Volume 4

Queensland Health

Queensland Health

Capital Infrastructure Requirements

Volume 4 Engineering & Infrastructure

Section 4.1 Principles

Queensland Government

Capital Infrastructure Requirements - Volume 4 Engineering and infrastructure Section 1: Principles

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

Queensland Health disclaimer

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

Contents

1 Introduction

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 and Infrastructure.

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.

1.2 Volume 4—Engineering and infrastructure requirements

The engineering and infrastructure requirements of the CIR comprise of two 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 specific content per discipline, including application of the principles, requirements and technical details. Each discipline also includes checklists for the designer's reference only, a table of minimum deliverables by project phase, and a form for submission of details regarding non-conformances.

1.3 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.

1.4 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 pre-requisite 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.

1.4.1 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.

1.4.2 Deemed to satisfy

Queensland Health facilities and supporting engineering services shall be designed and installed in accordance with the National Construction Code (NCC) 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 NCC Volume 1 (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 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 rationale 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 need to be extended or augmented, and the feasibility of expansion
- 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, including for new facilities on existing hospital campuses and for greenfield projects, include:

- assess the impact of proposed new works on existing engineering systems
- broadly establish the capacity and condition of existing infrastructure and whether these 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 Engineering and infrastructure Section 1 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 per discipline outlined in *Section 2 Manual* should be used as appropriate 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 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 the Hospital and Health Service (HHS) or health facility. Where the HHS or facility Building, Engineering Maintenance Services (BEMS) group have standardised on 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 and environmental variances across the state. Equipment and systems specified/used shall be suitable for the 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 2011* (or latest version if superseded) does not guarantee water quality, engagement and consultation with the local water supplier may be needed 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 minimum deliverables per project phase and documentation requirements is contained per discipline in *CIR Volume 4 Engineering and infrastructure Section 2 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 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 of 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. Major electrical and mechanical risers shall be separated.

Risers adjacent to communications rooms shall be avoided, or at least providing two clear sides of in-ceiling access from the communications room 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 expansions

Refurbishment projects should meet the intent of the CIR where feasible. These refurbishment or minor works projects though do not necessarily need to comply with the letter of the CIR where this is not applicable to the extent, nature or scale of works proposed. Where compliance is not feasible or appropriate for the project, the rationale and design approach that is being applied should be clearly discussed within design reports and associated documentation.

It is not the intent of the CIR that all capital works retain spare capacity, space or availability that exists within a hospital or any specific engineering service. The purpose of major capital works projects providing spare capacity is to facilitate future minor works without the necessity for infrastructure expansions. Each minor project is not then required to 'replace' the spare capacity that it uses, but this may be provided for where practicable.

However, any project within an existing site shall include an engineering services assessment prior to production of the master plan budget. An engineering baseline status of all relevant infrastructure services and services or systems impacted by the proposed works The Capital Infrastructure Planning Studies process for evaluating existing engineering systems should be referenced as an appropriate guide to the extent of systems and level of detail required. Further guidance is also provided in below 3.8—Engineering Infrastructure.

If an engineering baseline assessment outcome is that upgrade is necessary to meet capacity or to maintain overall redundancy (ie. N+1) due to the proposed works, further considerations shall apply:

- 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 but not for capital replacement.
- Where the impacted service is an infrastructure system but not plant, augmentation of capacity is preferred where possible to avoid wholesale replacement and the operational impacts that full upgrade or replacement will cause. However, each project and site requirements will differ, so the proposed strategy for infrastructure changes must be explained within design reports.

In addition, redevelopment, refurbishment or expansion 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 necessary to meet statutory obligations (such as electrical safety requirements, fire services requirements).

Refer also to *CIR Volume 1 Overview* section 2.6—advice on alterations to existing facilities for discussion of the applicability of the CIR to redevelopments, refurbishments and expansions.

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 Section 1.3, 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.

