Engineering Guidelines for Healthcare Facilities Volume 1 – Fundamentals

Health Technical Guideline HTG-2020-001

Victorian Health and Human Services
BUILDING AUTHORITY

VICTORIA State Government

Engineering guidelines for healthcare facilities: Volume 1 – Fundamentals

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Preamble

Victorian Health and Human Services Building Authority

The Victorian Health and Human Services Building Authority (the Authority) is a recognised leader in the origination, planning and delivery of social infrastructure projects for Victoria; and is responsible for the Victorian Government's multi-billion-dollar health and human services infrastructure program comprising $23 billion in managed assets and $6 billion of funded infrastructure committed and/or being delivered.

With this significant financial responsibility, the Authority has a keen focus on boosting efficiency and innovation in the planning, management and delivery of infrastructure to meet the needs of our growing population. This includes metropolitan, regional and rural hospitals, community health services, residential aged care and mental health facilities, and ambulance branches across Victoria.

The *Engineering guidelines for healthcare facilities* will ensure consistent update engineering practices are followed across all new and refurbishment projects across the health and human services portfolio.

Asset management

The asset management system provides a framework to ensure key asset management policy[1] principles are consistently applied over an asset's whole lifecycle, to realise the full value from assets in supporting service delivery objective.

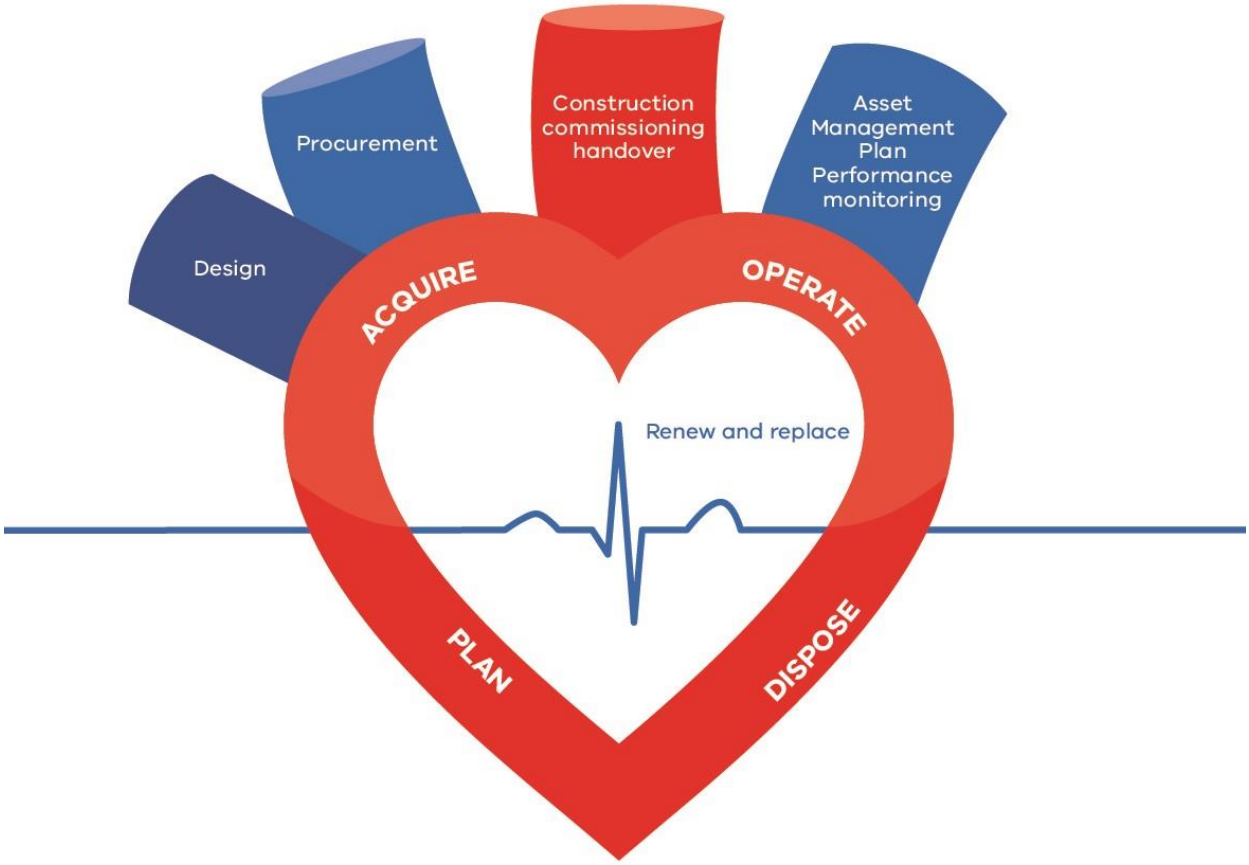
The asset management framework assists Victorian public sector agencies to manage their asset portfolio and provide better services for Victorian. It articulates key components of the asset management system to allow continuous improvement while keeping core principles.

