary and pathology facilities
- laboratory facilities, including cytotoxic and aseptic rooms.

Systems requiring specific pressure control will often include constant volume air handling to provide a fixed and stable supply of air to a room. The detailed requirements will need to be assessed based on the pressure control regime for the room and/or hierarchy of cleanliness applicable to spaces where gradient or steps of pressure control is required.

1.4.3.6.2 Variable air volume systems

Variable air volume (VAV) systems are generally suitable for most areas in the health facility other than the special cases requiring constant volume systems per section 1.4.3.6.4 above. Because of the potential for low airflows at low load, VAV systems must ensure minimum airflow rates are maintained, either by control limit or by use of fan assisted VAV boxes on central zones.

Humidity control across a variable volume air handling system can be influenced by turn-down based solely on temperature monitoring only. Where VAV systems are implemented humidity *monitoring* shall be provided and integrated within the control loop to ensure *both* temperature and relative humidity design conditions are maintained. Active humidity control (i.e. humidification) is not normally required in non-critical spaces to achieve design condition compliance.

Where climatic conditions permit, low-temperature VAV systems may provide energy efficiency benefits through lower energy usage and lower initial capital cost. Implementation of low-temperature VAVs shall include consideration of humidity control and the increased

condensation risk where surface temperatures of air diffusion devices are approaching or below dew point. The risk associated with ambient air contacting surfaces in lobby and spaces with direct external access shall be reviewed.

1.4.3.6.3 Packaged direct expansion

Packaged direct expansion systems include air and water-cooled unitary types of equipment, such as air-cooled split systems (DX) and variable refrigerant volume (VRF/VRV) systems. Packaged direct expansion systems are normally constant volume, however subject to the technical limitations of direct expansion plant may also be used with VAV or stepped fan speed fan coil units.

Airside performance for direct expansion systems can be expected to be the same as with other constant volume and VAV systems. The consequences associated with step changes in equipment capacity due to compressor switching should be avoided by using inverter controlled direct expansion systems only.

Generally, packaged direct expansion systems are normally limited to smaller sites, where central chilled water is not available or feasible. In addition, these systems have a shorter economic life compared with chilled and/or heating water systems.

1.4.3.6.4 Fan coil unit systems

Fan coil units are generally considered small-scale AHUs. They are most applicable to providing dedicated control to discrete spaces for requirements such as special control (i.e. isolation rooms, communications rooms etc) or out-of-hours operation (i.e. small administration areas).

Fan coil units may be served by chilled water with hot water or electric heating. Direct-expansion fan-coil units may also be considered where appropriate and supported by necessary whole-of-life cost analysis.

While systems utilising fan coil units are potentially suitable for patient rooms, the high cost of associated pipework and requirement for a higher amount of maintenance due to lots of smaller systems make them a solution suitable in special applications only.

Fan coil units shall be located within plantrooms to facilitate regular maintenance. In-ceiling fan coil units shall generally not be acceptable within clinical areas, however for non-clinical health areas (i.e. offices) where access can be readily obtained without disruption to operations they may be permitted in-ceiling.

Dedicated recirculating fan coil units may be appropriate for specific clinical spaces (i.e. birthing suites) where local variable temperature control is required. In-ceiling installation may be appropriate in these instances to provide a cost-effective solution which avoids ducting small air volumes to/from plantrooms. Any in-ceiling installation shall be in a location which provides appropriate maintenance access and addresses all requirements associated with acoustics for the room served and surrounding spaces.

1.4.3.6.5 Chilled beam

Chilled beam systems incorporating active or passive chilled beams within the ceiling space are an attractive solution for general application due to the potential for reduced ceiling space requirement, limitation of recirculation of air between spaces, long-term life expectancy and good thermal zonal control.

Implementation of chilled beams requires a very well-sealed façade, building pressurisation to prevent ingress of ambient air and appropriate room relative humidity control. Particular care is required when considering chilled beams in tropical environments, as any ambient air ingress will likely form condensation and lead to potential moisture and/or mould issues.

Chilled beam systems usually require higher initial capital investment due to the extensive distributed nature of the system. This may be offset though by potential to reduce floor-to-floor heights slightly, reduced primary air handling and ductwork system sizing, and overall operating energy efficiency. Where considered at the Concept Design stage, a whole-of-life cost analysis and associated design discussion shall be provided in the design report(s).

1.4.3.6.6 Displacement ventilation/air-conditioning

Systems that deliver supply air at low-level and extract heat from high-level can be an attractive solution for general applications. These systems provide excellent indoor air quality and good energy performance, however, consideration needs to be given to the location of the air outlet in relation to the room occupants, to ensure that drafts are not evident, and cooling is delivered to each occupant. In addition, higher ceilings (>3m) are generally required to allow sufficient stratification. Air outlets should be wall-mounted and coordination with the room planner is needed. The use of in-floor diffuser outlets is not recommended in the health facility context. These systems should be considered at the concept stage, including full life cycle cost analysis.

1.4.3.6.7 Evaporative cooling

Evaporative cooling is not suitable in tropical and sub-tropical climates and as such, application in Queensland is limited. Evaporative cooling may be provided if outside design conditions are suitable, however a whole-of-life cost analysis will be required. In addition, thermal modelling to demonstrate system effectiveness *throughout* the year will be necessary. While evaporative cooling may be reasonable in Queensland during winter or shoulder seasons, for areas requiring thermal control it is unlikely to be suitable for significant portions of the year and as such, alternative cooling systems may be required *in addition* to the evaporative system. Capital cost effectiveness is unlikely to be demonstrated.

Evaporative cooling may be used for support areas where relief cooling only is required, such as kitchens, workshops and some other non-critical areas, where suitable. Should evaporative cooling systems be proposed, consideration of ongoing maintenance requirements shall be outlined within design reports.

1.4.3.7 Other requirements

Ventilation systems in critical areas, such as operating rooms, recovery, Coronary Care Unit (CCU), Intensive Care Unit (ICU), ED and infectious diseases units shall operate on emergency power. Further requirements for areas or systems operating on emergency power shall be defined by site specific risk assessment and as nominated within the Electrical Services volume of the CIR.

Ducted air-conditioning systems shall be capable of providing compliant mechanical ventilation, even if natural ventilation is available.

Economy cycle shall:

- Only be provided where demonstrated as delivering value through a whole-of-life cost analysis and thermal modelling which shows effective use (hours per annum) of the economy cycle
- Not be included where it may be detrimental to pressure regimes, humidity control or achieving any other required environmental conditions
- Humidifiers are not required to be installed in health buildings unless for medical reasons or environmental control associated with specific equipment. Examples include operating rooms, ICU, CCU, ED and computer rooms. Humidification may be needed for systems operating with high fresh air rates during winter. Refer also to section 1.6.7 for technical requirements.

1.4.4 Ventilation

Ventilation shall be designed to meet Australian Standards and statutory requirements, with minimums not less than those nominated in Table 1.

1.4.5 Outside air

Outside air shall be provided according to AS 1668.2 and the requirements of the Table 1.

In areas where there are high people densities, occupancy rates shall be based of the architectural design documentation or the current version of Australasian Health Facility Guidelines (AusHFG) room layout sheets.

Ensure that there is sufficient outside supply to provide make up for exhaust systems.

All ventilation systems shall be designed to control the high level of odours often generated within healthcare facilities.

Variable volume supply air systems shall incorporate control devices to ensure minimum outside air supply to all areas is always maintained.

Outside air intakes and exhaust discharges shall comply with AS 1668.2, with additional guidance from ASHRAE Standard 170.

Further assessment of outside emission sources and their potential to contaminate indoor spaces may be required and any subsequent risks should be managed accordingly (such as for cooling towers, co-/tri-generation etc.)

1.4.6 Exhaust air

1.4.6.1 Exhaust ventilation

Exhaust systems shall be provided where required by code, for life safety or per room requirements (refer to RDS, room layout sheets or other user briefing, as appropriate).

Minimum exhaust air change rates for dirty utilities or equivalent shall be 20 air changes per hour (ACH). Higher air change rates in these spaces are acceptable for odour control.

Dedicated exhaust systems shall not be connected to general exhaust systems.

All bathroom and toilet exhaust systems shall be fully ducted and discharged to outside, not to a common roof or ceiling space.

Sanitary compartments, dirty utility rooms and similar spaces shall not be ventilated by a system which also serves areas such as operating rooms.

1.4.6.2 Fan systems

Fan systems shall be monitored by the BMS to provide remote alarm indication of fan failure. This shall not apply to independent toilet exhaust systems serving single-use toilet, shower or bath areas.

1.4.6.3 Scavenging

Each space routinely used for administering inhalation anaesthesia and inhalation analgesia shall be served by a scavenging system to vent waste gases per AS 2986 requirements. If a vacuum system is used, the gas collecting system shall be arranged so that it does not disturb patients' respiratory systems. Gases from the scavenging systems shall be exhausted to the outside.

Anaesthesia evacuation systems may be combined with the room exhaust systems provided that the component used for anaesthesia gas scavenging exhausts directly to the outside and does not recirculate.

Scavenging systems are not required for areas where gases are used only occasionally such as emergency rooms and offices for outline dental work.

Any scavenging system is recommended to be designed to remove as much waste anaesthetic gas as possible from the room environment (released by patient exhalation and anaesthetic machine or tubing leaks).

1.4.7 Building management systems

1.4.7.1 Overview

In general, Queensland Health facilities will use a BMS to manage the operation of plant and equipment with the facility. The BMS will control the mechanical plant as suitable for the site, and shall provide:

- plant control (such as temperature, humidity, pressure)
- optimum and scheduled start and stop of plant equipment
- load shedding, based on generator controller inputs
- energy management and optimisation
- alarm annunciation and management
- data gathering, logging and reporting.

In addition, the BMS shall monitor the status and key outputs of other services, such as:

- nurse call
- lifts
- water meters
- power meters and electrical systems
- lighting control systems
- SCADA—monitoring interface only permitted.

1.4.7.2 Requirements

Selection of a BMS shall be appropriate to the size, nature and location of the project. Where economically possible, it is preferable to extend on an existing BMS on small to medium-sized projects than to duplicate systems.

A single site wide BMS shall be provided for facilities. Multiple systems introduce significant operational and management risks and should be avoided except as interim/staging requirements during migration or up-scaling of a site.

Given the dispersed geography of healthcare within Queensland and within each HHS, the BMS shall provide capability to connect to remote sites to allow centralised monitoring and management of facilities by Queensland Health. All remote connections shall be securely via the Queensland Health ICT network—direct access via the internet shall not be permitted.

The BMS shall be an open protocol system, such as BACnet. Proprietary control protocols restrict future flexibility within a facility and for subsequent maintenance agreements.

Systems should be selected for high-level interface compatibility. Where this is not possible, low-level type interfacing may be considered to achieve a degree of system integration. This should always be considered a last choice.

1.5 Functional area requirements

1.5.1 General

The following sections outlines design requirements for selected areas. This is not an exhaustive design guide and does not address all areas of a hospital. Designers should also refer to the AusHFG for discussion of space function and design requirements. Further guidance is available from the current edition of the ASHRAE: *HVAC Design Manual for Hospitals and Clinics*.

1.5.2 Operating suites

1.5.2.1 Classification of surgeries

The designer should refer to the Queensland Health representative to establish the classification of surgical suites for the project.

1.5.2.2 Operating suite design

Where procedures, such as organ transplants justify special designs, installation shall meet performance needs as determined by applicable Australian Standards. These special designs are recommended to be reviewed on a case-by-case basis.

For all other installations, the following shall apply:

- supply air
- supply air to operating rooms shall 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

- the directions of airflows within operating units shall 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 i.e. from clean to less clean areas
- graduated pressurisation relative to pressure can be achieved by using carefully balanced supply air and exhaust air systems in areas adjacent to the operating unit. A pressure relationship diagram shall be established by the designers
- airflow into the operating unit shall be by means of a distribution system that provides a flow of clean supply air over the operating area first then away
- the entry of air shall be from the ceiling to deliver a downward air movement with a minimum velocity of 0.2 m/s at the level of the operating table (0.3 m/s max). To achieve this, a velocity of 0.4 m/s is normally required at the filter face
- humidity:
  - room shall be maintained within the range of 30 to 60 per cent relative humidity (adjustable), except when flammable agents are used, in which case a hazardous area assessment shall be undertaken
  - where humidifiers are used, they shall be of the steam type
  - limiting humidity range by cooling coil design is acceptable unless there is a specific surgical requirement to warrant precise control of humidity
- temperature:
  - the operating room temperature shall be adjustable to suit the requirements of the procedure in progress
  - burns surgery rooms may require temperatures up to 42°C. Requirements should be confirmed with Queensland Health for the particular facility
  - to enable individual temperature, infection and odour control, each operating room shall be served by a dedicated air-conditioning unit which may also serve that operating room's adjacent sterile support rooms
- exhaust arrangements:
  - exhaust registers shall be located so that the whole room is effectively scavenged, particularly at floor level
  - the consultant shall account for the adverse effect (turbulence) of the airflow pattern near the surgical field created by surgical lamps due to their shape, size location and the heat generated by the lamps
  - operating rooms for special procedures such as orthopaedic surgery, organ transplants or total joint replacement may require the provision of an ultra-clean air system to suit their intended use
  - extraction of relief air and, if incorporated, return air shall be located at low to mid-level
  - supply air outlets shall be located directly above the operating table. Exhaust/relief air shall be extracted at least in three corners of the operating room to remove anaesthetic gas leakages from the work area whilst ensuring good airflow through the room
  - low-level exhaust shall be extracted at 200 millimetres above floor level

  - lint filters should be provided in low-level extract outlets (replaceable behind hinged grilles)
  - nitrous oxide shall only be used where low-level exhaust is provided and the range of surgical procedures undertaken in the operating room restricted accordingly
  - operating rooms where lasers and diathermy equipment are being used shall have adequate suction/evacuation controls for the plume generated. Additionally, over-door lights shall be included externally to the room indicating 'laser in operation'
  - the siting of the return air grilles shall not cause short-circuiting of the supply air
- airflow:
  - the airflow at one metre from the supply air outlet, moving away from the outlet, shall have a minimum average velocity of 0.35m/s and at working height, not less than 0.3m/s
- control instrumentation:
  - the control instrumentation shall include the indication of:
    - operating status such as 'in use' or 'not in use'
    - terminal filter pressure differential
    - system purging
    - room temperature
    - room per cent relative humidity
    - setpoint controls (Temperature and relative humidity)
    - room differential pressure (to adjacent rooms)
- digital operating theatres:
  - designers shall ensure adequate provision for current known and proposed digital theatre requirements. These requirements include:
    - cooling loads
    - ventilation to equipment cupboards
    - electrical and communications
    - communications infrastructure
    - specialist mechanical services including medical gas reticulation
  - the designer shall ensure allowance is made for known intrusions into the laminar airfield caused by digital theatre equipment. Revised air distribution may be required altering the above requirements to ensure appropriate air distribution.

1.5.3 Critical care areas

1.5.3.1 General

Critical care areas include ICU, CCU, Wound Intensive Care (burn units) and Neonatal Intensive Care Unit (NICU). Room design shall be per the AusHFG. Additional engineering design guidance should be sought from the ASHRAE: *HVAC Design Manual for Hospitals and Clinics*.

1.5.3.2 Procedure, recovery, delivery and dental rooms

Procedure rooms in which the administration or aspiration of gaseous anaesthetics or analgesics are undertaken shall have adequate ventilation to ensure that the level of gaseous contamination does not rise above a maximum acceptable level. The utilisation of a scavenging system is acceptable.

Storerooms containing anaesthetic machines shall be ventilated to remove the build-up of nitrous oxide.

The designer shall also consider odour control in determining the amount of permissible recycled air and shall seek advice from the appropriate medical staff as to the procedure to be used. Consideration for 100 per cent exhausts for such spaces as burn treatment rooms where treatment can be particularly odorous.

1.5.3.3 Bronchoscopy and sputum induction units

Supply air to bronchoscopy and sputum induction rooms shall be delivered at a high level in a way that minimises recirculation of potentially contaminated room air and provides the cleanest practical air supply over the procedure area.

The directions of airflows within the procedure room shall always be from clean to less clean areas.

Total circulated air quantity shall not be less than 12 ACH when the supply air filters are at their maximum pressure drop of which a minimum of 20 per cent shall be outdoor air. Procedure rooms and recovery rooms shall be maintained at a negative pressure in relation to adjacent areas.

Rooms or booths used for bronchoscopy, sputum induction, aerosolised pentamidine treatments and other high-risk cough-inducing procedures shall be provided with local exhaust ventilation.

Air from rooms used for bronchoscopy shall not be recirculated unless a HEPA filter is provided.

Air from rooms used for sputum induction shall not be recirculated.

1.5.3.4 Endoscopy

Fully self-contained endoscope cleaning units shall be used to minimise the problems associated with glutaraldehyde fumes. Local exhaust systems shall be provided as necessary to suit the machine.

Fibre optic endoscopes storage cupboards shall be mechanically vented with an exhaust system to remove glutaraldehyde residuals.

Procedure rooms used for endoscopy shall be maintained at a negative pressure to surrounding spaces. Room air shall not be recirculated to other areas.

Supply air shall be directed over the procedure table with exhaust at the perimeter.

1.5.3.5 Sterile supply services

Sterile supply services shall comply with the requirements of AS 1668.2 and AS/NZS 4187.

Air movement and ventilation shall achieve a positive airflow from clean to contaminated work areas. Ventilation rates shall be maintained when the zone is not occupied sufficient to ensure dilution rates are maintained.

Air quality delivered to these spaces shall be equivalent to that delivered to operating theatres using HEPA filters.

Where steam sterilisers are provided, dedicated local exhaust shall be provided above the unit, especially above the doors.

1.5.4 Isolation rooms

Isolation rooms shall be provided in accordance with the AusHFG requirements.

Refer to the AusHFG *Isolation Room- Engineering and Design Requirements* guidelines for definition of room types and detailed engineering requirements.

1.5.5 Pathology, autopsy and body holding

Systems serving pathology areas shall be independent of other systems.

Exhaust from these areas shall be designed not to have any harmful effect or impose contamination on occupants, or to any adjacent areas.

Supply air and exhaust serving autopsy and dissection areas shall be designed to protect personnel undertaking procedures and be discharged in a manner that will not contaminate any adjacent area or system.

Requirements for facilities that conduct autopsies include:

- single pass air-conditioning utilising 100 per cent exhaust of all air exhaust intakes arranged to provide maximum fume and odour removal while protecting personnel
- operating the room under negative pressure in relation to adjacent areas
- if necessary, exhaust air to be filtered and additionally, any odours removed by utilisation of carbon filters
- installation of down-draught or back-draught exhaust systems
- exhaust systems to suit the requirements of the specialist autopsy table.

1.5.6 Pharmacy—additive and cytotoxic suites

Pharmacy facilities shall be designed and constructed in accordance with the Queensland Health policies and guidelines, including:

- Queensland workplace health and safety strategy—guide for handling cytotoxic drugs and related waste
- PICS guidelines
- APIC manufacturing of sterile API guide.

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

Cytotoxic suites shall be designed and constructed in accordance with AS 2252.5 Controlled Environments: Cytotoxic Drug Safety Cabinets—Design, Construction, Installation, Testing and Use. The basic design shall be that of an ISO Class 7 cleanroom (AS/NZS ISO 14644.4) varied in accordance with the requirements of AS 2252.5.

1.5.7 Laboratories and clean rooms

Laboratory areas and dispensing areas in pharmacy shall be designed to comply with:

- AS/NZS 2982—Laboratory design and construction
- AS/NZS 2243 series—Safety in laboratories
- AS/NZS ISO 14644—Cleanrooms and associated controlled environments.

Physical containment laboratories shall 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.

1.5.8 Podiatry, prosthetics, dental and orthodontic workshops

Fresh air, ventilation and air-conditioning systems shall be provided with a minimum supply air quantity of 20 L/s/m^2 of facility floor space.

Extraction shall be localised as close as practicable to the sources of contamination identified above.

Capture velocities at the point of localised extraction shall exceed 2 m/s.

Exhausts from this area shall be suitably filtered and discharged in a manner that will not contaminate any adjacent area or system.

Fume cupboards complying with AS/NZS 2243.8 Safety in laboratories—Fume cupboards shall be installed in chemical mixing areas.

Consider acoustic privacy during design in these areas to prevent noise nuisance in adjacent areas.

1.5.9 Linen

1.5.9.1 Processing areas

Air filtration, mechanical ventilation and air-conditioning systems servicing linen processing areas shall be designed to ensure appropriate lint and dust control.

Mechanical ventilation systems shall be designed to remove the heat generated by laundry drying processes utilising systems, such as exhaust registers over the dryers or dryers ducted direct to outside air with provision for lint collection on all exhaust discharges.

Regular maintenance shall be undertaken to prevent excessive build-up of lint. Excessive build-up of lint can be the source of a fire hazard.

Spot cooling with air-conditioned or tempered supply air is recommended to be considered to provide adequate operator comfort in laundries.

1.5.9.2 Linen store areas

Soiled linen rooms in Queensland shall be tempered to prevent ambient temperatures causing smells.

Exhaust from these spaces shall be provided through dedicated systems to reduce the risk of cross-infection.

The clean linen store shall be supplied with clean, filtered air and assume a positive pressure regime over adjacent spaces within the laundry.

1.5.10 Kitchen

Kitchens shall be provided with conditioned air to ensure appropriate working environment.

Supply air systems for kitchens shall not be shared with other areas.

Air distribution strategies over cooking equipment shall be considered to ensure proper operation of the equipment.

The various areas within a production kitchen shall be ventilated or air-conditioned to ensure compliance with food safety standards including:

- relevant sections of the Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, Australian Government Printing Service, Canberra
- Australia Cook Chill Council, Guidelines for chilled food production systems including Food safety programs 2000
- AQIS code of hygienic practice for heat-treated refrigerated foods packaged for extended shelf life, 1992
- HACCP Food Safety Management standards.

1.5.11 Mental health units

All mental health facilities shall be designed in accordance with the Queensland Health—mental health design guidelines.

Special purpose equipment designed for psychiatric or correctional facility use shall be used to minimise opportunities for self-harm.

All air grilles and diffusers shall be of a type that prohibits the insertion of foreign objects. Air diffusers shall be purpose-designed with airflow performance data provided by the manufacturer to ensure correct air distribution.

All components exposed in the room shall be constructed with rounded corners and shall have enclosures fastened with tamper-resistant screws.

Equipment shall be of a type that minimises the need for maintenance within the room.

All balancing, servicing and maintenance shall be performed from outside the patient rooms and preferably from outside the mental health unit.

1.6 Design criteria and detailed requirements

1.6.1 General requirements

Cooling is recommended to be provided for each area used by patients. Cooling is not required in any bathroom or toilet area with an exhaust system.

Heating is to be provided as appropriate for the climactic location of the facility.

All air-conditioning systems shall be capable of maintaining the rooms and areas at any temperature setpoint value within the range of temperatures indicated during normal operation over the entire range of outside ambient conditions. Refer to Table 1 and the AusHFG for details per room or area.

In critical care areas where relative humidity could fall below 30 per cent, humidification shall be provided. This can occur in winter for systems with high outside air rates. Humidification is also required when flammable agents are to be used. In this instance, relative humidity shall be controlled to maintain 55 per cent. Humidity control is not to be achieved via sprays in the AHUs without careful consideration that microbial and/or chemical contamination will not occur. This should be assisted by the completion of a risk management plan.

Control setpoints shall be per Table 1. Deviations to suit occupant preferences shall be advised as a non-conformance for Queensland Health review.

Rooms housing heat-sensitive equipment, such as computers of high criticality, linear accelerators, medical radiology equipment and the like, shall have conditions according to the equipment manufacturer's recommendations.

Kitchens require special attention to deal with high internal heat load and outside air make-up for hoods. Kitchen hoods with dedicated makeup air systems shall be considered.

Rooms containing heat-producing equipment, such as boiler or heater rooms or laundries, shall be insulated and ventilated to prevent the floor surface above and/or the adjacent walls of occupied areas from exceeding a temperature of 6°C above ambient room temperature, or per the NCC, whichever is the more stringent requirement.

1.6.2 Detailed design criteria

The various areas within the health facility shall comply with the design criteria provided within Table 1 and the AusHFG.

The table must be read in conjunction with the footnotes provided.

Further references for discussion of design criteria for healthcare facilities are provided in 1.6.2.1.

Table 1 Internal environmental criteria including ventilation and filtration requirements, adapted from ASHRAE 170-2017

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Surgery and critical care								
Delivery rooms (caesarean) [k] [l]	Positive	4	20	N/R	F8	No	20–60	20–24 (adjustable)
Emergency Dept triage	Negative	2	12	Yes	F8	No	Max 60	21–24

[a] If monitoring device alarms are installed, allowances shall be made to prevent nuisance alarms. Short-term excursions from required pressure relationships shall be allowed while doors are moving or temporarily open. Simple visual methods such as smoke trail, ball-in-tube or flutterstrip shall be permitted for verification of airflow direction.

[b] All exhaust and discharges shall comply with AS 1668.2 requirements. Filtration or treatment of exhausts shall be provided where required due to the risk associated with the discharge. To satisfy exhaust needs, constant replacement air from the outdoors is necessary when the system is in operation.

[c] Filtration efficiency—The filters nominated presume the provision of a general G4 filter on the air intakes and this requirement is not repeated. The filter listed is the main AHU filter and the HEPA, if listed, is the final terminal filter. Manometers or differential pressure monitoring devices shall be installed across filter banks with efficiencies greater than grade F6.

[d] Filtration efficiencies shall comply with AS 1324. Where nominated, HEPA filters shall be installed at the air outlet and comply with AS 4260, Type 1, Class A, Grade A2, with a minimum efficiency of 99.99 per cent

[e] Recirculating room HVAC units (with heating or cooling coils) are acceptable to achieve the required air change rates. Because of the cleaning difficulty and the potential for build-up of contamination, recirculating room units shall not be used in areas marked 'no'.

[f] The RH ranges listed are the minimum/maximum allowable at any point within the design temperature range required for that space.

[g] All air-conditioning systems shall be capable of maintaining the rooms and areas at any setpoint value within the range of temperature indicated during normal operation over the entire range of outdoor ambient conditions. Lower or higher temperature shall be permitted when patients' comfort and/or medical conditions require those conditions. Temperature range refers to operative temperature as defined in CIBSE Guide A with a PMV +/- 0.25 (ISO 7730). Clothing and activity levels are as per normal health facility operations for the areas listed.

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Emergency dept waiting	Negative	2	12	Yes [h]	F8	No	Max 65	21-24
Intensive care	Positive	2	6	N/R	F8	No	30–60	21–24
Laser eye room	Positive	3	15	N/R	F8	No	30–60	21–24
Medical gas storage [i]	Negative	2	8	Yes	NR	No	N/R	N/R
Medical imaging waiting rooms	Negative	2	12	Yes [j]	F8	No	Max 65	21-24
Neonatal intensive care	Positive	2	6	N/R	F8	No	30–60	22–26
Operating rooms [k] [l]	Positive	AS 1668.2	20	20% [m]	F8,HEPA	No	30–60	18-25 [n]
Procedure room [l]	Positive	3	15	NR	F8	No	30-60	21–24

[h] In a recirculating ventilation system, HEPA filters shall be permitted instead of exhausting the air from these spaces to the outdoors provided the return air passes through the HEPA filters before it is introduced into any other spaces.

[i] Per AS 4332 requirements. See NFPA 99 for further guidance.

[j] This requirement applies only to Medical Imaging waiting rooms programmed to hold patients awaiting chest X-rays for diagnosis of respiratory disease

[k] Gas scavenge shall be provided per AS 2896.

[l] Surgeons or surgical procedures may require room temperatures, ventilation rates or humidity ranges that differ from the minimum requirements. Alternative design conditions shall only be implemented where approved through the non-conformance submission process (refer *section 1.9*).

[m] Per ASHRAE Standard 170 or to achieve room pressure requirements, whichever is greater.

[n] Aligns with HTM-03-01 Appendix 2 in lieu of the more restrictive ASHRAE Standard 170 requirement of 20-24°C. Subject to review with clinicians if alternative operating ranges are required for specific facilities, noting that wider operating bands will generally incur an energy penalty to achieve.

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Recovery room	N/R	AS 1668.2 [o]	6	AS 1668.2	F8	No	30–60	21–24
Sterile stock room [p]	Positive	AS 1668.2 [q]	15	AS 1668.2	F8,HEPA	No	30–60	20–23
Trauma room [r]	Positive	3	15	N/R	F8	No	25-60	21–24
Treatment room [s]	Positive	2	6	N/R	F8	No	30–60	21–24
Wound Intensive Care (burn unit)	N/R	2	6	N/R	F8	No	40-60	21–24
Nursing								
Birthing room [t]	Positive	2	6	N/R	F8	N/R	Max 60	21–24
Examination room	N/R	2	4	N/R	F8	N/R	Max 60	21–24

[o] The minimum outdoor airflow rate shall be the greater of 10L/s per person or 2 m2 per person

[p] All room design shall comply with AS/NZS 4187 requirements as defined by the site and operational risk requirements.

[q] The minimum outdoor airflow rate shall be 20L/s per person at an occupancy of 5m² per person or 50 per cent, whichever is greater.

[r] The term trauma room, as used herein, is a first aid room and/or emergency room used for general initial treatment of accident victims.

[s] Treatment rooms used for bronchoscopy shall be treated as bronchoscopy rooms. Treatment rooms used for procedures with nitrous oxide shall contain provisions for exhausting anaesthetic waste gases.

[t] Refer to AusHFG for additional environmental control requirements for birthing suites/rooms, including provisions for local adjustable control.

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Negative pressure isolation rooms [u]	Negative	[u]	[u]	Yes	[u]	No	Max 60	21–24
Newborn nursery suite	N/R	2	6	N/R	F8	No	30–60	22–26
Patient Corridor	N/R	N/R	2	N/R	F8	N/R	N/R	N/R
Patient room	N/R	2	6	N/R	F8	N/R	Max 60	21–24
Positive pressure isolation room [u] [v]	Positive	[u]	[u]	N/R	F8,HEPA [u]	[u]	Max 60	21–24
Toilet room	Negative	N/R	To AS 1668.2	Yes	N/R	No	N/R	N/R
Diagnostic and treatment								
Bronchoscopy, sputum induction and pentamidine	Negative	2	12	Yes	F8	No	N/R	20–23
Endoscope cleaning [x]	Negative	2	10	Yes	N/R	No	N/R	21–24
Endoscopy procedure room [w]	Positive	2	6	N/R	F8	No	20–60	20–23

[u] Refer to AusHFG for further detail for Isolation Room design requirements.

[v] Positive pressure isolation rooms are those used for high-risk immune-compromised patients. Rooms are positively pressurized relative to all adjoining spaces to protect the patient. Also known as Protective environment isolation rooms.

[w] If the planned space is designated to be used for both bronchoscopy and endoscopy, the design parameters for 'bronchoscopy, sputum collection, and pentamidine' shall apply.

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Haemodialysis	N/R	2	6	N/R	F8	No	30–60	20–25
Hydrotherapy	Negative	2	6	N/R	F8	N/R	N/R	22–27
Medication room	Positive	2	6	N/R	F8	N/R	max 60	21–24
Physical therapy	Negative	2	6	N/R	F8	N/R	max 65	22–27
Treatment room	N/R	2	6	N/R	F8	N/R	30–60	24
Medical imaging [x]								
Medical imaging (diagnostic/treatment)	N/R	2	6	N/R	F8	N/R	Max 60	21–24
Medical imaging (surgical, critical care and catheterisation)	Positive	3	15	N/R	F8	No	30–60	21–27
Laboratory [y]								
Autopsy room	Negative	AS 1668.2	12	Yes	N/R	No	N/R	20–24
Bacteriology	Negative	2	6	Yes	F8	No	30-60	21–24
Biochemistry	Negative	2	6	Yes	F7	No	N/R	24

[x] When required, appropriate hoods and exhaust devices for the removal of noxious gases or chemical vapours shall be provided in accordance with AS 1668.2, AS/NZS 2982, AS 2243 series and Safe Work Australia (NOHSC Regulations and guidelines). Alternatively, NFPA 99.8 may be referenced.