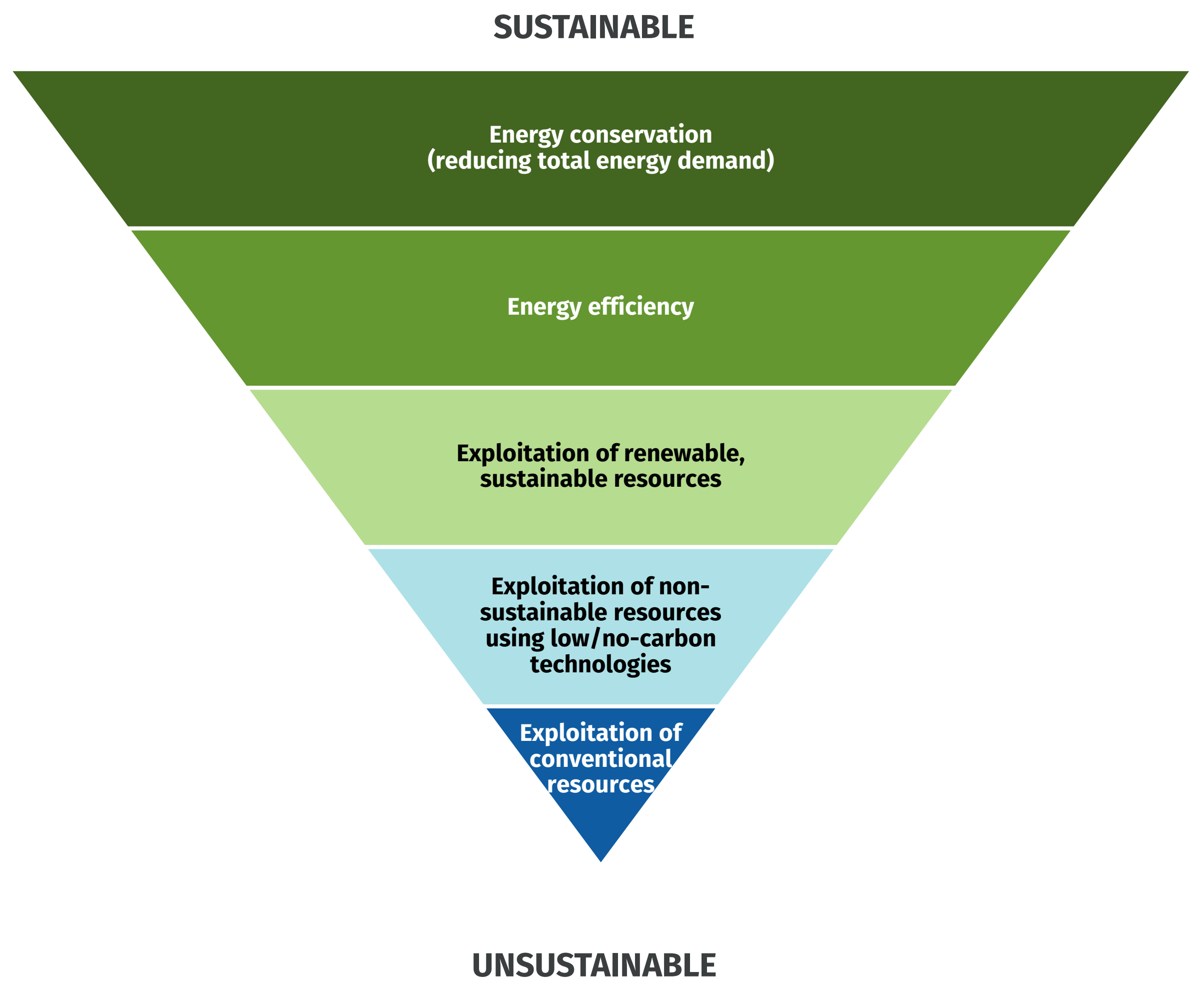
3.2 Sustainable development and operations

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 where water use is required for flushing and monitoring to meet microbial water quality needs
- cost-effectiveness over whole lifecycle.

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 within projects, such as an energy hierarchy, to help inform a responsible decision-making process:



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 wastewater 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 functionality.

The following shall be considered:

- systems shall be appropriate for the location in terms of climatic conditions, sophistication of facility services, availability of skills and support
- engineering systems shall be reasonably adaptable to respond to changes in planning and the likely changes in use and requirements
- Furniture fittings and equipment procurement shall address energy efficiency requirements so that they match the overall targets and aspirations of the facility.

Combining sustainability and quality

- Where building designs 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. 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.
- 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. The design and construction teams 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 or material, the long-term service requirements and cost benefits (whole-of-life) must be considered. The key objective for whole-of-life is that the right 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.

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.

Whole-of-life studies are not necessary or appropriate to every aspect of design but, in an engineering context, should be used within a project to consider aspects such as:

- major plant and equipment: strategies for site (i.e. centralised v decentralised)
- major systems and selections: comparison of selections, balancing capital v recurrent cost considerations etc.

3.3.2 Engineering considerations

As a 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.

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.

