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1. **Introduction**

1.1. **Introduction**

1.1.1. **Queensland Health capital infrastructure requirements**

The capital infrastructure requirements (CIR) are provided as part of a suite of documents associated with development works by Queensland Health. Works may include:
- new construction
- redevelopment
- condition based asset replacement
- extension and annexure.

This document forms Volume 4, Section 1, of the CIR. Other documents that form part of the CIR series include:
- Volume 1—Overview
- Volume 2—Functional design brief
- Volume 3—Architectural and health facility design
- Volume 4—Engineering.

Volume 4 outlines the requirements for engineering, with the other volumes addressing development process and architectural/planning requirements as noted above. The volumes of the CIR are intended to be independent but complimentary. An individual discipline of planning, architecture or engineering should not be required to read other volumes, but this is recommended to understand more completely the overall development process and requirements.

1.1.2. **Volume 4—Engineering and infrastructure minimum requirements**

The engineering and infrastructure minimum requirements of the CIR comprise three sections:
- Section 1 (this document) contains the principles applicable to Queensland Health development. This section generally does not specify how compliance is achieved in detail but outlines overarching requirements which must be adhered to. Section 1 may be read independently of the following sections.
- Section 2 provides a manual with checklists and procedures required to be followed during development works. Section 2 shall be read in conjunction with Section 1.
- Section 3 is a detailed technical specification for key items associated with engineering for health facility and healthcare development works by Queensland Health. Section 3 relies on the principles and methodologies described in Sections 1 and 2 and should not be referenced independently of these documents.

1.2. **Overarching objectives**

For all Queensland Health projects, the purpose of applying the CIR is to provide excellence in engineering planning and design through the application of engineering best practice to:
- support continuous health delivery
- ensure business continuity
- deliver reliable and maintainable plant and equipment
- deliver efficient, cost effective design
- address whole-of-life design considerations, including location and climate impacts
- support infection control
- be compliant with mandatory and ‘other’ performance guidelines

Further discussion is provided regarding principles of design in Section 3 of this document.
1.3. **Application of standards and codes**

In the event of any conflict between the requirements contained in this suite of documents and the scope of works prepared by Queensland Health, the scope of works details shall prevail.

In the preparation of this document references are made to the latest guides, codes and standards applicable. The user of this document must verify the latest guidance material available at the time work is to be carried out.

Reference standards and documents are noted separately in CIR, Volume 1—Overview. The minimum requirements shall be those listed in legislation, mandatory and relevant standards and accepted good practice guides relevant to healthcare facilities. It is a prerequisite that designers make themselves familiar with referenced documents as well as the relevant parts of any specific reference documents noted in individual sections.

Users of this guide are invited to provide feedback on any aspect of the standards that may be considered of benefit in order to facilitate continuous improvement in the design and operation of the healthcare facilities.

1.3.1. **Workplace health and safety**

Comply with all federal and Queensland Workplace health and safety policies and guidelines, including general Queensland requirements and Queensland Health specific requirements. The most stringent requirement shall apply in the event of any conflicts.

1.3.2. **Deemed to satisfy**

Queensland Health facilities and supporting engineering services shall be designed and installed in accordance with the Building Code of Australia (BCA) as a ‘deemed to satisfy’ position.

Fire engineering should only be undertaken, and is only allowed, when the result of the engineered solution will not reduce opportunities for future expansion nor constrain future flexibility.

Thermal modelling to meet the requirements of the BCA, Section J, may be utilised as a method of demonstrating compliance. This is considered a ‘deemed to satisfy’ approach via a non-prescriptive option.
2. Requirements of engineering design for Queensland Health facilities

2.1. Introduction
The following sections outline key requirements and considerations for the design of engineering systems for healthcare facilities within Queensland.

2.2. Project type
Engineering projects undertaken by Queensland Health can be categorised generally as:
- refurbishment of existing facilities
- condition based replacement of infrastructure (i.e. major maintenance)
- extensions to existing facilities
- new works.

The planning and design of engineering services should be consistent with the project type to ensure that particular considerations are made appropriate for the project type. A comprehensive risk assessment shall be undertaken for current and future occupants as a result of the proposed work.

2.2.1. Refurbishment
Considerations for refurbishment include:
- assessment of the impact on existing services systems and whether they are suitable for re-use
- establishment of the condition of existing systems and remaining life
- assessment of the capacity of existing systems and whether suitable for proposed use.
- provision of continuity of operations through careful planning of works
- where staging of the works is required, assess the impacts on operation of existing systems and facilities.

2.2.2. Replacement of infrastructure
Planned or condition based replacement of major plant and infrastructure pre-supposes that a condition assessment has been completed and the rational for plant replacement has been established. Considerations for works therefore include:
- establish the condition of directly supporting systems and necessity for upgrade (such as switchboards, power supplies and pumps)
- provide continuity of operations through careful planning of replacement.
- ensure a roll-back strategy is in place should works not proceed as required
- where staging of the works is required assess the impacts on operation of existing systems and facilities.

2.2.3. Extensions
Considerations for extensions to buildings include:
- assess the impact on existing services systems and identify the potential for extension or expansion
- assess the integration of existing plant, equipment and systems across development boundaries
- establish the capacity of existing services and whether these services systems can be extended or augmented
- where systems are suitable for extension/augmentation, establish the condition of these systems, their remaining life and report findings
- review and agree the basis of specification for new systems and equipment—either to match existing (subject to item 4 above and life-cycle cost analysis) or upgrade to current standards
• where staging of the works is required assess the impacts on operation of existing systems.

2.2.4. New works
Considerations for new building works include:
• assess the impact of proposed new works on existing services systems
• broadly establish the capacity and condition of existing infrastructure services and whether these services systems are suitable for use in serving or partially serving the needs of the new works
• where staging of the works is required assess the need for continuity of utility services, temporary plant and cutover of new plant and equipment systems
• any new works within a campus shall be integrated to provide single site-wide operation and monitoring.

2.3. Project size
These engineering guidelines are provided irrespective of project size, as indicated by the range of project types noted above.

The principles within this CIR, Volume 4, Section 1, Engineering and infrastructure principles, are considered appropriate for any Queensland Health project, however the detailed implementation may vary depending on the extent of work being undertaken. The application outlined in Section 2 and the detailed requirements of Section 3 may be used as applicable on a project-by-project basis.

2.4. Location considerations
In providing engineering services for healthcare facilities within Queensland, designers shall be cognisant of the following:
• The need to consider the ongoing servicing (including availability and the cost of parts) of equipment in rural/remote locations in selecting the type of equipment. Key issues include:
  – existing on-site/district capabilities to service and maintain plant
  – specifying equipment types that can be serviced/maintained within the required timeframes required for the particular service
  – establishing the availability of appropriate service/maintenance contractors and their attendance time for routine and breakdown service or maintenance.
• Specifying complex systems that cannot be maintained or serviced generally by local contract firms will create ongoing issues in the delivery of healthcare.
  – Where there is no alternative and proprietary/sole service systems are necessary the associated suppliers shall have suitable maintenance and service provisions available within the required timeframes and at reasonable cost.
  – Comprehensive maintenance agreements which include guarantees of operational availability and significant financial penalties otherwise may be appropriate for some equipment which requires supplier provided maintenance.
• Standardisation of equipment types across an Hospital and Health Service (HHS) or health facility. Where a HHS or facility Building, Engineering Maintenance Services (BEMS) group have standardised on particular systems or types ensure that this commonality is maintained. During the concept/design stage this information shall be obtained from the Queensland Health service representative or BEMS personnel to enable suitable design around standardised requirements.
• Geographical/environmental variances across the state. Equipment and systems specified/used shall be suitable for the different geographical and environmental differences encountered across Queensland. Equipment shall accommodate extremes of elements, such as temperature, weather, dust or marine environments that may be encountered.
• As Australian Drinking Water Guidelines (ADWG) 2011 (or latest version if superseded) does not guarantee water quality, there may be need to engage and consult with the local water supplier to determine if water quality improvements are necessary in facility design.
• The complexity, or otherwise, of equipment to meet the service need. This is linked to the first point above i.e. for example do not specify/use complex PLC control systems for HVAC in small country towns in Queensland, but rather a simple relay logic system or basic electronic controller.