[y] All laboratory facilities shall comply with the requirements of AS/NZS 2982 and AS 2243 series.

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Cytology	Negative	2	6	Yes	F7	No	N/R	21–24
General	Negative	2	6	N/R	F7	N/R	N/R	21–24
Glass washing	Negative	2	10	Yes	F7	No	N/R	max 26
Histology	Negative	2	6	Yes	F7	No	N/R	21–24
Media transfer	Positive	2	4	N/R	F8	N/R	30-60	21–24
Microbiology	Negative	2	6	Yes	F7	No	N/R	21–24
Non-refrigerated body holding room [z]	Negative	2	10	Yes	F7	No	N/R	21
Nuclear medicine	Negative	2	6	Yes	F7	No	N/R	21–24
Pathology	Negative	2	6	Yes	F7	No	N/R	21–24
Pharmacy [aa] [bb]	Positive	2	4	N/R	F8 [cc]	N/R	30-60	21–24
Serology	Negative	2	6	Yes		No	N/R	21–24
Sterilisation	Negative	2	10	Yes	F7	No	N/R	21–24
Sterilising and supply								
ETO steriliser room	Negative	2	10	Yes	F8	No	N/R	24

[z] A non-refrigerated body-holding room is applicable only to facilities that do not perform autopsies on-site and use the space for short periods while waiting for the body to be transferred.

[aa] Applies to general Pharmacy space only. Specific laboratory, including clean or containment, requirements should be applied based on space functional use.

[bb] Pharmacy compounding areas may have additional air change and filtering requirements beyond the minimum of this table depending on the type of pharmacy, the regulatory requirements, the associated level of risk of the work and the equipment utilised in the spaces

[cc] Higher filtration grades may be required for specific pharmacy areas such as sterile manufacturing. Subject to detailed design and requirements.

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Steriliser equipment room	Negative	2	10	Yes	F8	No	N/R	max 26
Central medical and surgical supply [p]								
Clean workroom—central medical and surgical supply [p]	Positive	2	6	N/R	F8 (HEPA)	No	30-60	21–24
Clean workroom—support space [p]	Positive	2	4	N/R	F8	N/R	N/R	21–24
Decontamination room	Negative	2	6	Yes	G4	No	N/R	20–24
Sterile storage [p]	Positive	2	6	N/R	F8, HEPA	N/R	Max 60	21–24
Service [dd] [ee]								
Bathroom	Negative	N/R	10	Yes	G4	No	N/R	21–26
Bedpan room	Negative	N/R	10	Yes	G4	No	N/R	21–26
Clean utility/store	Positive	2	6	N/R	F8 (HEPA) [p]	N/R	N/R	21–24
Cleaner's cupboard	Negative	N/R	10	Yes	N/R	No	N/R	N/R

[dd] Higher minimum total air changes (room exhaust) are recommended for service areas where this does not cause a requirement for provision of additional *conditioned* outside air.

[ee] All room exhausts shall comply with the requirements of AS 1668.2 or the values nominated in the above table, whichever is greater.

Area designation	Air pressure relationship to adjacent area [a]	Minimum air changes of outdoor air per hour	Minimum total air changes per hour	All room exhausted directly to outdoors [b]	Filtration efficiency [c] [d]	Air re-circulated by means of room units [e]	Relative humidity [f] (% RH)	Space design temp [g] (°C)
Dietary day storage	Negative	2	6	n/r	G4	No	N/R	22–25
Dirty utility	Negative	To AS/	20	Yes	N/R	No	N/R	21–24
Dish/pot washing	Negative	3	10	Yes	G4	No	N/R	max 26
Food preparation [ff]	N/R	3	10	N/R	F8	No	N/R	21–24
Hazardous material storage [gg]	Negative	2	10	Yes	N/R	No	N/R	21–26
Laundry general	Negative	3	10	Yes	G4	No	N/R	N/R
Soiled linen store	Negative	N/R	10	Yes	NR	No	N/R	N/R
Warewashing	Negative	N/R	10	Yes	F5	No	N/R	max 26

[ff] Minimum total ACH shall be that required to provide proper makeup air to kitchen exhaust systems as specified in ANSI/ASHRAE Standard 154.4 or AS1668.2, whichever is more stringent.

[gg] Storage of hazardous materials should reference the Material Safety Data Sheet and relevant dangerous goods Australian Standard for specific requirements.

1.6.2.1 Other references

- AusHFG
- Safe Work Australia *Workplace Exposure Standards for Airborne Contaminants*, Safe Work Australia, 2019
- ASHRAE: *HVAC Design Manual for Hospitals and Clinics*
- ASHRAE: *Standard 170: Ventilation of Health Care Buildings*
- HTM 03-01: *Heating and Ventilation of health sector buildings* (Parts A and B), National Health Service (UK)
- ANSI/ASHRAE Standard 154: *Ventilation for Commercial Cooking Operations*
- CIBSE Guide A, Environmental Design (2015)

1.6.3 Temperature difference within rooms

For conventional fully mixed or displacement air-conditioning systems the temperature at 1.5 metres above the floor in a room shall not vary by more than 1°C.

The temperature difference between rooms on the same zone shall vary by not more than 3°C. The temperature difference between floor level and 1.5 metres above the floor shall be not more than 1.5°C.

Zoning of air handling plant shall be provided to the extent required to limit the temperature difference between rooms served by the same zone to a maximum of 3°C.

Individual temperature and humidity control (as required for clinical need) shall be provided for critical care areas, including operating rooms, cystoscopy rooms, cardio cath lab, delivery room, recovery room and neonatal ICU.

1.6.4 Air distribution systems

1.6.4.1 Duct construction

Duct construction shall be in accordance with AS 4254.

1.6.4.2 Duct sizing

Duct sizing shall be based on the following or the NCC Part J requirements, whichever is more stringent:

- velocity:
  - main runs: 7.5m/s maximum
  - branch runs: 5m/s maximum
  - terminal connections: 4m/s maximum
  - flexible duct: 2.5m/s maximum
- pressure drop: 0.8pa/m maximum for all velocities and ducts.

1.6.4.3 Duct Insulation

As a minimum, insulation shall comply with the NCC Section J. The requirements for additional insulation (e.g. for acoustic attenuation purposes, should be assessed for each project).

Insulation shall be provided for ductwork to achieve thermal and acoustic performance.

All internal insulation within clinical areas shall be lined to facilitate infection control cleaning. Exposed insulation or perforated foil faced insulation shall not be acceptable.

1.6.4.4 Air distribution devices

All air distribution devices shall meet the following requirements:

- surfaces of air-distribution devices shall be suitable for cleaning
- the supply diffusers in surgeries shall be designed and installed to allow for internal cleaning
- psychiatric, seclusion and holding-patient rooms shall be designed with security diffusers, grilles and registers. Security diffusers shall be purpose-designed to provide correct air distribution to occupied spaces
- supply air and exhaust air grilles shall be made of non-corrodible material (e.g. anodised aluminium section)
- grilles within an occupied space shall be suitable for swab-down cleaning (not waterproof)
- cores for grilles shall be removable without requiring in-ceiling access or disconnection of ductwork
- in mental health patient bedrooms, ceiling-mounted air devices shall be of a secure type such that removal cannot be effected without special tools. There shall be no sharp projections or ligature points where a cord or string can be fixed.

1.6.4.5 Average air velocity within rooms

Average air velocity in the room shall be between 0.1 and 0.15 m/s within the occupied zone of 0-1.8 metres above floor level.

Under no circumstances shall the supply air rate be less than 4.5 ACH in any room any time. This applies to minimum air quantities on VAV systems as well as to constant volume systems.

1.6.5 Air filtration

Filter banks shall be provided in accordance with AS 1324, AS 1668.2, AS/NZS 4187 and the requirements of Table 1. In addition:

- Each filter bank with an efficiency of greater than ‘F6’ shall be provided with an installed manometer or differential pressure measuring device that is readily accessible and provides a reading of differential static pressure across the filter to indicate when the filter needs to be changed.
- Extended surface filters shall be used as they prolong filter life, reduce maintenance costs and reduce energy use.
- Filter frames shall be durable and dimensioned to provide an airtight fit with the enclosing ducting.

- All joints between filter segments and the enclosing ducting shall be fitted with a gasket or sealed to provide a positive seal against air leakage.

1.6.6 Air handling units

1.6.6.1 Capacity greater than 1000 l/s

The following design criteria shall apply to AHUs or fan coil units with a capacity greater than 1000 l/s (1 m^3/s):

- be factory-built units where possible for quality control and future maintenance
- include a minimum 1300mm high access doors for maintenance
- include separate chambers for fans, filters, coils and mixing plenums
- include lights in each accessible chamber
- include stainless steel drip trays internally
- include air-tight door locking mechanisms and door seals
- be provided with clearance to allow all doors to be opened 110 degrees to allow safe and easy maintenance.

1.6.6.2 Capacity less than 1000 l/s

The following design criteria *may* apply to AHUs or fan coil units with a capacity less than 1000 l/s (1 m^3/s) where compliance with the section 1.6.6.1 above criteria is economically or spatially inappropriate:

- be factory-built units where possible for quality control and future maintenance
- be constructed to avoid thermal or acoustic weaknesses, including no flexible joints or connections between chambers for fans, filters, coils and mixing plenums. Rigid, thermally contiguous construction shall be provided to not less than NCC requirements.
- include lighting to provide clear visibility of the condition within the filter, fan and coil sections
- include stainless steel drip trays internally
- include air-tight door locking mechanisms and door seals
- be provided with clearance to allow all doors to be opened:
  - In plantrooms: 110° to allow safe and easy maintenance
  - In ceilings: 180° for access and maintenance
- lift-off panels shall not be acceptable for in-ceiling fan coil units. All access panels must be hinged.

1.6.7 Humidifiers

The following criteria apply for the design and selection of humidification systems:

1.6.7.1 Design and operation

Humidifiers should be steam type. Due to limited requirement for use within most hospital spaces, self-generating steam humidifiers are preferred over a centralised system.

Reservoir type water humidifiers or evaporative-pan-type humidifiers shall not be used in ductwork or AHUs in healthcare facilities.

Where installed, humidifiers must provide an odourless, sterile (bacteria-free) injection of steam into the air stream.

Provide controls to limit duct humidity to a maximum value of 90 per cent RH when the humidifier is operating.

Humidifier steam control valves should be designed so that they remain off whenever the AHU is not in operation.

Humidifiers should be self-draining and self-cleaning.

1.6.7.2 Water supply

Humidifiers must be provided with a clean water supply from potable water.

Chemical additives used for steam humidifiers serving health care facilities must comply with AS/NZS 3666 series.

For humidifiers serving sterile areas, a pre-treated sterilised water supply using reverse osmosis (RO) water must be provided.

1.6.7.3 Installation

Locate humidifiers within AHUs or ductwork to avoid moisture accumulation in downstream components, including filters and insulation.

All parts of humidifier installation in contact with moisture must be provided in stainless steel. This includes vessels, pipework, jets and drip trays, along with ductwork for a minimum of one metre beyond the manufacturer's recommended air mixing zone.

Humidifiers should be installed to the manufacturer's recommendations, including minimum distances within ducts required for complete distribution and mixing, maximum pipe lengths and drainage requirements.

A humidity sensor shall be provided, located at a suitable distance downstream from the steam injection source.

1.6.8 Ultraviolet (UV) systems

Where provided, UV systems must be sized to provide effective contact time to the surface or airstream as appropriate to ensure micro-organisms are killed.

In-duct or in-AHU UV systems should be fully enclosed to prevent leakage of UV radiation outside of the equipment.

UV lamp chambers should be provided with electrical isolation devices to ensure the lamp is disconnected for maintenance and access.

UV systems must be interlocked with AHU doors or access panels to ensure the system cannot be accessed while the UV lamp is active. Monitoring of doors to effect isolation of the UV lamp in the event of a door being opened is an acceptable method of interlocking.

Appropriate UV radiation warning labels must be provided on all access points.

1.6.9 Heating

Heating systems shall be provided in accordance with the NCC Section J requirements. The use of re-heat shall be limited through appropriate thermal zoning and segregation of systems.

Open fires, portable heaters and unflued gas heaters shall not be installed within healthcare facilities.

Technical requirements for heating systems include all:

- electric heaters over 1 kW shall be provided with SCR control
- electrical heaters shall include safety systems for heater overload and heater fault and meet the requirements of AS/NZS 3102
- heating hot-water-based systems shall include three way valve at end of run to avoid dead-legs in periods of low heating requirements and to limit the impact of cold.

1.6.10 Economic life of plant

The effective economic life of plant and equipment shall be used for whole-of-life costing and evaluation of suitability as per Table 2.

For any exposed equipment (such as external, roof-mounted) in marine environments, the effective life shall be reduced by 25 per cent or the cost of additional treatments or protection to achieve equivalent life as shown in Table 2 shall be included in any whole-of-life or capital cost comparisons.

Table 2: Mechanical services—plant economic life[34]

Equipment item	Median years
Air-conditioning	
DX single or split package	10
VRF/VRV	10
Water-cooled package	15
Heat pumps	
Commercial air-to-air	15
Commercial water-to-air	19
Rooftop air-conditioners	
Single zone	15
Multi-zone	15
Packaged (10 – 100kW)	10-15
AHUs	
- Internal	20
- External	15
Boilers, hot water (steam)	
Steel water-tube	24 (30)
Cast iron	35 (30)
Electric	15
Burners	21
Other heaters	
Off-peak electric storage heaters	22*

[34] Per CIBSE Guide M Appendix 14.A1, ASHRAE HVAC Applications 2015 section 37.3, and AIRAH DA19.

Equipment item	Median years
Air terminals	
Diffusers, grilles and registers	27
Induction and fan-coil units	20
VAV and double-duct boxes	15
Ductwork	30
Dampers	20
Fans	
Centrifugal	20-25
Axial	15
Ventilating roof-mounted	15
Coils	
DX/water	20
Electric	15
Other elements	
Shell and tube heat exchangers	24
Packaged chillers	
Reciprocating	20
Centrifugal	20-25
Absorption	25
Cooling towers	
Stainless Steel	30
Fibreglass [35]	15-20
Other heat rejection	
Air-cooled condensers	20
Evaporative condensers	20
Pumps	
Base-mounted	20
Pipe-mounted	10
Sump and well	10
Condensate	15
Electric motors	18
Electric transformers	30
Other	
CHW pressurisation unit	20
Controls	
Electronic	15
Field controllers	10
Motorised control valves and actuators	10-15
Pipework and valves	20-25*

[35] Based on guideline economic life for 'Epoxy coated metal' and 'Plastic' cooling towers

1.7 Checklists

The following checklists are for the designer's reference and are not intended to be submitted for verification by Queensland Health.

1.7.1 Drawings

Project: **Document(s) reviewed:**	
Item No.	**Review checklist items**
M01	Confirm that the correct climate zone according to the NCC has been used in calculations and listed in the specification
M02	Confirm the most up to date architectural information has been used in calculations and referenced in the specification
M03	Check that wall layouts on the mechanical floor and site plans match the architectural plans and that referenced in the specification
M04	Check that the plan location of plant and mechanical services switchboards (MSSB) matches the architectural
M05	Check on the architectural floor plans that there is sufficient space to accommodate the sizes of all plant and MSSBs nominated in the mechanical drawings, schedules and/or specification sections
M06	Check on the mechanical layouts and/or schematics that all ductwork, pipework and plant sizes are nominated and all equipment designated to match that in the schedules and/or specification sections
M07	Check that all documentation references and interfaces with existing services where relevant
M08	Check that all items of mechanical equipment requiring power connection are documented and match drawing or specification equipment schedules
M09	Check that the pressurisation strategy is in accordance with Table 1
M10	Check that minimum outside air rates match that detailed in Table 1. Where not listed, use AS1668.2
M11	Check that minimum supply air rates are in accordance with Table 1
M12	Check that filtration efficiencies are in accordance with Table 1
M13	Check that temperature and humidity ranges are in accordance with Table 1
M14	Check that exhaust air requirements listed within Table 1 are met
M15	Check that room air circulation requirements listed within Table 1 are met.
M16	Check that occupancy rates are in accordance with room data sheets (RDS), room layout sheets and as per architectural layouts. As a minimum AusHFG RDS will be met
M17	Check that items and notes on the electrical services drawings are consistent with the specification.
M18	Check that air handling equipment has ducted outside air
M19	Check that the essential power is supplied to all critical care areas
M20	Check that constant volume systems are employed to all critical care areas

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
M21	Check that correct operating hours of different departments are suitable in control strategies and load calculations
M22	Ensure chiller staging is suitable for part load of 24-hour critical care areas

1.8 Deliverables

1.8.1 Stages of design

The design shall be completed in recognised milestones, with the following requirements to be documented at each milestone:

	Concept design	Schematic design	Detailed design	Construction documentation
Reporting requirements				
Compliance with the Queensland Health brief	Required.	Required.	Required.	Required.
Compliance with CIR	Assumed. All deviations must be raised via non-conformance submission.	Assumed, except for approved Concept Design deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved Concept and schematic design phase deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved deviations to date. New design deviations should not occur in CD phase as all scope is already approved in DD. Deviations with detailed CIR specification requirements only will be considered. All deviations must be raised via a non-conformance submission.
Listing of codes and standards	By exception, where deviation / amendment to CIR.	Summary table of standards applicable.	Summary table in design report and detailed within draft specifications as applicable.	Required and detailed within specifications.
Redundancy and reliability	Extent of redundancy applicable to major mechanical plant and equipment to be defined through site and operational risk assessment.	Infrastructure strategy defined. Major plant system redundancies outlined in schematics and reports.	Infrastructure strategy and associated schematics and plans progressed in more detail.	Full documentation of infrastructure completed. Specification to include redundancy criteria.

	Concept design	Schematic design	Detailed design	Construction documentation
		Distribution system redundancies outlined within schematics and reports.		
Heating and cooling demand	Preliminary load calculations provided based on proposed areas and functional types. Major plant sizing.	Load calculations progressed via computer modelling. Load profile analysis. Preliminary air balance completed.	Load calculations refined based on typical and developed layouts. Air schematics refined. Water schematics refined.	Full documentation of infrastructure completed. Demand calculations confirmed based on completed layouts.
Major plant	Preliminary major plant sizing—load, spatials. Review of redundancy provisions (refer also above).	Refined major plant sizing. Preliminary equipment selections.	Confirmed major plant sizing. Refined selections. Confirmed redundancy provisions.	Full documentation of infrastructure completed. Specification to include technical requirements, equipment schedules and controls strategy.
AHU strategy	Preliminary assessment to provide guidance on plant locations and sizes.	Refined assessment. Completion of whole-of-life study (if applicable) to confirm strategy.	Implement design and refine.	Confirm and finalise design, document distribution.
Commissioning testing and post-occupancy	Not applicable at CD.	Not applicable at SD.	Preliminary clauses within draft specification. Outline controls strategy.	Finalised specification. Finalised fire matrix (as applicable).
Maintainability	Overarching consideration to be given to concepts.	Location and size of plant and equipment to be considered in terms of ongoing maintenance requirements. Safety in design review. Provide statement in SD report that maintainability has been included.	Location and size of plant and equipment to be considered in terms of ongoing maintenance requirements. Plantroom drawings to include maintenance details/provisions. Safety in design review.	Ensure maintenance requirements included within specification. Provide maintenance zones within drawings (BIM).

	Concept design	Schematic design	Detailed design	Construction documentation
Cost estimates (in conjunction with QS for all phases)	Required for CD level infrastructure items.	Required for SD level infrastructure items.	Pre-tender estimate is normally managed by the QS. Input required by Engineer to QS to support refinement of the cost plan.	Pre-construction estimate is normally managed by the QS. Engineer to support confirmation of the cost plan only.
General coordination	Provide spatial requirements. Stakeholder liaison. Input to risk assessments.	Review project fire safety strategy. Stakeholder liaison. Input to risk assessments. Input to safety in design. Coordinate penetrations through structure and fire barriers.	RDS inputs. Stakeholder liaison. Input to risk assessments. Input to safety in design. Acoustic penetrations.	RDS inputs. Stakeholder liaison. Input to risk assessments. Input to safety in design. Advise on procurement options. Coordinate maintenance requirements for inclusion in specifications. Coordinate 'work by others' within specification documentation. Weatherproofing details.
Design Reports and Documentation	Provide input to the concept design report. For existing buildings, this must include engineering baseline assessment and commentary.	Provide input to the schematic design report. Provided preliminary specifications (if necessitated for delivery model).	Provide input to the detailed design report. Provide preliminary specifications. Provide technical schedules for major plant and equipment.	Provide detailed specifications, technical schedules and associated documentation for electrical services.
Drawings (refer also to the Queensland Health Project Information Requirements (PIR))				
Site plan	Required.	Required.	Required.	Required.
Plant locations	Required.	Preferred location of:	Expanded detail and layouts from on SD drawings.	Expanded detail and layouts from on DD drawings.

	Concept design	Schematic design	Detailed design	Construction documentation
		• major plant (chillers, cooling towers, HHW heaters etc) • AHU plan • Risers.		
Ductwork and pipework reticulation	Not Required.	preferred ceiling reticulation space dimensions.	Expanded from SD drawings. Include indicative sizing.	Expanded from DD drawings. Sizing to be finalised.
Schematics	Not Required. May be provided where assists explanation for requirements.	Water systems (CHW, HHW etc). Air schematics. Exhaust risers.	Expanded and refined from SD drawings. Specialist area full air schematics (i.e. Isolation rooms, operating theatres, laboratories etc).	Expanded from DD drawings Controls schematics, as applicable. Smoke hazard management schematics.
Plans	Not Required.	AHU zoning plans. Plant rooms.	Refined zoning plans. Distribution systems—ductwork, pipework (major runs). Typical room on-ceiling layouts. Maintenance provisions for plant.	Finalised zoning plans. All ductwork, pipework. All plant and equipment. All outlets, registers, grilles etc. Maintenance provisions for all maintainable items.
Details	Not Required.	Not Required. Typical details may support documentation	As needed to support DD.	As required to support full construction documentation.

For some projects, an engineering services master plan will be required prior to commencement of concept design.

1.8.2 Risk assessments and analysis

The following risk assessments are described in the requirements descriptions above, and shall be included at the concept and schematic design phases:

- Section 1.4.3.7—provision of emergency power for mechanical services.

1.8.3 Whole-of-Life studies

The following whole of life assessments are described in the requirements descriptions above, and shall be included at the schematic and detailed design phases:

- Section 1.3.3—energy/sustainability
- Section 1.4.2—major plant
- Section 1.4.3.6—AHU and air distribution system types

1.8.4 Value adding strategies

Provide a description of design decisions taken that show an innovative approach to reducing both capital and operating costs of the proposed systems.

List value-adding strategies adopted, such as shared reticulation, plant space, waste heat scavenging.

- Description:
- Benefit:

1.9 Non-conformance declaration (mechanical)

The designer is required to provide all deliverables detailed within Section 1.8.1 and adhere to the design principles and requirements outlined in Section 1.1 through Section 1.6.

Where the designer cannot meet these requirements, has not provided risk-assessments or whole-of-life studies, or has proposed an alternate solution, a non-conformance declaration must be prepared and submitted within the relevant design stage report.

The onus is on the designer to report any areas of non-compliance.

The following format shall be used:

Project: .....

Design phase: .....

Discipline: .....

CIR clause/requirement	Reason for non-conformance	Design report reference	Client (Y/N)
Eg 1.6.6 AHUs	*Refurbishment of existing plant*	*CDR Section 10.7*	

<< additional lines to be added as required >>

Signed: ..... **Date**: .....

Name: .....

Company: .....

Client review comments: .....

.....

.....

.....

2 Electrical

2.1 Introduction

The primary objective of the design of electrical services for healthcare facilities is to provide energy efficient building and services design, low whole-of-life costs while meeting workplace health and safety requirements and achieving occupant satisfaction with the internal environment.

Significant aspects of the electrical services design are governed by statutory requirements contained principally in the electrical codes and standards, as reference in *CIR Volume 1 Overview*. These regulations together with the referenced Australian standards cover the following major elements of electrical services for health facility buildings:

- power supply and distribution systems
- wiring for all electrical equipment
- emergency lighting and exit signs.

It is recognised that approval for departures from the statutory requirements is difficult and time-consuming to achieve. Notwithstanding, this document identifies some areas of the statutory regulations which should be challenged and where modifications to suit health facility projects could be sought by Queensland Health.

There are, however, other aspects of the electrical design which are not subject to regulations and are normally carried out in accordance with the following criteria:

- recommendations of Australian standards
- requests by health facility user groups
- designer's office design practice (good engineering practice).

This document will be used for the design of electrical services for all health facility buildings.

The following selected, cost-significant items of electrical services have the greatest potential for capital and recurrent cost savings:

- mains supply provision
- mains and sub-mains
- power distribution equipment
- standby supply provision
- interior lighting provisions
- peak demand management and reduction strategies
- protected wiring systems in patient treatment areas.

The designer shall design electrical services that deliver safe, reliable and flexible energy sources within the facility, that provide the expected lighting levels for comfort and functionality, using cost effective solutions that achieve an optimal balance between capital, operating and maintenance costs over the life of the service.

The primary objectives of the design guidelines for electrical services are to:

- ensure important electrical services design issues which have significant impact on the building design are properly addressed with appropriate solutions adopted at the early scheme design stage of the project development
- provide a catalyst for further improvements and individual design innovation
- encourage innovation, particularly with respect to:
  - minimising energy use through efficiency in equipment, and
  - through consideration of alternate power sources, including photovoltaic cells.
- provide better defined design parameters and future provision requirements in the selected areas for designers to achieve industry-wide cost efficiency and energy savings
- ensure cost reduction measures do not reduce the level of servicing provided or compromise safety standards
- focus on areas where cost efficiency in design could yield construction cost savings.

2.2 Principles

2.2.1 Reliability and redundancy

The design of health facility authority connections, redundancy and emergency power provisions shall require a site-specific risk assessment to consider:

- reliability of authority supply
- location and consideration of disasters—cyclones
- criticality of facility operations
- requirement to operate post disaster—scope of operation, scale and duration
- supply of engineering services on standby power—chillers, information communications technology (ICT)
- other site-specific factors.

A complete risk assessment for an appropriately reliable electrical supply is a duty of care owed to patients, staff and visitors. Each health facility will have a mixture of risk categories (clinical risks and non-clinical business continuity risks).

The assessed risk for any particular area will determine the electrical infrastructure for that area, designers and stakeholders should evaluate the economics of providing different distribution strategies. The design process should ensure that single points of failure for major infrastructure are minimised by providing the appropriate level of resilience and redundancy at the point of use.

Risk management carefully balances the approach to a design strategy with the cost–benefit relationships, where cost represents investment, business continuity and operational risk.

All stakeholders involved in the design, assessment or operation of the electrical system should understand and accept the intended operation, limitations and inherent possible failure scenarios of the system and, where necessary, implement contingency arrangements where risks of electrical failures cannot be, or are not, mitigated.

For refurbishment works, the risk assessment shall be undertaken, but in relation to the point in the electrical infrastructure as relevant to the project.

Throughout this electrical CIR, the level of resilience is expressed in terms of N+1 for certain load groups. This means the normal total requirement plus one resilient unit. The following is a non-exhaustive list of ways to achieve the N+1 requirement:

- a site supplied by two incoming feeders, each rated to 100 per cent of the facility demand
- switchboard supplied by two transformers rated each rated at 100 per cent of the required load, but supporting 50 per cent load each
- a system with two standby generators (each rated at full essential load) with a common point of coupling to the distribution network
- three generators each capable of supplying 50 per cent of the essential load
- two uninterruptible power supply (UPS) units, with each unit able to support the full load of Instantaneous Emergency Circuits. Independent battery systems each capable of the full autonomy time (Amp Hour capacity)
- modular UPS units with power and battery modules such that the capacity in each achieves the resilience requirement (two modules at 100 per cent, three modules at 50 per cent).

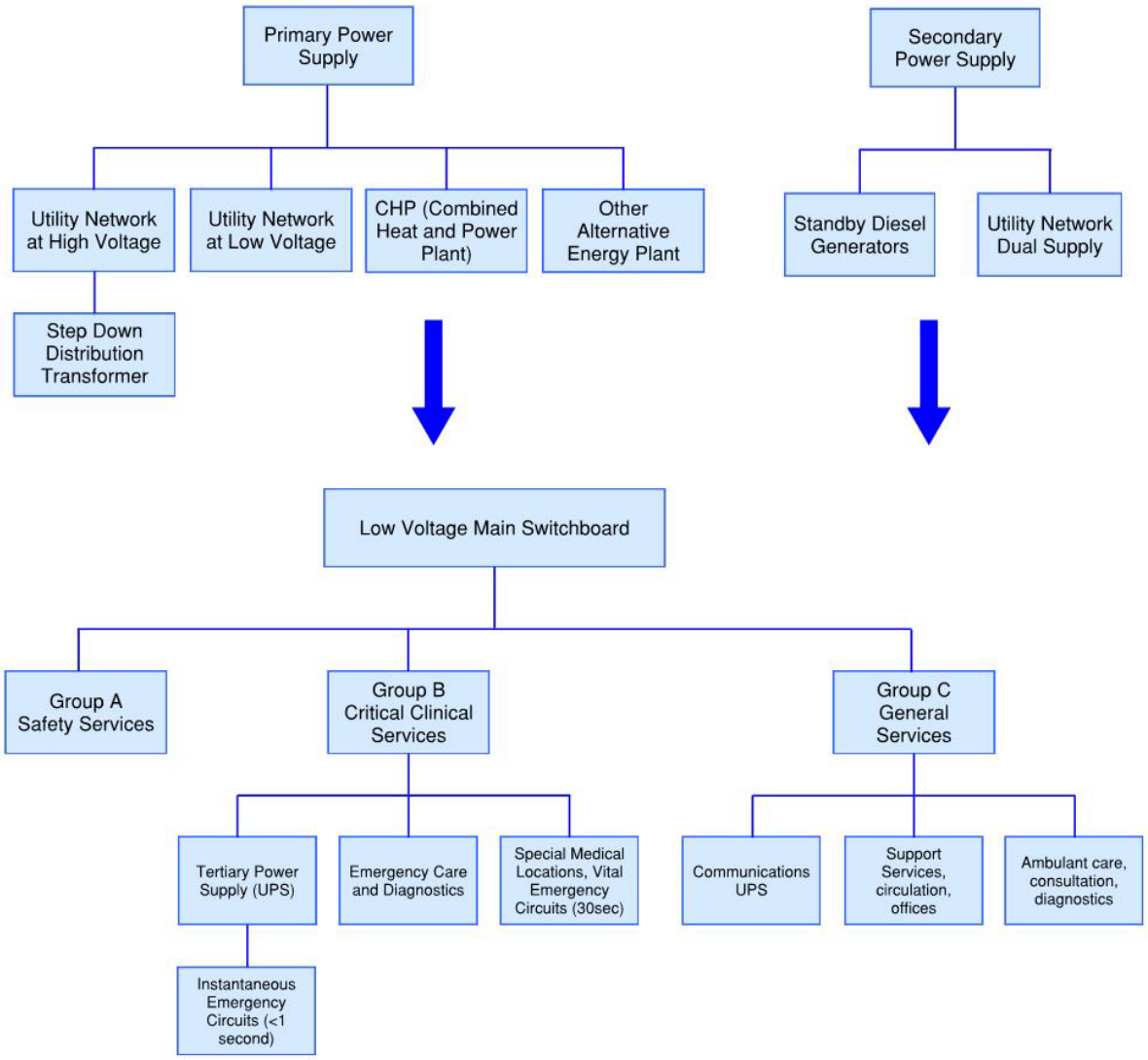
It is the responsibility of the designer to review the particular elements of the overall installation and determine the best response to the N+1 requirements and detail these within the risk assessment.