Guidance on preparing whole-of-life studies, including the development of net-present value analysis, is available from many sources. Useful examples include, but are not limited to:

- https://www.gsa.gov/node/81412
- https://www.wbdg.org/resources/life-cycle-cost-analysis-lcca

3.3.3 Cost effective design

Engineering services approximates 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 project 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
- whole-of-life costs should be applied (refer above) to ensure appropriate assessment of the cost of on-going maintenance for new or replacement major plant and equipment. 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.

3.3.4 Value engineering

Any 'value-engineering' process, which is applied to a project, shall include reassessment of whole-of-life considerations. A process of reducing project capital cost but at the long-term expense of operating costs is not acceptable.

Where a previously submitted approach to project strategies is impacted by a proposed value-engineering or value-management process, a full reconsideration of whole-of-life must be prepared and submitted. Consequential impact on subsidiary systems, project capital costs and operating costs, must be included in the analysis. Partial assessment only of directly impacted project elements only, where intentionally or unintentionally obscuring the full whole-of-life outcomes, will not be accepted.

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* (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).

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 services, 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 based on 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 or items:

- security of supply is required for major energy sources and utilities (i.e. 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 system level redundancy based on site risk assessment.

Reference is made to the engineering discipline specific sections within *CIR Volume 4 Engineering and infrastructure Section 2 Manual* for further application of redundancy and reliability assessment on a system-by-system basis.

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 should not normally be considered or factored into design unless specifically requested by the client.

Where expansion has been identified and quantified by a capital works plan, clinical service plan, 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 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.

Where appropriate, system capacity and connectivity should be provided for future needs (ie. pipe sizing, cable sizing, spare valved connections, additional points of system isolation etc) based on a project-by-project assessment.

Refer also to Section 2.9 of this document—Redevelopments, refurbishments and expansions 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 specialised maintenance requirements, such as sterilisers, cooling towers and other plant and equipment.

All engineering systems and facilities shall be designed for safe access for maintenance and servicing. This includes access to all plant and equipment, circulation around plant, provision of gantries and walkways where required, ramp access for trolley and forklift access, and 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

Documents shall be provided in accordance with and in formats defined by the Queensland Health *Project Information Requirements* (PIR) *for Building Information Modelling* (BIM).

3.7.3 Asset identification

All projects shall capture and record information regarding plant as part of the project deliverables, per the Queensland Health PIR for BIM. Information shall be captured in formats appropriate for integration into the Queensland Health Asset Management System.

Queensland Health shall provide asset identifiers via the *Single asset identifier (SAID) guideline (QH-GDL-354-1-1:2017)* and shall confirm scope of elements for identification. This is to be documented in the BIM Execution Plan (BEP) for both design and construction. The installing contractors shall affix the asset ID and provide data suitable for entry to Computerised maintenance management system (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.

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 to establish the 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.

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* and Australia New Zealand Food Standards Code.

3.10 Acoustics and vibration

The design of the facility and particularly plant and equipment shall consider the effects of noise and 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.

All plant and equipment noise shall be appropriately contained and treated to ensure the noise levels in surrounding occupied spaces are per the requirements of the project brief.

Refer also to *CIR Volume 3 Architecture and health facility design Section 2 Manual and Specification* and to engineering discipline specific requirements in CIR *Volume 4 Engineering and infrastructure Section 2 Manual*.

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[12] offers the following definitions:

[1] Manual 2, Disaster Medicine, Health and Medical Aspects of Disasters, Emergency Management Australia

- 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 action. 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:
  - Such as multiple trauma accident, where casualties are directed to the health facility for definitive treatment and care.
  - Such as a disaster impacting on the community and potentially hospital concurrently (i.e. cyclone, earthquake, flood).
  - An external, potentially deliberate, event such as a chemical, biological or radiological disaster or act.
- In the case of external disasters 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
- Designers shall consult with Queensland Health to establish a risk assessment for each site and service and shall provide design accordingly in response.

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 systems,* 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 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 onsite.

3.13 Services coordination and integration

All building and engineering services shall be fully coordinated to ensure correct operation. Designers 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, BMS 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 Central energy facilities

3.14.1 Introduction

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 large-scale facility. The opportunity to increase operational efficiency within a site, simplify maintenance and improve resilience shall be key drivers in this consideration.

3.14.2 Centralised vs. decentralised

One of the most important considerations is the location of the central energy plant on the site and the advantages of a centralised approach versus the multiple decentralised or precinct plant solution. These advantages and disadvantages of a centralised versus decentralised plant approach shall be evaluated on a site specific basis, and shall include consideration of:

- site load and diversity
- operating efficiency
- redundancy and reliability, including single-point-of-failure review
- maintenance costs
- complexity v simplicity—implementation and on-going operations
- expansion and future development.