2.5. Uniform reporting
A key element in standardising operations across HHSs and Queensland is ensuring that the documentation provided by each project is consistent, is in a neat and logical arrangement consistent between sites and that information is correctly captured into the Queensland Health asset management system.

Further detail of documentation requirements is contained in CIR, Volume 1, Section 2, Engineering and infrastructure manual.

2.6. Plant locations
Engineering plant and equipment should be contained within restricted spaces away from general public access.

Plant and equipment should be located in areas which don’t require access via the clinical space. Significant plant spaces shall be provided with a solution for goods access, such as a goods elevator, gantry.

The use of on-floor plant shall be assessed as part of master planning design. In general, for buildings of four levels or less the use of a common roof-top plant space for most engineering services shall be appropriate. For larger developments, on-floor air handling plant may be a more efficient solution from a space and cost perspective. A project-by-project assessment is required.

Electrical distribution boards (EDB) shall ideally be located central to the area served. EDBs shall be located such that access will not obstruct general movement throughout the floor and so that access is not restricted by storage in front of the EDB.

Engineering valves and services within ceiling spaces shall not require regular maintenance access. Breakdown or irregular access (rebalancing, changes) is acceptable. Elements of the hydraulic services, including TMVs and isolation valves, should be easily accessible for regular maintenance.

The distribution of plant and equipment shall be in accordance with fire and smoke compartments as far as practicable. Zoning services within smoke and particularly fire compartments is usually the most cost effective long-term solution. The impact of maintenance on fire collars, dampers and other such devices shall be included in any life-cycle costing associated with plant crossing fire compartments.
2.7. Ceiling voids
Ceiling voids shall be sized to allow appropriate installation of engineering services, with consideration for access, maintenance and future flexibility. Key access requirements include for review and testing of fire stopping, actuators and system balancing.

A ceiling sandwich diagram shall be established for each project to ensure reasonable zoning for each service and to minimise cross-over of services where possible.

2.8. Risers, tunnels and culverts
2.8.1. Risers
Risers shall be vertically aligned throughout a facility. This is a fundamental design requirement which shall be achieved in all new and redevelopment projects. Risers for multiple services shall not be commonly located such that in-ceiling pinch points occur. In particular, major electrical and mechanical risers shall be separated.

Risers adjacent to communications rooms shall be avoided where possible, or at least providing two clear sides of in-ceiling access shall be provided.

Hydraulic risers shall be located at columns. A maximum spacing of two column grids shall apply between risers (i.e. riser, no riser, riser) to minimise pipework runs on-floor and maximise future flexibility.

2.8.2. Riser, tunnels and culverts
Riser, tunnels and culverts sizing and installation shall include consideration of future proofing, including allowance for spare capacity and access into risers for future installation.

2.9. Redevelopments, refurbishments and extensions
Projects within an existing site shall include a full site-wide engineering services assessment prior to production of the master plan budget. The status of all major infrastructure services shall be included in the assessment.

Where the effective life of an impacted service is deemed less than five years the redevelopment budget shall include allowance for replacement of plant.

Where the effective life of a service is deemed greater than five years allowance shall be included in the redevelopment budget for system upgrades.

Redevelopment budgets shall include allowance to bring engineering systems to compliance with current codes where more than 50 per cent of the existing facility (by serviced area per discipline) is directly impacted by works or where necessitated to meet statutory obligations (such as electrical safety requirements, fire services requirements).

All projects within an existing facility shall ensure that the status of engineering redundancy and availability of spares is maintained or enhanced at the end of the project, irrespective of the scale of works directly undertaken.
3. Key considerations during design
3.1. Design for patient focus and improved patient outcomes

Evidence-based design (EBD) is an approach to healthcare design that gives importance to design features that impact patient health, wellbeing, mood and safety, as well as staff stress and safety. EBD is based on research to assess quantifiable benefits and outcomes which support positive patient focused outcomes.

As per the overarching objectives noted in Chapter 1.2 Engineering services design within Queensland Health facilities is to support health outcomes. Where EBD is applied to the health services planning, facility design or planning during the development of a project or facility, the engineering design should support this.

The application of EBD to planning, architecture or health service delivery should also consider the impact on engineering outcomes as a key consideration. Engineering systems for healthcare delivery and the requirements of the CIR should not be compromised by applying EBD to planning, architecture or health service delivery.

Any engineering ‘innovation’ proposed should adhere to the principles of EBD in that quantifiable benefits must be demonstrated while health service delivery, patient wellbeing and business continuity must not be compromised.

3.2. Sustainable development and operations
3.2.1. Key objectives
Without compromising patient / occupant health (e.g., implementing water savings which result in stagnant water that promotes microbial regrowth), the following key sustainable development objectives can be followed:

- comfortable and healthy indoor environment (in terms of thermal comfort, visual comfort and indoor air quality)
- minimised non-renewable resource consumption (such as energy, water) and environmental impacts (such as greenhouse, other air and water emissions, solid waste), except in the event that water use is required for flushing and monitoring to meet microbial water quality needs
- cost-effectiveness over whole life cycle.

As health facilities are energy intensive due to the core occupant/functional/process requirements and necessities for quality of care, close attention needs to be paid to energy issues. The design team should integrate an approach, such as an energy hierarchy on projects to help inform a responsible decision making process:

Sustainable
- energy conservation (reducing total energy demand)
- energy efficiency
- exploitation of renewable, sustainable resources
- exploitation of non-sustainable resources using low/no-carbon technologies
- exploitation of conventional resources.

Unsustainable
The key strategies in all instances shall be efforts to reduce energy consumption rather than just convert consumption from one media to another (i.e. mains electricity to solar). Energy conservation and reduction is the most effective long-term element of sustainable design. Similarly, strategies for reduction in water consumption shall be implemented, particularly water efficient fittings and fixtures and the reduction waste water to sewer. The use of alternate water sources shall also be considered on a project-by-project basis.
Sensible and appropriate levels of technology and design should be applied to reduce energy wastage and carbon dioxide emissions arising from the operation of the facility both for financial and environmental reasons without reducing the functional standards necessary.

The following items shall be considered:
- systems shall be appropriate for the location in terms of climatic conditions, sophistication of facility services, availability of skills/support
- engineering systems shall be reasonably adaptable to respond to changes in planning and the likely changes in use/requirements
- Furniture Fittings and Equipment (FFE) procurement shall address energy efficiency requirements so that they match the overall targets and aspirations of the facility.

**Combining Sustainability and Quality**
- Where building systems are encouraged to have designs that incorporate water saving practices, a challenge has been observed in the risk trade-off in microbial water quality. For example, as water use decreases and water retention times increase within a building, there is increased risk in microbial regrowth in all water systems, including cold, warm, and hot. Microbial regrowth in potable water systems creates a real risk to patients and must be properly managed in both design practice, construction practice, and operating practices. With regard to issues as they pertain to these requirements, it is important to incorporate automatic and manual capabilities for water quality monitoring and flushing systems. These systems may challenge sustainability practices, however, they are necessary in protecting public health.

- Furthermore, where building systems are encouraged to have designs that facilitate energy savings, another challenge has been observed in the risk trade-off in microbial water quality. An example is the energy required to maintain water temperatures in a warm water system and the potential energy savings associated with reducing this temperature. Consideration should be given to maintaining water temperatures in a water system above 60 degrees Celsius (where practical) to ensure sufficient water quality and minimize microbial contamination risks. These considerations may challenge energy efficiency practices; however, they are necessary in protecting public health.