2.2.2 Description of supply

The mains electricity supply capacity is normally assessed jointly by the designer and the supply authority based on the calculated value of the maximum demand of the new electrical installation, adjusted (normally) downwards to an assessed value comparable to the recorded values of similar installations.

Assessment of the maximum demand using AS/NZS 3000 may be conservative and therefore may result in a gross over-design of supply systems. The following sections detail the load assessment process.

Figure 1: General configuration of incoming and site power



2.2.3 High voltage infrastructure

2.2.3.1 Supply arrangement

Health facilities required to function during and after a local disaster shall be designed with the following redundancy:

- by preference, redundant (N+1) full capacity normal supply available from separate high voltage feeders on ring main network or separate supply authority zone substations and a 1 x100 per cent (N) critical clinical load (30 second vital load) supply
- a 1 x 100 per cent (N) capacity normal supply and a 2 x 100 per cent (N+N) of critical load vital (30 second) supply. Critical load shall be the load of all electrical services required to operate in a disaster and shall include at least the emergency vital (30 second) circuits as classified in AS/NZS 3009
- another arrangement giving equivalent reliability and appropriate redundancy

- health facilities that will continue to provide invasive surgery and emergency procedures on failure of normal utility shall have at minimum a 100 per cent (N) capacity normal supply and backup emergency supplies complying with AS/NZS 3009 capable of safely and reliably supplying the loads required until normal supply is restored or these services are shut down.

In addition:

- the supply authority shall deliver the primary electrical supply at the customer's terminals at a voltage depending on what is available and practicable for the healthcare facility
- where practical, feeders shall emanate from two independent network circuits and from two different street reticulation routes
- due to improved reliability, underground HV supply cable reticulation shall be adopted in lieu of overhead cables where possible
- the selection of tariffs shall be on a project-by-project basis, subject to the requirements of the facility, existing supply arrangements and physical location.

2.2.3.2 Distribution transformers

Requirements for distribution transformer shall include the following design considerations:

- The transformer capacity shall be sized to include the assessed present requirement and the planned spare capacity or the contingent spare capacity (refer to electrical supply demand Section 2.2.4), whichever is greater.
- The supply authority shall normally determine the size and quantity of the transformers where it owns and supplies the transformers.
- The designer shall provide an analysis of different infrastructure options for internal, external substations, configuration and ownership.
- Where indoor type substations are required, they shall be in a fire-rated enclosure within the main building or in an outbuilding.

2.2.4 Low voltage infrastructure

2.2.4.1 Electrical load assessments

The assessment of electricity supply demand for the purpose of determining the capacity of the substation or supply service shall be carried out in accordance with the following procedures:

- Calculate maximum demand of the various load groups of the new electrical installation in accordance with the criteria detailed below and the relevant Australian Standards. Consider the specific connected load and mode of operation for the facility.
- Forward the calculated maximum demand together with the following information to the supply authority for a joint assessment of the demand requirement.
- When initially communicating with the supply authority, known and established VA/m2 figures instead of Australian Standards calculations should be used as the number of socket outlets and three phase outlets (which are generally regarded as largely irrelevant to the maximum demand calculation) are not usually known when discussing with the supply authority. Refer to Table 1.

- The designer shall also consider the supply demand of the existing electricity installation (if any) proposed to be de-commissioned as part of the refurbishment project. Use demand data (such as from utility pulse metering, BMCS records) where possible.
- The number of socket outlets and three-phase outlets allowed for in the calculations and their likely usage rate (loading diversity factor). Depending on the resolution of the design an allowance based on VA/sqm in conjunction with other load information that may be available for specific equipment may be used.
- The number of standby equipment or motors and their loading requirements.
- Note: Supply demands of these standby motors are to be excluded from the demand calculations. Details of loadings are to be given to the supply authority for their information only.
- The number of lifts and their individual supply demand.
- Actual supply demands of similar installations and their locality for fine-tuning of the demand assessment by cross-referencing.
- Consideration shall be given to the appropriate allowance for the space/capacity (either in equipment or accommodation space) for additional requirements of known future budgeted new equipment or budgeted new building development being planned for implementation in the near-term.
- Consideration shall be given to the use of alternate energy sources and potential for reduction of grid electricity demand.

Table 1 shall be used when calculating an initial maximum demand assessment for the purposes of determining transformer capacity. For the purposes of initial demand sizing, these figures do not include spare capacity—additional spare capacity as per Section 2.2.4.3 below. It is recognised that these rates are higher than would typically be seen as measured loads; however, are intended to cover all climate zones and scenarios for initial transformer sizing.

Table 3: Electrical load profile

Department	VA/m2
Catering (commercial kitchen)	200
Day procedures—patient treatment areas	120
Emergency	120
Engineering services (other than on-site catering)	100
Critical care units	120
General inpatient wards	110
Main entrance	80
Mortuary	110
Operating theatre suites	120
Offices	100
Waiting areas, public spaces, corridors	80

Demand factors shall also be considered when utilising the above figures. A demand factor reflects that not all electrical systems will be used to full capacity and not all areas connected

to one substation will have the same time of day profile (for example clinics versus 24-hour wards).

Designers shall assess the demand factors for each service and department to make a value judgement of the site-wide normalised diversity. The rational shall be documented within design reports.

However if the information regarding departmental function is not readily available then the capacity shall be assessed based on the following per unit area allowance as per.

Table 4: Planned electrical capacity based on climate zones

Building categories:	VA/m2
Tropical design conditions (Zone 1)	120
Sub-tropical design conditions (Zone 2, 3)	100
Temperate design conditions (Zone 5)	80

2.2.4.2 Submain classification—grouping of loads

General

The method of determining the maximum demand and therefore the capacity of submains is prescribed in Australian Standards. The prescribed calculation method accounts for all items of electrical equipment connected to the submain circuits together with the appropriate diversity factors for different types of loads.

This method of assessment is generally used by designers and normally yields a cost-effective result. Alternative maximum demand methods based on health facility design experience is also acceptable.

Maximum demand in a submain can also be determined by assessment or by limitation. However, these methods are not practical and not normally applicable to the electrical services loadings in health facility buildings.

Notwithstanding, the opportunity for over-design and therefore ineffective provisions lies in the following areas:

- type of conductors for different types of electrical services
- assessment of spare capacity for future requirements.

Types of submains

The types of submains for distribution of electricity supply from the main switchboard (MSB) to light and power distribution boards and building services switchboards in various parts of a health facility building can broadly be categorised into the following groups:

- Group A—safety services (Australian Standard defined)
- Group B—critical clinical services (Queensland Health defined)
- Group C—general services (remainder)
- These classifications are driven around the reliability requirements within specific areas of the facility, and a provision for the ability (or otherwise) to have power available during both planned (maintenance) and unplanned (outages) scenarios.

Group A—safety services

Examples of emergency services include:

- fire hydrant booster pumps, automatic fire sprinkler pumps, fire detection and alarm system, air handling equipment for control of spread of fire and smoke
- emergency warning and intercom system (inter-fire zone cabling)
- centralised battery supply system for emergency evacuation lighting
- lifts as nominated in the NCC.

Submains and associated support systems for the above Australian Standard defined safety services equipment shall have fire and mechanical protection ratings as specified in the respective Australian standard having jurisdiction over the system or installation.

Cable support systems for emergency services shall comply with the seismic constraint requirements.

Group B—Critical clinical services

Standby lighting and power systems in accordance with standards shall be provided in critical clinical care areas, as defined in AS/NZS 3009.

Submains for lighting and general-purpose power outlets in critical clinical care areas require special consideration to ensure reliability of power supply, with consideration for continuity of supply in planned and unplanned outages.

As defined by Queensland Health, critical clinical care areas are those areas where acute resuscitation procedures occur on a regular basis. These areas include:

- resuscitation bays in the ED
- treatment bays in the ED in level five and six facilities
- operating rooms, anaesthetic bays and recovery area
- day procedures rooms
- cardiac catheterisation rooms
- CCU
- ICU
- NICU.

In addition, critical clinical care provisions shall be assumed for:

- selected areas of medical imaging unit
- acute mental health inpatient units including paediatric intensive care unit (PICU), mental health high dependency units (HDU) and observation units
- computer (IT Servers) systems, subject to further or alternate requirements identified by eHealth Queensland.

Light and general-purpose power outlets in critical clinical care areas shall have dedicated submains originating from the MSB, feeding dedicated distribution boards. The switchboard(s) and submains shall be configured to ensure reliability of electrical supply.

Each critical clinical care area shall be served by two submains—with at least one connected to standby generator (essential) supply (where such a system is installed). Where no generator is

installed, both submains shall be connected to the Group B section of the MSB. The two submains shall be reticulated via diverse physical pathways where possible, at a minimum on physically separate cable trays along the same route. Connected circuits shall be arranged in a fully redundant methodology, such that if one supply fails the alternate supply shall be utilised to supply the area. The change-over of supply shall be achieved via either manual or automatic switching.

Critical clinical care submains cables are not required to be fire rated. Protection against mechanical damage shall be provided.

Instantaneous emergency circuits (<1 second per AS/NZS3009) shall be connected to all critical patient equipment involved in invasive subcutaneous procedures. This will allow clinical personnel time to complete or finalise an invasive procedure without risk to the patient.

Vital emergency supply (within 30 seconds per AS/NZS3009) shall also be provided to all subsidiary mechanical, hydraulic, medical gas and security systems (which are dependent on an electrical power source to operate) and are essential in delivering the services to the critical care areas.

Group C—General services

The remaining submains for services and equipment not listed in Group A and B comprise the following:

- general light and power throughout the buildings
- Support Services, circulation, offices
- ambulant care, consultation, diagnostics
- mechanical services systems servicing group c areas
- medical imaging systems
- hydraulic services system.

Light and power submains for non-critical care areas may either be dedicated or shared circuits via suitably protected tee-offs.

Light and power submains to be provided with standby generator supply shall be separate from the normal supply submains. They may be either dedicated or shared circuits. Dual distribution boards are not required for Group C areas, on the basis that areas of this classification can accept a loss of power (either planned or unplanned).

Submains for small mechanical and hydraulic services plants may either be dedicated or shared circuits via suitably fused tee-offs. Submains for major mechanical plants should be dedicated.

Submains for computer server systems and medical imaging systems shall be dedicated. They may be used for lighting and general purpose power sub circuits in the same department.

All of the above submains need not have fire and mechanical protection ratings. The least cost cable type is to be selected.

Assessment of submain capacities

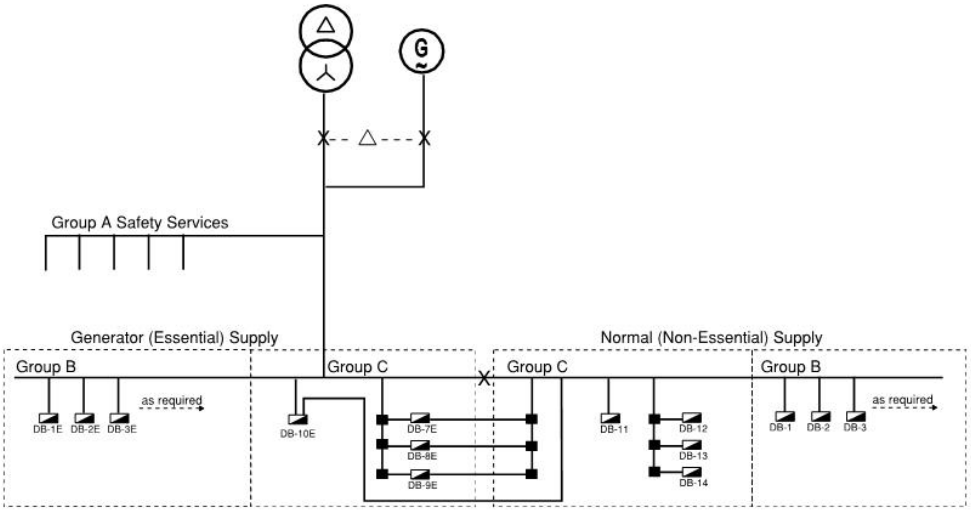
The maximum capacity of all sub mains shall be assessed in accordance with the Australian Standards, including any necessary de-rating for installation specific requirements.

Submains for mechanical services, fire services and lifts shall be sized to match the rated duties of the equipment.

Submains for lighting and general-purpose power circuits shall be assessed by calculation method using the permitted diversity factors in accordance with the standards.

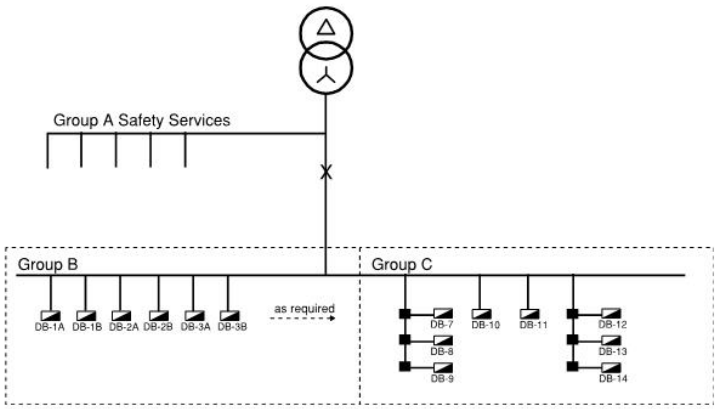
Spare capacity as detailed below shall be provided.

Figure 2: Example submain grouping configurations



EXAMPLE SUBMAIN GROUPINGS - WITH GENERATOR SUPPLY

Note - these are examples of acceptable solutions, this diagram does not represent all acceptable scenarios



EXAMPLE SUBMAIN GROUPINGS - WITHOUT GENERATOR SUPPLY

2.2.4.3 Spare capacity

Spare capacity shall be included in new build electrical designs at various points of the installation. Where possible (without triggering major infrastructure upgrades) this spare capacity shall also be factored into refurbishment works. Where the spare is unable to be provided in refurbishment work, this shall be explained within design reports for final acceptance by Queensland Health.

Transformer sizing

In additional to the VA Rates outlined in 2.4.1 the following spare capacity shall be included to determine initial maximum demand for transformer capacities:

- When appropriate, the planned spare capacity shall be assessed based on the anticipated power requirement of any future development.
- In the absence of any known future requirements, a contingent spare capacity of 25 per cent shall be included.

Consumers mains

Consumers mains shall be matched to the maximum capacity of transformers (which in turn shall be sized for spare capacity requirements as detailed above).

Main switchboards

Shall be provided with a chassis rating matched to the maximum capacity of the supplying transformers (which in turn shall be sized for spare capacity requirements as detailed above).

Shall have circuit breakers supplying downstream distribution boards and mechanical services switchboard with the ability to accommodate the spare capacity described below. This may be achieved through provision of a circuit breaker frame size which allows larger trip units to be installed in the future, or through adjustable trip settings within the installed circuit breaker.

Shall have spare outgoing circuit breakers provided within the design. The size of these shall be determined by the design engineer, accounting for the size of the Facility and the specifics of the electrical installation – the details of this assessment shall be provided within the design reports. At minimum there shall be five spare circuit breakers on each of the essential and non-essential sections of the MSB, sized to accommodate installation of light and power distribution boards or MSSB in the future.

Submains cables

Submains cables shall be matched to the capacity of the downstream distribution boards and mechanical services switchboards, inclusive of the spare capacity detailed below.

For shared downstream infrastructure of Group C classification, the common submain shall account for the cumulative effect of the spare capacity at each t-off point of the shared circuit.

Distribution boards and mechanical services switchboards

Distribution Boards shall be provided with a minimum:

- 25 per cent spare capacity for future load growth above the calculated initial maximum demand, including a chassis rating to accommodate the spare capacity.
- 25 per cent space for additional switchgear (ie spare poles), with not less than 12 spare poles

MSSB shall be provided with a minimum:

- 25 per cent spare capacity for future load growth above the calculated initial maximum demand, and not more than 130kVA.
- This spare capacity shall be calculated as a multiplier of 1.25

Cable reticulation

Cable trays, ladders and ducts shall be provided with:

- 50 per cent spare capacity for future cable reticulation
- This spare capacity shall be calculated as a multiplier of 1.5.

2.2.5 Generation

Design requirements for generator systems shall include:

- emergency generator systems shall be provided to allow no-break transfer of supplies for the purposes of testing and restoration of power
- a SCADA/PLC system shall be provided with synchronous control where multiple generators operate concurrently
- generators shall be rated for continuous operation and selected to run at 80 per cent nameplate capacity to accommodate the site load and impacts of starting and stopping loads
- a minimum load of 40 per cent generator capacity shall be available for testing of generators, without the need for load banks
- loading and load shedding shall be automatic. Load shedding systems shall be assessed on a site by site basis for the most appropriate configuration and operation
- distribution infrastructure to be designed so that main circuit breakers can be routinely maintained without causing interruption to critical services
- uninterruptible supplies for surgical lights and any additional other equipment as defined by the proprietor, such as computers
- subject to the site risk assessment, sites shall be designed with an external connection points for alternate source of supply.

The risk of electrical infrastructure failure should be considered when designing for availability. Required system resilience is achieved by having dual circuits and by having an alternative power supply or source.

A holistic approach to the design of the electrical infrastructure for availability, resilience and risk management is required. Refer also Section 2.2.1.

2.2.6 Power factor correction

The Network Service Provider (NSP) will have minimum power factor requirements which must be met. When undertaking new construction or refurbishment works, the building power factor must be considered.

Where the building will not naturally meet the requirements of the NSP then Power Factor Correction (PFC) must be installed.

If PFC equipment is determined to not be required as part of the project works, ensure practical provisions are made for the connection of any future PFC equipment, should it later be required.

2.2.7 Renewables

The use of renewable energy sources shall be assessed in terms of a whole-of-life assessments for all new and major refurbishment projects. This includes alternative energy sources including wind, biodiesel, gas, solar, photovoltaic—with the designer to determine the most appropriate to suit the site requirements.

It is noted that certain renewables strategies will be assessed and implemented outside of individual project scope, and these do not need to be considered at project level (e.g. bulk power purchase strategies).

2.2.8 Switchgear monitoring

Switchboards supplying emergency, critical and UPS loads shall be provided with switchgear that is monitored at the BMCS. The BMCS shall be able to monitor open, closed and trip status.

2.2.9 Energy efficiency and demand reduction

Energy efficiency measures shall be incorporated into the design as good practice, and to meet the requirements of the NCC. They may be necessary to achieve particular energy targets or ratings.

A whole-of-life analysis should be undertaken for large capital cost options such as:

- PFC at the MSB (minimum correction will be required by the supply authority)
- large-scale implementation of variable speed drives and high efficiency motors
- cogeneration or tri-generation.

Energy efficiency measures shall not compromise patient/occupant health care, nor the provision and/or quality of engineering services.

Design of the power infrastructure shall include consideration of peak demand reduction to reduce capital costs.

Strategies for demand reduction shall be assessed on a whole-of-life cost basis with preferential weighting given in final assessment to strategies which reduce actual energy consumption of a facility in lieu of just utilising an off-grid energy source to reduce peak demands.

2.2.10 Location of infrastructure

Major electrical infrastructure, including HV switchgear, transformers, main switch boards, generators and UPS systems shall be located above flood levels for the facility.

2.2.11 Economic life

The effective economic life of plant and equipment shall be utilised for whole-of-life costing and evaluation of suitability as per Table 3.

Electrical equipment should not be exposed. As such, the effective life in marine and non-marine environments should be equivalent. Protection measures to prevent the ingress of salt, humidity and adverse conditions should be provided and appropriately costed. The cost of additional treatments or protection to achieve equivalent life to that shown in Table 3 shall be included in any whole-of-life or capital cost comparisons.

Table 5: Electrical services plant economic life

Component	Economic life (Years)
Main cables	25–30
Switchgear and distribution equipment	25–30
Final circuits and outlets	20–25
Lighting installations	20–25
Light fittings	10–15
Electric motors	25–30
Standby prime generators, diesel	20–25
Batteries (lead acid)	3–5
Batteries (other batteries, subject to technology)	7–15

2.2.12 Integrated testing

The testing of all plant both for new and existing healthcare facilities is of critical importance to verify the correct operation during normal and abnormal conditions, such as a loss of utility supply or a fire situation.

Each individual health facility electrical services system should be tested and commissioned independently prior to integration with other building control and monitoring systems.

The testing and commissioning shall comply with the requirements of AS/NZS 3017.

2.3 Detailed requirements

2.3.1 Switchboards

2.3.1.1 Main switchboards

MSB at all new healthcare facilities shall as a minimum be designed to the following:

- to withstand the maximum prospective fault level available with the maximum substation transformer
- shall be housed in a separate, accessible room, suitably ventilated and not subject to flooding
- divide the busbar system into separate Group A, Group B and Group C circuits, each segregated from the other by fixed and continuous barriers. Clearly label each segregated section of the busbar system
- MEN: Provide a bolted removable link in the incoming compartment, between the neutral and earth busbars
- Form 3B or higher to Australian Standards for Arc Fault Containment. Forms of containment ‘i’ and ‘h’ will not be accepted.
- front or rear connected, with a minimum of 1000 millimetres clearance in front of all switchboards

- parallel transfer switches be installed at the MSB for testing of the standby generator plant on live load in accordance with consultation with local network authority i.e. Ergon/Energex requirements
- spare capacity as detailed in Section 2.2.4.3
- provide complete grading and discrimination of all switchgear throughout the installation with the utility and standby generation system
- service protection devices to be selected to grade with utility LV protection
- surge protection at MSB to AS 1768 at point on entry from external sources
- PFC equipment to be installed (where required)
- provision for the connection of a future cogeneration or tri-generation plant shall be integrated into the design of the switchboard
- MSB design and shop drawings shall be submitted to the local supply authority for approval.

2.3.1.1.1 Distribution boards

Distribution boards shall be fitted with circuit breakers and residual current devices (RCDs) where it is required for all final sub-circuits to be fed from them. Refer to Section 2.2.4.3.

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

For refurbishment works, liaise with local site engineers to determine existing brand/type and design of distribution boards and match where appropriate.

2.3.1.1.2 Labelling

All electrical switchboards shall be clearly labelled. A logical naming system shall be established, referencing building number. For refurbishment works, liaise with local site engineers to determine site specific naming convention, and match accordingly.

Within MSBs, it is required that all outgoing circuit breakers are fitted with a label which specifies at minimum:

- name of downstream supply (eg distribution board, mechanical service switchboard, equipment)
- circuit breaker frame size
- circuit breaker trip unit size and setting
- outgoing submain cable size and type.

Final sub circuits

Provide a circuit schedule within each distribution board detailing the pole number, circuit breaker rating, and brief description of circuit. To be stored in an A4 plastic holder inside distribution board doors.

All RCD protected outlets provided under AS/NZS 3003 shall be identified and labelled in accordance with the standard.

All other outlets and switches shall be labelled with reference to the supplying distribution board circuit number; and colour coded to AS/NZS 3003.

2.3.1.1.3 Switchgear

Refer to Section 2.2.8 for switchgear monitoring requirements.

For refurbishment works, liaise with local site engineers to determine existing brand/type of switchgear and match where appropriate.

Provide evidence of discrimination and coordination requirements being met within the design.

Final sub circuits

In addition to the requirements of AS/NZS 3000, 30mA RCDs shall be installed on all circuits where users function in a wet area or trade areas in the repair of electrical equipment.

Wet areas generally comprise laboratories where electrical and conductive fluids exists, in x-ray dark rooms, kitchen and mortuary areas.

Trade areas generally comprise biomedical engineering, electrical and mechanical maintenance areas

2.3.2 Generators

2.3.2.1 General requirements

The provision of standby power supply for the following services is mandatory where required by Australian Standards:

- emergency lift service (as required by the NCC)
- fire control equipment (including fire alarm, detection, warning and intercommunication systems)
- evacuation equipment (including emergency and exit lighting)
- smoke control equipment.

Provision of battery supply as emergency supply may be deemed to satisfy upon review with Queensland Health.

The need for standby supply for other safety services (Group A) and critical clinical care (Group B) areas and the extent of its reticulation shall be evaluated for the health facility taking into account the following factors:

- the procedures which are regularly undertaken and involve patients that are susceptible to interruption of the electrical supply
- the frequency at which such procedures are undertaken
- the frequency at which areas are used for their designated function
- the availability of battery-operated or gas-operated equipment (including lighting) to continue critical procedures or to resuscitate a patient.

Most health facilities will require a standby power supply regardless of the nature of the normal electricity supply.

Once the need for a standby supply is established for the health facility, the preferred supply source is a standby generating plant comprising one or more diesel-fuelled, engine-driven generator(s) with automatic start and changeover.

Refer to Section 2.2.1 for further discussion on reliability requirements.

2.3.2.2 Capacity

The capacity of the standby generating plant shall be sized to match the diversified demand of the connected loads.

The generating plant selection must meet the following criteria:

- rated for continuous duty
- load not to exceed 80 per cent of the set prime/continuous rated capacity
- able to meet the lighting and general power load on start up without stalling
- incorporate delay start up (load sequencing) to diversify the induction motor start up currents over time in lieu of a peak current condition, or incorporate reduced voltage starting where possible, to allow the set to reach satisfactory operating conditions without stalling. A single step generator will always result in the largest generator set selection
- appropriate sizing techniques to allow for non-linear load (as a distorted load waveform will increase heating effects in the alternator windings)
- the generating plant may exceed the minimum capacity as assessed to meet the above criteria, in the following circumstances:
  - in upgrading a facility to incorporate a new generator, the cost to modify a MSB to split the load between normal and standby load exceeds the cost of providing 100 per cent standby capacity, then the higher capacity plant should be incorporated
  - studies have been undertaken to compare the advantages and disadvantages between dual power supplies and a higher capacity emergency supply plant and the results indicate that choosing to increase generator capacity is more advantageous
  - the normal electricity supply is known to have reliability problems and a decision has been made to increase the capacity of the standby generator plant to improve the health facility power supply, then higher capacity and redundant plant should be incorporated.

2.3.2.3 Plant configuration

When the assessed generating plant capacity approaches or exceeds 750 kVA, the configuration of the generating plant will depend on the load diversity, so that a large generating plant is not required to provide supply to small health facility loads.

Plant configuration shall be assessed on capital and recurrent cost considerations as well as diversity of range of output. Generally, fewer and larger plant provide a simpler installation and long-term maintenance solution over lots of smaller plant. Irrespective of simplicity or lowest cost options, the design shall ensure the requirements for reliability and redundancy are provided per section 2.2.1 above.

Where load diversity, set size or other justifiable considerations determine the need for multiple generating sets, the sets shall operate in synchronous mode.

Sets shall be of equal size, but mixed sizes are permissible, if existing plant is reused or load diversity justifies such a configuration.

2.3.2.4 System control regime

The operation of the standby generator(s) shall be automatic upon mains supply failure. Consideration must be given to the sequential connection loads to the standby supply system to avoid stalling of the generator engines.

2.3.2.5 Load testing of generators

The power distribution system shall be designed to permit testing of the generators on load without the need for dummy loads (heat banks).

The preferred method of load testing generators, subject to approval of the supply authority, is to use the emergency/essential health facility load as the test load and to connect and disconnect the load by synchronising the generator(s) with the normal electricity supply.

The supply distribution system shall be arranged to permit the operating of mechanical services equipment on standby generator supply without disturbing the lighting and general purpose power circuits of the building.

The operation of the mechanical services (ventilation only) equipment may not provide adequate load. A load mix of mechanical, general light and power may be required to form the 'live load' to test the generator.

The standby generation plant should be regularly tested to a scheduled testing program that checks the system for maintenance or fault problems such that the system is in readiness for use in the event of an electricity supply failure.

At regular intervals, not exceeding an annual event, the electricity supply to the health facility should be turned off and the standby generation plant tested under an actual supply failure condition to verify its readiness to satisfactorily work.

Where such events are considered unsatisfactory due to risks to patients, then standby generation plant should be designed for synchronous operation with the mains power supply.

A complete failure test, simulating failure of the electricity supply at the point of connection, must be performed at commissioning. Such a test should involve all building services emergency systems.

2.3.2.6 Standby power coverage

The following services shall be provided with standby electrical supply from a diesel generating plant in accordance with the recommendations of AS/NZS 3009 and as modified in Table 4 below.

Where available, specific room requirements shall be detailed per the AusHFGs as applicable to the project.

Lighting or power provided with less than 100 per cent supply may be distributed through the department in any pattern to suit departmental needs.

Table 6: Standby power coverage

Area/facility	Lighting %	Power %
Angiographic laboratory - Angio equipment	100	100 100
Blood bank refrigerators	30	100
Blood bank type and cross matching areas	30	100
Cardiac catheterisation room - Cath lab equipment - Control Room	100	 100 Per manufacturer requirements for UPS, standby (essential) and non-essential power.
Computer centre cooling systems	100	100 %
Consultation room	30	Per AusHFG RDS
CCU - Acute beds - Elsewhere	 100 50	Per AusHFG RDS
Diagnostic laboratories	30	30, or per site power reliability risk assessment
ED treatment rooms	100	All socket outlets per bed Note1
Food preparation (cooking)	30	30 or greater if determined by a site power reliability risk assessment
General corridors	25	Nil
High dependency beds	50	Per AusHFG RDS
Inpatient beds		The greater of the AusHFG RDS or AS/NZS 3009
Inpatient treatment rooms	30	Per AusHFG RDS
Isolation rooms—negatively pressurised	100	Per AusHFG RDS HVAC systems - Exhaust fans
ICU - Beds - Elsewhere	 100 50	Per AusHFG RDS for beds or pendants
Labour and delivery suite	30	Per AusHFG RDS
Nurses station	30	Per AusHFG RDS or 30, whichever is greater.
Obstetrical recovery rooms	30	All socket outlets
Offices	30	Nil

Area/facility	Lighting %	Power %
Post-operative recovery room	50	All socket outlets
Reception/waiting	30	Per AusHFG RDS or greater if determined by a site power reliability risk assessment.
Renal units	30	Per AusHFG RDS All renal RO plant shall be 100%
Specialist neonatal	50	100, plus UPS per AusHFGs
Surgical suite - Operating rooms - Anaesthetic rooms - Elsewhere - Ventilation system	 100 100 30	 All socket outlets All socket outlets Nil Full ventilation
Therapy rooms	30	Nil
Toilets/bathrooms/change rooms	30	Nil
Tutorial room	30	Nil
Utility—dirty or clean	30	Nil
Air conditioning refrigeration plant	Nil	Critical care areas only. See Note 3
Essential communications facilities including supporting air-conditioning plant	30	100
Fire alarm system	Nil	Per Australian Standards
Helipad	100	100
Lifts	Nil	See Note 2
Medical suction and air system	Nil	100
Security alarm system including duress alarms	Nil	100
Smoke exhaust fans	Nil	Per Australian Standards

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

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

Note 3: The supply of standby power to chilled water plant servicing critical areas should be considered.

2.3.2.7 Fuel storage

The diesel fuel storage capacity for the standby generating plant shall be assessed by the designer taking into consideration the following factors:

- full load fuel consumption rate of the generating plant
- locality of the health facility and its proximity to a fuel supply depot (time needed to refill tank)
- the role of the health facility as a medical service provider in the region
- average fuel level in the tank prior to tank refill
- quantity of fuel stored in the tank and its turnover time or rejuvenation cycle
- the requirements of AS/NZS 3009.

2.3.2.8 Connection of mobile generator

Regardless whether a healthcare facility has permanent diesel generating plant installed, a quick connection facility (i.e. socket outlet connection or busbar cable connection facility) shall be provided for linking the critical loads identified under standby power to a temporary (mobile) generator set.

Provision of generator start signals in both normally open and normally closed configurations shall be provided at the plug-in point.