3.14.3 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 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.

3.14.4 Design considerations

In addition to the advantages and disadvantages noted in 3.13.2 above, the assessment of a centralised versus decentralised plant option shall include consideration of:

- siting of plant: proximity to major loads, to minimise excessive reticulation lengths and excessive pumping heads
- discharge emissions from the plant and their impacts to adjoining occupied buildings
- noise control from plant
- accessibility for maintenance and deliveries and the like
- replacement of any component without disruption.

3.15 Building Information Modelling

3.15.1 Building Information Modelling (BIM)

The PIR document lists Queensland Health's BIM objectives, which broadly covers the management of information throughout project initiation, planning, design, construction, and operation.

A BEP is required for design and for construction. The Queensland Health BEP templates should be used as defined in the PIR. A BIM Manager shall be appointed for all stages across design and construction.

3.15.2 Use of BIM for Queensland Health

The expected use of BIM on projects is clearly defined using project tiers in the PIR for Building Information Management document.

3.16 Electronic and ICT communications systems principles for selection and Integration

3.16.1 Introduction

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

This section offers a brief overview of the principles to be adopted when considering the design of the range of information, communication and electronic engineering systems which may run on the ICT Infrastructure to be found in a Queensland hospital. The details provided are for guidance only, they are purely indicative and non-exhaustive.

ICT systems will be designed and installed in accordance with all Queensland eHealth Standards including the ICT Cabling Standard.

The principles outlined below are provided as a guide and are not intended to be prescriptive. The need and extent of the electronic and ICT systems and, in particular the level of integration of these systems, will be determined on a project by project basis.

3.16.2 Planning and context

Digital systems, and their respective integration, have rapidly become a significant component of all capital infrastructure health projects with responsibilities for planning, design, delivery and commissioning to be clarified and agreed with all stakeholders in the early stages of business case development.

The design team is to ensure important communication planning and design issues which have an impact on the building design and other building services design are properly addressed, with appropriate solutions selected and adopted at the early business case stage of the project development.

It is a fundamental principle and requirement that a structured and consistent approach to the planning, design, delivery, and commissioning of digital solutions within capital infrastructure health projects is affected through a dedicated digital workstream.

It is expected that the roles and responsibilities within the digital environment are clearly defined and allocated to the appropriate stakeholder groups throughout the capital infrastructure delivery lifecycle.

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

Key early considerations include:

- early engagement with eHealth

- review and agreement of the Queensland Health Master Systems Integration Framework
- proposed cabling routes to connect new or refurbished facilities
- site location in context to the major data centre(s)
- site location in context to the legacy PABX Room and
- cost and service impacts for the intended level of systems integration.

The required systems and level of integration may also be influenced by:

- recommendations of Australian Codes and Standards
- new developed technologies that offer significant benefits to a health facility
- user preference based upon specific project briefing process
- best practice and lessons learned from similar projects.

3.16.3 Systems and infrastructure

The number and type of electronic and ICT systems across a development can be extensive and basic systems would typically include:

Engineering systems that may run and achieve interoperability on the ICT Infrastructure:

- CCTV
- security management system
- electronic access control
- duress—fixed and mobile
- intercom systems
- Building Management and Control System (BMCS)
- electronic/digital way finding/signage
- nurse call
- public address
- lighting control and emergency lighting systems
- PLC/SCADA System(s)
- pay TV/MATV signal distribution system(s)
- hearing augmentation
- master clock system
- pneumatic tube system monitoring and alarm
- TMV monitoring system
- distributed antenna system
- audio visual systems.

The degree of interconnection and interoperability of systems e.g. into the Message Integration Engine, of the following systems shall be conducted on a case-by-case basis, depending on the size location and nature of the project:

- nurse call
- BMCS
- security (access control and CCTV)
- fire indicator panel
- emergency warning and intercom system (EWIS)
- fixed duress
- intercom.