3.2.2 Design, operations and handover

As much as the design can be developed to be efficient, the future operation and management of the building and its systems will have a huge bearing on energy consumption. To this end the design team shall liaise closely with the relevant BEMS team to assist in checking that all design features are clearly understood and systems properly handed over for successful operation of the systems.

The success of initiatives will be based on briefing, design, construction and operational approach and depend as much on institutional issues as technical ones, an overall energy strategy should embrace the following:
- institute an enterprise-level energy management program integrated with other functions (risk management, cost control, quality assurance and employee recognition)
- involve all key stakeholders early in design process—keep the team focused on common goals; clarify and document the rationale for key design decisions supported by energy use and performance benchmarks
- apply life-cycle cost analysis to purchasing and decision making, including non-energy benefits (such as reliability and environmental impacts)
- avoid excessive ‘safety margins’ by using right-sizing to trim initial costs
• include integrated performance monitoring controls in the design and incorporate the
  information gained into operations and maintenance and an ongoing process of
  opportunity assessment
• thorough commissioning to published standards and post-construction fine-tuning of the
  mechanical services shall be implemented to reduce energy consumption
• incorporate a comprehensive quality assurance process (often called ‘commissioning’ or
  ‘retro-commissioning’) into new construction and renovation to detect and correct
  physical deficiencies that erode savings and/or performance
• provide facility operations staff with timely site-specific training to minimize energy
  usage
• patient health and care, occupant wellbeing, the provision of services, and the quality of
  services provided should not be put at risk by the overall approach taken.

3.3. Whole of life design

3.3.1. Overview

In selecting a system/material, the long term service requirements/cost benefits (whole-of-
life) are considered and not necessarily from a short-term perspective. The key objective for
whole-of-life is that an optimum service installation for a specific facility is identified and that
facility managers have confidence in the system selected.

For engineering services, whole-of-life means to consider the capital cost of an installation
 together with operating, maintenance and component replacement costs during the life of
 the service or facility—the initial capital expenditure is often quickly overtaken by recurrent
costs; any additional installation costs are soon realised early in the life of the facility.

It should be noted however that whole-of-life cost studies are part of a larger decision-
making process. As well as the physical and economic aspects of engineering services,
designers and operators will need to consider functionality, technological changes and
health operational changes, together with sustainable development, social and legal
implications.

3.3.2. Engineering considerations

As health building is likely to be refurbished and alter function several times during the
lifetime of the facility the designer shall consider the flexibility of services and future proofing.
In addition consideration shall be given to the requirements and costs for dismantling and
disposal at the end of the life of the building and partial dismantling during refurbishments.
The cost and energy performance of a facility must be able to be monitored and facility
managers must be able to control energy usage and plan effective
maintenance/replacement programs.

Careful consideration must, therefore, be given to the following elements:
• proposed capital expenditure
• maintenance and repair costs
• replacement costs at the end of economic life, inclusive of disposal costs
• utilities (i.e. power, water, gas) usage costs.

In addition the following relevant data is to be considered as part of any analysis:
• escalation rate
• discount rate
• energy escalation rate
• operating hours
• economic life
• costing or investment period.
3.3.3. Cost effective design

Engineering services approximate to around half the capital development cost of a health facility for new construction. Cost effective engineering design is therefore critical to achieving projects within budget.

In order to achieve cost effective design, the design shall ensure that:

- plant and equipment shall be specified to allow competitive pricing—except where directly required to be a specific item due to clinical needs or to suit a site/district wide approach to equipment selection
- the cost of on-going maintenance shall be considered, particularly in the selection of new plant and equipment within an existing facility. The potential cost impact on existing maintenance agreements and/or the ability of a facility to continue with a single maintenance agreement shall be included in considerations.
- design needs to consider capital and recurrent cost impacts of all elements—including direct maintenance and maintenance agreement costs, with major elements reviewed as a whole-of-life costing as per above.

3.4. Benchmarking

3.4.1. Requirement

All Queensland Health projects shall be benchmarked against commensurate projects/works to ensure value for money is obtained. Benchmarks shall be used to:

- establish project budgets in very early design phases (such as concept, pre-master planning, feasibility)
- evaluate value for money from projects following development of design.

Spending above or below a benchmark shall require justification to demonstrate both value for money (where above or below a benchmark) and adherence to guidelines and minimum requirements (particularly where below a benchmark). Benchmarking shall therefore be used as both a cost and quality control check within projects.

3.4.2. Basis for benchmarking

The main factors which impact on cost in health facility developments, in addition to the size of the facility, expressed in floor area or bed numbers, are:

- Clinical Service Capability Framework (CSCF) (i.e. the complexity of services provided)
- functional make-up (i.e. more expensive departments, such as operating theatres, laboratories or less expensive departments, such as clinics, engineering and stores)
- building configuration (i.e. single storey, low rise or medium rise)
- site locality (i.e. metropolitan, regional or rural)
- site specific factors (i.e. ground conditions)
- carparking (i.e. on-grade, low rise, multi-level or basement).

It shall be noted that all benchmarks are based on historical data and allowance shall therefore be made to evaluate benchmark information in current dollar terms, allowing for inflation, escalation and market movements.

3.4.3. Innovation

All benchmarked project elements shall include allowance for innovation and advancement in engineering design. Innovation shall generally be assessed via whole-of-life costing methods and benchmarking to demonstrate value for money to Queensland Health.
3.4.4. **External infrastructure and allowances**

Benchmarks shall generally not include external infrastructure costs as these are normally very site and project specific. External infrastructure beyond a building/facility/site includes sewer, stormwater, water, fire, gas, electrical supplies, telecommunications and items, such as external lighting, security and provisions for landscaping.

Cost comparisons between projects of infrastructure may significantly and unduly influence an outcome and the infrastructure costs should therefore be apportioned and assessed separately.

3.5. **Redundancy and reliability**

The reliability and redundancy of plant and equipment providing continuous operation of engineering services is critical to patient wellbeing and health facility functionality.

The provision of redundancy shall be provided on the basis of a site risk assessment, considering external infrastructure and internal criticality of services. The following principles of redundancy shall be applied to all engineering services, with consideration also of any directly supporting services/items:

- security of supply is required for major energy sources and utilities, such as power, generation, chilled water, domestic water and gas
- major plant will consider single failure with alternative paths continuing service
- all major and critical plant and supporting infrastructure to be located:
  - above storm surge and flooding levels
  - in areas with cyclonic protection
  - with safe access to plant areas, particularly with consideration of cyclonic protection
- distribution of infrastructure within the site and within the building will consider single points of failure and methods of providing reliability as far as possible
- critical equipment shall be maintainable without disruption to services
- all critical equipment should be backed-up with either duty/standby or an N+1 arrangement
- critical systems, such as essential power, gas and water, shall consider N+2 system level redundancy based on site risk assessment.

3.6. **Right sizing, flexibility and future proofing**

Health buildings are subject to constant change due to changing models of care and technology changes. As well as the health building structure its associated building services need to be designed with in-built future flexibility.

The pattern of use within a building is almost certain to change. Changes will be driven by many reasons, for example from competitive pressures and patient requirements, new management approaches, new technologies, changing fashions and changes in regulations.

Designing for future adaptability, such as a complete change of use, requires considerable design input and would not be considered unless specifically requested by the client.

Where expansion has been identified and quantified by a capital works plan, clinical service plan or Queensland Health policy or other public direction, review of the future allowances shall form part of the project master planning and feasibility phase. The design shall make provision for but not include the future expansion, taking into account issues such as space, access and the impact that future expansion can have on the provision and quality of engineering services. For example, for hydraulic services, this could include the
consideration of dead legs and maintaining adequate water temperature being delivered across a growing facility to mitigate future water quality issues.