The plug point shall ideally be in a locked enclosure in an accessible position, such as adjacent to a loading dock or other suitable location for positioning of a temporary generator.

2.3.3 Uninterrupted power supplies

2.3.3.1 General requirements

Circuits classified by the Australian Standards as requiring instantaneous restoration or continuity of supply shall be provided with UPS standby power source. Preference shall be given to the provision of a central UPS system, over multiple smaller units for new installations. Refurbishments shall consider the existing approach, spatial availability and maintenance preference.

A risk assessment shall be carried out to evaluate the requirements for UPS. These requirements shall be scheduled and agreed with the facility staff as part of design.

The requirements for UPS for ICT systems shall be in accordance with the relevant Queensland Health ICT standards.

Minimum requirements for clinical UPS are:

- N+1 UPS redundancy
- minimum of 30 minutes battery autonomy (at the end of the 10-year battery life)
- connection to the health facility standby power system
- wrap around maintenance bypass
- monitoring by the BMCS.

2.3.3.2 Minimum performance requirements

Each UPS shall comprise a rectifier/charger and inverter combination and shall be provided complete with static switch to satisfy synchronous bypass operation requirements.

The UPS shall provide continuity of electric power to the load without interruption upon failure or deterioration of the input source for a maximum protection time determined by the capacity of the battery bank.

The UPS system shall be designed to supply high-quality AC electric power to single and three phase equipment.

- The system shall include:
  - static inverter
  - independent on board oscillators
  - output filtering
  - ventilation fans
  - instrumentation monitoring and control functions
  - sealed lead acid battery banks (recombination cells)
  - battery bank circuit breakers (complete with earth leakage protection)
  - battery bank enclosures, or open frame racks
  - static switch (synchronous bypass facility)
  - external maintenance bypass facility
  - system control for control, instrumentation and alarms
  - operational and maintenance manuals.
- The UPS shall comply with performance limits set out below:
  - load power factor range 0.5 lagging to 0.7 leading without derating
  - efficiency at full load greater than 95 per cent with the battery on float charge
  - input harmonic distortion mitigation (industry standard less than 5 per cent)
  - battery bank rating at 10 years minimum design life
  - screened against the emission of electromagnetic interference to Australian Standard 1044, IEC 62040-2: 2005-10, 2nd edition Uninterruptible Power Systems (UPS) - Part 2: Electromagnetic compatibility requirements
  - output voltage regulation for:
    - static transfer ± 5 per cent
    - 50 per cent load change ± 8 per cent
    - drop out or return of incoming supply ± 5 per cent.
    - Output Voltage Transient Response: The output voltage returns to within ±1 per cent of the steady state value within 50ms.

  - System output:
    - Nominal output voltage rating: 400 V 3-phase.
    - Output voltage tolerance: +/- 1 per cent
    - Dynamic load response:

- +/- 5 per cent after 2 ms
- +/- 1 per cent after 50 ms
- Testing shall be carried out during manufacture and at completion in accordance with manufacturer's normal test programme. Usually in accordance with industry standards IEC 62040-3: 2011-03, 2nd edition Uninterruptible Power Systems (UPS) - Part 3: Method of specifying the performance and test requirements. Power factor shall be recorded.
- Tests shall include:
  - load test for minimum of two hours at full rated load.
  - main supply on and off
  - bypass effected automatically by simulated component failure
  - bypass effected manually
  - load steps with balanced load
  - load steps with unbalanced load
  - overload conditions.
- Site tests utilising load bank shall be performed after installation is complete and before final connection of load. Tests shall include:
  - functional tests of all controls, indicators and alarms
  - load test for minimum of two hours at full rated load. Mains shall be switched off.
  - waveforms analysed for harmonic content
  - standby generator power test.

2.3.4 Metering

Digital multifunction meters shall be incorporated at various strategic locations of the electrical network and connected to the BMCS and/or energy management system. Subsidiary electrical metering of various areas of the installation can assist in the auditing of energy use and also in the troubleshooting for circuit abnormalities.

As a minimum, multifunction meters shall be provided to monitor all submains servicing distribution boards, MSSB and all other major control cabinets and as required to meet the requirements of environmental monitoring, management and assessment/verification system (such as Green Star, and NCC Section J8).

2.3.5 Cable reticulation

Submain cables shall be continuously supported via cable ladder, cable tray or in cable ducts. Cables shall not be self-supporting.

Sub-circuiting from distribution boards shall be supported by cable tray or catenary wire (in accordance with standards).

Cables shall generally run vertically within walls to minimise potential for future maintenance or modification issues associated with cables being located in walls away from visible power outlets.

2.3.6 Lighting

2.3.6.1 General requirements

Design of interior lighting for health facility and healthcare buildings shall be provided based primarily on the recommendations of the Australian standards (AS/NZS1680 and AS/NZS 1158) and the NCC.

Design requirements shall include:

- lighting selections shall be standardised across a facility and the different types of light, fitting and source shall be rationalised to minimise recurrent costs
- all lighting shall be maintainable and accessible. Particular attention shall be given to lighting in public spaces, atria and associated WHS requirements
- lighting shall be zoned for energy efficiency and based on use of areas
- The selection of lighting sources, luminaires and their control gear shall comply with the regulatory limits prescribed in the NCC.
- Except where specific lighting is required to meet the function of the critical care spaces, lighting shall consist of LED fittings.

Infection control

Prevent intrusion of dust in operating theatres and other defined clinical areas through lighting fittings.

Luminaires in operating theatres and critical areas to be sealed or have a physical barrier that prevents dust migration. Flat surfaces shall be avoided as to not promote dust to settle and require extra cleaning maintenance.

2.3.6.2 Lighting control

Lighting control shall be provided appropriate for the area served:

- automated lighting control shall generally not be provided throughout, but manual control within individual rooms, offices or bedrooms may be appropriate
- public areas shall incorporate lighting control to ensure lighting levels are maintained at all times for safety and security purposes
- The use of manual and/or automatic control of lighting in both administrative and patient areas so that lighting ‘scenes’ can be selected for example, based on the ambient lighting conditions, or to account for different times of the day (day, evening) shall be considered. Table 5 notes standard schemes
- Linking of interior perimeter light dimming systems, activated through daylight sensors shall be considered. This requires a collaborative design approach with the architect and HVAC engineer in order to maximise natural daylight whilst minimising energy gain

- Artificial lighting control prescribed in the NCC shall be used where applicable (for example where parts of the facility have a separate building classification 3, 4, 5 or 6)
- Auto/off switches shall be provided to manually override the lighting control system if required.

Table 7: Standard preset lighting scenes

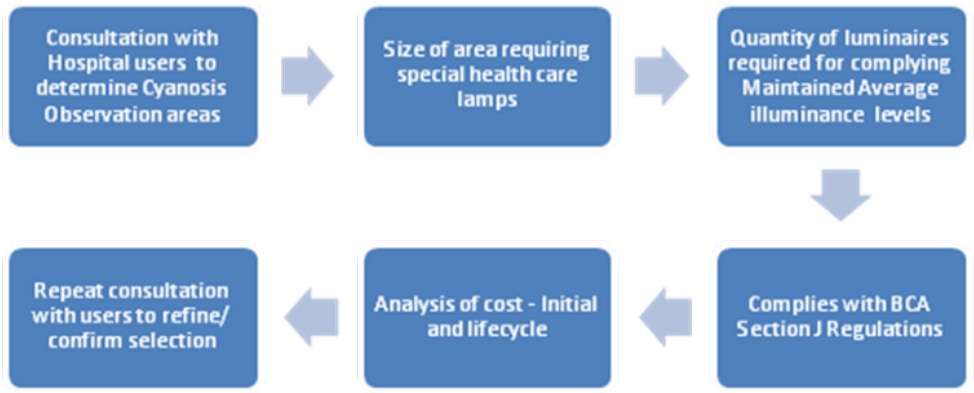
Standard preset lighting scenes (note these are to be tailored for the specific requirements of users)		
General ward	Day	General lighting locally switched
	Night	Night lights switched manually from nurses' station Patient reading light separately switched
Nurses station	Day	General lighting locally switched
	Night	Task/over bench lighting locally switched
Ward corridor	Day	24-hour timeclock control; consider integrated daylight sensors
	Night	Nightlights switched manually from nurses' station
Interdepartmental corridor	Day/night	Consider integrated use of timeclock control and movement sensors

2.3.6.3 Colour rendering

Colour corrected lights shall be provided where required for clinical purposes.

Cyanosis lights shall be provided where nominated by design codes or requested by users. The use of cyanosis lights shall be assessed on a project-by-project basis using the process noted in Figure 3.

Figure 3: Design process for selection of special colour rendering lamps



Designers shall consider advances in LED lighting technology and the ability to achieve the requirements of colour correction for cyanosis observation without the need for 'healthcare specific lamps'.

2.3.6.4 Night lighting

Night lights shall be installed in all patient care areas and exit passages where normal lighting levels will decrease at night.

Night lights shall be mounted at a low level and shall be low intensity and diffused.

2.3.6.5 Clinical lighting

A clinical observation light shall be provided where clinical observation is required.

A patient reading light shall be mounted at each bed head.

If the clinical observation light is not required to be colour-corrected, clinical observation lighting and patient reading lighting can be incorporated into one fitting.

2.3.6.6 Security lighting

Lighting shall be provided for security purposes where required based on site risk assessment.

2.3.7 Exit and emergency lighting

For medium to large health facilities, or multiple building facilities, the emergency evacuation lighting system shall consist of single point self-contained battery backed luminaires connected to a computer monitored network to facilitate remote testing and maintenance reporting. This shall facilitate regular automated testing of the emergency lighting system.

Each luminaire should be individually addressable, labelled and be identified on a zone drawing.

The monitoring software shall reside on a server available to maintenance staff.

Where the facility incorporates a BMS, this shall be interfaced with the emergency lighting system. The emergency lighting shall remain a separate entity and be monitored only by the BMS.

Where a facility does not currently have a computer monitored emergency lighting network, provision shall be made to install such a system for the extent of new works, with the ability to extend to the rest of the facility in the future.

2.3.8 Small power

Provision of socket outlets should be in accordance with the RDS based on standardised room configurations from the AusHFG. The end users must be required to justify each additional socket outlet with a corresponding item of equipment. This check should be carried out for each room.

Outlets for non-clinical purposes (such as cleaner's outlets) shall be nominated by the designers in accordance with the requirements of Australian Standards.

Outlets in nurseries and children's wards shall be fitted with safety shutters.

Sockets, switches and general purpose outlets shall not degrade the sound insulation performance of acoustic rated partitions.

2.3.9 Body and cardiac protection

Body and cardiac protection shall be provided in accordance with the Australian Standard, the AusHFG and as identified during design.

As a minimum all AS/NZS 3003 Patient Areas, that are identified by the Facility (the AS/NZS 3003 'responsible organisation/entity) as being intended that low-voltage medical electrical equipment will be used on a patient, are to be provided with a body protected wiring system.

Minimum requirements for cardiac protection are nominated in AS/NZS 3003.

- RCDs
- isolation transformer and line isolation monitors.

RCDs are more cost effective than the alternative transformer isolated supplies. Therefore, they shall be used for all listed body and cardiac protected areas.

Transformer isolated supplies may be preferred in selected cardiac protected areas on the basis of clinical needs.

2.3.10 Lightning protection

A lightning protection system (LPS) shall be provided in accordance with Australian Standards based on a facility risk assessment.

Should a facility risk assessment deem an LPS is required:

- the designer shall apply a separate risk assessment to each building within the healthcare facility and where the risk assessment has deemed a LPS necessary it shall be provided in accordance with the requirements of AS 1768
- the building roofing and structure, where it is possible, shall be used for lightning protection to avoid separate air terminals and down conductors.
- a traditional LPS consisting of air terminals, down conductors, earthing rods and equipotential bonding conductors shall be provided, if the roof and structure cannot be used
- air terminals offering enhanced protection shall be spaced in accordance with AS 1768 for standard air terminals
- overvoltage surge protection shall be installed, as a minimum requirement, at the MSB and at the point of entry into each building, to divert and attenuate the energy of a direct or indirect lightning strike and to reduce the opportunity for damage to the remainder of the electrical system.

2.3.11 Electromagnetic radiation

Designs shall comply with the requirements Australian Standards for electromagnetic radiation and interference.

Remedial strategies shall be clearly documented to control EMF issues.

2.4 Checklists

The following checklists are for the designer's reference and are not intended to be submitted for verification by Queensland Health.

2.4.1 Drawings

Project: **Document(s) reviewed:**	
Item No.	**Review checklist items**
E01	Check that supply connection point(s) are documented for all new mains and/or sub-mains and that the services engineer(s) have certified that all connections are to local authorities' requirements.
E02	Confirm that the capacity of the existing supply to take the increased load has been checked
E03	Check that wall layouts on the electrical floor and site plans match the architectural plans.
E04	Check that the plan location of the MSB and distribution boards (DBs) matches the architectural.
E05	Check on the architectural floor plans that there is sufficient space to accommodate the sizes of the MSB and DBs nominated in the electrical drawings and/or specification sections.
E06	Check on the electrical plans that all cable sizes are nominated from the point of supply to the MSB and then to the DBs and sub-DBs.
E07	Check that the MSB and DB single line diagram layouts include connection to existing, number of circuits shown on plan and spare capacity.
E08	Check that all items of electrical equipment requiring power connection are shown connected and match drawing or specification equipment schedules. Cross check for consistent indication on architectural furniture/equipment plans.
E09	Check the specification and equipment schedules for consistent indication of communications, data, security and fire detection requirements and similarly c.f. the architectural furniture/equipment plans.
E10	Check that all ceiling mounted electrical fittings (such as lights, fans and smoke/heat detectors) match the architectural reflected ceiling plan(s). Check for conflicts with AC grilles, sprinklers.
E11	Check architectural for location of fire rated ceilings. Check that nominated light fittings do not negate fire rating. Use surface mounted fittings or provide details of recessed fittings with fire rated encasement to match ceiling fire rating.
E12	Check the mechanical services drawings to confirm that all items of equipment requiring power connection (such as fans, AC units) are connected. Check that lighting for all plant room(s) has been documented.
E13	Check hydraulic services drawings to confirm that all items of equipment requiring power connection (such as HWS's, pumps) are connected.
E14	Check that cable and conduit routes are nominated for concealment in the structure. Check with architectural drawings to see that this is achievable. For alterations work, check with architectural that nominated cable routes are possible within the existing structure or ensure that alternatives (such as skirting ducts, surface mounted

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
	conduits/ducts) are documented/ detailed. Check cable routes for isolated or remote items of equipment.
E15	Check that external lighting (such as to verandas, covered ways, pathways, parking) and external electrical equipment connections are documented. Check that these match architectural site and external works/landscaping plans.
E16	Check that light switches located adjacent to door openings are on the lock side of the door.
E17	Check that items and notes on the electrical services drawings are consistent with the specification.
E18	Check that plant rooms have appropriate lighting installed to allow correct and safe maintenance.
E19	Check electrical cable tray routes for clashes with ducts and pipe work.

2.4.2 Specification coordination

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
SE01	Check that the final issue of drawings matches the drawing index in the specification.
SE02	Check that items indicated in the commercial clauses are included Check that items referred to in the 'conditions of tendering', a commercial conditions section that are indicated as 'not forming part of the contract' are included elsewhere in the specification, if required to be part of the work under the contract. Check similarly that items included in the tender schedules are detailed in the technical specification sections or drawings.
SE03	Check that the contract stages/phases are clearly identified and are consistent with the architectural and other disciplines' drawings.
SE04	Check the specification section by section, item by item, against the architectural and other disciples' drawings for consistency in the indication of all items. Check for discrepancies, omissions and material that is not relevant to the contract.
SE05	Check the schedule of finishes against the specification index and the architectural and other disciplines drawings for omissions and consistency in the indication of all items. In particular, check for discrepancies or omissions in room names/reference numbers, materials/finishes types and any non-applicable items that may require deletion, with particular reference to finishes indications on floor and ceiling plans.
SE06	Check that all specific cross references to other portions of the specification or drawings exist and are relevant to the contract.
SE07	Check that all non-specific references (such as 'see architectural drawings', 'see structural', 'refer to hydraulic services section', 'see notes' or 'work by others') are eliminated. All cross references should be specific (i.e. to a particular note or drawing and detail or specification item). Check that the contract responsibility for all documented items is clearly specified.
SE08	Check door and hardware schedules against the other sections of the specification and the architectural drawings for consistency in the indication of all items. In particular, check for consistent indication of room names/reference numbers, door reference numbers, door types, special requirements (i.e. doors in smoke/fire walls, acoustic).

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
SE09	Check all furniture, equipment, and fittings/fixtures schedules for consistent indication of all items against the other sections of the specification and the architectural and other disciplines' drawings.
SE10	Check that a copy of the development consent, complete with consent conditions, has been included in the specification
SE11	Check that all disciplines have a common requirement for O&M information and AS BUILT drawings

2.5 Deliverables

2.5.1 Stages of design

The design shall be completed in recognised milestones, with the following requirements to be documented at each milestone:

	Concept design	Schematic design	Detailed design	Construction documentation
Reporting Requirements				
Compliance with the Queensland Health brief	Required.	Required.	Required.	Required.
Compliance with CIR	Assumed. All deviations must be raised via Non-conformance submission.	Assumed, except for approved Concept Design deviations. All new design deviations must be raised via non-conformance Submission.	Assumed, except for approved Concept and schematic design phase deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved deviations to date. New design deviations should not occur in CD phase as all scope is already approved in DD. Deviations with detailed CIR specification requirements only will be considered. All deviations must be raised via a non-conformance submission.
Listing of codes and standards	By exception, where deviation/amendment to CIR.	Summary table of standards applicable.	Summary table in design report and detailed within draft specifications as applicable.	Required and detailed within specifications.
Redundancy and Reliability	Overarching Strategy to be discussed. Site Supply Arrangement Detailed.	Infrastructure strategy defined. Discussions with Authorities progressed.	Infrastructure strategy and associated schematics progressed in more detail. Agreements with Authorities reached.	Full documentation of infrastructure completed. Specification to include redundancy criteria.

	Concept design	Schematic design	Detailed design	Construction documentation
	Preliminary discussions with Authorities commenced.		Load flow and fault assessments.	Discrimination studies undertaken.
Electrical Supply and Demand	Demand calculations completed to a CD level. Identify potential upgrades or reconfigurations required.	Demand calculations completed to SD level. Load profile analysis. Identify requirement for new substations or connections. PFC equipment assessment.	Demand calculations refined based on typical and developed layouts.	Full documentation of infrastructure completed. Demand calculations refined based completed layouts.
Standby power requirements	Identify standby power concepts, including generator and UPS considerations.	Assessed requirement (kVA). No. of generating sets. Diesel storage capacity. UPS Strategy.	Infrastructure strategy and associated schematics progressed in more detail.	Full documentation of infrastructure completed. Specification to include all standby power criteria.
Spare capacity	Required in accordance with Section 2.2.4.3.	Required in accordance with Section 2.2.4.3.	Required in accordance with Section 2.2.4.3.	Required in accordance with Section 2.2.4.3.
General lighting and power	Not Required.	Overarching principals proposed for the design listed, including lighting controls. Security lighting risk assessment.	Preliminary lighting selections undertaken. Non-standard power requirements discussed. Target lux levels nominated. Energy efficiency strategy determined.	Full lighting and power design completed. NCC Part J6 lighting design compliance. Energy efficiency targets met.
Patient treatment areas	Not Required.	List areas proposed to be body protected.	List areas proposed to be body protected.	Full documentation of system completed.

	Concept design	Schematic design	Detailed design	Construction documentation
		List areas proposed to be cardiac protected.	List areas proposed to be cardiac protected. Determine RCD or line isolation monitor.	Specification to include all criteria.
Lightning protection	Risk assessment.	Details of proposed LPS.	Further refine details of proposed LPS.	Full documentation of system completed. Specification to include all LPS criteria.
Commissioning testing and post-occupancy	Not applicable at CD.	Not applicable at SD.	Not applicable at DD.	Include requirement for final as-installed lux level testing to be undertaken post installation. Ensure O&M requirements included within specification.
Maintainability	Overarching consideration to be given to concepts.	Location and size of plant and equipment to be considered in terms of ongoing maintenance requirements. Safety in design review. Provide statement in SD report that maintainability has been included.	Location and size of plant and equipment to be considered in terms of ongoing maintenance requirements. Safety in design review.	Ensure maintenance requirements included within specification.
Cost estimates (in conjunction with QS for all phases)	Required for CD level infrastructure items.	Required for SD level infrastructure items.	Pre-tender estimate is normally managed by the QS. Input required by engineer to QS to support refinement of the cost plan.	Pre-construction estimate is normally managed by the QS. Engineer to support confirmation of the cost plan only.
General coordination	Provide spatial requirements.	Review project fire safety strategy.	RDS inputs.	RDS inputs.

	Concept design	Schematic design	Detailed design	Construction documentation
	Stakeholder liaison. Input to risk assessments.	Stakeholder liaison. Input to risk assessments. Input to Safety in Design. Coordinate penetrations through structure and fire barriers.	Stakeholder liaison. Input to risk assessments. Input to safety in design. Acoustic penetrations.	Stakeholder liaison. Input to risk assessments. Input to safety in design. Advise on procurement options. Coordinate maintenance requirements for inclusion in specifications. Coordinate 'work by others' within specification documentation. Determine cable pulling requirements (routes and anchor points). Weatherproofing details.
Design reports and documentation	Provide input to the concept design report. For existing buildings, this must include engineering baseline assessment and commentary.	Provide input to the schematic design report. Provided preliminary specifications (if necessitated for delivery model).	Provide input to the detailed design report. Provide preliminary specifications. Provide technical schedules for major plant and equipment.	Provide detailed specifications, technical schedules and associated documentation for electrical services.
Drawings (refer also to the Queensland Health PIR)				
Site plan	Required.	Required.	Required.	Required.
Plant locations	Required.	Preferred location of: • Substation • Switchboard	Expanded detail and layouts from on SD drawings.	Expanded detail and layouts from on DD drawings.

	Concept design	Schematic design	Detailed design	Construction documentation
		• Emergency generator • Mains entry to site • Risers.		
Cable reticulation	Not Required	Preferred ceiling and sub-floor reticulation space dimensions.	Expanded from SD drawings. Include indicative sizing.	Expanded from DD drawings. Sizing to be finalised.
Schematics	Not Required	Power distribution single line diagrams: • HV (high voltage) power supply arrangement • Standby generator • Power distribution single line diagram.	Expanded from SD drawings. HV SLD. MSB schematics. Distribution board schematics. UPS schematics. Standby generator schematics. Fuel schematics. Exit and emergency lighting.	Expanded from DD drawings. Cable sizing. Circuit breaker settings. Distribution board pole counts. Controls interfaces. Lighting control.
Lighting	Not Required.	Not Required.	Preliminary layouts. Use of typical room layouts and key-plan designations will be acceptable at DD.	Full layout drawings. Lighting control. Switching. Circuiting.
Power	Not Required.	Not Required.	Layouts showing infrastructure locations. Identification of body/cardiac protected rooms. No individual small power room layouts required.	Expand on DD drawings. Layouts for small power in rooms. Circuiting.

	Concept design	Schematic design	Detailed design	Construction documentation
Lightning Protection	Not Required.	LPS schematic diagram.	LPS schematic diagram. Roof layouts. Ground layout.	Expand on DD drawings. Earthing and bonding. Additional details.
Details	Not Required.	Not Required.	As needed to support DD.	As required to support full construction documentation.

For some projects, an Engineering Services Master Plan will be required prior to commencement of concept design.

2.5.2 Risk assessments and analysis

The following risk assessments are described in the requirements descriptions above, and shall be included at the Concept and schematic design Phases:

- Section 2.2.1 Reliability and redundancy site-specific risk assessment
- Section 2.2.3.2 Analysis of infrastructure options
- Section 2.2.4.1 Rationale of demand factors and diversity
- Section 2.2.5 Site Risk assessment for external connections for alternate sources of supply
- Section 2.3.3.1 Risk assessment for UPS requirements
- Section 2.3.10 Lightning Protection.

Additional risk assessments also required for schematic design:

- Section 2.3.9 Transformer Isolated Supplies—justification for use
- Section 2.2.4.3 Rationale of spare circuit breaker provision in MSB design
- Section 2.3.6.6 Risk assessment for security lighting.

2.5.3 Whole-of-life studies

The following whole of life assessments are described in the requirements descriptions above, and shall be included at the schematic and detailed design phases:

- Section 2.2.7 Use of renewables
- Section 2.2.9 Energy Efficiency Measures
- Section 2.2.9 Demand reduction strategies.

2.5.4 Value adding strategies

Provide a description of design decisions taken that show an innovative approach to reducing both capital and operating costs of the proposed systems.

List value-adding strategies adopted, such as shared reticulation, plant space, waste heat scavenging.

Description:

Benefit:

2.6 Non-conformance declaration (electrical)

The designer is required to provide all deliverables detailed within Section 2.5 and adhere to the design principles and requirements outlined in Section 2.1 through Section 2.3.

Where the designer cannot meet these requirements, has not provided risk-assessments or whole-of-life studies, or has proposed an alternate solution, a non-conformance declaration must be prepared and submitted within the relevant design stage report.

The onus is on the designer to report any areas of non-compliance.

The following format shall be used:

Project: .....

Design phase: .....

Discipline: .....

CIR clause/requirement	Reason for non-conformance	Design report reference	Client (Y/N)
Eg 2.2.4.3 Spare capacity	*'Light touch' refurbishment only.*	*CDR Section 10.7*	

<< additional lines to be added as required >>

Signed: ..... **Date**: .....

Name: .....

Company: .....

Client review comments: .....

.....

.....

.....

3 Fire

3.1 Introduction

The following principles describe the policies and procedures that enable compliance with the NCC series.

Principally, the objectives of the provisions of the NCC for fire safety are to:

- safeguard occupants from illness or injury while evacuating during a fire
- provide facilities for occupants and the fire brigade to undertake fire-fighting operations
- prevent the spread of fire between buildings.

Fire safety systems are installed in buildings to achieve these objectives. Design and installation of fire detection and suppression systems are to meet the requirements of the NCC, applicable Australian Standards and all relevant codes.

3.2 Process

3.2.1 Building approval

A building approval is required to be issued, by a building certifier, in accordance with the *Building Act 1975* before construction works can commence.

For a building certifier to issue an approval, they need to have completed an assessment of all documentation and be satisfied the work is capable of complying with the NCC and referenced standards.

Any building work that involves a fire safety system or fire engineered solution triggers a referral application, as per the Planning Act 2016, to the Queensland Fire and Emergency Services (QFES). A compliant assessment outcome must be issued by QFES before a building certifier can issue a building approval.

The design documentation for all fire safety systems must include a sufficient level of information for QFES to undertake their assessment.

3.2.2 New construction

All works including alterations and additions are defined as new works and therefore shall comply with the NCC.

Where works constitute a substantial alteration or change in use, the existing fire safety systems shall be upgraded to comply with current NCC requirements.

Where existing buildings are proposed to be altered, and the proposed works do not constitute a substantial alteration, earlier building assessment provisions may be used subject to confirmation from a building certifier.

Ultimately, defining whether construction constitutes new works or is a minor alteration is the purview of the building certifier.

3.2.3 Change-in-use and substantial alterations

Where a *certificate of occupancy* is changed through a change-in-use, the portion of the building affected is to be upgraded to comply with current NCC requirements.

In accordance with the Building Act 1975, where proposed building works constitute more than 50 per cent of the existing total floor area and are considered to pose a risk to the safety of the occupants, entire fire safety systems shall be upgraded to comply with current NCC requirements. These requirements shall always be confirmed by a building certifier.

Where upgrading a fire safety system is not practical or economical, a transitional upgrade in accordance with the Building At 1975 may apply, subject to approval from a building certifier.

3.2.4 Queensland development code

All works shall comply with the relevant mandatory parts of the Queensland Development Code.

3.2.4.1 Bushfire management

Where a proposed development is in an area designated as a bushfire prone area as declared by QDC or a Local Council authority, consideration must be given to the development of a bushfire management plan in accordance with relevant legislation.

3.2.5 Fire engineered solutions

Compliance with the NCC is achieved by complying with the governing requirements of the NCC and the performance requirements of the NCC.

Compliance with the performance requirements is achieved by one of:

- developing a performance solution
- complying with the deemed-to-satisfy requirements
- a combination of both.

Compliance with the deemed-to-satisfy requirements is the preferred approach for compliance with the NCC. However, where a departure to the deemed-to-satisfy provisions of the NCC is sought, this shall be raised during the concept and schematic design phases of the project.

The designer shall provide adequate rational and reasoning for all proposed departures - refer also to section 3.6. A whole-of-life analysis, taking into consideration future maintenance costs, shall be provided for any proposed departure.

Where departures have been identified by other parties, such as the building certifier and/or the architect, the fire protection design must incorporate all design requirements contained within the fire engineering report.

3.2.6 Maintenance and sustainability

Fire system design shall take into consideration ongoing maintenance requirements. The design must incorporate appropriate provisions to adequately maintain the system in accordance with all applicable requirements of fire codes and legislation.

Sustainability initiatives, where practical and economical shall be incorporated into the fire system design to lower system operating costs.

3.3 Fire protection systems

3.3.1 General

Fire protection systems in buildings relates to the active process of protecting the building and its occupants from the effects of fire by use of one or a combination of the following:

- fire detection and occupant warning systems
- fire hose reels
- fire hydrants
- automatic fire sprinkler systems
- gaseous suppression and water mist systems
- fire extinguishers and fire blankets
- smoke hazard management systems.

3.3.2 Automatic fire sprinklers

Automatic fire sprinkler systems are provided to control the development and spread of fires in buildings. They are provided appropriate to the size of the fire compartment, function, use and height of the building and the applicable fire hazards within the building.

Automatic fire sprinkler systems shall be provided where required by the NCC.

3.3.3 Fire hydrants

Fire hydrant systems are used by the attending fire brigade to control the spread of fire and protect neighbouring properties.

These systems are required to facilitate the needs of the fire brigade appropriate to the floor area of the building and associated fire hazards.

Fire hydrant systems shall be provided where required by the NCC.

3.3.4 Fire hose reels

Fire hose reel systems, where required, allow occupants to undertake initial fire suppression attack on a fire.

Fire hose reel systems are required for certain buildings appropriate to the size of the fire compartment, function of the building and applicable fire hazards.

Fire hose reel systems shall be provided where required by the NCC.

3.3.5 Portable fire extinguishers and fire blankets

Portable fire extinguishers and fire blankets allow occupants to undertake initial fire suppression attack on a fire.

This equipment is typically distributed throughout the building so that it is readily available if occupants choose to undertake initial fire suppression.

Portable fire extinguishers and fire blankets shall be provided where required by the NCC.

3.3.6 Fire detection and occupant warning systems

Fire detection and occupant warning systems are provided in building to detect the effects of a fire and to allow occupants to evacuate safely from a building.

These systems typically consist of the following major components:

- smoke and thermal detectors
- manual call points
- occupant warning speakers
- fire indicator panel.

The fire indicator panel should always be located at the designated building entry point to allow the fire brigade to quickly and easily identify the area in which a fire has been detected.

In conjunction with a fire detection system, other systems that are used to assist occupants in the safe evacuation of buildings include:

- emergency warning and intercom systems (EWIS)
- smoke hazard management systems.

Design of the fire detection systems must take into consideration the environment in which they will operate to minimise the likelihood for unwanted alarms.

3.3.7 Emergency warning and intercom systems

Emergency warning and intercom systems are provided to warn occupants of an emergency and assist occupants with the evacuation of a building. These systems are provided appropriate to:

- The floor area, the function and height of a building
- The number, mobility and other characteristics of the occupants.

An emergency warning and intercom system provides the capability to coordinate a staged approach to the evacuation of occupants from a building. This is achieved through the use of system zoning, warden intercom phones and public address facilities.