There are a range of other ICT associated considerations, which although usually deemed non-engineering elements, will impact upon the building and building services design and installations:

- communication and computer rooms including redundant air conditioning, racks, power rails in racks, PS, generator backed up power, cable management, fire protection, environmental monitoring and room physical security
- telecommunication lead in(s) to the campus, terrestrial or aerial
- structured cabling, including fly and patch leads
- data outlets including wireless access point (WAP) cabling and outlets for equipment, such as a workstation on wheels (WoW), both wireless and docking
- mobile telephone distributed antenna system and mobile phone macro tower(s)
- radio-based communication including for use by facility staff as well as emergency service providers such as police, fire and rescue, ambulance, Government Radio Network (GRN)
- UPS to servers, network equipment and other key equipment
- telecommunication panels including MDF and IDF
- patient entertainment/engagement system cabling and possibly active equipment
- equipment and cabling to support Video conferencing/telehealth. This may include fixed speakers, microphones, screens, projectors, matrix switchers, cabling to floor boxes, cabling between a table and display/projectors/screens
- external or internal intercom, this may be provided as part of the telephone system
- pager Infrastructure
- public address system, this may be integrated with the telephone system or EWIS
- video conferencing
- patient observation system
- Real-Time Location Services (RTLS)

- biomedical services network
- university network
- corporate wireless network
- guest/BYOD wi-fi
- public telephones
- point of care terminals
- single sign on/rapid access
- thin client/virtual desktop Infrastructure.

It is evident that all capital infrastructure health projects will have a digital component regardless of size, complexity or tenure of the project. For example, this may include a large scale greenfield hospital, a leased community health facility or a small theatre refurbishment that includes a digital component of works.

The principle of early engagement with eHealth and appropriate utilisation of the Queensland Health MSI framework should be applied at project commencement and should be integrated into the design development process for all design teams working in the Queensland Health environment involved in the planning, procurement, delivery and commissioning of capital infrastructure health projects.

3.17 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 (i.e. life-safety systems of fire doors, fire alarms, fire extinguishers smoke hazard management systems and security services including duress and CCTV).

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 the defined purpose. Testing and commissioning shall be fully documented with records captured as project information in accordance with the Queensland Health BIM guidelines.

All installations, irrespective of size, need to be properly commissioned. Queensland Health shall be provided opportunity to witness any testing and commissioning activities. The following general principles shall apply.

3.17.1 Phases of activities

The process of handing-over a facility to Queensland Health shall involve several activities:

1. Planning—the process of commissioning and handover shall be planned from early in the design. A design which considers the requirements for commissioning and handover will include necessary elements within specifications and documentation to assist and facilitate this.
2. Pre-commissioning—prior to commissioning activities commencing, more detailed planning shall be conducted to schedule out each and every commissioning activity and test. Key stakeholders shall be involved in this process, including engineers, contractors, project managers, user representatives and client engineering representatives (i.e. building, engineering and maintenance staff (BEMS)). Planning shall include:
    - details of each commissioning element and test, including pass and failure criteria
    - documentation of dependant tests between services (i.e. between mechanical and electrical for generator mode operation, between mechanical, electrical and fire for fire mode operational testing)
    - integration testing of systems to ensure all interfaces operate as specified and required
    - stress testing of elements, systems and facilities
    - contingency for retesting if required.
3. Commissioning—the activities of commissioning by the contractors, with witness testing by the design consultants at the conclusion of contractor commissioning.
4. Testing and witness validation—verification of the commissioned outcomes via systematic and randomised testing of the facility or systems by both the consulting engineers and the client or client representatives such as BEMS. Testing and witness validation shall be a project hold point. Any failure during this period shall be rectified fully via complete re-commissioning and testing before the project proceeds.
5. Documentation—all commissioning activities and outcomes shall be fully documented, as detailed further below. A building users guide shall be provided to assist occupants and maintenance staff in working within and operating the facility.
6. Handover—provision of the fully commissioned and operational facility to the client. The process of handover includes the provision of a fully commissioned and operational facility to the client. It should be noted, that the facility may go through 'handover' many months prior to the client being ready to occupy the facility. This gap between handover and occupancy may be termed 'off-line pre-occupancy'.
7. Off-line pre-occupancy—the time period where the facility may have completed handover from the constructor to the client, but it remains unoccupied by the client. During this period, there is a risk of microbial water quality degradation within all potable water systems due to stagnation, which will require active management. Water quality needs to be maintained during this period by preparing and implementing a systematic flushing program. Any water treatment systems provided (such as addition of chlorine residual) need to be operational.
8. Post occupancy support—key requirements include:
    - rectification of any defects which do not affect operations

- provision of the post occupancy survey and review of outcomes
- provision of site maintenance and inspection as specified with project documentation or statutory requirements
- building tuning of plant and systems to achieve optimal operation
- rectification of any defective items which occur during the defects and liability period (DLP), also known as the warranty and defects period
- provision of breakdown and emergency support as specified
- training of client engineering representatives and subsequent refresher training to ensure that staff are capable of managing a facility at the conclusion of the DLP
- full condition assessment at the conclusion of the DLP to confirm all plant and equipment is in condition commensurate with one year's operation under comprehensive maintenance (i.e. as new, but with reasonable wear and tear for one year of operational life).