Refer also to Section 2.9 of this document—Redevelopments, refurbishments and extensions for discussion of future proofing and flexibility requirements.

3.7. Maintenance and facility management
Breakdown and planned maintenance are performed by a combination of in-house resources and contractors depending on the complexity and extent of tasks required. Some minor contracts are specifically let for particular specialised maintenance requirements, such as sterilisers, cooling towers and other plant and equipment.

All designs for engineering systems and facilities shall be designed for safe access for maintenance and servicing, such as access to all plant and equipment, circulation around plant, provision of gantries and walkways where required, ramp access for trolley and forklift access, space to safely carry the necessary tools.

Plant and equipment selections, including fittings and fixtures, for projects on existing sites shall be based on standardisation across a single site and should be readily available.

Standardisation across a district shall be considered at the direction of the district BEMS manager and with agreement of the Queensland Health project director. Standardisation shall not be applied where value for money cannot be demonstrated by operational cost efficiencies.

3.7.1. Comprehensive maintenance agreements
Quotations for comprehensive maintenance agreements shall be obtained for all major plant and systems for periods following warranty and defects (also known as defects liability period) of one year, two, five and 10 years.

Comprehensive maintenance shall be factored in to whole-of-life costing. The implementation of comprehensive agreements shall be based on instruction from the district BEMS manager.

3.7.2. Standard document format
All projects shall provide information in a standardised Queensland Health document format. Document capture shall include all design and construction documentation, particularly as constructed, equipment schedules, technical data, functional descriptions and operating and maintenance manuals as:
- electronically in AutoCAD/Revit and PDF
- in hardcopy.

Detailed requirements for documentation are noted in CIR, Volume 4, Section 2, Engineering and infrastructure manual.

3.7.3. Asset identification
All projects shall capture and record information regarding plant and equipment via the Queensland Health Asset Management System.

Queensland Health shall provide asset identifiers via the Single Asset Identification policy (SAID) and shall confirm scope of elements for identification. The installing contractors shall affix the asset ID and provide data suitable for entry to CMMS in a format specified by Queensland Health.
3.8. Engineering Infrastructure
All projects shall provide assessment of engineering infrastructure as early as possible. Engineering infrastructure includes:
- power
- gas
- water—domestic and fire supplies
- storm water
- sewer
- telecommunications.

An engineering master plan shall be developed before budgets are finalised and the costs of connections, upgrades or modifications to authority and external facility infrastructure shall be established as part of this assessment.

For all projects resulting in a change in site demand to any infrastructure service shall ensure discussions occur with authorities, statutory bodies or providers as early as possible within a project to establish feasibility and potential cost impacts of any service modifications.

This work shall include an assessment of the potable water system for the buildings. The assessment will include expected water quality to be received by the facility (including engagement with the water supplier), how water quality may change throughout the facility, and active practices that should be placed into building design that will improve water quality (such as disinfectant dosing systems, hydraulic systems, water quality sampling and flushing stations, and other related water monitoring and quality maintenance equipment and practices). The assessment will also serve as an input to the development of the Water Risk Management Plan (WRMP) following completion of the facility.

3.9. Infection control
Research has shown that the healthcare environment can house secondary organisms with the potential for infecting patients. If healthcare-associated infection is to be mitigated and reduced, it is imperative that infection control is ‘designed-in’ at the concept planning and design stages of new construction or refurbishment project and that input continues up to the final construction stage.

Designers, architects, engineers, facilities managers and planners shall work collaboratively with infection control teams to deliver facilities in which infection control needs have been planned for, anticipated and met.

The principles of capital construction project from initial concept through to post-occupancy evaluation and major infection control issues and risks that shall be addressed include:
- understanding and assessment of the risks of infection relating to construction projects and the built environment
- understanding of the water supply system (cold, warm and hot) and as a potential source of microbial contamination and designing in prevention and remediation
- timely, collaborative partnerships to achieve infection control goals specific to each construction project
- understanding by all stakeholders of the basic principles of ‘designed-in’ infection control
- good project management in relation to infection control considerations for all new-build and refurbishment projects
- quality control throughout the duration of the construction project, including clear documentation of all decisions relating to infection control
• all Queensland Health kitchen and associated food infrastructure shall meet the Food Act 2006 (Qld) and Australia New Zealand Food Standards Code.

3.10. **Acoustics and vibration**
Key items of consideration for the acoustic performance of a project are:

- **off-site noise sources**, such as road, rail, aircraft or adjacent facilities
  - noise sources that must be considered are those that have the potential to influence the design of the development in terms of the building façade requirements (particularly glazing) and the positioning of external amenity areas

- **on-site noise sources**, such as building services plant and equipment, medical equipment, emergency vehicles, service vehicles and public site access and car parking
  - noise generated within a healthcare facility must be considered when determining the location of sensitive activities and in the design of building elements, such as façade, walls, floors
  - impact of environmental noise impact from the site to surrounding facilities and sites.

The design of the facility and particularly plant and equipment shall consider the effects of vibration on staff and patient well-being. All vibrating plant and equipment shall be isolated appropriately to ensure no transmission of vibration to surrounding structure or facilities. Vibration criteria shall be set appropriate for the use of an area and the surrounding areas.

The building structure shall be designed in accordance with Australian standards to minimise structural borne vibration and transmission of vibration. Issues to be considered include footfall vibration, impacts on medical equipment, impacts on patient well-being, noise and vibration transmission between rooms/buildings/facilities and acoustic privacy.

3.11. **Emergency management and disaster recovery**
In disaster management in Australia the terms emergency and disaster are often used interchangeably. The Australian Emergency Management Glossary\(^1\) offers the following definitions:

- **Emergency**—an event, actual or imminent, which endangers or threatens to endanger life, property or the environment and which requires a significant and coordinated response.
- **Disaster**—a serious disruption to community life which threatens or causes death or injury in that community and damage to property which is beyond the day-to-day capacity of the prescribed statutory authorities and which requires special mobilisation and organisation of resources other than those normally available to those authorities.

All health facilities must have an emergency plan providing for the following:

- an internal emergency affecting the facility itself. Internal emergencies relate to health facility based incidents, such as fire, bomb-threat, technological, industrial, gas leaks, structural damage and industrial. Plans for emergency evacuation of the facility and mutual aid arrangements for the care of patients are an essential element of a facility’s daily emergency procedures and planning. Such planning may involve the response by...
other emergency services and medical and health agencies, together with various auxiliaries and needs to be integrated with local community authorities

- an external disaster where casualties are directed to the health facility for definitive treatment and care. In the case of external disasters where casualties may be directed to the health facility with little or no warning, an effective response may well depend on the soundness and testing of the external disaster plan and the extent of training of staff required to provide such response

- Queensland Health shall define the level of criticality of a facility and the requirements for management and operation during and after disaster events. Key considerations shall include:
  - post disaster operation
  - period of stand-alone mode
  - extent of services to operate post disaster
  - the engineers shall consult with Queensland Health to establish a risk assessment for each site.

3.12. Earthquake and cyclone provisions

The objective of the earthquake seismic loading provisions is to prevent injury and loss of life from collapse of non-structural components of the building, such as mechanical and electrical services, by ensuring that earthquake forces are transferred to the structure. The requirements for earthquake and cyclone resistant design shall also be as a direct result of the risk assessments conducted for assessment of requirements for:

- redundancy and reliability (see Section 3.5)
- emergency and disaster recovery (see Section 3.11).

The building services (including essential services) shall be designed to resist earthquake forces, in accordance with AS 1170.4 and the seismic restraint manual (Guidelines for mechanical services by SMACNA).