Where an emergency warning and intercom system is required by the NCC for a building and the building forms part of a campus, consideration shall be given to interfacing the system with other emergency warning systems on the site.

All such considerations should be presented to QFES.

3.3.8 Smoke hazard management systems

Smoke hazard management systems are provided to ensure evacuation routes in building are maintained for a sufficient period of time for occupants to safely evacuate.

These systems can comprise of the following sub-systems:

- car-park ventilation
- kitchen hood exhaust systems
- zone pressurisation systems
- hot layer smoke control
- fire-isolated exit stair pressurisation
- lift shaft pressurisation.

Smoke hazard management systems shall be provided where required by the NCC and where these systems are required, the fire detection system design shall be coordinated with the mechanical design to ensure proper operation is achieved.

3.4 Checklists

The following checklists are to assist designers in providing necessary input to Queensland Health throughout the design process. The checklists are not exhaustive and additional checks, design and reporting may be required. The designer shall apply professional judgement regarding additional information to be provided.

The following checklists are for the designer's reference and are not intended to be submitted for verification by Queensland Health.

3.4.1 Schematic design

Project:	
Item No.	**Review checklist items**
General	
	Carry out on-going checks for compliance with regulations.
	Monitor compliance of the developing design with the project brief.
	Draw up a strategy for fire safety and define the parameters for fire detection and suppression systems, and review with other design consultants, particularly the architects.
	Confirm design criteria, scope and extent of fire services.
	Update recommendations to Queensland Health for their development of an operating and maintenance strategy.
	Carry out initial overall spatial co-ordination.
	Provide information for RDS, where these are used
	Identify client requirements which will necessitate design input from a specialist designer, sub-contractor or supplier, and the timing of their appointment.
	Define the essential performance requirements of systems. This may involve establishing numerical criteria for the nominal capacities of plant, the range of operating duties anticipated and consideration of the requirements for submitting samples and prototypes.
	Advise of significant allowances or constraints incorporated in the main design that may affect the specialist design.
	Undertake consultation with Queensland Health stakeholders concerning any risk management/WH&S issues
Fire services design	
	Determine main pipe routes around floors to and from risers.
	Determine approximate pipe sizes, head types and locations, valve sizes and locations, and sizes of ancillary equipment (such as pump sets).
	Determine FIP locations, SIP and pump room sizes and locations.
	Design automatic controls systems as required to meet with the operational, functional and spatial requirements of the specification.

3.4.2 Design development

Project:	
Item No.	**Review checklist items**
General	
	Carry out on-going checks for compliance with regulations.
	Negotiate with public and other utility authorities for the provision of incoming services and agree spatial requirements.
	Monitor compliance of the developing design with the design philosophies.
	Review design against NCC
	Team-wide design review to signal end of design development stage.
Fire services design	
	Confirm design criteria for fire systems.
	Establish indicative plant and riser sizes for fire systems and plant room locations/sizes.

3.4.3 Contract documentation

Project:	
Item No.	**Review checklist items**
Team liaison	
	Check the provision for and adequacy of the preliminary builder's work information previously issued by others.
	Confirm builder's work information for specified equipment or materials, or where alternatives to those provisionally or pre-selected are agreed.
	Co-ordinate the design so that the requirements for all access platforms, stairs, rails and protection elements required for future maintenance and operation of plant/equipment.
	Carry out spatial co-ordination associated with major spaces: plantrooms, risers, depths of ceiling and floor voids.
	Consider requirements for installation.
	Carry out final detailed spatial co-ordination between the building services and the structure/architecture.
	Modify the final detailed spatial co-ordination for approved alternative equipment or materials.
Fire services design	
	Carry out final detailed design calculations for all remaining services in accordance with relevant standards.
	Carry out detailed design of pipework systems.

Project:	
Item No.	**Review checklist items**
	Carry out detailed design of anchors, guides and other provision for movement of services and systems due to building movement.
	Modify distribution systems and equipment capacities as may be required as a result of final detailed spatial co-ordination.
	Check pump system duties based on the final equipment selection and co-ordinated installation drawings.
	Specify final location of access panels, and other equipment required to facilitate maintenance.
	Carry out final coordination with hydraulic engineer for all drain points
	Carry out final selection of all terminal devices – sprinklers, detectors
	Confirm designs for pump rooms, booster systems, brigade connections
Commissioning	
	Identify and incorporate into system designs the essential components and features necessary to enable the proper preparation and commissioning of building services.
	Review all designs to ensure that systems are commissionable.
	Review commissioning requirements.
	Coordinate fire services statutory and authority testing requirements for the project
	Integrate commissioning activities with other services, particularly mechanical and electrical services for shutdown and interface testing.

3.5 Deliverables

3.5.1 Stages of design

The design shall be completed in recognised milestones, with the following requirements to be documented at each milestone:

	Concept design	Schematic design	Detailed design	Construction documentation
Reporting requirements				
Compliance with the Queensland Health brief	Required.	Required.	Required.	Required.
Compliance with CIR	Assumed. All deviations must be raised via non-conformance submission.	Assumed, except for approved concept design deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved concept and schematic design phase deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved deviations to date. New design deviations should not occur in CD phase as all scope is already approved in DD. Deviations with detailed CIR specification requirements only will be considered. All deviations must be raised via a non-conformance submission.
Listing of codes and standards	Summary table of standards applicable.	Summary table of standards applicable.	Summary table in design report and detailed within draft specifications as applicable.	Required and detailed within specifications.
Design process	Preliminary assessment and sizing of fire services infrastructure requirements, including tanks, pumps and major valve sets. Consideration of reticulation strategy to allow quantity and	Refine major infrastructure requirements. Confirm all points of connection to external infrastructure (i.e. water supplies).	Confirm any department specific fire services design requirements as part of the user group process. Ensure RDS capture final requirements for outlets or other special provisions.	Prepare specification and schedules. Prepare final drawings—plans, schematics and all necessary details.

	Concept design	Schematic design	Detailed design	Construction documentation
	location of risers to be determined. Identification of required plant and riser areas for integration into building spatial planning.	Prepare fire services schematics and preliminary plant room drawings.	Update documentation and progress fire services plan drawings. Provide confirmed plant room drawings.	
Redundancy and reliability	Per appropriate Australian Standards and any site-specific factors.	Confirm strategy for site supply redundancy and reliability. Include necessary details in schematic drawings to confirm reticulation redundancy and reliability strategies.	Reconfirm strategy and no material changes to site requirements.	Specification and drawings to include redundancy and reliability requirements per the site strategy.
Future proofing	Allow for site expansion at major infrastructure (i.e. sprinkler manifolds, water storage tanks).	Confirm and align strategy by documentation in schematics and design reports.	Confirm and align strategy by documentation in schematics, plans, design reports and draft specification	Specification and drawings to include future proofing per approved strategy.
Disaster management	Per the requirements of Australian Standards and site-specific factors.	Confirm and align design documentation with strategy.	Confirm and align design documentation with strategy.	Confirm and ensure design documentation captures extent of the required strategy.
Performance	Per the requirements of Australian Standards and NCC.	Per the requirements of Australian Standards and NCC.	Per the requirements of Australian Standards and NCC.	Per the requirements of Australian Standards and NCC.
Commissioning testing and post-occupancy	Not applicable at CD.	Not applicable at SD.	Preliminary requirements included in draft specifications.	Specification of testing and handover requirements. Generally, these will be per the Australian Standards for the respective fire safety systems. Ensure O&M requirements included within specification.

	Concept design	Schematic design	Detailed design	Construction documentation
Maintainability	Preliminary assessment of plant and riser spatials, including requirements for maintenance.	Refined from concept design. Servicing access confirmed on SD drawings for plant areas. Safety in design review. Provide statement in SD report that maintainability has been included.	Detailed design drawings to show maintenance provisions for plant areas. All valves to be accessible and not concealed in ceilings or enclosed. Safety in design review.	Detailed in documentation for all plant areas, risers, serviceable equipment and valves. Final design phase safety in design review.
Cost estimates (in conjunction with QS for all phases)	Provided by QS based on estimated preliminary plant requirements and outlet counts.	Confirmed by QS based on any revised design parameters.	Confirmed by the QS based on device counts and/or sq.m basis per department.	Confirmed by the QS based on final design requirements confirmed by the engineer.
General coordination	General coordination including: Provide spatial requirements for plant rooms, risers and points of access. Key stakeholder liaison.	General coordination including: Confirm spatial requirements. Stakeholder liaison. Input to safety in design.	Refined requirements via user group consultation. Coordination with architect for access and maintenance review. Coordination with other engineering services, particularly for points of interface (associated works).	General coordination including: Safety in design. Coordinate maintenance requirements for inclusion in specifications. Coordinate 'work by others' within specification documentation.
Design reports and documentation	Provide input to the concept design report. For existing buildings, this must include engineering baseline assessment and commentary.	Provide input to the schematic design report. Provided preliminary specifications (if necessitated for delivery model).	Provide input to the detailed design report. Provide preliminary specifications. Provide technical schedules for major plant and equipment.	Provide detailed specifications, technical schedules and associated documentation for fire safety services.

	Concept design	Schematic design	Detailed design	Construction documentation
Drawings (refer also to the Queensland Health PIR)				
Design drawings	Not required, but a preliminary schematic can be advantageous for articulating requirements.	Schematics. Preliminary plant layouts.	Schematics revised. Plan drawings (plant areas, floor plans, reflected ceiling plans for typical rooms). Include maintenance requirements.	All finalised schematics plans and details.

3.5.2 Whole-of-life assessments

The following requirements for Whole of Life assessments are described in the sections above, and shall be included at the concept and schematic design phases as appropriate:

- Section 3.2.5—fire engineered solutions
- Section 3.2.6—maintenance and sustainability

3.6 Non-conformance declaration (fire services)

The designer is required to provide all deliverables detailed within Section 3.5 and adhere to the design principles and requirements outlined in Section 3.1 through Section 3.3.

Where the designer cannot meet these requirements, has not provided risk-assessments or whole-of-life studies, or has proposed an alternate solution, a non-conformance declaration must be prepared and submitted within the relevant design stage report.

The onus is on the designer to report any areas of non-compliance.

The following format shall be used:

Project: .....

Design phase: .....

Discipline: .....

CIR clause/requirement	Reason for non-conformance	Design report reference	Client (Y/N)
Eg 3.3.2 Automatic fire sprinklers	*Existing building, non-sprinklered*	*CDR Section 5.4*	

<< additional lines to be added as required >>

Signed:..... **Date**: .....

Name: .....

Company: .....

Client review comments: .....

.....

.....

.....

4 Hydraulics

4.1 Introduction

Hydraulic services comprise the works installed by a licensed person in accordance with the *Queensland Plumbing and Drainage Act 2018* and statutory regulations generally known as plumbing and drainage codes.

Hydraulics services comprise the following:

- sanitary drainage
- sanitary plumbing
- trade waste plumbing and drainage
- trade waste pre-treatment
- grey and black water systems
- stormwater systems including gravity or siphonic systems
- rising mains and pumps
- fixtures and fittings
- water services (hot, cold and temperature-controlled water systems) including any treatment facilities provided
- gas services (natural and LPG)
- hydrotherapy pools
- water recycling systems including RW collection and reuse systems with associated treatment systems for non-drinking water applications noted in section 4.10 - Water Storage for Reuse
- landscaping irrigation systems
- renal dialysis or RO water plant design.

Where water reuse systems are proposed, the intended use, the method of treatment for the storage water and the reticulated water supply shall be confirmed by the relevant stakeholders. The provision of reuse systems shall only be implemented on the basis of completing a detailed assessment and analysis of the risks associated with the reticulated non-drinking water. During the review process the key items of the system proposed will be documented on a checklist that can be used to record required stakeholder approvals and compliances with government regulations, codes, standards and guidelines.

4.2 Principles

4.2.1 General

The general provision of hydraulic services shall include:

- Selected materials shall be suitable for the specific characteristics of the service being installed and shall include consideration of parameters, such as temperature and concentration of wastes, corrosion, leaching, chemical attack, infection control (through disinfectant residual or other treatment procedures) and the limitation in the use of PVC.
- Fixed services and maintenance points shall be located in a manner that does not create unacceptable risk or disturbance to patients or staff—including maintenance personnel—and healthcare procedures.
- Rodding points shall be located where practicable outside of front of house areas
  - locations shall be conditional on compliance with AS/NZS 3500.2
  - design to minimise changes in direction requiring access for rodding
  - where this is not possible their location is to be considered based upon a location of least disturbance/infection risk basis
  - access shall be provided adjacent each toilet and shall not require removal of pans.
- Access panels and points shall be located with due regard to the health and safety of the personnel maintaining the equipment, where possible, such items are to be located in accessible locations such that ladders and steps use will be eliminated or kept to a minimum. Access points of particular note include isolation valves, chemical injection ports, TMVs, showerheads and aerators.
- Service elements, such as pipes, valves, fixtures, isolating valves, operating switches and alarms shall be clearly identified, labelled and accessible.
- All hydraulic services shall incorporate isolation provisions (over and above that for compliance with codes) to allow for maintenance of the various portions of systems and also facilitate future modifications or extensions. Where capped and valved take-off points are provided for future modification and extension, care shall be taken to avoid the creation of 'dead legs' that could be prone to microbial proliferation.
- Location and operation of fixtures shall suit the application and shall not cause a health risk. TMVs shall be located as close as possible to warm water outlets points.
- Fixtures and fittings shall be easily cleaned. This is particularly important for TMVs.
- Water discharge devices, such as flushing tanks and shower roses, shall be selected to enhance water conservation. Where possible the requirements of water efficient fixtures and fittings are to be incorporated into the selection process, however water use reductions should not to be incorporated where they may affect the hygienic operation of the facility. Watermark accredited fixtures only shall be used.
- All hydraulic pipework in noise sensitive areas shall be acoustically treated to avoid nuisance. Noise related issues can include:
  - structure-borne noise through the connection of the pipework to the building structure
  - noise from water movement in pipes
  - transfer of noise where pipework penetrates acoustically rated partitions.

- Where waste pipes are located in the ceiling spaces of occupied areas the waste pipes shall be acoustically separated by a construction with a Rw +Ctr rating of 30. All acoustic treatment for hydraulic services shall be in accordance with the acoustic' requirements and/or the health facility's management.

4.2.2 Redundancy and reliability

All designs for hydraulic services shall provide an adequate level of redundancy and reliability to meet objectives of the facility risk management plan, such as maintain services throughout normal utility failure.

- Subject to the site risk management plan, the redundancy of water systems should be a minimum allowance of twelve (12) hours.
- The provision of connections on critical water storage infrastructure systems to enable alternative source of water to be supplied via. water tankers.
- Assessment of Utility water infrastructure and the opportunity to provide dual water feeds from separate networks to the site. Providing the option to maintain water supply to the facility if one of the infrastructure networks is not operating due to maintenance or failure.
- On new facilities the design of new water and drainage systems shall consider increased capacity for the connection of future development to facility.
- Design shall provide:
  - isolation valves on reticulation systems to facilitate convenient isolation of specific areas while minimising disruption or reliability of supply.
  - isolation valves on reticulation systems for connection of potential future works.

4.2.3 Water quality

Water quality shall be maintained in accordance with section 4.4—Water Supplies.

Water quality monitoring points shall be considered on the main water reticulation systems within the facility. The monitoring shall interface with BMS to provide real time data and enable immediate response when an alert signal is activated.

Water treatment and monitoring equipment shall be designed by a specialist, and shall include:

- requirements for the delivery for any chemicals
- containment and clean-up of possible chemical spills
- ensure all chemical injection ports do not exacerbate pipe corrosion (e.g. design injection systems which prevent contact of concentrated, corrosive chemicals with susceptible pipe materials).

4.2.4 Infection control

Consideration shall be given to infection control requirements associated with the storage and treatment of potable water. Reference shall be made to the water risk management plan

provisions under the *Public Health Act 2005* (https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/risk-management) and the Public Health Regulation 2018.

4.2.5 Energy and resource management

Opportunities for energy efficiency within hydraulic systems shall be investigated as part of early design concept planning. Energy and water efficiency initiatives shall not compromise patient/occupant health care, nor the provision and/or quality of hydraulic services. Areas of consideration shall include:

- commercial hot water systems with solar or cogeneration contribution Solar energy as a heat source for water heating within Queensland shall be used for all facilities
- options for heat reclaim systems from other services heat rejection (i.e. mechanical services central plant) for pre-heating of hot water feed water systems and/or hot water storage
- the use of natural gas in lieu of electricity as a source of heating power
- right sizing of pumps
- the use of water efficient fixtures and fittings that are WELS rated 4 and above. Refer to recommended WELS requirements below
- the use of circulating systems with heat reclaim
- metering of all major supplies to buildings, floors and departments, to allow monitoring and tracking of any water leaks or inefficient usages.
- Heat recovery from other plant and equipment, particularly major mechanical plant, shall be investigated and applied based on whole-of-life analysis.

4.2.6 WELS rated fixtures and tapware

To achieve water efficiency and reduce water consumption the installation of high rated WELS (Water Efficiency Labelling Scheme) fixtures and tapware shall be investigated as part of early design concept planning. The use of the water efficient fixtures and tapware shall not compromise patient/occupant health care, nor the provision, operation and/or quality of hydraulic services. WELS rated products to be considered shall include:

- toilets with 4-star rating that have an average flush of 3.5 litres
- showers with 4-star rating that have flow rate of 6 litres/minute
- basins with 6-star rating that have flow rate of 4.5 litres/minute

The use of WELS rated products only applies to the above applications where the requirement for increased flows is not necessary.

4.2.7 Sanitary fixtures

Sanitary fixtures constitute a major cost component of hydraulic services and shall be selected to achieve the following criteria:

- function

- aesthetics
- durability
- vandal and breakage resistance (to the degree possible)
- clean lines
- sealed to wall and floor surfaces
- ongoing availability of parts and services.

Additional requirements and considerations follow.

4.2.7.1 Hygiene

Fixtures shall facilitate ease of cleaning and minimise the potential for holding infectious material. Cleaning costs are a major component of health facility operating costs and fixtures which are time consuming to clean add significantly to this.

4.2.7.2 Durability

In general, most domestic standard fixtures are of adequate durability for health facility applications. Exceptions to this are non-ceramic materials (such as plastic and fibreglass) where the potential for damage by cleaning with abrasives may require additional management control.

4.2.7.3 Suitability for function

The fixture must be suitable for its function. Beyond meeting the basic function, additional enhancements must be demonstrated to be necessary on a clinical need basis.

4.2.7.4 Colour

Only white fixtures (not coloured) shall be selected, noting the requirements associated with DDA and colour selections for WCs.

4.2.7.5 Manufacturer

The manufacture shall be reputable, preferably an Australian company, experienced in the manufacture and supply of healthcare facility fixtures, and have an extensive range of spares.

4.2.7.6 Cost

Where the above criteria are met, selection between alternatives shall be based on lowest capital cost.

4.3 General reticulation requirements

4.3.1 Design pressure and velocity

The design of water piping systems shall achieve 200kPa minimum static water pressure and a maximum water pressure of 500kPa.

The maximum velocity of water within pipework shall be limited to 1.5 m/s.

4.3.2 Piping reticulation

Pipe sizing shall be calculated based upon a probable simultaneous demand.

The design shall allow for domestic hot water or warm water draw off loads to all sanitary fixtures utilising an accepted diversity factor based on recommended probability of simultaneous use.

All potable water pipework should be constructed of copper.

4.3.3 Pumping systems and deep excavation

Pumping systems for sewer, stormwater and water supply shall be avoided if other means are available.

Systems, positions of risers, improved grading and other planning decisions shall be revised to eliminate the need for pumping.

Prudent design shall be exercised to avoid excessively deep drainage. Pumping may be unavoidable where the cost effectiveness of full gravity drainage is not viable.

4.4 Utilities water supplies

Maintaining a reliable supply of safe potable water is critical to the operation of a hospital facility. The management of risks associated with water supply is therefore a fundamental part of hospital design, construction and operations. Risks include:

- continuity of supply
- water quality reliability
- during normal operations
- post external or internal infrastructure maintenance event
- after an unscheduled event or disaster
- maintenance provisions, including potential for stagnant water in isolated sections of a supply system.

Web-based information sheets, found on the webpage titled *Water risk management in healthcare facilities* (https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/risk-management), shall be used to manage water quality and hazards in healthcare facilities.

The additional information provided in Section 5 Water Risk Management Plan is intended to assist designers/constructors implement the principles applied in the web-based information sheets toward the design and construction of new healthcare facilities.

4.5 Domestic cold water systems

Cold water systems should be kept at or below 20°C and should fully comply with Australian Standard and CIR requirements. Further discussion is also provided in *section 4.10—Water storage for reuse.*

The following provides guidance for design of the cold water system:

- Isolation & flushing capacity: Plumbing should be able to be isolated and flushed in reasonably-sized sub-sections of the facility. For example, if there are three large buildings on the site, each building (at minimum) should have back-flow prevention and flushing capabilities. If possible, dual-capacity isolation and flushing should be allowed within individual buildings.
- Avoid dead legs: If and where plumbing outlets are removed, the supporting pipe work that leads up to those removed (or unused) outlets is to be removed. Pipe work to be removed back to the pipe mains.
- Avoid long-lengths of low-flow pipework: Long lengths of pipe that will experience low and/or stagnant flow should be avoided. If there is pipe which does experience low flow rates, there should be automated methods installed such that pipe can be regularly flushed.
- Copper pipe preferred: It is preferred that copper pipe is used. Copper pipe is able to handle general chlorine levels up to 5 mg/L and occasional super chlorination levels that exceed 20-30 mg/L (for out-of-the-ordinary pipe cleaning). Where chlorine or other chemicals may be injected, the injection ports which contain or are placed adjacent to copper pipe must be properly protected from high-strength concentrations of chemicals. At these locations, quill inserts or other means of protecting plumbing materials must be implemented.
- Water temperature kept ≤ 20°C: Cold water plumbing infrastructure should be kept as cool as possible. Plumbing should be routed away from areas which may increase temperature such as air-conditioning/heating systems and crawl space/roof space where ambient temperature has capability to increase plumbing temperatures. If necessary, pipe insulation should be used to maintain low water temperatures.
- Pressure similitude: Water pressure in cold and hot water systems should be similar.

4.6 Domestic hot water systems

Hot water systems should be kept at or above 65°C and should fully comply with AS and CIR requirements. The following provides additional guidance for design of the hot water system:

- Isolation & flushing capacity: plumbing should be able to be isolated and flushed in reasonably-sized sub-sections of the facility. For example, if there are three large buildings on the site, each building (at minimum) should have back-flow prevention and flushing capabilities
- Avoid dead legs: if and where plumbing outlets are removed, the supporting pipe work that leads up to those removed (or unused) outlets should be removed. Pipe work should be removed back to the pipe mains as much as possible
- Avoid long-lengths of low-flow pipework: long lengths of pipe that will experience low and/or stagnant flow should be avoided. Consideration required in layout planning to avoid remote single low use fixtures. Automatic flush systems with control timer and operation monitoring to adopted. Can be part of TMV installation. If there is pipe which

does experience low flow rates, there should be automated methods installed such that pipe can be regularly flushed

- Copper pipe preferred: It is preferred that copper pipe is used. Copper pipe is able to handle general chlorine levels up to 5 mg/L and occasional super chlorination levels that exceed 20-30 mg/L (for out-of-the-ordinary pipe cleaning). Where chlorine or other chemicals may be injected, the injection ports which contain or are placed adjacent to copper pipe must be properly protected from high-strength concentrations of chemicals. At these locations, quill inserts or other means of protecting plumbing materials must be implemented
- Water temperature kept >65°C: Hot water plumbing infrastructure should be kept as hot as possible prior to thermostatic mixing valves (TMVs). Pipe insulation to be installed to maintain high water temperatures. The hot water system should be designed to occasionally reach 80°C at outlets (by intentionally bypassing TMVs and flushing water out of spigots and shower heads) if an effort to pasteurise plumbing works is ever required. Note that this type of pasteurisation exercise should only be carried out if the appropriate risk management is in place
- Install TMVs close to point of use: The use of TMVs to create warm water (less than 50°C) shall comply with the requirements of AS4032, this CIR, and other related requirements. TMVs should be located as close as possible to points of use (within 6 m) and are to be accessible for cleaning and maintenance. The temperature of water at the outlet shall be in accordance with appropriate standards and healthcare facility guidelines, with consideration of user safety.

4.7 Domestic warm water systems

A warm water system with a single TMV and loop for supplying warm water to a designated functional/operational area (such as maternity) should be avoided during the design of the hydraulic system. Warm water should be achieved by the provision of TMVs as close to outlets as possible and per the considerations of section 4.2.1.

4.8 Sanitary plumbing and drainage

4.8.1 General

Drain pipes shall be designed and installed to comply with Australian Standards and local regulations.

Gravity drain systems shall be installed wherever possible.

If pumping systems for the disposal of sewerage or effluent are installed they shall be installed in duplicate and shall be connected to the health facility standby generator power supply to operate as duty/assist/standby, with all pumps linked to the BMCS for fault. The storage volume of a pump out system shall be to relevant standards or local authority requirements, and the storage volume shall be subject to a site risk assessment.

Drain pipes shall 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

recommended that pipework is concealed and vents are interconnected in roof or ceiling spaces to reduce the number of roof penetrations.

Drainage piping must not installed within the ceiling or exposed in operating and delivery rooms, nurseries, food preparation areas, food serving facilities, food storage areas, computer centres, communications rooms, electrical cupboards and rooms—and other sensitive areas, such as pharmacy, pathology and Central Sterilising Services Department (CSSD). Where exposed overhead drainage piping in these areas is unavoidable, special provisions shall be made to protect the space below from leakage, condensation or dust particles. This is to include the use of drip trays and leak detection devices linked back to the BMS.

Waste water system access covers, inspection openings and inspection chamber covers shall not be located within high risk areas (those particularly susceptible to infection spread), within functional areas, nor pass through walls and ceiling spaces of patient rooms and treatment rooms.

Inspection and cleaning openings shall be positioned external to the building fabric. Where this is not possible, inspection and cleaning openings shall be positioned in ducts or within the wet areas it serves. Inspection and cleaning openings within ceiling spaces should be avoided. Where possible the opening is to be positioned above the flood level of adjacent fitments in order that it may be used without the risk of flooding.

Access pits suitable for cleaning and pumping out are recommended in service areas rather than cleanout openings within pipes and junctions. Access pits are recommended to be located adjacent to vehicular access. All access pits are to have bolt down double seal airtight covers.

Floor drainage grates shall not be installed in the clean area of a sterile supply unit or treatment area. It is recommended that floor drains are rationalised to an absolute minimum due to their ability to harbour bacteria.

Positive venting is preferred, however air admittance valves (AAVs) may be used based on a cost analysis and assessment of benefit to a project.

Traps, pits and tanks shall be accessible for maintenance, cleaning and pump out as appropriate without impacting on health service delivery. Traps, pits and tank inspection openings shall have gas and air-tight covers.

4.8.2 Sanitary plumbing and drainage

4.8.2.1 WC pans

WC pans shall be pedestal type with a flush-to-floor concealed trap connection and shall be suitable for disabled persons use in compliance with Australian Standards.

Only when justified by cost analyses are wall hung WC pans or wall flush back pans acceptable.

WC pans shall be provided with white open front seats (mixed sex use) where appropriate, constructed of solid section, high quality, scratch resistant thermosetting plastic with soft close hinges. Seat covers shall only be provided to WC pans located in shower rooms or bathrooms.

WC pans shall be provided with cisterns and dual flushing buttons, pads.

Concealed in-wall cisterns shall only be provided where architectural constraints demand.

Flushing valves (either tank or mains-fed) shall be subject to cost justification.

4.8.2.2 Patient and public use basins

Basins for use by patients and the public shall be selected on the basis of the total cost to install including the cost of any associated supports, vanity.

In general on stud walls patient-use basins shall be simple support vanity type with wall-mounted cocks with self-draining spout. On masonry walls, wall-hung basins may be cost effective.

Basin shall be provided with 40 mm metal chrome plated 'P' or bottle trap with in-wall waste pipe. Integral trap basins shall be not be used except in disabled persons toilets.

Supplies to taps shall be colour coded.

- Yellow: warm water 38–43.5ºC
- Blue: cold 15ºC
- Red: hot water 50ºC and above (not for use in patient care areas).

4.8.2.3 Scrub basins

Scrub basins shall only be installed where a demonstrated clinical need for scrub facilities exists.

Scrub basins shall be supported from masonry or suitably reinforced stud wall construction.

Scrub taps shall be elbow action or knee action with wall mounted self-draining spout.

Temperature controlled water shall be provided via TMV set at required delivery temperature in accordance with AS3500.4 and relevant authority requirements.

4.8.2.4 Scrub troughs

Scrub troughs shall be fabricated from stainless steel grade 302 1.2mm thick.

Scrub troughs shall be provided with single lever down cast spray elbow action taps, knee operated or sensor taps. Client request for knee-operated or sensor taps may be approved if justified. These shall be supplied from a temperature adjustable thermostatic mixer valve.

Only where clinical justification can be established shall hands free proximity switch or similarly activated sprays be provided. Where provided, such taps shall incorporate a timer and TMV temperature control and be of modular electronic design suitable for easy component replacement.

Consideration shall be given to the incorporation of modular electronic temperature control and operation, however these more sophisticated methods of control will need to be justified as part of a cost in use analysis.

4.8.2.5 Showers

Showers shall be provided with slide rail telephone-type handsets and flexible hose. Slide rails shall be 32 mm stainless steel securely fixed as a grab rail. Hoses shall extend 1800 mm

from wall mounting and terminate not less than 150 mm above the flood level of the shower floor. Handsets shall be impact resistant. White plastic hoses shall be minimum 15 mm reinforced plastic material.

Consideration shall be given to the methods of limiting stagnant water in hand sprays and the periodic sterilisation of such.

Particular attention shall be provided to sealing shower outlets effectively to a continuous waterproof membrane. The membrane which shall prevent the transmission of water via the interface between floor waste risers passing through floors.

The floor of ensuite rooms shall be graded from door of room to floor waste outlet. At an early stage of planning, incorporate a set down into concrete floor so that provision is made for graded floor.

At concept design stage of PWD bathrooms consideration of fixture orientation shall be undertaken to ensure the WC pan is not within distance of the shower rose preventing potential risk for cross-contamination of drinking water supply

4.8.2.6 Sinks

Sinks shall be constructed of stainless steel with wall-mounted taps and local isolation taps. Where appropriate, provide lever action single mixer tap rather than hot and cold sink set taps.

Sinks for domestic applications of a non-medical nature shall be standard commercial products.

Non-standard fabricated stainless steel sinks shall only be provided in kitchens or where a clinical need can be demonstrated.

Sinks shall be complete with stainless steel on plastic 50 mm waste outlets. Provide loose fitting plastic plug.

4.8.2.7 Urinals

Wall hung ceramic urinals with manual cisterns shall be used in preference to stainless steel urinals or electronic flushing devices.

Stand on grate stainless steel urinals shall not be used.

Automatic urinal flush cisterns shall not be used.

The use of water less urinals shall be considered as part of the overall water saving measures. Their incorporation shall be subject to a detailed cost in +use exercise as the replacement of fragrance inserts and additional cleaning requirements may not be viable when compared to the cost of water especially if the water is reclaimed.

4.8.2.8 Baths

Baths shall be constructed of thermoplastic and shall have wall mounted cocks.

Flow rates to baths shall allow a quick fill time (20 mm inlet outlet cocks and services shall be provided).

Cleaning regimes shall utilise non-abrasive cleaning materials.

4.8.2.9 Flow control

Water flow to showers shall be determined by flow required from selected shower outlet for 10 minute duration.

Diversity of flow shall be applied to the number of showers in the facility.

Water conservation by terminal fitting flow control is considered important to water quantities used by healthcare facilities at fixtures which provide a continuous flow, such as showers and basins. Where a filled fixture (such as bath or pot sink) is provided, the fill time shall not be increased by excessive flow control.