The asset lifecycle planning approach reflects the key consideration that asset managers will need to assess in implementing effective asset management. The **Asset lifecycle heart model** (Figure 1) is adopted by VHHSBA and demonstrates the conceptual stages of the asset lifecycle.

This asset lifecycle approach has been implemented to ensure asset management is an integrated, holistic approach that takes advantage of the impact of early planning and acquisition of the asset, through to operation and disposal. Through planning, analysis and timely execution across the asset lifecycle allows appropriate data-driven decision making to occur.

[1] See Asset Management Policy released web page <https://www.vhhsba.vic.gov.au/news/asset-management-policy-released>

Figure 1. Asset lifecycle heart model



Engineering guidelines for healthcare facilities plays a pivotal role in successful development across all stages of the asset lifecycle, defining the standard approach when undertaking asset-related activities in these stages.

Introduction

The prime objective of a healthcare facility is to improve the health and well-being of the occupants, the engineering services within a healthcare facility are a fundamental part of this process.

The *Engineering guidelines for healthcare facilities* are a guide for the development of design and specification documentation for health care facilities. The guidelines are not intended to be used as a prescriptive pathway for healthcare facility designs. The guidelines are intended to inform educate and develop skill across the industry and are to be used by competent designers allowing them to apply their knowledge and skills to deliver the performance requirements within defined parameters.

It is a requirement that all projects will be delivered in line with all relevant codes and regulations.

In all projects, designers will assess the intent of this document and *Australasian health facility guidelines* (AusHFGs) and make recommendations as to how these can be most appropriately incorporated into the project. A considered understanding of the intent of this document and AusHFGs is expected of all designers, together with advice on how this intent can be best achieved within the context of the project.

The Engineering guidelines for healthcare facilities comprises

- Volume 1 – Fundamentals
- Volume 2 – Electrical and lighting
- Volume 3 – Data, comms and security
- Volume 4 – Heating, ventilation and air-conditioning
- Volume 5 – Fire and hydraulics
- Volume 6 – Specialist healthcare engineering and provisions
- Reference table 1 – Design parameters
- Reference table 2 – Acoustic design parameters
- Reference table 3 – Required noise reductions for room adjacencies

Volume 1 applies to all disciplines and sets out the fundamental principles for the design of engineering services in healthcare facilities. The remaining volumes are discipline specific and can be used in concert with, or independently of, each other.

Universal design

Universal design is a design philosophy that ensures that products, buildings, environments and experiences are innately accessible to as many people as possible, regardless of their age, level of ability, cultural background, or any other differentiating factors that contribute to the diversity of our communities. Universal Design can be applied to all fields of design, including engineering for healthcare facilities.

Universal design is a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation.

When compared to financial and natural resources, human ability is arguably the most precious resource of all. Human ability is enabled, supported and encouraged by a universally designed environment that gives everyone the opportunity to participate with a minimum of outside support or element could allow unassisted use. Independence is best and can be extended with universal design.

Universal design is a design approach that seeks to create environments, objects, and systems that can be used by as many people as possible. To this end, universal design is the process of embedding **choice** for all **people** in the **things** we design.