It is important to establish early in the design process the earthquake design category, including structure type and site factor for the health facility as determined by the structural engineer and Queensland Health.

The Seismic hazard level (SHL) to SMACNA will be category A, B or C depending on the earthquake forces calculated in AS1170.4.

In cyclone prone areas, the design shall ensure suitable protection of openings, intakes, exhausts. Essential services shall be designed to operate during cyclonic conditions, with consideration of the requirements for reliability and emergency operation. It is important to consider the impacts of extreme events on the supply and quality of incoming water to the facility, as well as the quality of stored water on site.

3.13. Services coordination and integration

All building and engineering services shall be fully coordinated to ensure correct operation. The engineering check lists provided in CIR, Volume 4, Section 2, Engineering and infrastructure manual, shall be used as a guide, however the engineers shall ensure that all necessary checking and verification of coordination has occurred.

Coordination between engineering disciplines at interface points shall be particularly noted and documented, including physical interfaces, BEMS interfaces and services provided in support of other disciplines. Each system supporting an engineering service (such as BMS, EMS, SCADA, fire, security, nurse call) shall be capable of operating as a stand-alone
system without reliance on another service. Integration of engineering systems (i.e. convergent networks) shall be assessed on a site-by-site basis.

3.14. Integrated project delivery and Building information modelling

3.14.1. Benefits of integrated project delivery

Typically integrated project delivery (IPD) uses three-dimensional, real-time, dynamic building modelling software shared between all design parties to increase productivity in building design and construction. The process produces the building model which encompasses building geometry, spatial relationships, geographic information and information regarding building components. Studies have shown typical productivity savings as noted below when IPD is adopted. Specific benefits of IPD include:

- improved decision-making by reducing poor design decisions and using digital models and electronic design visualisations during design and construction
- improved contract documentation by reducing the level of unknowns in contract documents—eliminating the use of the RFI process to 'fill in the gaps'. Establish accuracy and precision and improve the level of construction cognition and assembly understanding on the part of the architects, engineers and owners
- improved preconstruction estimating by reducing the level of guesswork and inefficiency in preconstruction estimating by leveraging schematic design take-offs generated in the IPD process. Leverage the use of multiple pricing models by the contractor and reuse as-built digital models in new markets
- improved procurement and scheduling by reforming procurement and project scheduling through the use of time modelling (sometimes known as 4D modelling) and cost modelling techniques—eliminating job-site slowtime/downtime and improving sub-trade coordination, overlap and phasing
- improved coordination by reducing the number of field coordination errors by integrating the design models of the major design disciplines early in the design process and using clash detection software to facilitate interdisciplinary design coordination—thereby solving coordination issues virtually rather than in the field
- improved cost-efficiency to reduce cost impacts of coordination errors, incorrect fabrication and improper installation by adopting a pre-fit workflow from the designer to the sub-contractor and enforcing greater installation precision. Reduce the use of overtime labour and premium charges for recouping project schedule lost to these unnecessary errors. Reduce spending in general conditions, insurance and carrying costs by optimizing project schedules that will result in faster construction
- improved closeout documents to transform the archaic quality of closeout documents, particularly traditional as-built/record drawings, by migrating to a BIM-centric approach for all project documents. Transition the digital model generated during design and construction to facilities management, allowing the owner/operator to use it for building lifecycle management.

3.14.2. Building information modelling

As an enhancement to integrated project delivery, building information modelling (BIM) is the process of generating and managing building data during its life cycle. This extends beyond just the design process to also include as-constructed information, plant and equipment data and operational parameters.

BIM requires input from designers, constructors, contractors and maintainers to be an effective tool. The lifecycle cost of BIM and maintaining the accuracy of data within the model should be considered before an initial end-of-project model is requested.
3.14.3. Use of Building Information Modelling (BIM) for Queensland Health
The use of BIM on projects should be considered where required by the project brief or directly by instruction from Queensland Health. All new projects shall consider the use of integrated project delivery and the potential for upgrade to full BIM depending on the scale, scope and duration of the project.

Generally the use of IPD will follow where adopted by the lead designer/architect. Where applied, the BIM model shall include similar data as defined for the asset management system. It is noted that a capital cost may be incurred to include information within the model where not required for the purposes of design and documentation.

3.15. Commissioning, testing and handover of systems
The commissioning and handover of projects is a joint responsibility—Queensland Health, designers, constructors and contractors. A commissioning plan shall be provided for all projects, clearly detailing activities, responsibilities and acceptance criteria. The plan shall be submitted by the contractor for approval by the project sponsor prior to implementation. Queensland Health facilities generally support life-critical services and commissioning activities shall be rigorously applied in consideration of this.

All Queensland Health projects require appropriate commissioning, testing and validation protocols prior to handover to ensure the building services are satisfactory before handover. It is essential that all safety systems have been checked and are working correctly, such as fire doors, fire alarms, fire extinguishers, duress alarms, Closed Circuit Television (CCTV) cameras.

In addition to safety systems all other utility systems under mechanical, electrical and other building services shall be fully tested and commissioned to ensure they are fit for purpose. Testing and commissioning shall be fully documented with records entered into handover documentation.

All installations, irrespective of size, need to be properly commissioned. Queensland Health shall be provided opportunity to witness any testing and commissioning activities. Refer to CIR, Volume 4, Section 2, Engineering and infrastructure manual for a more detailed discussion of requirements for commissioning, testing and handover.

4. Discipline Specific
4.1. Mechanical services
4.1.1. Introduction
The purpose of heating ventilation and air (HVAC) conditioning 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
- energy management system
- associated control systems
- trigeneration/cogeneration
- refrigeration (coolrooms).

HVAC systems are generally required to deliver:
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- energy conservation and efficiency
- healthy environments
- comfort control
- infection control
- reliability
- flexibility/adaptability
- maintainability
- commissionability
- fire/smoke/life safety
- whole-of-life efficacy
- acoustic integrity.

4.1.2. Planning context
Energy system masterplans are seen as complimentary to site/clinical masterplans and a significant initiative for health facility developments and will allow projects and approaches to future work to benefit from a cohesive approach. Depending on the project size, new build v existing and the like, the analysis of benefits of decoupling the central energy plant from clinical facilities, decentralising or centralising services shall be subject to a study that addresses issues, such as:
- location of plant space in the building or remote
- freedom for space planning in buildings/costs and architectural impacts
- noise and vibration impact
- future expansion of the plantroom
- maintenance access.

Projects with clearly identified future stages shall have appropriate spare space allowances in central plant rooms, or strategy for future expansion, for installation of future chillers/boilers and facilities to allow connections, such as valves, space on headers for extensions to be completed seamlessly and without interruption to existing systems. Each riser should be designed to have 30 per cent spare capacity available for future installation of services with this requirement clearly shown as such on drawings, and then to be clearly labelled as such upon completion.

4.1.3. Energy/Sustainability
4.1.3.1. Passive measures
The following passive measures shall be considered in order to reduce energy wastage:
- a ratio of external envelope to floor area that within the constraints of the site, and internal circulation results in an efficient building form
- a well insulated and sealed external building envelope with thermal mass to dampen the effect of external environmental conditions
- optimum fenestration ratios to achieve passive solar heating, good daylight factors for natural light penetration whilst minimising the effects of solar gain/glare to perimeter spaces
- 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, containment and safety.