4.8.2.10 Isolation

Individual isolation shall be provided where the architectural layout is such that group isolation to basins is not economical.

Individual mini taps shall be used for hot and cold service flow control where required

4.8.3 Trade waste

4.8.3.1 Introduction

Wastes which are not acceptable for direct discharge to sewer mains shall be identified and a method incorporated in the design that will treat or break down the strength or temperature of the liquid waste so that compliance with.

4.8.3.2 Alternative approaches to pre-treatment

Assumptions shall not be made regarding the type and strength of liquid waste that may be generated from areas of health facilities. At scheme design stage of planning, written statements from users shall be obtained regarding the frequency, quantity and strength of liquid trade waste which may be generated

As part of the scheme design phase of the project a 'waste audit' shall be undertaken for all types of waste (solid or liquid). The audit can then be used to assist in deciding the most appropriate ways of dealing with the waste.

Options for dealing with trade waste shall be, in order of preference:

- eliminate or minimise the waste
- pre-treat the waste before discharge to sewer
- reduce the concentration of contaminants to acceptable levels
- separate the waste and have it removed from the site by other means (usually contractor).

4.8.3.3 Regulatory standards

The following shall not be disposed of to the sewerage system:

- hypodermic needles
- syringes
- instruments

- utensils swabs
- dressings
- bandages paper or plastic items
- any portions of human or animal anatomy
- infectious and solid waste subject to agreement of the regulation authority.

4.8.3.4 Grease traps

All waste pipework shall be insulated and trace heated to guard against grease deposition whilst in transit to the grease arrestor where temperatures cannot be guaranteed.

Where pre-cooked meals are produced off site and re-constituted on site the provision for grease treatment shall be adjusted in accordance with the on-site load.

Should washing up be undertaken on site and cooking off site, grease trap provisions related to 50 per cent of full load calculations shall be offered to authorities for negotiation and approval.

Grease traps shall be of the type approved for use by the local authority.

Grease traps generate corrosive fumes and the use of copper materials with grease wastes shall be avoided.

Grease traps shall 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 shall be provided above the arrestor to allow cleaning and to ensure objectionable odours do not escape into other areas of the facility.

The designer shall review in detail the grease producing facilities and assess whether small packaged under bench grease control measures are appropriate for use in the facility.

All pre-treatment waste systems, such as dilution pits, arresters and strainer baskets shall be located in the service/dirty zones of the department if the system cannot be installed externally.

The direct pumping of grease waste shall not be permitted

Where provision for pumping of the grease arrestor for maintenance purposes only, then a permanent pump-out pipe link to a disposal point shall be provided if no alternative exists.

Pumps shall be a positive displacement helical screw type.

Mobile pump arrangements provided by the cleaning service are preferred to in-house pump systems. Where practicable locating pump points above stainless steel traps should be considered.

4.8.3.5 Plaster traps

Plaster traps shall have easy access for emptying and cleaning.

Traps shall be located outside the treatment room or shall be accessible from outside the room. Servicing should be able to be carried out with minimum disruption.

4.9 Stormwater

4.9.1 General

Stormwater systems shall be designed and installed to comply with Australian Standards, Queensland Design Code, local regulations and a site specific storm water discharge assessment. Design shall be based on rainfall intensities for applicable ARI (Average Recurrence Interval) from record data provided by an authorised agency of the Australian Government i.e. Bureau of Meteorology.

A stormwater drainage system shall be designed in accordance with the local authority's requirements. The system shall collect surface water runoff, roof water discharge and convey the water discharge to an appropriate onsite or local authority system.

Stormwater is to flow through a series of pipelines and pits and gravitate to the on-site stormwater detention basin, council system, local waterway or onsite storage facility whichever is applicable to the site.

Surface water drainage lacking a fail-safe flood path is to be avoided.

Storm water drainage grates shall be cross-webbed in car parks and paths and not be located in wheel chair access areas or trolley areas.

4.9.2 Surface stormwater

The minimum design criteria for surface water collection shall be based on local and regional rainfall criteria.

The requirements for increased surface run-off in tropical areas shall be considered.

4.9.3 Stormwater detention

Where required by the local authority, a stormwater drainage system that will collect roof water and surface water runoff shall be installed in accordance with local council requirements.

The piping system shall generally be configured to cater for the 100 year storm, lesser intensities can be considered where the risk of flooding is not high i.e. canopies. The designer shall undertake a full review of the roofs and identify those that are critical before reducing the return frequency.

Under no circumstances shall the return frequency be less than 20 years.

Stormwater is to flow through a series of pipelines and pits and gravitate to an on-site stormwater detention basin. The stormwater shall then discharge into council's system for the area, waterway, or storage system.

4.9.4 Stormwater retention

Where required by the local authority, a stormwater drainage system that will collect roof water and surface water runoff in accordance with local council requirements shall be installed.

The stormwater shall flow through a series of pipelines and pits and then treated for impurities, before infiltration into in-ground absorption pits.

4.9.5 Roof drainage

4.9.5.1 General

Roof rainwater collection systems shall be designed to cater for a storm event suitable for the area of design. Particular attention shall be made to tropical areas and the requirements for increased rainwater discharge.

Roof drainage systems shall be designed to incorporate separate overflow relief discharges to minimise roof gutter overflow and consequent building damage and service interruptions. Overflows shall be in a safe but visible location.

4.9.5.2 Gutters

Methods of preventing leaf build up in gutters shall be incorporated into the design to prevent building damage and service interruption due to gutter overflow.

Box gutters shall not be used for health care facilities. Eaves gutters or fail safe design are required.

All gutters and external downpipes shall be manufactured from high grade (316) stainless steel to maximise life expectancy.

4.10 Water storage for reuse

4.10.1 General

Water storage and reuse shall comply with all local, state and federal regulations associated with water efficiency, health and safety and public health.

4.10.2 Roof water

It is not recommended that roof water be used for potable use in healthcare facilities. Where it is proposed for non-potable use (such as garden watering), it shall not be used in a way where aerosols can be generated and inhaled.

4.10.3 Grey water

Collection of shower, bath and basin waste shall be assessed with a whole-of-life costing analysis to determine if the collection of grey water is acceptable and if the local authority will allow it.

The assessment shall review the types of treatment necessary to ensure human health is not compromised.

Grey water shall not be used in a way where there is potential for aerosols to be generated.

4.11 Landscape irrigation

Landscape irrigation systems shall be avoided where possible. Planting should comprise native plants suitable for the geographical location.

Landscape contracts shall include a significant plant stabilisation period to establish self-sustaining growth.

Landscape watering, where provided, shall comprise local hose cocks with manual local controlled satellite systems.

Recycled or non-mains water shall be used for landscape irrigation where provided.

Self-activated tractor sprinklers shall be utilised for large grassed areas.

Where automatic irrigation systems are unavoidable, dripper or subsoil systems shall be provided in preference to spray systems.

4.12 Gas services

The gas service installation is to be designed and installed in accordance with relevant local authority, gas supplier/retailer, Australian Standards and guidelines.

4.12.1 Natural gas

Where natural gas is available, it shall be used in preference to LP gas.

The incoming pipeline shall be a metered service with associated regulator and located in an appropriate position on the property.

All necessary safety valves and equipment shall be provided as per standards and authority requirements, including QFES.

4.12.2 LP gas

An LPG storage tank shall be located in a safe and secure area where it is accessible to service vehicles.

The LPG tank shall have with lockable hinged steel dome cover to valve and regulator complete with hinge pins, padlock and keys.

The tank size shall ensure that the time between refilling is not less than three weeks at maximum daily load, subject to a site risk assessment necessitating greater capacity.

The tank size shall include consideration of future capacity (load growth), nominally 25 per cent.

The LPG tank shall be installed on a minimum of 100 mm thick reinforced concrete slab designed by the structural engineer to suit the ground conditions.

An 1800 mm high chain wire fence security with galvanised steel posts and galvanised steel top and bottom rails shall be provided.

Appropriate fire protection facilities shall be installed.

Kitchens shall be provided with appropriately labelled gas isolation valve/s at the main entry point for isolation in event of fire.

The LPG service and pipework shall be sized for natural gas to enable easy conversion should natural gas become available to the site in the future.

4.13 Commissioning, testing and validation

Commissioning and testing shall be provided for all hydraulic services installations in accordance with the NCC, relevant Australian Standards, Queensland Health, the HHS and any site specific requirements.

The commissioning process shall generally follow the requirements of the *AusHFG Part F 0950 - Operational Commissioning*.

Additional guidance and requirements for the testing and validation of hydraulic systems is provided in:

- CIBSE:
- Guide G: Public Health and Plumbing Engineering
- Commissioning Code W: Water Distribution
- ASHE:
- Health Facility Commissioning Handbook: Optimizing Building System Performance in New and Existing Health Care Facilities
- Health Facility Commissioning Guidelines.

4.14 Checklists

4.14.1 Documentation coordination

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
H01	Check that site and/or local authority connection points are documented for all new service lines including cold/hot/warm water, fire protection, sewer, gas and stormwater.
H02	Confirm that the capacity of the existing services have been checked to take increased loads and have certified that all connections are to local authorities requirements. Confirm the town water supply has sufficient flow, pressure and disinfectant residual, and whether additional treatment will be required to maintain microbial quality throughout the facility.
H03	Check that all hydraulic floor and site plans match architectural room layouts and civil site details.
H04	Check that all plumbing fixture locations match the architectural floor and furniture/equipment plans; that locations and details match fixture schedules on the drawings and/or specification; and that all fixtures are connected to the required supply and drainage services.
H05	Check that all plumbing fixtures have the required taps and fittings scheduled and/or specified.
H06	Ensure that isolation valves and flushing points have been added to facilitate cleaning.
H07	Check that pressure valves, thermostatic mixing valves and stop valves are consistently indicated in schedules on the drawings and/or specification. Check that access to concealed items is detailed.
H08	TMV's to be placed as close as possible (preferably within 6 m) to points of usage. Ensure that TMVs can be easily accessed for cleaning.
H09	Check that drainage requirements for floor wastes, tundishes and condensate lines for mechanical services have been documented.
H10	Check that roof stormwater drainage connections match architectural floor and roof plans and that external/paving stormwater connections match architectural, civil and landscape drawings.
H11	Check that all vent pipes are shown on the architectural roof plan and elevations.
H12	Check that all required sub-soil drainage (such as to foundation, basement and retaining walls, planter boxes) and connections to stormwater drainage system are documented.
H13	Check that all supply and drainage pipe sizes, material types and grade are noted on the drawings and match the specification.
H14	Check that all wastes, traps, droppers and drainage pipe runs in ceilings and/or bulkhead ducts have sufficient room to accommodate required falls. Check for conflicts against structural for slab/beam depths; architectural for suspended ceiling levels/ceiling framing details; mechanical for duct sizes/locations; and electrical for recessed light fitting depths.
H15	Check that vertical piping is concealed in wall chases, recesses or ducts on architectural. Check architectural for required maintenance access panels.

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
H16	Check that drainage invert levels are given and falls are adequate; that pits are located at major junctions and pit details are scheduled including lid type. Check against architectural, civil and landscaping for consistency with adjacent surface types, paving and ground levels.
H17	Check that cold water piping is protected from warm areas and/or is insulated (note, temperatures should be verified to remain below 20oC during life of system).
H18	Check that all hydraulic equipment requiring electrical connection (such as HWS and pumps) are shown on the electrical services drawings.
H19	Check that gas service has been provided to required kitchen equipment, mechanical plant. Check for consistency with architectural furniture/equipment plans and specification schedules.
H20	Check fire protection sprinkler locations with architectural ceiling layout for conflict with light fittings, AC registers. Check that all exposed pipe work is to be painted.
H21	Check that drainage has been provided for fire sprinkler control valve set.
H22	Check location of hydrants, fire hose reels, pump rooms, matches architectural. Check testing provision made for hydraulically least favourable hydrant/hose reel (drain or operable window).
H23	Check that items and notes on drawings are consistent with the specification.

4.14.2 Specification coordination

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
	Check that the final issue of drawings matches the drawing index in the specification.
	Check that items indicated in the commercial clauses are included Check that items referred to in the 'conditions of tendering', a commercial conditions section that are indicated as 'not forming part of the contract' are included elsewhere in the specification, if required to be part of the work under the contract. Check similarly that items included in the tender schedules are detailed in the technical specification sections and/or drawings.
	Check that the contract stages/phases are clearly identified and are consistent with the architectural and other disciplines' drawings.
	Check the specification section by section, item by item, against the architectural and other disciples' drawings for consistency in the indication of all items. Check for discrepancies, omissions and material that is not relevant to the contract.
	Check that all specific cross references to other portions of the specification or drawings exist and are relevant to the contract.
	Check that all non-specific references (such as 'see architectural drawings', 'see structural', 'refer to hydraulic services section', 'see notes' or 'work by others') are

Project: Document(s) reviewed:	
Item No.	**Review checklist items**
	eliminated. All cross references should be specific, i.e. to a particular note or drawing and detail or specification item. Check that the contract responsibility for all documented items is clearly specified.
	Check door and hardware schedules against the other sections of the specification and the architectural drawings for consistency in the indication of all items. In particular check for consistent indication of room names/reference numbers, door reference numbers, door types, special requirements (such as doors in smoke/fire walls, acoustic).
	Check all furniture, equipment and fittings/fixtures schedules for consistent indication of all items against the other sections of the specification and the architectural and other disciplines' drawings.
	Check that a copy of the development consent, complete with consent conditions, has been included in the specification.
	Check that all disciplines have a common requirement for O&M information and as built drawings.

4.15 Deliverables

4.15.1 Stages of design

The design shall be completed in recognised milestones, with the following requirements to be documented at each milestone:

	Concept design	Schematic design	Detailed design	Construction documentation
Reporting Requirements				
Compliance with the Queensland Health brief	Required	Required	Required	Required
Compliance with CIR	Assumed. All deviations must be raised via non-conformance submission.	Assumed, except for approved concept design deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved concept and schematic design phase deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved deviations to date. New design deviations should not occur in CD phase as all scope is already approved in DD. Deviations with detailed CIR specification requirements only will be considered. All deviations must be raised via a non-conformance submission.
Listing of codes and standards	Summary table of standards applicable	Summary table of standards applicable	Summary table in design report and detailed within draft specifications as applicable.	Required and detailed within specifications
Design process	Preliminary assessment and sizing of hydraulic services infrastructure requirements,	Refine major infrastructure requirements.	Confirm any department specific hydraulic services design requirements as part of the user group process. Ensure RDS	Prepare specification and schedules.

	Concept design	Schematic design	Detailed design	Construction documentation
	including tanks, pumps and major valve sets. Consideration of reticulation strategy to allow quantity and location of risers to be determined. Identification of required plant and riser areas for integration into building spatial planning. Coordination with civil for external/incoming infrastructure connections.	Confirm all points of connection to external infrastructure (ie. water supplies). Prepare hydraulic services schematics and preliminary plant room drawings.	capture final requirements and other special provisions. Update documentation and progress hydraulic services plan drawings. Provide confirmed plant room drawings.	Prepare final drawings—plans, schematics and all necessary details.
Redundancy and reliability	Provide site specific water risk management plan. Design per appropriate Australian Standards and any site-specific factors.	Confirm strategy for site supply redundancy and reliability, including review and validation of site specific water risk management plan. Include necessary details in schematic drawings to confirm reticulation redundancy and reliability strategies.	Reconfirm strategy and no material changes to site requirements.	Specification and drawings to include redundancy and reliability requirements per the site strategy.
Future proofing	Allow for site expansion at major infrastructure per site master plan and CIR.	Confirm and align strategy by documentation in schematics and design reports.	Confirm and align strategy by documentation in schematics, plans, design reports and draft specification.	Specification and drawings to include future proofing per approved strategy.

	Concept design	Schematic design	Detailed design	Construction documentation
Disaster management	Per the requirements of Australian Standards and site-specific factors.	Confirm and align design documentation with strategy.	Confirm and align design documentation with strategy.	Confirm and ensure design documentation captures extent of the required strategy.
Performance	Per the requirements of Australian Standards and NCC.	Per the requirements of Australian Standards and NCC.	Per the requirements of Australian Standards and NCC.	Per the requirements of Australian Standards and NCC.
Commissioning testing and post-occupancy	Not applicable at CD.	Not applicable at SD.	Preliminary requirements included in draft specifications.	Specification of testing and handover requirements. Generally, these will be per the NCC, statutory testing and local authority requirements. Ensure O&M requirements included within specification.
Maintainability	Preliminary assessment of plant and riser spatials, including requirements for maintenance.	Refined from Concept Design. Servicing access confirmed on SD drawings for plant areas. Safety in design review. Provide statement in SD report that maintainability has been included.	Detailed Design drawings to show maintenance provisions for plant areas. All valves to be accessible and not concealed in ceilings or fully enclosed. Safety in design review.	Detailed in documentation for all plant areas, risers, serviceable equipment and valves. Final design phase safety in design review.
Cost estimates (in conjunction with QS for all phases)	Provided by QS based on estimated preliminary plant requirements and area.	Confirmed by QS based on any revised design parameters.	Confirmed by the QS based on fixture counts and/or sq.m basis per department.	Confirmed by the QS based on final design requirements confirmed by the Engineer.
General coordination	General coordination including: • Provide spatial requirements for plant rooms, risers and points of access.	General coordination including: • Confirm spatial requirements. • Stakeholder liaison.	Refined requirements via User Group consultation.	General coordination including: • Safety in design.

	Concept design	Schematic design	Detailed design	Construction documentation
	• Key stakeholder liaison.	• Input to Safety in Design.	Coordination with architect for access and maintenance review. Coordination with other engineering services, particularly for points of interface (associated works).	• Coordinate maintenance requirements for inclusion in specifications. • Coordinate 'work by others' within specification documentation.
Design reports and documentation	Provide input to the concept design report. For existing buildings, this must include engineering baseline assessment and commentary. Provide site water risk management plan.	Provide input to the schematic design report. Provided preliminary specifications (if necessitated for delivery model). Updated site water risk management plan.	Provide input to the detailed design report. Provide preliminary specifications. Provide technical schedules for major plant and equipment. Confirmed and refined site water risk management plan.	Provide detailed specifications, technical schedules and associated documentation for hydraulic services.
Drawings (refer also to the Queensland Health PIR)				
Design drawings	General site plan for hydraulic services infrastructure, plantrooms and external interfaces. Not required, but a preliminary schematic can be advantageous for articulating requirements.	Schematics. Preliminary plant layouts. Identification of riser locations.	Schematics revised. Plan drawings (plant areas, floor plans). Contributions via the RDS. Include maintenance requirements.	All finalised schematics, plans and details.

4.15.2 Risk assessments and analysis

The following risk assessments are described in the requirements descriptions above, and shall be included at the concept and schematic design phases, with appropriate review and confirmation throughout the remainder of design:

- Section 4.4—Water Supplies
- Section 4.8.1—Sanitary plumbing and drainage: General
- Section 4.12.2—LP gas.

4.15.3 Whole-of-life assessments

The following requirements for Whole of Life assessments are described in the sections above, and shall be included at the concept and schematic design phases as appropriate:

- Section 3.2.5—Heat recovery systems
- Section 4.10.3—Grey water.

4.16 Non-conformance declaration (hydraulics)

The designer is required to provide all deliverables detailed within Section 4.15 and adhere to the design principles and requirements outlined in Section 4.1 through Section 4.13.

Where the designer cannot meet these requirements, has not provided risk-assessments or whole-of-life studies, or has proposed an alternate solution, a non-conformance declaration must be prepared and submitted within the relevant design stage report.

The onus is on the designer to report any areas of non-compliance.

The following format shall be used:

Project: .....

Design phase: .....

Discipline: .....

CIR clause/requirement	Reason for non-conformance	Design report reference	Client (Y/N)
Eg 4.8.2.1 WC Pans	*Existing building, selections to align with existing*	*CDR Section 5.4*	

<< additional lines to be added as required >>

Signed: ..... **Date**: .....

Name: .....

Company: .....

Client review comments: .....

.....

.....

.....

5 Water risk management plan

Engagement with the water utility at an early stage of the design process is essential. The reasons for these discussions are to determine water supply reliability, water quality, and other related issues. Therefore, discussions with the utility should include the following:

5.1 Supply reliability

The purpose for the supply reliability assessment is to determine the risk of a supply interruption locally and within the overall supply region. Issues to be evaluated should include the determination of any known risks with ageing pipework, if there is a storage reservoir in close proximity, and the water service provider (WSP) plans for mitigation of these risks. This discussion will inform decisions to be made by the design team on the need for and extent of emergency storage to be provided. It will also alert the water utility to undertake work to improve reliability at the supply location. Issues to understand include:

- expected average notification period from WSP before loss of supply: _____ hrs
- possible minimum notification warning period before loss of supply: _____ hrs
- the WSP expects that loss-of-supply events may last for up to: _____ days.

5.2 Water quality reliability

It is important for the design team to know if the WSP has a water quality management plan approved by the Department of Energy and Water Supply, and it therefore can be expected that the WSP will continuously supply water that meets or exceeds the Australian Drinking Water Guidelines (ADWG) 2011 (or latest version if superseded). The risks to be managed by understanding water quality reliability include (a) possible regular deviations from ADWG, such as when a WSP does not supply potable water and (b) instances when WSPs typically meet ADWG, but water quality conditions may expect degradation within healthcare infrastructure (potable water is not sterile or microbe-free).

ADWG is only an advisory document and Queensland WSPs must follow their own drinking water quality management plans that embody key recommendations of the ADWG. A critical water quality factor is the level of residual disinfectant (as free chlorine or chloramines) available in the supply and whether this will be sufficient to be maintained above 0.5 mg/L through the entire facility's potable water system. In order to achieve this, it is likely that approximately 2 mg/L will need to be achieved at the inlet to the building water system depending on infrastructure size and complexity.

Advice from the WSP will inform decisions by the designer on whether additional water treatment will be required. Dosage for any treatment system will be subject to testing results and local Utility provider quality management plan. All records regarding water supply quality shall be made available to designers as required to inform the risk assessment.

In addition to discussions with WSP to assess the water quality serving a site, the facility managers of existing buildings shall provide annual on-site testing result information for review to determine if further dosing/treatment measures are required. Depending on circumstances, additional treatment may include dosing additional disinfectant (e.g. dosing of sodium hypochlorite to provide free chlorine residual). Water quality and treatment specialists

should be engaged to properly interpret results from this discussion. Issues to understand include:

- what type of residual disinfectant is used by the WSP: (chlorine or chloramines)
- is the disinfectant residual to be received at the hospital >2 mg/L: (Y / N)
- will residual disinfectant be measurable at the far-lengths of the hospital system? (Y / N)
- will water be delivered off-specification to ADWG (e.g., turbidity >0.5 NTU)? (Y / N)
- will the facility manager be notified if a water quality problem occurs? (Y / N)
- does the WSP monitor for any specific microbial parameters? (type, frequency)
- what is the WSP's average & range of water temperature?___oC avg., _____ oC range.

5.3 Potable water connections

Where the WSP network allows for supply from two independent networks to the site a feed connection will be provided from each network (formerly known as Grade 1 supply). Information shall be obtained of the range of expected supply pressures, to be used in the sizing of internal supply pipelines and any booster pump systems if required.

If the above is not feasible, it is recommended that the water service is supplied from an external ring main and connected at two locations with a valve midway to maintain continuity of supply in each section of the building should maintenance be required. Connections onto supply authority mains shall allow feed from either direction of the main, allowing for isolation up or down stream of the health facility.

Water meters shall be provided for each site connection. Meters will be read by the water authority for property billing purposes. In addition to the authority meter, sub meters to monitor water consumption shall be installed on a per building basis as a minimum, with additional metering for high use systems such as kitchen, laundry, cooling towers etc. Consideration shall be made to central monitoring of meters.

5.4 Water quality

Water quality shall not cause risk to patients, who may be more susceptible to the risk of infection than the general population. Consideration of any treatment that may be required shall be based on the quality of the water received and facility-specific risk factors. It will be necessary to have water quality and water treatment design specialists included within the design team. Water quality monitoring points at the metering locations shall be included as part of design.

5.5 Water storage

The site water supply risk assessment shall review the reliability of the mains supply and evaluate whether storage tanks are required to maintain appropriate continuity of supply to site.

The design team should appreciate that the use of storage tanks may introduce additional water quality risk through increasing the time water is retained within the facility, through contact of the water surface with the atmosphere, and providing additional contact area for microbial contamination to occur. Where water consumption is critical to the delivery of health

care, this may require the use of bulk storage where mains supplies could potentially be compromised. The designer is to undertake a review of possible duration of interruptions, assess critical use requirements and provide storage as required.

Where storage tanks are required, they shall be separated into two 50 per cent compartments each capable of separate drain down and cleaning without system shut down. Entry and exit pipes shall be carefully located and mixers should be installed to ensure that stagnant water does not occur within the tanks.

5.6 Water treatment

Any water treatment systems provided should be designed for ease, flexibility and reliability of operation. This should include means for manual operations in the event of system problems and providing ports for the connection of temporary treatment/dosing systems if needed.

5.7 Summary risk assessment

Depending on the information collected above, the risk to water supply and quality within the healthcare facility could be low, medium, high, or very high as follows:

	Approximated risk levels based on parameter values			
WSP parameter and/or condition of water supply	**Low**	**Medium**	**High**	**Very high**
Notification prior to loss of supply (Risk = loss of water)	48 hrs	24-48 hrs	6-24 hrs	< 6 hrs
Length of supply loss (Risk = loss of water)	< 2 hr	2-3 hr	3-6 hr	> 6 hr
Value of chlorine or chloramines residual in supply (Risk = biofilm growth and potable water microbial regrowth)	2-4 mg/L	1-2 mg/L	0.5-1.0 mg/L	< 0.5 mg/L
Turbidity measurement value, off-specification delivery (Risk = colonisation of plumbing with microorganisms)	≤ 0.5 NTU	0.5-1.0 NTU	1.0-5.0 NTU	> 5.0 NTU
Supplied water temperature values (Risk = biofilm growth and potable water microbial regrowth)	< 20 °C	20-24 °C	24-26 °C	> 26 °C

Note that this table is provided as guidance to facility designers to interpret potential water quality risks and develop a functional water quality design that responsibly mitigates any risk if necessary. The above values may be more stringent than the requirements set by ADWG (which protects health of the general public), but the intent is for facility design to allow protection of people which may be part of more at-risk populations (such as immunosuppressed or immunocompromised patients).

6 Medical gas

6.1 Introduction

Medical gas outlets and associated pipeline systems are installed to provide a safe, convenient and cost-effective system for the provision of medical gases to clinical and nursing staff at the point-of-use. Medical gas systems include the following services:

- oxygen
- nitrous oxide
- medical breathing air
- surgical tool gas
- mixtures of medical gases
- carbon dioxide
- medical suction.

A reticulated system is preferred as it reduces the problems associated with the use of gas cylinders within the clinical space, such as safety, transport, storage and noise. Each medical gas is recommended to emanate from a central storage or generation point and reticulate to outlets throughout the health facility building(s).

Anaesthetic gas scavenging disposal systems are provided to control occupational exposure to waste anaesthetic gases and agents.

Commissioning and sign-off shall occur in the presence of a senior anaesthetist for the facility and representative of BTS as required.

6.2 Principles

The requirements noted in this section shall be followed for all new installations and refurbishment or upgrading of existing installations. It is not necessary to apply the guidance retrospectively unless patient or staff safety would be compromised. In this case, the requirements given in this section shall be followed.

Existing installations undergoing works shall be assessed for compliance with the CIR and current Australian standards and guidelines. A plan for upgrading the existing system should be prepared, taking account of the priority for patient safety.

Medical oxygen, compressed air and nitrous oxide multi-bottle storage manifolds shall be arranged in a 'duty' and 'reserve' configuration incorporating automatic change-over facility. Each manifold is recommended to include sufficient bottle storage to meet two days demand with additional bottles held in storage to meet three days or holiday period demand. All

medical gas bottle manifolds are recommended to be sited adjacent to each other in a location which facilitates ease of access for bottle delivery and pickup.

Medical gases design shall be designed for resilience and consideration shall be given to provision of ring mains for systems where possible to improve reliability of supply.

Consideration shall be given to provision of an emergency supply connection at the VIB for each inpatient unit.

Gauges and sensors shall be installed with allowance for maintenance and replacement without shut-down of medical gas systems.

A bulk emergency supply point shall be provided for all breathing gas systems including medical air and oxygen.

The provision and quantity of emergency supply shall be based on a site specific risk assessment, which shall include consideration of location, reliability of resupply and impact of loss.

Medical gases supplied from cylinder or liquid sources comply with the appropriate sections of the current edition of the Australian Code of Good Manufacturing Practice for Medicinal Products—Annex 6, Manufacture of medicinal gases

Bacteria filters should be included in medical and surgical compressor systems to reduce the risk of delivering spores or other infectious material to vulnerable patients.

6.2.1 Cross contamination risks

It is essential to ensure that there is no possibility of a cross-connection between any system and that all parts of each system to which connections can be made by users are gas-specific. In this regard testing and commissioning of systems shall prescriptively follow the requirements of the standards and guidelines.

Medical gas systems may be extended to those departments where respiratory equipment or surgical tools are serviced, such as in electronic and biomedical equipment workshops and sterile services departments .

Medical gases shall not be used to supply pathology departments, general workshops or mechanical services. These areas should be provided with separate installations. They should not be provided with medical gas terminal units.

Portable suction devices should be used in infectious disease units.

6.2.2 Medical gas purity

Medical gases supplied from cylinder or liquid sources comply with the appropriate sections of the current edition of the Australian Code of Good Manufacturing Practice for Medicinal Products—Annex 6, Manufacture of medicinal gases.

Bacteria filters should be included in medical and surgical compressor systems to reduce the risk of delivering spores or other infectious material to vulnerable patients.

Micro-organisms can penetrate a bacteria filter if the material is wet. Therefore, it is essential that the dryness of the medical air supplied to a bacteria filter is checked regularly (at least every three months) at the test point.

6.3 Requirements

6.3.1 General

The design of all medical gas supplies shall be per the Australian standards for either generating plant, bottled or bulk liquid systems.

Gas consumption shall be estimated as normal average consumption.

The time taken to obtain an alternative source of supply for a medical gas shall be estimated on a worst case basis, i.e. as occurring late at night, on holidays or weekends. This shall include site specific consideration of disaster impacts (floods, cyclones) etc impacting on gases delivery and service.

The types, capacities and locations of primary and reserve sources of supply shall be based on both system design parameters and the need for supply security, identified by a risk assessment during the planning stage. Security of medical air supplies is a critical requirement. Total electrical failure shall not be allowed to jeopardise supplies and all medical air systems must be supported by an appropriate fully automatic manifold.

6.3.2 Oxygen systems

6.3.2.1 Oxygen demand

When designing or reviewing an installation to supply medical oxygen to a healthcare facility, the most appropriate method of supplying the gas shall be determined by the potential size and variability of the facility medical oxygen demand.

To determine the most suitable and cost-effective method of supplying medical oxygen and the appropriate size of the installation, comprehensive demand figures shall be provided to the designer. These demand figures should be based on:

- the current average daily gas usage based on the past 12 months' supplies
- the maximum potential daily demand volumes based on peak flow conditions, as below
- any planned extensions to the health facility/pipeline that may affect the demand
- the expected natural annual growth in the use of medical oxygen.

The maximum potential daily demand shall be based on the peak flow conditions measured between 8 am and 6 pm, with all operating rooms in use and with maximum demand being provided to pipeline outlets. It shall not be based on the theoretical pipeline design flow conditions.

Where actual flow monitoring is impracticable, daily cylinder or liquid consumption figures shall be used.

Historic consumption records shall be reviewed to assess the current usage and the natural growth of the medical oxygen demand. The growth predictions shall consider any planned extensions to the health facility or pipeline systems and changes in clinical practices in the health facility that could affect the medical oxygen demand.