- **Choice** involves flexibility, and multiple alternative means of use and/or interface.
- **People** include the full range of people regardless of age, ability, sex, economic status, etc.
- **Things** include spaces, products, information systems and any other things that humans manipulate or create.

Universal design is a user-centred process that evolves as designers and users broaden their own understanding, perspectives and experience by working with the range of users in a variety of ways.

Universal design is an approach to the design of all products and environments to be as usable as possible by as many people as possible regardless of age, ability or situation.

Under the *Absolutely Everyone: State disability plan 2017–2020*, government is developing policy to embed universal design principles across the state and make more infrastructure, services and places accessible to people of all abilities. This will enable and empower a diverse population by improving social participation, health and wellness.

All capital works projects are to have universal design as an underlying design requirement that seeks to go over and above Access to Premises compliance levels. This ensures that projects plan to create smart, equitable, safe and comfortable environments for all occupants, regardless of their capability levels.

Designs are to demonstrate these universal principles:

- **Equitable use (Fair)** – the design does not disadvantage or stigmatise any group of users
- **Flexibility in use (Included)** – the design accommodates a wide range of individual presences and abilities
- **Simple and intuitive use (Smart)** – use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level
- **Perceptible information (Independent)** – the design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities
- **Tolerance for error (Safe)** – the design minimises hazards and the adverse consequences to do accidental or unintended actions
- **Low physical effort (Active)** – The design can be used efficiently and comfortably, and with a minimum of fatigue
- **Size and space for approach and use (Comfortable)** – appropriate size and space is provided for approach/reach/manipulation, and use, regardless of the user's body size, posture or mobility.

More information on universal design is available on VHHSBA website's Universal design page <https://www.vhhsba.vic.gov.au/universal-design>.

Universal design is assuming growing importance as a new paradigm that represents a holistic and integrated approach to design ranging in scale, for example, from product design to architecture and urban design, and from simple systems such as those that control the ambient environment to complex information technologies. Worldwide, a confluence of factors is driving the demand for more universally usable products, environments, and services. These factors include the competitive and global nature of modern business, the flourishing communications technology industry, the international disability movement, and the rapidly growing aging and disabled populations all over the world.

Universal design can be distinguished from meeting accessibility standards in the way that the accessible features have been integrated into the overall design. This integration is important because it results in better design and avoids the stigmatizing quality of accessible features that have been added on late in the design process or after it is complete, as a modification.

Universal design also differs from accessibility requirements in that accessibility requirements are usually prescriptive whereas universal design is performance based. Universal design does not have standards or requirements but addresses usability issues.

Abbreviations

For the purposes of this guideline, the following abbreviations apply:

Abbreviation	Definition
AChr	Air changes per hour
AGS	Anaesthetic gas scavenging
AGV	Automated guided vehicle
AIRAH	Australian Institute of Refrigeration, Air Conditioning and Heating
AS	Australian Standard
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
BAS	Building automation system.
BMCS	Building management and control system
BMS	Building management system
CCU	Cardiac care unit
CFA	Country Fire Authority
CFD	Computational fluid dynamics
CFU	Colony forming unit
CIBSE	Chartered Institute of Building Services Engineers
CSSD	central sterilising and supply department
CT (scanner)	Computerised tomography, sometimes referred to as computerised axial tomography (CAT)
db	Dry bulb temperature
DDC	Direct digital control
EES	Essential engineering services
GRP	Glass reinforced plastic
HEPA	High efficiency particulate air filter
HVAC	Heating, ventilation and air conditioning
ICU	Intensive care unit
IP	Ingress protection
IPU	In-patient unit
LINAC	Linear accelerator
MFB	Metropolitan Fire Brigade
MRI	Magnetic resonance imaging
NATA	National Association of Testing Authorities
NEBB	National Environmental Balancing Bureau
NCC	National Construction Code
RC	Rating Curve Mk II
NZS	New Zealand Standard