4.1.3.2. Active measures
The following active measures will be incorporated into the design in order to reduce energy wastage:
- 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, taking into account cross contamination issues
- the use of energy efficient motors with variable speed drives where appropriate, for pumps and fans
- HVAC systems to be adaptable to respond to a range of environmental standards which can vary depending on room function. Systems will, where appropriate, make use of free cooling and differing operating modes in response to external climatic conditions. Benefit from systems that utilise water rather than air as a heat transfer medium or where air systems effectively satisfy occupied zones only shall be explored as suitable system initiatives
- energy management systems integrated with a direct digitally controlled BMS system to allow monitoring, control and load shedding capability of selected plant
- 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
- engineering systems to be reasonably adaptable to respond to changes in planning and the likely changes in clinical needs, advancement in medical equipment and systems technology
- efficient insulation of distribution pipework and ductwork to minimise unwanted heat gains/losses
- trigeneration plant where appropriate demands exist.

4.1.4. Modularity, adaptability, integration and reliability
All efforts will be made to fully integrate all items of mechanical, electrical and ecologically sustainable design (ESD) services with the architecture and landscape design.
All mechanical systems must be designed and installed to provide adequate and measurable reliability by providing plant items and systems that satisfy design requirements for critical areas, through standby, modular or load shedding arrangements that are clearly defined in operational instructions.

The susceptibility of health facility activities to departures from the optimal environmental conditions varies greatly. Most activities (other than where safety is paramount) can tolerate several hours of lost conditions without major damage, but some are at risk even with brief losses of control.

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

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

A multidisciplinary approach may be required when considering legionella risks. Consideration should be given to the possibility of microbial contamination from a hydraulic system being dispersed via a mechanical ventilation system.
4.1.5. Design conditions

4.1.5.1. Outside design conditions

Outside design conditions shall be based on the most accurate climatic data available for the location of the proposed project.

Outside design conditions shall be selected as follows:

a) For the locations listed in AIRAH—ACS Design Aid DA9a: Air conditioning systems - Design temperature data.

b) For operating unit plants and critical care areas use the 'critical process', 24 hour data if available for the location, otherwise use the 'comfort or non-critical' data with appropriate allowance.

c) For all other plants use the 'comfort or non-critical Process Installations' data.

d) For locations not listed in design temperature data use data for the nearest listed location having similar climatic characteristics.

4.1.5.2. Room design conditions

The air velocity and temperatures within occupied zones shall be provided to maintain clinical requirements and accepted comfort limits.

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

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

4.1.6. Major plant selection

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.

In general, 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 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, giving consideration to:

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

4.1.7. Air handling systems

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

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

Zoning of all air conditioning systems shall acknowledge different dynamic loads and conditions likely to occur due to:
- external glazing and wall materials
- roofs and suspended floors
- hours of operation
- clinical or process functions
- internal heat gain from people, lights, equipment.

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.

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.

4.1.8. Infection control
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 air flow from clean to less clean areas. Maintaining required pressure regimes will frequently require air quantities in excess of the minimum scheduled in the Australian Standard and the CIR.

Positive flow at adequate rates is preferred to the defining of pressure differentials between areas. In some circumstances, flow may be required only on opening of doors and the system shall have adequate flexibility to accommodate this requirement.

Provision shall be made to ensure adequate air supply with varying filter resistances in areas requiring high levels of airborne contaminant control. Typically this will be in operating rooms, set-up rooms, isolation rooms and high infection risk areas and the like.

If individual room recirculation (unitary fan coil) units are to be used in high risk areas, high efficiency filters 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/delivery rooms
- nurseries
- protective isolation rooms/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.

Consideration should be given to the possibility of microbial contamination resulting from the hydraulic system being dispersed via the mechanical ventilation systems. For example, microbial 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.

4.2. Electrical services

4.2.1. 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.

To provide 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 also through consideration of alternate power sources including photovoltaic cells, wind energy, bio-diesel and solar cooling
- 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.

4.2.2. Power
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.
4.2.3. Source of supply, redundancy and reliability

4.2.3.1. Risk assessment

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 key 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 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.

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

- by preference, redundant full capacity normal supply available from separate high voltage feeders on ring main network or separate supply authority zone substations and a 1 x 100 per cent critical clinical load (30 second vital load) supply
- a 1 x 100 per cent capacity normal supply and a 2 x 100 per cent 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 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 capacity normal supply and backup emergency supplies complying with AS 3009 capable of safely and reliably supplying the loads required until normal supply is restored or these services are shut down.

4.2.3.3. Generators
Key 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/source.

A holistic approach to the design of the electrical infrastructure for availability, resilience and risk management is required.
4.2.3.4. Demand reduction
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.

4.2.3.5. 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.

4.2.4. Patient protection
Body and cardiac protected areas shall be provided as required by the model of care and the relevant standards.

4.2.5. Lighting
Design of interior lighting for health facility and healthcare buildings shall be provided based primarily on the recommendations of the Australian standards and the BCA.

Key design requirements shall include:
- luminaires shall be labelled with the type of lamp that should be used for re-lamping
- lighting selections shall be standardised across a facility and the different types of light, fitting, globe 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
- 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.

In addition, consideration shall be given to the following areas where cost efficiency could be achieved:
- identify areas where the recommended illuminance could be further reduced from specified or lighting levels nominated within standards/guidelines
- design parameters for illumination calculations and use of energy efficient light source.

4.2.6. Emergency and exit 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 building management system (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.
4.2.7. Energy/sustainability
Energy efficiency measures shall be incorporated into the design as good practice, provided that it does not compromise patient/occupant health care, nor the provision and quality of services. They may be necessary to achieve particular energy targets or ratings. A life cycle cost analysis should be undertaken for large capital cost options and as a minimum for:
- power factor correction at the main switchboard (minimum correction will be required by the supply authority)
- luminaires with low loss ballasts and electronic control gear
- use of high efficiency light sources where possible
- daylight harvesting encompassing photo electric sensors and dimming
- variable speed drives and high efficiency motors
- cogeneration or trigeneration.

4.3. Communications services
4.3.1. Digital health facility
The requirements for the national and Queensland eHealth initiative are pending further development.

4.3.2. Engineering
The requirements provision of engineering services networks shall be determined separately.

Systems associated with critical operation of facilities shall not be fully integrated. In particular, SCADA networks shall be independent of other systems and shall be hard-wired. Wiring systems and cabling for each service (BMS, nurse call and security) shall be structured and colour coded appropriately.

Consideration shall be given in the design of communications facilities to co-location with engineering services equipment for security (ACID and CCTV), nurse call and MATV.

4.3.3. Referral to Health Services Information Agency (HSIA) requirements
The detailed requirements for ICT services for healthcare facilities within Queensland are contained within the separately developed standards and guidelines provided by HSIA. The designer shall refer to the HSIA guidelines, policies, directives and referenced standards for further detail regarding ICT installations.

4.3.4. Nurse call
A nurse call system shall be provided for all appropriate facilities. Specific requirements for implementation shall be evaluated on a site-by-site basis, but shall generally be based on a single site-wide nurse call system shall be provided with consideration of the requirements noted particularly in Sections 2.4, 3.3 and 3.7 of this document.

General provisions of nurse call shall include:
- nurse call
- emergency call
- staff assist
- annunciator panels
- patient handset, which shall be cleanable and waterproof.
- nurse call management and reporting software.

The integration of the nurse call system with health facility administration functions to create a bed management and housekeeping management system shall be reviewed on a project specific basis.
4.3.5. MATV
MATV shall be provided to facilitate free-to-air television services for patient entertainment and staff common facilities.

Detailed implementation shall be assessed on a site-by-site basis, but shall generally include roof mounted antennae, backbone cabling, amplifiers and on-floor distribution cabling. The integration of MATV with patient entertainment systems and/or Queensland Health ICT systems shall be assessed based on the site ICT configuration.

4.3.6. Public address
A public address system shall be provided based on a site needs assessment.

Hearing augmentation systems shall be installed at public service areas in accordance with Australian Standards and the requirements for equitable access and services.

4.3.7. Patient entertainment
The provisions for patient entertainment shall be established for each project on a site-by-site basis. Integration of patient entertainment with Queensland Health ICT systems and internet access shall be assessed by Queensland Health.