For new health facilities, where no historic information is available, the estimated demand shall be based on the proposed size and type of the health facility and the usage figures of the facilities being provided. A guide to oxygen flows based on bed numbers is shown in UK *Health*

Technical Memorandum 02-01: Medical gas pipeline systems Part A: Design, installation, validation and verification. The final design of gas piping and outlets shall comply with AS 2896 Appendix B, as a minimum.

6.3.3 Medical breathing air

The compressors shall be suitable for continuous running on load and for high frequency start/stop operation.

Compressors shall be selected to maximise energy efficiency. The efficiency of plant, expressed as the volume of air delivered to the pipeline distribution system (after losses in the drying system and filtration system) per kilowatt-hour (kWh), should be stated by the supplier of the system.

Dewpoint shall be less than the minimum recorded ambient temperature or a maximum of 5°C whichever is drier, at pipeline pressure.

6.3.4 Surgical tool air

The central supply system for surgical tool air shall supply air of a minimum purity as specified in AS 2568 and a water content of not more than 60 ppm.

Cylinder supply systems for medical tool air shall be provided in accordance with Clause 2.4 and 2.9.3 of AS 2896 with at least four hour capacity under average use.

6.3.5 Medical Suction

Vacuum pumps must be dry type.

Gas scavenge may be connected to vacuum systems. Scavenge outlets must be separately identified in accordance with AS 2896.

Suction systems must be able to be isolated at all floor take-offs without disrupting other areas.

Allowance must be included for installation of biological filters at each riser cupboard to limit contamination of the main pipework system.

6.3.6 Nitrous oxide

The risk of chronic exposure to nitrous oxide shall be reviewed as part of design of any scavenge system.

6.3.7 Sizing information

Sufficient cylinders for changing one complete bank shall 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 shall be held in the medical gas store to ensure continuous supply for one week or greater, subject to site risk and supply assessment.

6.3.7.1 Air receivers

Receiver capacity shall be such that each compressor starts less than 10 times per hour during normal working conditions.

6.3.8 Pipeline distribution

6.3.8.1 Pipeline design—general

The pipeline system shall be designed so that the flows given in AS 2896 can be achieved at each terminal unit: the flows are expressed in free air.

Diversified flows shall be used for the purposes of pipe size selection.

The overall pipeline design shall be based on a five per cent pressure drop from the plant/source of supply to that measured at the terminal unit outlet at the specified test flows.

Size of piping to all areas shall be calculated from the design flow.

Pipework and terminal units shall be arranged in such a manner that the service can be expanded as required without major alterations to the building being necessary (i.e. within dedicated medical gas risers/ducts).

Spare capacity:

- All riser pipe sizing shall allow for a 25 per cent additional capacity in medical gas flow to the furthest point served.
- All connections from the riser (ie. per floor) shall be sized to accommodate an additional 25 per cent medical gas flow above the calculated design requirements.
- Pipework from the riser to the first Isolation Valve Box (IVB) on each branch after the riser shall be sized for an additional 25 per cent flow to the requirements of the branch.

6.3.8.2 Surgical tool air design

The design of pipework and systems for surgical tool air shall allow continuous use of tools for a period of up to three minutes.

The surgical tool air receiver shall be sufficiently sized to accommodate flow for all theatres and procedure rooms, based on diversification of flows as per AS 2896.

The starts per hour of tool air compressors shall be carefully considered where tool air plant is provided in lieu of bottled supply.

6.3.8.3 Pipeline identification

Medical gas pipelines shall be identified at all junctions, terminations (such as at the rear of outlet fittings), control points, on both sides of bulkheads and wall penetrations and at intervals not exceeding 3 m throughout their length.

6.3.8.4 Pipeline Installation

Medical gas piping shall be kept away from areas where they may be subject to any of the following:

- mechanical damage
- chemical damage
- excessive heat
- splashing, dripping or permanent contact with oil, grease or bituminous compounds, electrical sparks.

Exposed pipelines shall not be installed in lift shafts, kitchens, laundries, boiler plant rooms, generator rooms, incinerator rooms, storage rooms designed to house combustible materials, or in any other fire-risk areas.

Where pipelines in hazardous areas are unavoidable, they shall be enclosed in non-combustible, non-corrosive materials that have no electrolytic reaction with copper in order to prevent the possibility of the liberation of gases into the room in the event of pipeline failure.

Medical gas pipelines shall be routed away from natural gas pipelines where there is a potential for a flammable gas mixture to accumulate in the case of a leak.

Where pipelines are run in enclosed ducts with other services such as water supply systems, they shall be inspected regularly as corrosion can occur as a result of chloride deposits following leakage.

Pipework shall not be run in enclosed ducts with other services where they cannot be inspected.

Internal pipelines should be suitably protected where there is a possibility of physical damage, for example from the passage of trolleys, tugs.

External pipe runs shall be avoided when possible. Where external runs are necessary, they shall be protected as follows:

- On external vertical surfaces up to the maximum height of exposure to possible damage (for example vehicular movement): by means of galvanised, profile-section steel of sufficient thickness to afford adequate protection. The protection should cover the entire space taken up by the pipeline(s) but stand off the surface such that the pipes can be inspected visually (The armour should be readily detachable to permit more detailed inspection).
- When crossing horizontal surfaces, roofs: similar protection to (a) above should be provided to withstand ‘stepping’ damage using profiled section, as above.

Pipework shall be protected from lightning strikes.

Underground pipelines shall be run in properly drained ducts not less than 450 millimetres x 450 millimetres which have removable covers.

Where it is not possible to provide removable covers, two full sized pipes shall be run in separate trenches with valves provided in a convenient location at either end. The separation distance between the two trenches should be not less than two metres.

The route of any underground pipeline should be identified on the surface and should be clearly shown on site layout drawings.

Pipelines concealed within walls shall have their route clearly shown on ‘as-built’ drawings.

Pipelines need further protection in certain circumstances as follows:

- where pipes pass through walls, partitions or floors, they should be provided with sleeves of copper pipe (with fire stopping)
- where exposed to general view, be provided with appropriate wall or ceiling plates.

6.4 Checklists

The following checklists are to assist designers in providing necessary input to Queensland Health throughout the design process. The checklists are not exhaustive and additional checks, design and reporting may be required. The designer shall apply professional judgement regarding additional information to be provided.

The following checklists are for the designer's reference and are not intended to be submitted for verification by Queensland Health.

6.4.1 Schematic design

Project:	
General	
	Carry out on-going checks for compliance with regulations.
	Monitor compliance of the developing design with the project brief.
	Confirm design criteria, scope and extent of medical gas and other public health services.
	Update recommendations to Queensland Health for their development of an operating and maintenance strategy.
	Carry out initial overall spatial co-ordination.
	Provide information for RDS, where these are used.
	Project-wide design review to signal end of technical design stage.
	Identify client requirements which will necessitate design input from a specialist designer, sub-contractor or supplier, and the timing of their appointment.
	Define the essential performance requirements of systems. This may involve establishing numerical criteria for the nominal capacities of plant, the range of operating duties anticipated and consideration of the requirements for submitting samples and prototypes.
	Advise of significant allowances or constraints incorporated in the main design that may affect the specialist design.
	Obtain indicative quotations for plant not requiring specialist design.
Medical gas design	
	Determine main duct and pipe routes around floors to and from risers.
	Determine approximate plant capacities, terminal sizes and locations, valve sizes and locations, vacuum pump sizes, locations and sizes of ancillary equipment (such as receivers, pressure vessels).
	Establish capacity of bulk gas facilities such as oxygen vessels, carbon dioxide vessels and verify anticipated delivery schedules and health facility demand usage.
	Calculate maximum demand for all gases, compressed air and vacuum systems.
	Determine main pipe and drain routes around floors to and from risers.
	Confirm main below-ground routes and manhole locations.
	Design review

Project:	
Commissioning	
	Review commissioning requirements.
Deliverables	
	Prepare a report on building services issues as part of the technical design report.
	Prepare or revise risk assessments for the design.
	Prepare an initial schedule of cast-in/formed builders work openings that are structurally significant.
	Support development of a cost plan for medical gas services.
	Prepare detailed schematic drawings.
	Prepare technical design drawings to convey spatial allocations in risers and floor/ceiling voids.
	Sign-off the technical design report.

6.4.2 Design development

Project:	
	Carry out on-going checks for compliance with regulations.
	Monitor compliance of the developing design with the design philosophies.
	Team-wide design review to signal end of design development stage.
	Confirm primary design criteria for mechanical systems.
	Finalise plant and riser sizes for medical gas systems and plant room locations/sizes.
	Prepare drawings for design.
	Update schematic drawings for design.
	Provide programme information on design and construction issues.
	Prepare a report on medical gas services issues as part of the design development report.
	Sign-off the design development report.
	Prepare performance specifications if required by procurement strategy.

6.4.3 Contract documentation

Project:	
	Advise on an appropriate method of procuring maintenance expertise.
	Define the scope and content of operating and maintenance manuals appropriate for the project.
	Define the requirement for record drawings.
	Specify form of delivery and the method of production of record drawings.

Project:	
	Define what level of documentation, commissioning results and other information must be available prior to practical completion and handover. (Take into account possible implications of phased handover and partial possession.)
	Prepare method statement (prior to commencement of works) for the maintenance of existing services.
	Check the provision for and adequacy of the preliminary builder's work information previously issued by others.
	Confirm builder's work information for specified equipment or materials, or where alternatives to those provisionally or pre-selected are agreed.
	Co-ordinate requirements for all access platforms, stairs, rails and protection elements required for future maintenance and operation of plant/equipment.
	Detail all fire stopping requirements.
	Design weatherproofing details for all services passing through external elements of the building.
	Carry out spatial co-ordination associated with major spaces: plantrooms, risers, depths of ceiling and floor voids.
	Carry out final detailed spatial co-ordination between the building services and the structure/architecture.
	Carry out final detailed design calculations for all remaining services in accordance with recognised national standards.
	Determine detailed pipe sizes and routes.
	Carry out detailed design of pipework gradients for builders' work and coordination, including waste drainage and condensate runs.
	Carry out detailed design of anchors, guides and other provision for movement of services and systems due to thermal expansion and contraction and building movement.
	Modify distribution systems and equipment capacities as may be required as a result of final detailed spatial co-ordination.
	Coordinate the requirements for medical services panels with all other services and the architect
	Coordinate the location of all medical gas outlets, valve isolation boxes, alarm panels and other visible services with the architect and all other services.
	Size, select and determine final locations of commissioning sets based on the final equipment selection and co-ordinated installation drawings.
	Specify final location of access panels.
	Carry out final detailing of drain and vent points.
	Carry out final selection of all terminal devices.
	Select and confirm location of control and isolation valves, to achieve the specified function and to suit the characteristics of items served and final system configurations as based on the final equipment selection and co-ordinated installation drawings.
	Carry out final selection of all anti-vibration mountings.
	Design review.

Project:	
	Identify and incorporate into system designs the essential components and features necessary to enable the proper preparation and commissioning of building services.
	Review all designs to ensure that systems are commissionable.
	Where required appoint an independent specialist commissioning contractor responsible for testing and commissioning.
	Prepare detailed design drawings.
	Produce builders work information.
	Produce materials and workmanship specifications.
	Produce equipment schedules.
	Review that all plant and equipment incorporated into the works can be safely maintained in compliance with current legislation.
	Provide input to the detailed cost plan.
	Prepare co-ordinated for construction drawings.
	Produce a commissioning specification.

6.5 Deliverables

6.5.1 Stages of design

The design shall be completed in recognised milestones, with the following requirements to be documented at each milestone:

	Concept design	Schematic design	Detailed design	Construction documentation
Reporting requirements				
Compliance with the Queensland Health brief	Required.	Required.	Required.	Required.
Compliance with CIR	Assumed. All deviations must be raised via non-conformance submission.	Assumed, except for approved Concept Design deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved concept and schematic design phase deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved deviations to date. New design deviations should not occur in CD phase as all scope is already approved in DD. Deviations with detailed CIR specification requirements only will be considered. All deviations must be raised via a non-conformance submission.
Listing of codes and standards	Summary table of standards applicable.	Summary table of standards applicable.	Summary table in design report and detailed within draft specifications as applicable.	Required and detailed within specifications.
Design process	Preliminary assessment of anticipated medical gas usage and sizing of plant/bottles. Includes confirming normal external supply	Refine gas usage based on further information regarding departments.	Confirm any department specific requirements as part of the user group process. Ensure RDS capture final requirements for	Specification to include medical gas design as refined during the design process.

	Concept design	Schematic design	Detailed design	Construction documentation
	periods applicable for calculation of emergency supplies. Consideration of reticulation strategy to allow quantity and location of risers to be determined. Identification of required plant and riser areas for integration into building spatial planning.	Prepare medical gas schematics and preliminary plant room drawings.	outlets or other special provisions. Update documentation and progress medical gas plan drawings. Provide confirmed plant room drawings.	Prepare final drawings—plans and schematics.
Redundancy and reliability	Per appropriate Australian Standards and any site-specific factors.	Confirm strategy for site supply redundancy and reliability. Prepare schematic drawings to confirm reticulation redundancy and reliability strategies.	Reconfirm strategy and no material changes to site requirements.	Specification and drawings to include medical gas design inclusive of discussion of redundancy and reliability requirements and strategy.
Future proofing	Overarching strategy to be discussed and incorporated into medical gas strategy from the Concept Design Stage.	Confirm and align strategy by documentation in schematics and design reports.	Confirm and align strategy by documentation in schematics, plans, design reports and draft specification	Specification and drawings to include future proofing per approved strategy.
Disaster management	Per the requirements of Australian Standards and site-specific factors.	Confirm and align design documentation with strategy.	Confirm and align design documentation with strategy.	Confirm and ensure design documentation captures extent of the required strategy.
Performance	Per the requirements of Australian Standards.	Per the requirements of Australian Standards.	Per the requirements of Australian Standards or as amended through the User Group process.	Documented per the final approval requirements from Australia Standards or as varied by approval through the User Group process.

	Concept design	Schematic design	Detailed design	Construction documentation
Commissioning testing and post-occupancy	Not applicable at CD	Not applicable at SD	Preliminary requirements included in draft specifications.	Specification of testing and handover requirements. Generally, these will be per the Australian Standards for medical gases. Ensure O&M requirements included within specification.
Maintainability	Locations for plant must consider access for bottle exchange (singles or man-pack as appropriate), VIE access and potential for replacement of medical gases plant and equipment including receivers.	Refined from Concept Design. Servicing access confirmed on SD drawings for plant areas. Safety in design review. Provide statement in SD report that maintainability has been included.	Detailed design drawings to show maintenance provisions for plant areas. All valves to be accessible and not concealed in ceilings or enclosed. Safety in design review.	Detailed in documentation for all plant areas, risers, serviceable equipment or elements (i.e. filters) and valves. Final design phase safety in design review.
Cost estimates (in conjunction with QS for all phases)	Provided by QS based on estimated preliminary plant requirements and outlet counts.	Confirmed by QS based on any revised design parameters.	Confirmed by the QS based on outlet counts and/or sq.m basis per department.	Confirmed by the QS based on final design requirements confirmed by the engineer.
General coordination	General coordination including: • Provide spatial requirements for plant rooms, risers and points of access. • Key stakeholder liaison. • Input to risk and reliability assessments.	General coordination including: • Confirm spatial requirements. • Stakeholder liaison. • Input to safety in design.	Refined requirements via user group consultation. Coordination with architect for access and maintenance review. Coordination with other engineering services, particularly for points of interface (associated works).	General coordination including: • Safety in design. • Coordinate maintenance requirements for inclusion in specifications. • Coordinate 'work by others' within specification documentation.

	Concept design	Schematic design	Detailed design	Construction documentation
Design reports and documentation	Provide input to the concept design report. For existing buildings, this must include engineering baseline assessment and commentary.	Provide input to the schematic design report. Provided preliminary specifications (if necessitated for delivery model).	Provide input to the detailed design report. Provide preliminary specifications. Provide technical schedules for major plant and equipment.	Provide detailed specifications, technical schedules and associated documentation for medical gas services.
Drawings (refer also to the Queensland Health PIR)				
Design drawings	Not required, but a preliminary schematic can be advantageous for articulating requirements.	Schematics Preliminary plant layouts.	Schematics revised. Plan drawings (plant areas, gas outlets, reticulation paths, riser details etc). Include maintenance requirements.	All finalised schematics, plans and details.

6.5.2 Risk assessments

The following risk assessments are described in the sections above, and shall be included at the Concept and schematic design Phases:

- Sections 3.2 and 3.3.1—Site-specific risk assessment (reliability of supply).

6.6 Non-conformance declaration (medical gas)

The designer is required to provide all deliverables detailed within Section 6.5 and adhere to the design principles and requirements outlined in Section 6.1 through Section 6.3.

Where the designer cannot meet these requirements, has not provided risk-assessments or whole-of-life studies, or has proposed an alternate solution, a non-conformance declaration must be prepared and submitted within the relevant design stage report.

The onus is on the designer to report any areas of non-compliance.

The following format shall be used:

Project: .....

Design phase: .....

Discipline: .....

CIR clause/requirement	Reason for non-conformance	Design report reference	Client (Y/N)
Eg 6.3.2.1 Oxygen demand	*'light touch' refurbishment only.*	*CDR Section 10.7*	

<< additional lines to be added as required >>

Signed:..... **Date**: .....

Name: .....

Company: .....

Client review comments: .....

.....

.....

7 Security

7.1 Introduction

The purpose of security services within healthcare facilities is to provide a secure environment to ensure:

- safety for all staff, patients and public
- the ongoing operation of the facility and equipment is not compromised by theft or damage.

Early completion of a security risk assessment is essential so that the necessary security measures can be incorporated into the building design for greater effect and cost efficiency. For example, cabling for security equipment often requires access conduit through floors and walls that are fire rated. A security risk assessment shall therefore be conducted for all new facilities and all existing facility expansions, extensions or redevelopments.

Special consideration shall be given to areas that are classified or where confidential patient information, drugs, cash and vital attractive property are stored or handled.

7.2 Principles

7.2.1 Risk management

To implement an effective security program, a realistic assessment should be made of the potential threats, vulnerabilities and risks that need to be managed for any given facility. WHS legislation requires that all risks, including violence must be identified, assessed, eliminated or controlled.

Security risks in healthcare facilities can arise from two main sources:

- internal security risks, such as staff, client and visitor related
- external risks, such as those who enter the premises/grounds with criminal intent — thieves, vandals and those who plan to commit criminal acts.

Effective planning and design are required to minimise and where possible, eliminate foreseeable risks associated with health facility design.

Areas of potential risk shall be identified from consultation with employees, risk managers, the WHS personnel, security personnel and the Police local area command crime prevention officer. This coordination should occur during the preparation of the project feasibility plan and the project definition plan to ensure all issues are adequately addressed and funded.

Refer to:

- AS/NZS ISO 31000 Risk management—principles and guidelines
- ISO/IEC 31010 Risk management—risk assessment techniques.

7.2.2 Crime prevention through environmental design principles

Crime prevention through environmental design (CPTED) is a situational crime prevention strategy that focuses on the design, planning and structure of cities and neighbourhoods. It aims to reduce opportunities for crime by employing design and place management principles that minimise the likelihood of essential crime ingredients from intersecting in time and space.

The CPTED design principles shall be adhered to in the design of healthcare facilities including:

- 'Territorial reinforcement' stimulates community ownership and policing. It includes maintaining the space so that it has a clean and well cared for appearance, using actual and symbolic territorial markers, such as signage and site maps and the location of activities to avoid conflict.
- 'Surveillance' is achieved through supervision by those who overlook or pass through spaces. It includes effective sightlines between public and private space, effective use of lighting and paths to group people, landscaping, strategic positioning of buildings and activities and use of CCTV.
- 'Access control' through physical and symbolic barriers that attract, channel or restrict pedestrian and vehicle movement, such as paths, roads, fences, lines of lighting, signs, gardens, gates, locks and doors. Making it clear where people can and can't go makes it more difficult for criminals to reach potential victims and targets.
- 'Space management' is linked to territorial reinforcement. It ensures that space is well used and maintained, such as by coordination of activity and rapidly repairing vandalism or graffiti.

7.2.3 Security and privacy

The design of security systems for healthcare facilities shall include respect for patient privacy. The storage, collection and use of CCTV data is subject to compliance with federal and state privacy legislation and Queensland Health policies.

CCTV shall not be provided in bathrooms, change rooms or areas where privacy would normally be expected, except where required for specific clinical needs and with appropriate signage.

Where it is necessary to provide CCTV with potential to compromise privacy and respect for patent dignity this shall only be for clinical monitoring and shall not be a recorded feed.

7.3 Internal security risks and requirements

7.3.1 Introduction

When designing healthcare facilities, designers shall consider security for 'high risk' areas, such as:

- mental health inpatient units
- EDs
- drug and alcohol units
- methadone clinics
- ICU/HDU units
- community mental health centres
- paediatric units
- aged care units
- brain injury and rehabilitation units
- child protection units
- maternity units
- pharmacy
- locations where staff may work alone in isolation.

Consideration must be given to the:

- perimeter security (doors and windows, entrances, property perimeter, fences and access control)
- control of access to the buildings and rooms
- cash handling and transit routes
- location of shops and banking facilities
- avoidance of areas where staff work alone or in isolation
- location and design of car parks
- location, design and lighting of access routes to car parks, bus stops
- provision of duress alarms, intruder alarms, proximity alarms and CCTV
- designs for reception areas
- designs for consultation rooms, treatment rooms and waiting rooms
- safe transit routes between units and buildings, such as any routes that may be traversed in the course of patient treatment or transfer, or in the process of duress response.

7.3.2 Stores and loading docks

Goods delivery, loading and unloading areas should be well lit, protected from the weather.

Stores area and loading docks should be located as far as practical away from public areas and car parks. Restrict entry/exit to the store to only one door that can be visually

monitored from the supply officer's office. Fire exit doors should only be able to be opened from the inside and the area should be alarmed.

Ensure stock is held in secured areas that are not easily accessible to patients and unauthorised staff. Where possible, inpatient unit stores should be locked and accessible only to the nurse or unit manager or their delegate. Consider using closed circuit televisions (CCTV) cameras and access controlled doors in these areas.

7.3.3 Emergency department

EDs are a high security risk area in health facilities, mainly since they are the first department where patients present for treatment and where some patients and visitors become agitated and aggressive. Duress alarms must be provided—fixed alarms for counter staff and mobile duress alarms for staff who do not work in a fixed location. Emergency waiting areas should be fully visible to the staff station.

CCTV camera surveillance should be provided in:

- waiting areas
- main entrance
- ambulance entrance
- camera surveillance is also recommended to be considered for any rooms used for mental health assessments or for behaviourally disturbed patients
- EDs should be designed to allow secure separation of treatment areas from public areas. Security barriers may include glass fronted counters for reception staff and access controlled doors
- nurse call buttons must be provided in public toilets serving EDs.

7.3.4 Pharmacy security

Security control measures and processes taken to prevent any unauthorised entry to the pharmacies and unauthorised access to pharmaceuticals should be designed in accordance with 'defence in depth principles'.

While the following security measures are designed primarily for pharmacies, their application is equally relevant to any area where pharmaceuticals and particularly drugs and other controlled substances are held (such as satellite pharmacies, drug trolleys, inpatient unit areas).

The following security control measures should be considered when designing or refurbishing areas used by pharmacies:

- construct walls, floor and ceilings of the pharmacy, out of solid or reinforced materials
- extend walls, where practicable to the underside of the floor slab above to prevent any intrusion over the wall or through the ceiling space

- reinforce all windows on the perimeter walls to prevent entry; existing windows may be reinforced with shatter resistant film or by replacing the glass with laminated glass or the use of security grilles
- incorporate a laminated glass screen into the design of the dispensing area, to enable staff to carry out dispensing operations with safety, while maintaining communications with staff and patients
- design a two door entry approach (i.e. one door for the public and health facility staff to access the dispensing window and a separate door for the entry of pharmacy staff to pharmacy areas)
- incorporating the provision for closing off dispensing areas of the pharmacy when closed, (such as a locked door from the corridor or roller shutter)
- fitting doors to the pharmacy with quality single cylinder locks to comply with fire regulations and electronic access control readers, with an internal door handle to enable occupants to escape in the event of an emergency
- install an intruder security alarm system that meets Australian Standard AS2201 and incorporates a duress alarms to enable staff to activate the alarm in the event of an emergency
- restricting and monitoring access to the pharmacy by:
  - using electronically access controlled doors, restricting entry to unauthorised persons
  - having a restricted keying system fitted to the locks in order to prevent duplication of keys
  - strictly regulating the issue of keys and access cards, including provision for after-hours access
  - keeping doors closed and locked to restrict entry.
- CCTV cameras to monitor access doors, to screen entry of personnel and record any access to the pharmacy after hours
- CCTV cameras to monitor the dispensing counter
- drug safes should be secured in drug rooms with access control card readers.

The person in charge of the pharmacy service is responsible for the control of drugs and pharmaceuticals. This person is to ensure that, in consultation with the pharmacy staff, members of other relevant disciplines, facility management, written policies and procedures are developed for the secure handling of all pharmaceuticals and general access into the pharmacy areas.

All pharmaceuticals should be stored in appropriately controlled conditions which are secure and safe and where only authorised personnel have access.

Schedule 8 substances can only be accessed by a pharmacist or other authorised staff member. All Schedule 8 and Schedule 4 drugs of accountability are to be stored in safes of certain specifications and secured in accordance with statutory requirements.

Drugs dispensed for individual patients should be stored in medication trolleys or other suitable equipment which is always kept locked and stored in an area which is not accessible by members of the public. All inpatient unit drugs shall be kept in a drug wall safe and the key held by an authorised person.

7.3.5 Paediatric and maternity units

Video intercom and/or CCTV cameras should be considered at entrance points and should have the following features:

- show clear facial features of persons entering the area
- include an intercom system to communicate with those who intend to enter
- provide a remote release button to open the door
- adequately cover hidden areas
- camera protected and discrete.

CCTV cameras should be recorded and monitored by licensed security officers in a secure location, monitors must not be in view of the general public. The necessary duress responses will be coordinated between the security staff and with staff working in the vicinity of duress alarm.

The provision of CCTV cameras at entry points is recommended.

Duress alarms should be provided in accordance with any requirements by Queensland Health including patient absconding/removal alarms. Refer also to the paediatric and maternity HPU security checklists.

7.3.6 Carparking

A vehicle control and space allocation plan should be developed. Access control and authorised vehicle identification measures should be implemented. A label or decal may be used to identify authorised vehicles.

Facilities should investigate through local councils the options available to control illegal parking i.e. restricted parking schemes. Security control measures, such as access control. CCTV cameras, boom gates and ticket vending and validation machines should be considered.

Traffic flow numbers and road usage should be investigated to optimise directional traffic movement, separate entry and exit points should be considered where possible. Car park layouts and allocations should always consider the shift workers and visiting medical officers.

Road use and design must also make provisions for emergency vehicles and restricted parking spaces should be allocated for emergency services and other authorised vehicles, such as ambulances, fire engines and police vehicles.

Staff and visitor parking should be kept separate. Staff parking should be provided under or within close range of the workplace. The parking area should be well lit and protected from the elements.

Risk control strategies to be considered include:

- provide, where practicable, afternoon and night shift staff with designated, controlled parking spaces as close as possible to the facility in a well-lit, easily observed area connected to the facility by well-lit paths
- ensure vehicle entry to car parks is by automated gates or doors, via camera and intercom, or by passing through an entry/exit gate staffed by security personnel
- display signs in car parks reinforcing theft awareness (such as park smarter, lock it or lose it)
- display signs that advise that regular security patrols are undertaken and that 24-hour CCTV camera monitoring is in place
- ensure the carpark design and associated landscaping is done in a way to provide minimal protection for intruders such as dark spots or hiding places.

Ensure single and multi-storey car parks have:

- good car parking lighting (refer to Australian Standard 1158.3.1 and 1680). In this regard provide lighting sufficient to allow facial recognition. Design car park so that dark spots and hiding places are minimised
- emergency help buttons or intercoms direct to security staff or switchboard
- landscaping which leaves the area open and does not intrude the line of sight
- flexibility to close some entrances and exits during low traffic periods
- approved locks on exits intended for emergency exit only
- frequent patrols by security staff
- restrict the parking of delivery vehicles to designated spaces
- ensure health service pool vehicles are parked in a secure overnight car park with good lighting and regular security patrols. A fenced compound or lock-up garage area is preferable
- provide security for bicycles and motorcycles (i.e. storage areas).

7.3.7 Reception and waiting rooms

Reception and waiting areas should be easily identifiable and accessible to patients and visitors. The design and layout should provide reception staff with a clear view of all persons in the waiting area. The activities of clinical staff should not be visible from the waiting rooms or reception areas.

Reception areas should be spacious and quiet with comfortable seating. Seating should be a bench type and secured to the floor. Public telephones should be provided to enable ready communication with friends and relatives.

Furniture should be attractive and comfortable but should be selected regarding its safeness and the possibility that it may be used as a weapon. Colour is an important factor and should be selected for its calming, rather than stimulating, qualities.

Seating should be spaced to allow room for baby strollers, wheelchairs and mobility aids. To reduce the incidence of vandalism or client frustration, waiting areas should be clean and well-maintained with all fittings in working order. Bariatric seating may be required, and advice should be sought from the Queensland Health project representative.

Climate control will help maintain a comfortable and calming environment. Easy access to amenities, such as phones, water and snack dispensers and public toilets is important to enhance comfort and reduce stress levels.

Reception counters should be designed to enhance the security of staff but maintain the ability to interact with public as appropriate.

7.3.8 Treatment and interview rooms

Separate sound insulated rooms shall be provided to isolate distraught or emotionally disturbed patients, families or friends; people with acute behavioural disturbance; and intoxicated or very noisy people.

All treatment rooms, interview, consultation and meeting rooms that may be used by patients (of any kind) shall have:

- preferably two doors on different walls to reduce risk of staff entrapment
- duress alarm
- if two doors are not feasible, the desk or staff seating position shall enable staff to escape the room directly
- a fitout configuration such that the staff member doesn't sit with their back to the patient while using a computer
- glass observation panels on at least one door to allow casual observation by work colleagues.

7.3.9 Medical gases

Ensure access to any gases storage areas is restricted by use of doors, barriers and signs. All types of gases must be secured against unauthorised removal, tampering, vandalism and misuse.

7.4 Physical security provisions

7.4.1 Access control and intruder detection

7.4.1.1 Access control

An access control system provides a means to control access through nominated doors fitted with locking devices and access control readers for electronic locking. Access control incorporates:

- key locks
- electronic locks.

When designing access control systems it is imperative that all key stakeholders are consulted and that all reasonably foreseeable security risks associated with access to workplaces are identified.

Effective access control involves:

- securing perimeters, doors and vulnerable areas
- securing high risk and sensitive areas
- controlling access (such as fences, roads, traffic and pedestrian movements)
- providing safe access and exit especially after hours and during emergencies.

Design shall include:

- electronic locks shall be provided with a master key override where appropriate
- interlocks and interfaces between security systems and fire services shall be fail safe and hard-wired
- interlocking relationships between doors shall be identified as required
- all door access provisions or restrictions shall comply with the requirements of the NCC.

After-hours public entry points, such as wards and external doors shall have access controlled doors, with CCTV camera surveillance and intercoms (or video intercom) to allow screening of persons presenting at the door.

7.4.1.2 Intruder detection

Intruder detection and alarm systems are recommended for areas that are closed after normal working hours.

Intruder alarm systems should be considered in the following areas:

- pharmacy and satellite rooms where restricted drugs are kept
- all drug safes where restricted drugs are kept
- mortuary areas where deceased bodies are stored
- external doors to baby nurseries, including PICU, NICU
- communications rooms, plant rooms, records and supply areas
- non-24-hour departments
- all external perimeter doors, and in some cases, unit perimeter doors to indicate unauthorised exit or access.