Abbreviation	Definition
Pa	Pascal – measurement of pressure
PC	Physical containment
PCA	National Construction Code Series Volume 3: Plumbing Code of Australia
PCV-U	Unplasticised polyvinyl chloride. Also known as UPVC
PET	Positron emission tomography
PVC	Polyvinyl chloride
RCD	Residual current device
RH	Relative humidity
SDS	Safety data sheets
TMV	Thermostatic mixing valve
UCV or UCA	Ultra-clean ventilation or Ultra-clean air
UPS	Uninterruptible power system
VAV	Variable air volume
VHHSBA	Victorian Health and Human Services Building Authority
VOC	Volatile organic compound
wb	Wet bulb temperature
WHS	Work health and safety

Glossary

Term	Definition
Access for maintenance	Includes access for maintenance, inspection, measurement, operation, adjustment, repair, replacement and other maintenance related tasks.
Accessible, readily	Readily accessible, easily accessible, easy access and similar terms mean capable of being reached quickly and without climbing over or removing obstructions, mounting upon a chair, or using a movable ladder, and in any case not more than 2.0 m above the ground, floor or platform
Air handling unit	A component part of an air-handling system that includes equipment that provides air movement > 1000 l/s, as well as equipment to control the direction, rate of airflow, division of airflow and condition of air.
Asset	The asset defines with physical form (tangible) and non-physical form (Intangible) according to the VHHSBA Strategic Asset Management Plan
Building Code Australia	National Construction Code Series Volume One: Building Code of Australia Class 2 to 9 Buildings and Volume Two: Building Code of Australia Class 1 and Class 10 Buildings.
Competent person	A person, who has acquired, through training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the required task correctly.
Completion tests	Tests carried out on completed installations or systems to demonstrate that the installation or system, including components, controls and equipment, operates correctly, safely and efficiently, and meets performance and other requirements.
Credible event	For the purposes of this guideline, ‘credible event’ is used to mean both credible and plausible events that may occur and have adverse effects on the delivery of essential engineering services. A credible event is one for which there is data or evidence that a particular event can happen and, without countermeasures or intervention, will cause harm or loss – for example, a power failure.
Critical load (uninterruptible)	Critical load is the load that is required to be supplied at all times, even during the changeover from normal supply to alternative or emergency generator supply; includes data and communications, light and power in procedural areas and essential safety measures. Note that **AS3009** defines these as instantaneous loads.
Default	Specified value, product or installation method which is to be provided unless otherwise documented
Definitions	For the purposes of these guidelines, the following definitions apply:
Design life	The period for which it is assumed, in the design, that an asset will be able to perform its intended purpose with only anticipated maintenance but no major repair or replacement is necessary
Designated Bushfire-prone area	An area that the Victorian Government Minister for Planning has designated as a bushfire-prone area for the purposes of the building control system.
Distribution board	A switchboard other than the Main Switchboard.
Easily maintainable	see Accessible

Term	Definition
Economic life	The period from the acquisition of an asset to the time when the asset, while still physically capable of fulfilling its function and with only anticipated maintenance, ceases to be the lowest cost alternative for satisfying that function.
Economy cycle	Is a mode of operation of an air conditioning system that, when the external ambient air thermodynamic properties are favourable, increases the amount of external air used in the air handling system.
Electricity distributor	Any person or organisation that provides electricity from an electricity distribution system to one or more electrical installations. Includes distributor, supply authority, network operator, local network service provider, electricity retailer or electricity entity, as may be appropriate in the relevant jurisdiction.
Emergency loads	Emergency load is the minimum electrical load that is required to sustain patient services during a short time outage (30 seconds up to four hours); includes adequate light and power to meet clinical needs, essential safety measures, medical gases, sterilisers and sanitisers, building services to patient treatment and accommodation areas and adequate lighting to occupied areas.
Essential engineering services	Engineering services that are required for a facility to maintain business continuity and meet contingency planning requirements for the continued delivery of health and associated services.
Facility	A Department of Health and Human Services facility providing health services or associated services, including administration functions (such as head or regional offices).
Facility category	The category (1, 2 or 3) as defined in the Essential services section.
Facility risk management plan	A plan prepared by the agency to document the risk management process undertaken to examine all credible risks to the delivery of services arising from an interruption to one or more EES and plans to achieve the required level of business continuity.
Fan coil unit	A component part of an air-handling system that includes equipment that provides air movement < 1000l/s, as well as equipment for the purpose of controlling the direction, rate of airflow, division of airflow and condition of air.
Fire mode	A specific mode of operation for building systems that is instigated by a fire alarm being activated within the building.
Future proof	A system is unlikely to become obsolete or designed to allow as yet unplanned change or modification.
Future ready	A system designed to be changed or altered as part of a planned future strategy.
Health services	The health services provided to the community by departmental facilities.
High level interface	Systems transfer information in a digital format using an open system interface.
If required	A conditional specification term for work which may be shown in the documents or is a legislative requirement.
Local (government) authority	A body established for the purposes of local government by or under a law applying in a state or territory.
Low level interface	Systems transfer information via terminals and voltage free contacts