4.4. Security services
4.4.1. 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.

The location and proximity of some departments may warrant special consideration in the furniture design and access and exit requirements. The placement of windows and doors can influence the level of security within a facility. Landscaping design and vegetation must also be considered as this can have impact on both personal and property security.

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.

Security systems shall comply with requirements of Queensland Health policies and Australian and international standards. Particular attention is drawn to the security guidelines for Queensland Health policy and supporting documents.

4.4.2. 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 is 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 and ISO/IEC 31010 Risk management—risk assessment techniques.

4.4.3. 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.

4.4.4. Internal security risks
When designing healthcare facilities, designers shall consider security for ‘high risk’ areas, such as:
- mental health inpatient units
- emergency departments
- drug and alcohol units
- methadone clinics
- Intensive Care Unit (ICU)/High Dependency Unit (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 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.

4.4.5. Security and privacy
The design of security systems for healthcare facilities shall include respect for patient privacy.

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 patient dignity this shall only be for clinical monitoring and shall not be a recorded feed.

4.4.6. Access control and intruder detection
4.4.6.1. 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.

Key requirements for 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.

4.4.6.2. 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 Paediatric Intensive Care Unit (PICU), Neonatal Intensive Care Unit (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.

4.4.6.3. Master key systems

All master key systems shall be a transferable profile owned by Queensland Health.

4.4.7. Closed circuit television

CCTV cameras is 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. In particular, CCTV shall be used in the following areas:
• facility main entrances
• emergency department
• mental health areas
• ambulance bays
• entrances used for access to a birthing suite after hours
• after-hours entrances
• nurses stations, with consideration of privacy associated with patient charts and records
• areas which cannot be adequately observed from nurses stations
• car parks
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.

4.4.8. 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, emergency department 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, wardspersons and security officers.

4.4.9. 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.

For larger health campuses secondary monitoring locations may be appropriate and the need for these shall be assessed on an operational need on a site-by-site basis.

4.5. Fire safety services
4.5.1. Introduction
Fire systems are systems installed in buildings to detect or protect the building and occupants from smoke or fire. The fire detection and suppression systems are to meet the requirements of all relevant codes and functionality using cost-effective solutions that achieve an optimal balance between capital, operating and maintenance costs over the life of the service.

Principally the objectives of the provisions of the BCA for fire fighting equipment and services 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.

The fire fighting equipment and services are to be provided to meet or exceed the minimum deemed-to-satisfy provisions.

The functional statement and performance requirements of the BCA shall be complied with. The use of fire safety engineering shall be subject to detailed consideration as defined in Chapter 1.3.
Fire water should not be used for potable water or cooling tower purposes without analysis and a risk management plan.

4.5.2. Fire protection
Fire protection of buildings relates to the active process of protecting the building (fire fighting) by use of:

- fire hose reels
- fire hydrants
- sprinkler systems
- gaseous or chemical fire quenching systems
- fire extinguishers.

Provision of fire protection services in health facilities is defined by current regulations and codes to give an appropriate level of protection to patients, personnel and buildings. Water main pressure and all requirements for fire tanks and pumps assemblies shall be identified early in the design process.

4.5.2.1. Sprinklers
Sprinklers shall be provided in accordance with standards and regulations, appropriate for the facility. The need for fire sprinklers for a specific facility shall be established during the design process by a BCA consultant, fire services engineer or fire safety engineer.

4.5.2.2. Hydrants and hose reels
Hydrant and hose reel systems shall be provided in accordance with standards and regulations. The need for hydrant and hose reel system for a specific facility shall be established during the design process by a BCA consultant, fire services engineer or fire safety engineer.

4.5.3. Fire detection and evacuation systems
Fire detection is the process of detecting fire or smoke in buildings using:

- smoke and thermal detectors including VESDA and multi-criteria
- manual call points (note when linked to the detection system will initiate a brigade call out when operated).

In conjunction with the detection or protection systems, other services are used to assist occupants in the safe evacuation of buildings:

- emergency warning and intercommunication system (EWIS)
- smoke management systems
- emergency lighting systems.

4.5.3.1. Fire detection and alarm
A fire detection and alarm system is required in accordance with standards and regulations. The need for the system for a specific facility shall be established during the design process by a BCA consultant, fire services engineer or fire safety engineer.

A minimum 20 per cent spare capacity in each detector loop and overall at the FIP shall be provided.

The fire indicator panel shall be installed within the fire control centre or fire control room as appropriate.

All systems are to be non-proprietary systems.
4.5.3.2. Emergency warning and intercommunication systems
An EWIS is required in accordance with relevant standards and regulations. The need for the system for a specific facility shall be established during the design process by a BCA consultant, fire services engineer or fire safety engineer.

Emergency warning and intercommunication systems are to be designed and installed to suit the sites layout. One system should preferably be provided for an entire site, subject to review of practicality and site constraints.

A master evacuation control panel (MECP) (if required) shall be located in the fire control room, as appropriate for the campus.

Secondary evacuation control panels (SECP) shall be located at the main entrance to every building that requires a EWIS for campuses of greater than one building. All SECP’s will be directly interfaced with the MECP via the common communications cabling infrastructure.

- Emergency warning via alert tones and emergency tones after a specified time lapse will be achieved via warning speakers installed throughout the buildings. Areas with ceilings will be installed with ceiling mounted speakers.
- areas without ceilings will be installed with wall mounted speakers.
- carpark and plantrooms will be installed with horn type speakers.

All systems are to be non-proprietary systems.

A minimum 20 per cent spare capacity in the zone amplifiers and ability to expand the main panel shall be provided.

4.5.3.3. Smoke hazard management systems
A smoke hazard management system is required in accordance with standards and regulations and shall be provided as part of the mechanical services installation. The need for the system for a specific facility shall be established during the design process by a BCA consultant, fire services engineer or fire safety engineer.

If required, the fire fans control panel shall be collocated with the FIP to control mechanical plant in fire mode. Interface to mechanical services equipment at mechanical control panels.

4.5.3.4. Emergency lighting
Emergency lighting shall be provided as required in accordance with standards and regulations and is detailed further within Section 4.2.6 under electrical services.

4.6. Hydraulic services
4.6.1. Introduction
Hydraulic services comprise the works installed by a licensed person in accordance with the Plumbing and Drainage Act 2002 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 and cold 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
• irrigation systems
• renal dialysis or RO water plant design.

4.6.2. General requirements
The general requirements for 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. Copper piping is the preferred material for hydraulic services.
• 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; 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; preferably within 6 metres.
• 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. The acoustic treatment shall be in accordance with the acoustic engineers requirements and/or the health facility’s management.

4.6.3. 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
- 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
- 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.

4.6.4. Infection control

4.6.5. 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.

Sanitary fixtures shall be selected on the following criteria:

4.6.5.1. Hygiene
That is ease of cleaning and 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.

4.6.5.2. 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.

4.6.5.3. Suitability for function
Quite clearly the fixture must be suitable for its function. Beyond meeting their basic function, additional enhancements must be demonstrated to be necessary on a clinical need basis.

4.6.5.4. Colour
Only white fixtures (not coloured) shall be selected, noting the requirements associated with DDA and colour selections for WCs.
4.6.5.5. 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.

4.6.5.6. Cost
Where the above criteria are met, selection between alternatives shall be on the basis of lowest capital cost.

4.6.6. Water Supplies
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), were published in January 2017 to be used to manage water quality, including other water-related hazards, in healthcare facilities. The additional information provided below 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.

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:

- **Supply Reliability**: The purpose for this 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

- **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).

- It should be noted that 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. This discussion will inform decisions by the designer on whether additional water treatment will be 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? ____°C avg., ____- ____°C range

**Potable water connections:** If practicable, 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. 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.