In larger facilities the security management software will interface the alarm signal as well as video surveillance images may be seen on spot monitors that also pinpoint the location of the intrusion. The relevant requirements from the Australian cabling regulations and Australian standards should be incorporated into all aspects of commissioning, installing, activating and maintaining security alarms systems.

7.4.1.3 Master key systems

All master key systems shall be a transferable profile owned by Queensland Health.

7.4.2 Closed circuit television

CCTV cameras are provided to enable real-time monitoring of site security risks and to record incidents should they happen. In general, CCTV does not prevent incidents from happening, except where overt security and CCTV presence acts as a general deterrent to criminal behaviour. Records of security incidents shall be made available to health facility security and appropriate law enforcement agencies if requested and required for the purposes of review and/or prosecution.

CCTV shall include cameras, cabling and head end recording equipment. Provision shall be included for review of CCTV feeds and recordings. The design of CCTV systems shall include consideration of recording rates, image quality and image retention periods. A project specific technical assessment shall be conducted in conjunction with the health facility security staff to establish appropriate site-specific requirements.

The security risk assessment shall include consideration of any areas which require CCTV coverage. Generally, CCTV should be provided to areas of public access or where monitoring of staff safety is necessary. CCTV shall be used in the following areas:

- facility main entrances
- ED
- mental health areas
- ambulance bays
- entrances used for access to a birthing suite after hours
- after-hours entrances
- nurse stations, with consideration of privacy associated with patient charts and records
- areas which cannot be adequately observed from nurse stations
- car parks
- other areas as identified by the site risk assessment(s).

Consideration shall be given to the provision of CCTV for occupational health and safety (OHS) purposes in areas, such as plant rooms. The site risk assessment shall be required to evaluate key areas at risk.

7.4.3 Duress

Duress alarm points shall be considered for:

- duress alarms are to be installed in all potentially high-risk areas
- fixed alarms are for people who work in fixed positions and as a back-up system to personal duress alarms

- all reception desks
- all staff stations and nurses' stations
- mental health, drug and alcohol, ED and social work consultation rooms
- pharmacy counters
- cashier stations
- any areas where staff may work alone
- methadone clinics
- personal duress alarms for staff that are mobile in the course of their work, such as nurses, doctors, wards persons and security officers.

7.4.4 Security system management

A site-wide integrated platform for security management shall ideally be provided to facilitate effective monitoring and coordination of security activities and response.

A security control position shall be established within a facility for the location of security equipment, monitoring and site control.

7.4.5 Security interfacing and integration

Integration of electronic systems can provide improvements in efficiency and productivity. As systems exchange selected information it allows better assessment and actions in either an automated response or user-driven decision. Communication between different systems allows 'if this (on system a), then do that (on system b)' outcomes that can provide significant beneficial operational outcomes of the hospital, staff and patients.

Integrated security systems are particularly useful in small facilities and in high risk areas. Integration of security systems shall be reviewed on a site-by-site basis in consultation with hospital operations, BEMS and Security representatives.

7.4.5.1 Planning considerations

As part of the site by site consultation, for both new and existing developments, it is important that early planning and engagement with the BEMS and ICT stakeholders is provided to determine the style of integration of the security components into a hospital network environment. This potentially may take the form of one of the following or a hybrid strategy:

- Security network is standalone, separated from any other hospital network system. (This would be considered a rare outcome and envisaged would only be for existing legacy networks).
- Security network is integrated within the hospital BEMS network. The BEMS network is physically separated from the hospital Queensland Health ICT network.
- Security network is integrated within the hospital BEMS network. The BEMS network integrates into the hospital Queensland Health ICT network at the master control/core level. Effectively this has the two major networks running concurrently with an interface

between them to pass data/ information back and forth. This would often be referred to as a semi-converged or 'shared backbone' system.

- Security network is partly or fully integrated into the hospital Queensland Health ICT network as part of a unified converged network strategy. This also allows opportunities for ICT VLANs if required by the stakeholders or hybrid solutions.

Agreement as to which hospital body also manages the continued operation and support of the security network (BEMS/ICT/both) should also be determined and clearly documented as part of the overall consultation and discussions.

7.4.6 Security and electronics

Integration of the security network into a larger network such as the BEMS and/or Queensland Health ICT will necessitate discussions around having a systems integrator to manage and advise the level of information transfer between the security system to other hospital systems as part of an overall 'electronics' philosophy.

The potential list of electronic systems and interfaces is extensive and realistically cannot be comprehensively captured by this document for all potential project scenarios. Some high level examples are:

- duress alerts can be displayed on nurse call annunciators
- man-down functions integrated onto portable multifunction voice handset or mobile phone
- mobile tracking of wandering patients, moveable assets and security of high value goods via real time location wireless systems that also provide voice communications and mobile data services
- access control systems also being able to record time and attendance within critical rooms (highly restricted drug stores, neonatal nurseries, mortuaries, etc)
- statistical mapping of recorded incidences to determine where on campus additional mitigation solutions need to be considered by utilising real data to assist in making informed decisions
- ability for security feeds to be shared to a fire control centre for any area under fire alarm. This would permit better understanding of a potential event and a more appropriate fire response.

7.5 Checklists

7.5.1 Introduction

The following checklists are for the designer's reference and are not intended to be submitted for verification by Queensland Health.

7.5.1.1 Schematic design

Project:	
Item No.	**Security services review checklist items**
	Consult local authorities about matters of principle in connection with the services design of the works.
	Obtain information on the existence of site security risk assessments.
	Evaluate constraints from clients' brief, potential sites or schemes.
	Coordinate a security service review appropriate for the scale/scope of design. Review to include all necessary stakeholders to conduct an effective CPTED review, site, facility, department or other level security risk evaluation.
	Obtain information and documents on existing security services.
	Visit site(s) to assess physical restrictions that might influence the design philosophy or the development of the security design.
	Advise the Client on the need for arrangements to be made for and define the extent of special investigations or tests (could be intrusive or non-intrusive).
	Review and report on the condition/status of any existing services installations (usually only required for buildings being refurbished/extended).
	Confirm design criteria, scope and extent of security and other public health services.
	Establish indicative plant and riser requirements for security systems.
	Advise of significant allowances or constraints.
	Identify client requirements which will necessitate design input from a specialist designer, sub-contractor or supplier, and the timing of their appointment.
	Participate in team-wide design review to signal end of concept design stage.
	Propose primary design criteria and extent of security systems.
	Define the essential performance requirements of systems.
	Prepare sketch drawings for preferred preliminary design.
	Prepare sketch schematic drawings for preferred preliminary design.
	Provide program information on design and construction issues.
	Prepare a report on security services issues as part of the design development report.

	Prepare performance specifications for security services if required by procurement strategy.

Design development

Project:	
Item No.	Security services review checklist items
	Confirm design criteria, scope and extent of security services.
	Define the essential performance requirements of systems.
	Agree 'battery limit' between security systems and the ICT, fire, BMS, lift and associated building engineering plant/systems with the various Services designers.
	Review site security assessments and coordinate update with Security Working Group if required.
	Conduct updated CPTED assessments for refined design elements and coordinate review of these assessments with the remainder of the design team.
	Advise of significant allowances or constraints.
	Identify client requirements which will necessitate design input from a specialist designer, sub-contractor or supplier, and the timing of their appointment.
	Design security infrastructure architecture, including sources of supply, level of resilience. An iterative design process involving stakeholder consultation.
	Carry out initial overall spatial co-ordination. An iterative design process involving design team coordination.
	Determine main cabling distribution routes and location of devices including cameras, active devices, PIRs.
	Review RDS, and user group requirements with respect to location, quantity and type of security devices.
	Identify fire egress routes and design emergency evacuation strategies for necessary integration with security services devices and operation.
	Design systems as required to meet with the operational, functional and spatial requirements of the specification.
	CPTED assessment reviews.
	Sitewide security requirements review for single campus integrated solution, (if appropriate and relevant).
	Monitor compliance of the developing design with the project brief.
	Input data into final RDS.
	Review commissioning requirements.
	Prepare a report on security services issues as part of the technical design report.
	Prepare or revise risk assessments of the design.
	Prepare an initial schedule of cast-in/formed builders work openings that are structurally significant.
	Prepare a cost plan for security services.

	Prepare detailed schematic drawings.
	Prepare technical design drawings to convey design requirements, including coordination with other services.
	Sign-off the technical design report.

7.5.1.2 Contract documentation

Project:	
Item No.	**Security services review checklist items**
	Finalise 'battery limit' between security system and the various building engineering plant/systems e.g. fire, BMS, ICT.
	Finalise major cable reticulation pathways.
	Finalise position of all security field devices on plans.
	Review all camera positions for effective coverage. Modify if required.
	Coordinate all ACID devices and requirements as nominated on RDS and from the Security Working Group assessments.
	Review architectural, landscape, lighting and other services drawings to assess adherence to agreed CPTED principles and site implementation. Provide detailed comments as necessary.
	Ensure integration of security services with all architectural, interiors, landscaping, lighting and other services.
	Ensure coordination of all security services ICT requirements where a converged or semi-converged networking solution is implemented (ie. IP connectivity, backbone network infrastructure and RJ45 outlets provided via ICT services).
	Identify and incorporate into system designs the essential components and features necessary to enable the proper preparation and commissioning of building services.
	Review all designs to ensure that systems are commissionable.
	Where required appoint an independent specialist commissioning contractor responsible for testing and commissioning.
	Finalised drawings.
	Advise builders work requirements for door hardware.
	Produce specification.
	Produce equipment schedules (if required).
	Update services cost plan.

7.6 Deliverables

7.6.1 Stages of design

The design shall be completed in recognised milestones, with the following requirements to be documented at each milestone:

	Concept design	Schematic design	Detailed design	Construction documentation
Reporting requirements				
Compliance with the Queensland Health brief	Required.	Required.	Required.	Required.
Compliance with CIR	Assumed. All deviations must be raised via non-conformance submission.	Assumed, except for approved concept design deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved concept and schematic design phase deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved deviations to date. New design deviations should not occur in CD phase as all scope is already approved in DD. Deviations with detailed CIR specification requirements only will be considered. All deviations must be raised via a non-conformance submission.
Listing of codes and standards	Summary table of standards applicable.	Summary table of standards applicable.	Summary table in design report and detailed within draft specifications as applicable.	Required and detailed within specifications.

	Concept design	Schematic design	Detailed design	Construction documentation
Design process	Sitewide security considerations. May include sitewide CPTED workshop to inform the design process. Investigation of existing systems on site—interface, upgrade, replacement?	Sitewide CPTED workshop(s). Project security risk assessment report. Electronic security schematics. Physical security description via the schematic design report.	Confirm any department specific requirements as part of the user group process. Ensure RDS capture final requirements. Develop physical security floor plans to capture departmental and overall sitewide requirements. Update and refine schematics. Define interfaces to other services, particularly ICT.	Specification to include security services design as refined during the design process. Prepare final drawings—plans and schematics.
Redundancy and reliability	Per appropriate Australian Standards and any site-specific factors.	Confirm strategy for redundancy and reliability. Prepare schematic drawings to confirm reticulation redundancy and reliability strategies for critical systems.	Reconfirm strategy and no material changes to site requirements.	Specification and drawings to include security design inclusive of discussion of redundancy and reliability requirements and strategy.
Future proofing	Overarching strategy to be discussed and incorporated into security strategy from the concept design stage. Consider particularly the implications of vendor specific security products and services.	Confirm and align strategy by documentation in schematics and design reports.	Confirm and align strategy by documentation in schematics, plans, design reports and draft specification.	Specification and drawings to include future proofing per approved strategy.

	Concept design	Schematic design	Detailed design	Construction documentation
Disaster management	Per the requirements of Australian Standards and site-specific factors.	Confirm and align design documentation with strategy.	Confirm and align design documentation with strategy.	Confirm and ensure design documentation captures extent of the required strategy.
Performance	Per the requirements of Australian Standards and Queensland Health policies.	Per the requirements of Australian Standards and Queensland Health policies.	Per the requirements of Australian Standards or as amended through the user group process.	Documented per the final approval requirements from Australia Standards or as varied by approval through the user group process.
Commissioning testing and post-occupancy	Not applicable at CD.	Not applicable at SD.	Preliminary requirements included in draft specifications.	Specification of testing and handover requirements. Ensure O&M requirements included within specification.
Maintainability	High-level considerations at concept design.	Refined from concept design. Include requirements for access to main equipment. Include review of security control room / office, ergonomics etc. Safety in design review. Provide statement in SD report that maintainability has been included.	Detailed design drawings to show maintenance provisions where applicable. Safety in design review.	Detailed in documentation for all risers, serviceable equipment or elements, and major hardware (servers etc). Final design phase Safety in design review.

	Concept design	Schematic design	Detailed design	Construction documentation
Cost estimates	Provided by QS based on estimated preliminary requirements and device counts.	Confirmed by QS based on any revised design parameters.	Confirmed by the QS based on device counts and/or sq.m basis per department.	Confirmed by the QS based on final design requirements confirmed by the engineer.
(in conjunction with QS for all phases)	General coordination including: • Provide spatial requirements for plant rooms, risers and points of access. • Key stakeholder liaison • Input to risk and reliability assessments.	General coordination including: • Confirm spatial requirements. • Stakeholder liaison. • Input to safety in design.	Refined requirements via user group consultation. Coordination with Architect for access and maintenance review. Coordination with other engineering services, particularly for points of interface (associated works).	General coordination including: • Safety in design. • Coordinate maintenance requirements for inclusion in specifications. • Coordinate 'work by others' within specification documentation.
Design reports and documentation	Provide input to the concept design report. For existing buildings, this must include engineering baseline assessment and commentary.	Provide input to the schematic design report. Provided preliminary specifications (if necessitated for delivery model).	Provide input to the detailed design report. Provide preliminary specifications. Provide technical schedules for major plant and equipment.	Provide detailed specifications, technical schedules and associated documentation for security services.
Drawings (refer also to the Queensland Health PIR)				
Design drawings	Not required, but a preliminary schematic can be advantageous for articulating requirements.	Schematics. Preliminary security control room layout, if applicable.	Schematics revised.	All finalised schematics, plans and details.

	Concept design	Schematic design	Detailed design	Construction documentation
			Plan drawings for all areas to indicate physical security devices and provisions. Include maintenance requirements.	

7.7 Non-conformance declaration (security)

The designer is required to provide all deliverables detailed within Section 7.6, and adhere to the design principles and requirements outlined in Section 7.1 through Section 7.4.

Where the designer cannot meet these requirements, has not provided risk-assessments or whole-of-life studies, or has proposed an alternate solution, a non-conformance declaration must be prepared and submitted within the relevant design stage report.

The onus is on the designer to report any areas of non-compliance.

The following format shall be used:

Project: .....

Design phase:.....

Discipline: .....

CIR clause/requirement	Reason for non-conformance	Design report reference	Client (Y/N)
Eg 2.3.6.6 Security Lighting Risk Assessment	*Internal fit out only, no external lighting required*	*CDR Section 10.7*	

<< additional lines to be added as required >>

Signed:..... **Date:** .....

Name: .....

Company: .....

Client review comments: .....

.....

.....

.....

8 Lifts

8.1 Introduction

The suitable type, size and number of lifts shall be provided for health facilities to meet the performance criteria specified.

Lift types will generally be:

- passengers—used for staff, ambulant patients, visitors
- goods—use for food trolleys, medical supply trolleys, linen trolleys, furniture and equipment, garbage and waste
- bed trolley lifts used for patients in beds and empty bed.

8.2 Principles

8.2.1 Needs assessment

The need for lift (vertical transportation) services shall be determined by several factors which include:

- the number of floors in the facility
- the number of beds in the facility
- types of departments/services proposed to be accommodated within the building
- type of inter-departmental traffic within the building likely to be generated for movement of people and goods
- the number of staff and shift patterns, visitors and visiting hours
- the location of theatres and x-ray facilities
- the distribution of food, beverages, supplies and waste disposal
- types and sizes of items required to be transported (such as beds, trolleys, other goods)
- emergency evacuation of patients, staff and visitors.

The type and extent of lift services to be provided is determined by the type and volume of traffic likely to be generated within the building and the service performance level that is considered acceptable for the level of medical service being provided by the facility.

Design economy shall be achieved by careful selection of the most suitable type, quantity and size of lifts for the facility.

8.2.2 Lift positions

When lift services are found to be necessary for a new healthcare building, the planning and schematic design for the lift installation shall be carried out by a professional lift consultant at the very early stage of the project.

The proposed lifts shall be located to provide an efficient health facility operation and should be easily accessible. The required number of lifts as determined by detailed traffic analysis will be grouped in one or more banks. Usually the passenger lifts grouped in one group and the bed trolley lifts and or goods lifts in different groups. Multiple lift banks shall be provided where general horizontal travel distances necessitate based on a site-specific assessment.

Stairwells should be planned and positioned immediately adjacent to a group of lifts to encourage pedestrian traffic for short vertical travel requirements.

In determining lift locations consideration shall also be given to overall people traffic strategies to limit the potential for cross infection between patients, visitors and staff.

The architectural design shall not locate patient bedrooms against lift shaft walls or lift motor rooms.

8.2.3 Interfaces and other requirements for lift services

- Consideration shall be given to the provision of a graphical head end. All lift installations shall provide interface for graphical systems and BMS monitoring.
- Interface shall be provided between lift control and security (CCTV and ACID) systems.
- Lift motor rooms and lift shafts for MRLs shall be temperature controlled.

8.2.4 Number of Lifts

- The number of lifts required for a health facility building shall be determined by the peak two way traffic requirements in terms of the following:
  - Number of people and vehicles (trolleys) requiring the lift service during the peak period, peak traffic or peak period is not defined in the guideline. Examples potentially giving rise to peak traffic periods would be staff shift changeovers, visiting times, meal-times, casualty or outpatient overloads
  - Handling capacity of the proposed lifts (i.e. the number of passengers and vehicles the lift system can transport in a five-minute peak period)
  - The extent of two-way traffic during the peak period
  - Whether it is desirable to group all lifts together. Consideration should be given to the separation of general public and specialised patient lifts in larger health facility situations and the effect this has on the budget.
- Detailed traffic analysis and performance calculations shall be carried out during the early planning stage of the project to determine the number of lifts required and their optimum grouping and location.
- Should the results of the traffic study indicate that only one lift is required for both ambulant and non-ambulant patients, one additional lift of the same type shall be provided in case of one lift being put out of service for routine maintenance or due to equipment faults. Both lifts shall be grouped together but may be in separate fire rated shafts.

8.2.5 Type and mix of lifts

The types and mix of lifts shall be assessed based on the following criteria:

- Bed/passenger lifts are to be used for both people and vehicular traffic for moving goods and patients on trolleys.
- Orthopaedic bed/passenger lifts may be used in place of bed/passenger lifts provided that the need for a larger lift car can be justified based on clinical need.
- Consideration may be given to a separate food services lift for meal delivery. However, justification for the provision is required.

For lift installations with four or more cars, the lift car entrance at the main landing for loading of food trolleys and other supplies trolleys shall be separated from the normal lift lobby. Where functionally allowable patient and public lifts shall be separated.

Exclusions:

- Dedicated Food services lift(s) is/are not required. Express services can be provided by the provision of special key control in the lift control system.
- Dedicated 'dirty' goods lift(s) is/are not required.
- Lifts used for waste/dirty goods shall not be planned for dual use as food services lifts.

8.3 Requirements

8.3.1 Lift performance parameters

Patient care/FM lifts

For patient care and facilities management lifts, in the absence of hospital specific guidance, calculations should be based on.

- Patient care: 4 up and down movements per 100 beds in five minutes.
- Facilities management: 2 up and down movements per 100 beds in five minutes.

The inclusion of priority call systems will provide for segregation of patient care and facilities management movements as single journeys without the need to stop for other passengers.

Staff/public lifts

Staff/public lifts should consider their use by elderly, disabled and other users in wheelchairs of with other mobility devices. A wide shallow car is preferred with wide doors to assist is passenger transfer.

Car load factors should be reduced to make allowances for non-ambulant patients with a recommended lift capacity between 21 and 26 passengers.

Waiting time is to be within the range of 30–50 seconds.

Handling capacity within the range of 10 to 15 per cent of the total population for the 5-minute interval where 10 per cent should be used for very light use buildings and 15 per cent is used for heavy use buildings.

Two way traffic simulations should to be based on a 40 per cent incoming, 20 per cent inter-floor and 40 per cent outgoing traffic profile.

Design populations should be between 3 and 5 persons per IPU bed dependant on the mix of staff using these lifts.

Populations for non-patient ward departments should be based on a person per meterage or persons per room basis depending on the type of use.

8.3.2 Drive systems

Machine room-less and conventional overhead traction type lifts shall be considered to maximise efficiency and minimise plant requirements.

Hydraulic lifts shall only be considered suitable for the following applications:

- low rise health facility of up to two landings and not more than five metre travel
- very large capacity low rise applications
- lift shafts and motor rooms must be designed to control noise transfer from lifts and equipment into adjoining spaces.

8.3.3 Lift controls

8.3.3.1 General

Each lift group shall be controlled by a common control system, facing lifts being considered as a single controlled group.

The control systems shall be microprocessor based.

A special service control facility accessed from within the lift car, shall also be provided to permit authorised staff to secure exclusive service of the designated lift(s) for medical emergencies or routine meal delivery.

An interface shall be provided to the security system which shall allow the specification of a priority call from security for operational emergencies, building security and fire.

8.3.3.2 Operation under emergency control

The lift control system shall be capable of operating the lifts on emergency power in the following manner:

- immobilise lifts already stopped at the main landing
- bring remaining lifts, one at a time, to the main landing in sequence
- permit one or more designated lift(s) to then return to and remain in service as determined by the available capacity of the emergency power supply.

All critical health facility operations lifts shall run as per normal service requirements when on emergency power. Generators shall be sized to accommodate all such lift loads.

8.3.3.3 Earthquake protection

The lift design and installation shall incorporate earthquake provisions in accordance with AS 1170.4.

8.3.4 Lift car—sizes and finishes

A bed/passenger lift shall have a minimum clear size of 1600 millimetres wide between hand/bump rails x 2360 millimetres deep x 2300 millimetres high to the underside of the lift car ceiling and be provided with hand/bump rail all round and a stainless steel skirting.

A bigger car size, 1800 millimetres wide between hand/bump rails x 2675 millimetres deep x 2300 millimetres high to the underside of the lift car ceiling, shall be provided where appropriate to accommodate orthopaedic and intensive care beds.

Where there are project specific requirements for other lift sizes (e.g. helicopter trauma lift), these shall be sized based on site needs assessment of size, speed and number of lifts.

8.3.5 Finishes

Lift car finishes shall be cleanable and chemical resistant.

Car finishes shall be free from edges, ledges and joins which would impact on infection control.

Car floors shall be hard-wearing, durable and may be selected to meet architectural requirements.

8.4 Checklists

8.4.1 Schematic design

Project:	
General	
	Carry out on-going checks for compliance with regulations.
	Monitor compliance of the developing design with the project brief.
	Confirm design criteria, scope and extent of lift services.
	Update recommendations to Queensland Health for their development of an operating and maintenance strategy.
	Carry out initial overall spatial co-ordination for new lift services.
	Identify client requirements which will necessitate design input from a lift supplier.
	Define the essential performance requirements of systems.
	Obtain indicative quotations for plant not requiring specialist design.
	Undertake consultation with Queensland Health stakeholders concerning any risk management/WH&S issues.
Lift design	
	Provide a detailed lift traffic analysis.
	Review requirements for goods lifts and locations served with facility operations staff.
	Determine approximate lift car requirements, plant room requirements, lift shaft and overrun/pit requirements, switchgear locations, control panel locations.
	Confirm preliminary interfaces with other services, particularly mechanical and electrical services.
	Design automatic controls systems as required to meet with the operational, functional and spatial requirements of the specification.
Deliverables	
	Prepare a report on lift services issues as part of the technical design report.
	Prepare or revise risk assessments of the design.
	Provide details of lift shafts.
	Prepare input to the cost plan for lift services.
	Sign-off the technical design report.

8.4.2 Design development

Project:	
General	
	Carry out on-going checks for compliance with regulations.

	Monitor compliance of the developing design with the design philosophies.
	Review design against BCA and energy targets (if relevant).
	Carry out calculations in relation to any energy-related planning conditions and advise team of implications to overall design.
	Team-wide design review to signal end of design development stage.
Lift design	
	Confirm design criteria for lift systems.
	Confirm plant and lift shaft requirements.
	Coordinate detailing with other services.
Deliverables	
	Prepare drawings for preferred design.
	Provide programme information on design and construction issues.
	Prepare a report on lift services issues as part of the design development report.
	Prepare performance specifications if required by procurement strategy.

8.4.3 Contract documentation

Project:	
Team liaison	
	Check the provision for and adequacy of the preliminary builder's work information previously issued by others.
	Confirm builders' work information for specified equipment or materials, or where alternatives to those provisionally or pre-selected are agreed.
	Co-ordinate requirements for all access platforms, stairs, rails and protection elements required for future maintenance and operation of plant/equipment.
	Detail all fire stopping requirements.
	Design weatherproofing details for all services passing through external elements of the building.
	Detail all acoustic stopping for services penetrating builders work elements.
Lift design	
	Carry out final detailed design calculations for all remaining services in accordance with recognised national standards.
	Size, select and determine final locations of commissioning sets based on the final equipment selection and co-ordinated installation drawings.
	Specify final location of access panels.
	Carry out final selection of all anti-vibration mountings for major plant (i.e. machine room equipment).
	Carry out design and incorporation of all interfaces (including relays or other devices or modifications to hardware or software).

Commissioning	
	Identify and incorporate into system designs the essential components and features necessary to enable the proper preparation and commissioning of lifts.
	Where required ensure appointment of an independent specialist commissioning contractor responsible for testing and commissioning.
Deliverables	
	Prepare detailed design drawings.
	Produce builders work information.
	Produce equipment schedules.
	Review that all plant and equipment incorporated into the works can be safely maintained in compliance with current legislation.
	Update detailed cost plan.
	Prepare detailed specifications for lift services.

8.5 Deliverables

8.5.1 Stages of design

The design shall be completed in recognised milestones, with the following requirements to be documented at each milestone:

	Concept design	Schematic design	Detailed design	Construction documentation
Reporting requirements				
Compliance with the Queensland Health brief	Required.	Required.	Required.	Required.
Compliance with CIR	Assumed. All deviations must be raised via non-conformance submission.	Assumed, except for approved Concept Design deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved Concept and schematic design phase deviations. All new design deviations must be raised via non-conformance submission.	Assumed, except for approved deviations to date. New design deviations should not occur in CD phase as all scope is already approved in DD. Deviations with detailed CIR specification requirements only will be considered. All deviations must be raised via a non-conformance submission.
Listing of codes and standards	Summary table of standards applicable.	Summary table of standards applicable.	Summary table in design report and detailed within draft specifications as applicable.	Required and detailed within specifications.
Design process	Present initial strategy to CD level design. Lift design strategy to consider the project specific vertical transportation	Confirm and align strategy with SD level vertical transportation design.	Confirm align strategy with DD level vertical transportation design.	Specification to include vertical transportation design as refined during the design process.

	Concept design	Schematic design	Detailed design	Construction documentation
	requirements with reference to the hospital design brief.			
Redundancy and reliability	Overarching Strategy to be discussed and incorporated into vertical transportation strategy from the concept design stage.	Confirm and align strategy with SD level vertical transportation design.	Confirm and align strategy with DD level vertical transportation design.	Specification to include vertical transportation design inclusive of redundancy strategy.
Lift planning and management	Overarching Strategy to be discussed and incorporated into vertical transportation strategy from the Concept Design Stage. Segregation of lift services to prevent cross contamination and provide infection control. Strategy to be dependent on size of hospital and specific segregation requirements.	Confirm and align strategy with SD level vertical transportation design.	Confirm align strategy with DD level vertical transportation design.	Specification to include vertical transportation design inclusive of segregation strategy.
Future proofing	Overarching Strategy to be discussed and incorporated into vertical transportation strategy from the Concept Design Stage.	Confirm and align strategy with SD level vertical transportation design.	Confirm and align strategy with DD level vertical transportation design.	Specification to include vertical transportation design inclusive of future proofing strategy.
Disaster management	Overarching Strategy to be discussed and incorporated into vertical transportation strategy from the concept design stage.	Confirm and align strategy with SD level vertical transportation design.	Confirm align strategy with DD level vertical transportation design.	Specification to include vertical transportation design inclusive of disaster management strategy.
Lift performance	Present initial strategy to CD level design.	Confirm strategy at development of SD level design.	Confirm strategy at development of DD level design.	Specification to include vertical transportation design inclusive of designed lift performance.

	Concept design	Schematic design	Detailed design	Construction documentation
	Lift performance strategy to align with: • Redundancy and reliability • Lift planning and management • Future proofing • Disaster management.			
Commissioning testing and post-occupancy	Not applicable at CD.	Not applicable at SD.	Not applicable at DD.	Specification of testing requirements including independent testing and certification of vertical transportation services. Ensure O&M requirements included within specification.
Maintainability	Overarching consideration to be given to concepts.	Access to maintenance areas for vertical transportation equipment to be considered in terms of ongoing maintenance requirements. Safety in design review. Provide statement in SD report that maintainability has been included.	Access to maintenance areas for vertical transportation equipment to be considered in terms of ongoing maintenance requirements. Safety in design review.	Ensure maintenance requirements included within specification.
Cost estimates (in conjunction with QS for all phases)	Required for quantity of lifts and types of lifts.	Confirmed by QS based on any revised design parameters.	Confirmed by the QS, including preliminary finishes schedule.	Confirmed by the QS based on final design requirements confirmed by the engineer.

	Concept design	Schematic design	Detailed design	Construction documentation
General coordination	General coordination including: • provide spatial requirements for lift shafts • key stakeholder liaison • input to risk assessments.	General coordination including: • confirm spatial requirements • review project fire safety strategy • key stakeholder liaison • input to risk assessments • input to safety in design.	Coordination with other engineering services including: • structural services • electrical services • mechanical services • ICT and security services • fire services • fire engineering • hydraulic services.	General coordination including: • key stakeholder liaison • input to risk assessments • input to safety in design • advise on procurement options • coordinate maintenance requirements for inclusion in specifications. • Coordinate 'work by others' within specification documentation.
Design reports and documentation	Provide input to the concept design report. For existing buildings, this must include engineering baseline assessment and commentary.	Provide input to the schematic design report. Provided preliminary specifications (if necessitated for delivery model).	Provide input to the detailed design report. Provide preliminary specifications. Provide technical schedules vertical transportation.	Provide detailed specifications, technical schedules and associated documentation for vertical transportation services.
Drawings (refer also to the Queensland Health PIR)				
Drawings/advice	Provide spatial requirements for shafts.	Confirm shaft sizes. Confirm car sizes.	Provide lift car drawings where appropriate to detail special features.	Detailed shop drawings to be provided by the lift contractor.

8.6 Non-conformance declaration (lifts)

The designer is required to provide all deliverables detailed within the relevant section 8.5, and adhere to the design principles and requirements outlined in Section 8.1 through Section 8.3.

Where the designer cannot meet these requirements, has not provided risk-assessments or whole-of-life studies, or has proposed an alternate solution, a non-conformance declaration must be prepared and submitted within the relevant design stage report.

The onus is on the designer to report any areas of non-compliance.

The following format shall be used:

Project: .....

Design phase: .....

Discipline: .....

CIR clause/requirement	Reason for non-conformance	Design report reference	Client (Y/N)
Eg 8.3.2 Drive Systems.	*No upgrade to motors.*	*CDR Section 10.7.*	

<< additional lines to be added as required >>

Signed:..... **Date**: .....

Name: .....

Company: .....

Client review comments: .....

.....

.....