9. Project archiving—the collation of all project documentation (pre-design, design, construction and post construction) into a project archive and the suitable retention of this information by Queensland Health for use in future planning, benchmarking and other activities.

3.17.2 Planning checklists

The following checklist is applicable to all sizes of installations:

- Has the appointment of a commissioning specialist been considered?
- Can the systems be commissioned in accordance with the specification and the CIBSE commissioning codes (1–5)?
- Can the installed building services be adequately and safely maintained after handover, including maintaining water quality between commissioning and 'going live'?
- Have validation checks at manufacturer's works been allowed for on the major plant items?
- Have checks for the patented and proprietary systems been nominated rather than just assumed to be working?
- Has sufficient detailed design information been provided, especially in respect of control regimes, including set-points, system flow rates and plant capacities?
- Is the specification definitive in its content of the commissioning responsibilities and acceptance criteria and tolerances?
- Is the specification adequately detailed in respect of the protection of plant and equipment during transportation, installation, commissioning and testing?
- Has a feedback procedure been implemented to recognise and address design problems that manifest during commissioning and testing in order to prevent repetition on future projects?
- Has a preliminary commissioning plan and schedule of requirements been outlined in specification documents?

3.17.3 Pre-completion checklists

3.17.3.1 Early construction

During the early phases of construction, once the trade contractors have been appointed and are established on the project, the following shall be implemented:

- a project commissioning team shall be established to control, review, track and manage the commissioning activities
- a responsibilities matrix for commissioning and handover shall be created and shall be maintained regularly as construction and detailed planning progresses
- client representatives shall be invited to attend all commissioning and handover meetings and planning
- preliminary commissioning plans shall be established by each trade outlining their activities.

3.17.3.2 During construction

Commissioning plans shall be reviewed between trades to establish interface points. An interfaces matrix shall be created and maintained for the remainder of the project.

The responsibilities matrix shall be reviewed.

Documentation of any site changes shall be maintained for ALL changes from design documentation, irrespective of how seemingly small. Issues, such as cable locations in walls, pipe locations in ceilings, valve access point are information which must be accurate to minimise future cost of maintenance or alterations.

Where a trade completes work within an area, floor or facility, as-constructed documentation shall be provided based on the approved workshop documentation and any site changes implemented. The contractor shall verify their as-constructed documentation with review by the consultant and client as or if required.

3.17.3.3 Two to three months before completion

Approximately two to three months before the scheduled completion date it should be ensured that:

- Queensland Health is informed of any likelihood of change to the scheduled completion date
- contractual obligations regarding witnessing of commissioning and testing, failure defect and deficiency inspections and outstanding items of work (snagging) are clarified
- Queensland Health is made fully aware of its post-handover obligations, including the need to arrange insurances and contracts for maintenance
- arrangements are made to recruit operation and maintenance personnel as required
- relevant authoritative bodies have been approached to determine any necessary inspections and approvals, this may include the local authority, the health and safety committee and the fire authority

- Queensland Health is consulted regarding the format and required procedures for the handover meeting
- tariffs for the utility supplies have been negotiated and a contract with a meter operator arranged
- inspection of works commences in accordance with inspection policy and programme.

3.17.3.4 One month before completion

Approximately one month before the scheduled completion date, it should be ensured that:

- if required, an engineer is appointed to assist Queensland Health during the initial period of occupation
- licences are obtained for the storage of hazardous chemicals
- pre-commissioning cleaning of the water, heating, ventilation, and air-conditioning systems is carried out
- all water services are flushed and hydrostatically tested according to AS3500
- draft operation and maintenance manual and record drawings are submitted and checked
- ongoing inspections are carried out in accordance with inspection policy
- a schedule of any outstanding work is agreed
- any additional works that are required are arranged
- all necessary statutory examinations have taken place (fire systems, means of escape, pressure systems and lifts)
- all utility supplies are inspected, approved and signed off
- user demonstrations and training session(s) have taken place, details recorded of those in attendance and certificates of competence awarded, as appropriate.