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.

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.

If the mains supply of potable water is assessed to be reliable, the use of storage tanks may not be required. 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.

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.

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:

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**Approximated Risk Levels Based on Parameter Values**

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### WSP Parameter and/or Condition of Water Supply

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notification prior to loss of supply (Risk = loss of water)</td>
<td>48 hrs</td>
<td>24-48 hrs</td>
<td>6-24 hrs</td>
<td>&lt; 6 hrs</td>
</tr>
<tr>
<td>Length of supply loss (Risk = loss of water)</td>
<td>&lt; 2 hr</td>
<td>2-3 hr</td>
<td>3-6 hr</td>
<td>&gt; 6 hr</td>
</tr>
<tr>
<td>Value of chlorine or chloramines residual in supply (Risk = biofilm growth and potable water microbial regrowth)</td>
<td>2-4 mg/L</td>
<td>1-2 mg/L</td>
<td>0.5-1.0 mg/L</td>
<td>&lt; 0.5 mg/L</td>
</tr>
<tr>
<td>Turbidity measurement value, off-specification delivery (Risk = colonisation of plumbing with microorganisms)</td>
<td>≤ 0.5 NTU</td>
<td>0.5-1.0 NTU</td>
<td>1.0-5.0 NTU</td>
<td>&gt; 5.0 NTU</td>
</tr>
<tr>
<td>Supplied water temperature values (Risk = biofilm growth and potable water microbial regrowth)</td>
<td>&lt; 20 °C</td>
<td>20-24 °C</td>
<td>24-26 °C</td>
<td>&gt; 26 °C</td>
</tr>
</tbody>
</table>

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 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).

#### 4.6.7. Domestic cold water systems

Cold water systems should be kept at or below 20°C and should fully comply with AS and CIR requirements. The following provides additional 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 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. 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 superchlorination 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.

### 4.6.8. 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. 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 superchlorination 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). If necessary, pipe insulation should be used 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 oC) shall comply with the requirements of AS, this CIR, and other related requirements. TMVs should be located as close as possible to points of use (preferably within 6 m), and should be accessible for cleaning and maintenance. The temperature of water at the outlet shall be in accordance with appropriate standards and guidelines, with consideration of user safety.

- **Cleaning and maintenance considerations**: Point of use areas such as basin taps, baths, and showers should be accessible and capable of being cleaned, especially where valves and other fittings may be attached (such as sink and shower fittings).

### 4.6.9. 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 the considerations as specified in 4.6.8.

4.6.10. Sanitary plumbing and drainage
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 pumpout 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.

It is recommended that drainage piping is not installed within the ceiling or exposed in operating and delivery rooms, nurseries, food preparation areas, food serving facilities, food storage areas, computer centres, 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 BMCS.

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 pumpout as appropriate without impacting on health service delivery. Traps, pits and tank inspection openings shall have gas and air tight covers.

4.6.11. Stormwater
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. Particular consideration shall be given to increased stormwater systems for tropical and cyclone prone areas.

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.

4.6.12. Gas services
The gas service installation is to be designed and installed in accordance with relevant Australian Standards and guidelines.

4.7. Lift services
4.7.1. 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.

The design, installation and operation of lift services shall be in accordance with the relevant Australian standards, the BCA, VHS requirements, Disability Discrimination Act 1992 requirements and Queensland Health policies.

4.7.2. Needs assessment
The need for lift (vertical transportation) services shall be determined by a number of factors which include the following:
- 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.

4.7.3. 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.

4.7.4. 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 tempered.

4.8. Medical gases
4.8.1. 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
• laboratory gases.

A reticulated system is preferred as it reduces the problems associated with the use of gas cylinders, such as safety, transport, storage and noise. Each medical gas is recommended to emanate from a central storage or generation point and reticulated 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.

4.8.2. 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.

4.8.2.1. Requirements
• 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.

4.8.2.2. 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 (SSDs).

Medical gases shall not be used to supply pathology departments, general workshops or mechanical services. These areas should be provided with separate installations however they should be designed and constructed to the same specification as a medical gas. They should not be provided with medical gas terminal units.
Portable suction devices should be used in infectious disease units.

**4.9. Central energy facilities**

**4.9.1. Introduction**

A central energy heating and cooling system distributes thermal energy from a central source to multiple buildings in a large healthcare campus situation. This is in contrast to the alternative which includes decentralised local plant.

The use of a central energy facility shall be an important consideration for the design of new health facilities and in the event of major refurbishment, redevelopment or similar for an existing facility. The opportunity to increase operational efficiency within a site, simplify maintenance and improve resilience shall be key drivers in this consideration.

**4.9.2. Application**

From a mechanical engineering services perspective, numerous inputs combine to form the decision making parameters for centralised energy services.

**4.9.2.1. Centralised vs. decentralised**

One of the most important of these considerations is the location of the central energy plant (CEP) on the site and the advantages of a centralised approach versus the multiple decentralised or precinct plant solution.

The benefits of a central energy plant can be significant. A central energy plant enables larger plant to be operated in a more efficient manner against a larger heating and cooling load, as a greater diversity is experienced when compared to buildings provided with individual plant. Enhanced back up and redundancy can also achieved in a single location, as well as allowing more rigorous plant maintenance functions to be remote from patient care and visitor areas.

District or precinct options for cooling and heating energy plant are often attractive in campus style settings, where built form may be interspersed and scattered over a large area. Under these scenarios, the cost of extensive distribution systems can be prohibitive to serve from a single central plant. Although for a staged redevelopment allows only the pipe reticulation relevant to each stage to be implemented thereby reducing the initial capital costs.

Disadvantages associated with precinct solutions are that the diversity factor experienced at the plant is diluted by splitting up the load—although if precinct plants are interconnected, then this dilution of diversity is minimised and enhanced redundancy can be created. Duplication of plant often results in loss of efficiency however, as well as increased maintenance cost and an increased capital cost.

**4.9.2.2. Redundancy and reliability**

Arguments of redundancy and single point of failure are two fold in that with precinct plant, loss of any one plant would mean that services are preserved to a significant portion of the site. However, loss of an entire plant is an exceptionally rare occurrence. The main risk for loss of an entire central plant would be related to some catastrophic failure, mains failure and/or terrorist attack. Central energy plants are generally designed to operate with an N+1 configuration on all major plant items and hence loss of all plant within the facility would be exceptionally rare. Notwithstanding this, it is necessary in the design of central plant to consider single point of failure issues and take appropriate steps to mitigate such eventualities.
4.9.2.3. Co and trigeneration
The opportunity of cogeneration/trigeneration viability also acts as an input to central plant considerations. For a cogeneration plant to be economically attractive, the availability of waste heat loads is a necessity so as to drive the cogeneration plant for as long as possible. To optimise the opportunity for cogeneration to be viable, it is therefore necessary for the waste heat loads to be centralised in a single location to enable the cogeneration plant the greatest opportunity of using its waste heat to greatest effect.

In view of the above, all site major plant and whole-of-life analyses shall consider both a decentralised precinct approach and a central energy option.

4.9.2.4. Design considerations
The assessment of a central plant option shall include siting considerations and consideration of:
- proximity to major loads, so as to minimise excessive reticulation lengths and excessive pumping heads
- discharge emissions from the central plant and their impact to adjoining occupied buildings
- noise control from the central plant
- capability for future expansion
- accessibility for maintenance and deliveries and the like.
- replacement of any component without disruption to any other element of the CEP
- maintenance traffic flows to be remote from health facility traffic flows, patients and visitors and the like.

Whilst the proximity to the major cooling and heating loads suggest that the CEP should be as close to the larger main health facility buildings as possible, the other key issues noted above indicate that the CEP needs to be remote from the main buildings, albeit not so remote so as to cause excessive pumping heads.