3.17.3.5 One week before completion

Approximately one week before completion, it should be ensured that:

- all commissioning work has been completed and witnessed
- the commissioning report(s) and associated information have been issued
- all the required test certificates have been issued
- final inspections have been completed as required
- water treatment appropriate to the installed services has been carried out
- all warranty documentation has been issued
- the completed or semi-complete operation and maintenance manuals and record drawings have been issued and approved
- all the required tools, spares, consumables have been assembled and an inventory provided
- waste or surplus materials been removed from the site
- workplace health and safety information has been checked and issued

- re-lamping, filter changing and cleaning have taken place as required by the specification
- the listed outstanding defects have been rectified to acceptable standards
- all meter readings and fuel stocks have been recorded
- all water services including storage tanks are cleaned and disinfected according to AS3500
- measures are put into place to prevent stagnation
- continue water testing in accordance with water risk management plan provisions under the *Public Health Act 2005* (https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/risk-management).

3.17.4 Commissioning

Commissioning activities shall be detailed for each service as part of design documentation and as outlined within the CIR. Additional commissioning required shall be performed to ensure a fully functional, correct and as-specified project is provided at handover.

Refer to detailed requirements for each engineering service detailed in *CIR Volume 4 Engineering and Infrastructure section 2 Manual*.

It is important to not have stagnant water in the water storage and supply systems. The commissioning and post commissioning phases shall include plans to ensure water circulation and/or flushing.

3.17.5 Testing and validation witnessing

Testing and validation witnessing shall be provided to verify the commissioning as provided by the contractors. The engineer shall undertake such tests as are necessary to satisfy them that a system has been correctly installed and commissioned suitable for handover.

The Queensland Health representatives may request testing of any system installed to validate that it has been correctly commissioned to their satisfaction.

Any failures during the testing and validation period shall result in full re-commissioning of the system, any associated or sub-ordinate systems, plant or equipment and re-commissioning of all system integration points.

3.17.6 Documentation

3.17.6.1 Design and installation information

Comprehensive documentation to support commissioning and testing activities is of paramount importance. The records will show that statutory requirements have been met allowing the building to be certified as safe for occupation.

Commissioning documentation provides a record of the design operation of the commissioned systems. These records are invaluable in ensuring that the performance of the system is kept up to standard. Additionally, they provide an essential basis for the logical adjustment of system performance or for the recommissioning of systems following modifications or adaptations of the accommodation or its services.

For most Queensland Health projects operating and maintenance information will be entered into the Queensland Health CMMS.

3.17.6.2 Building users guide

A building users guide (BUG) shall be provided as part of the handover/commissioning documentation for all projects to enable the building occupants and health facility engineering personnel to manage the facility in the most appropriate manner.

A BUG is an operational tool that will assist facility officers, project officers and occupants in the day-to-day operation of their space and will assist in:

- informing staff on facility management practices, security and waste processes. This will include quality targets for the water supply system, and if applicable, operating instructions for the water treatment equipment
- informing and motivating staff to embrace a new approach to process and cultural change within the workplace
- reducing time in development and delivery of fit-outs
- providing more efficient communication between staff, service providers and building owner thus enhancing service delivery outcomes
- providing support to the relocation/change management process
- providing a higher standard of maintenance by focusing on more effective strategies, such as compliance and energy efficient provisions in the built environment
- Providing source information for the development of a WRMP, which will be one of the first tasks undertaken by the facility management/operations team.
- reduction in energy consumption allowing savings that can provide for more efficient building systems, capital works and fit outs
- provision of a healthy work environment.

A BUG will be of greater importance for more significant or more complex facilities where:

- facility managers to understand in detail what they need to do to operate the asset efficiently and to assist in the identification of further tuning that may be necessary to continuously improve performance and respond to future changes
- contractors to understand how to service and maintain the particular systems not only for reliable operations, but also for energy and water efficiency
- occupants to understand any limitations that they must work within to maintain the design performance
- future effective fit-out/refurbishments streamlining owner approvals for the building to conform with the Queensland Health and State and Australian Government strategic energy efficiency policies together with any carbon reduction strategy.

3.17.7 Building handover

At practical completion and as a minimum the following tabulated commissioning information shall be provided:

- main plant performance results
- air and water (flow regulation) results
- specialist plant commissioning/test results
- pipe work and ductwork pressure test certificates
- fire alarm test certificates
- security/CCTV test certificates
- wet fire pressure test and flow certificates
- check-sheets recording systems interface
- check-sheets recording the commissioning of building management/controls systems
- electrical completion and inspection certificate
- emergency lighting test certificate
- lightning protection test certificate
- test sheets recording the progressive testing of the electrical installation in accordance with Australian Standard 3000
- statutory authorities' approvals
- as-built record drawings (indicating location of test points)
- operation and maintenance manuals
- results of monitoring for disinfectant residual, water temperature, Legionella and other water-related hazards (as identified within the water risk management plan) at a representative number of outlets across the facility in accordance with water risk management plan provisions under the Public Health Act 2005 (https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/risk-management)
- measured water temperatures for cold, hot and warm water systems at representative points throughout the system, including water heaters and storage tanks.

3.17.8 Offline pre-occupancy

During the time which the building has been through handover from the constructor to the client, but remains mostly unoccupied, there is a risk of microbial water quality degradation if the potable water systems are stagnant. To minimise the risks of microbial growth in the potable water system, the requirements as per the water risk management plan provisions, under the Public Health Act 2005, should be put in place (https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/risk-management)

Monitoring disinfectant residual, temperature, Legionella and other water-related hazards (as identified within the water risk management plan for the facility) should be conducted.

3.17.9 Post occupancy

3.17.9.1 Building tuning

The function of commissioning is to set a system into the required mode of operation, as envisaged by the designer. Fine tuning is the process of adjusting the operation of a commissioned system to match the actual need of the building occupier more closely. In certain instances this may include some form of remedial action to mitigate any adverse operational effects of overdesign.

The design of a building services system is normally based on the interpretation of the client's requirements and a series of criteria assessments made by the designer.

Inevitably, the specified parameters against which a system is commissioned do not generally coincide precisely with the actual operational requirements of the building occupier. The design provision may either exceed or underestimate the eventual requirements.

In the early stages of building occupation, these imbalances may lead to adjustments to flow rates in the air and water distribution systems to accommodate the occupier's requirements. The need for amendment to the flow rates should be assessed, the revised flow rates decided, appropriate adjustments made to the system and the actual modified flow rate measured and recorded. Additionally, the commissioning record documentation should be amended as necessary and, as with any installation modification; checks made to measure and record any effect on the remaining fluid distribution in the adjusted system.

Depending on the precise requirements of the occupants, the commissioning carried out to the original design may need to be readdressed if the final requirements differ from those envisaged in the initial design. This could justify a separate commissioning process to fine tune a system to match the occupant's specific needs.

3.17.9.2 Ongoing operation

To ensure satisfactory operation of the facility into the future the performance of the engineering services should be maintained and monitored.

The key elements of a suitable program include:

- regular maintenance testing and recalibration of base building services
- prompt action in response to performance issues
- monitoring and maintenance of indoor temperature at set summer and winter ranges
- regular HVAC tests for contaminants and removal of contaminants
- offsite storage for all hazardous material, such as paint and cleaning products
- all plant monitored and maintained according to statutory requirements and building operation and maintenance manuals
- a WRMP must be established in accordance with the water risk management plan provisions under the *Public Health Act 2005*
- (https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/risk-management).

In addition, implement suitable targets for lower energy use and greenhouse gas emissions by:

- monitoring and reporting of building energy use and greenhouse gas emissions
- conducting energy assessments annually for buildings
- reducing energy use via the use of energy performance contracts and other energy efficiency projects
- metering of building energy consumption and water use, including cooling towers
- implementing staff educational programs to promote energy conservation.

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

3.17.10 Building performance evaluation

BPE can be defined as:

> 'the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time.'

The BPE process is an integral part of the process of facility planning within all health projects. It is to be completed approximately 12 months after handover of the completed project to the HHS. The focus of BPEs is on lessons learned and continual improvement such that this feedback will be applied to future capital projects.

The process for undertaking a building performance evaluation is similar for all types and sizes of capital projects. The need to investigate specific, unusual or more detailed issues may require some modification to standard methodology. A BPE may be used for a range of purposes. This includes the refinement of technical processes and standards, testing of service planning assumptions plus the testing and evaluation of investment decisions and business cases for implemented projects.

The purpose and objectives of each type of BPE will determine the format and range of the data to be collected. The purpose of a particular evaluation will determine the nature of the data gathered, observations undertaken, and questions asked. The emphasis to be given when analysing the data and reporting of the conclusions and recommendations generated by the study will also be affected by the purpose of the BPE.

Conclusions are drawn in terms of how well the facility or building matches the criteria established for the BPE. Ways to improve building design, performance and fitness for purpose are identified, documented and ultimately fed into relevant guidelines and policy documents.

Ultimately, this process is intended to improve the delivery and performance of future health facility capital projects.