Term	Definition
Main switchboard	A switchboard from which the whole electrical installation can be controlled.
Maximum demand	Maximum electrical consumption over a 15-minute period; this is generally called the contract maximum demand.
Negative air flow	The flow of air from contaminated to clean areas, where the amount of air moved takes precedence over the actual pressure differential.
Negative pressure	The relative differential pressure difference between zones necessary for the separation of clean and contaminated areas, where pressure differential takes precedence over the amount of air moved from one zone to another and draws air towards the pressure zone.
Perioperative department	An area of a hospital or facility which undertakes care of patients from surgical preparation through to discharge from recovery.
Plausible event	A plausible event is one for which there is no data or direct evidence that a particular event can happen (that is, the event may never have happened) but a possibility exists that it may happen following from a defensible, logical extension of facts – for example bush fire, civil unrest, earthquake, flood, malicious damage and tempest.
Positive air flow	The flow of air from clean to contaminated areas, where the amount of air moved takes precedence over the actual pressure differential.
Positive pressure	The relative differential pressure difference between zones necessary for the separation of clean and contaminated areas, where pressure differential takes precedence over the amount of air moved from one zone to another, and forces air away from the pressure zone.
Pressure gradient	The relative differential pressure difference between zones necessary for the separation of clean and contaminated areas, where pressure differential takes precedence over the amount of air moved from one zone to another.
Professional engineer	Chartered engineer registered on the National Engineering Register (NER).
Proprietary	Identifiable by naming the manufacturer, supplier, installer, trade name, brand name, catalogue or reference number
Provide	Provide, and similar expressions mean supply and install and include the development of the design beyond that documented.
Purge mode	A system forced into supplying 100% outside for a limited period, regardless of external ambient conditions, to allow the dispersion of odours. For example: a manual override function in operating theatres and some areas of emergency.
Redundancy of supplies	The provision within the system design of alternative sources of utility services, capable of meeting the requirements, for example; additional grid feeders or access to an alternative tapping point or second water main.
Reliability	Reliability is the probability of an item to perform a required function under stated conditions for a specified period of time (ASQ 2011).
Reliability of supplies	The predictability and consistency of the delivery of the engineering services. This does not of itself prescribe supplies without failure but supplies where the number and circumstances of the failures are known and are reasonably predictable.

Term	Definition
Required	Required by the contract documents, the local council or statutory authorities.
Resilient system	A system that can withstand several component failures while continuing to function normally.
Security of supplies	This term describes the system characteristics or design that guard against a failure in the supply of utilities and engineering services to and within the site. This characteristic could be achieved by a number of means such as: redundant supplies, use of ring mains for the distribution of services within the facility, connection to a source and supply system with minimum risk of failure, such as underground feeders from a secure grid; a control system with 'seamless' switching to alternative supplies.
Spare capacity	The difference between maximum output and the commissioned maximum design demand of a piece of plant or equipment.
Spare space allowance	Spare space is additional to spare capacity, and is to accommodate additional equipment, plant or services in plantrooms and risers. Calculated per space, not aggregated across the project.
Statutory authority	A public sector entity created by legislation, that is, a specific law of the Commonwealth, State or Territory.
Sterile area / environment	Achieved by the HVAC system through conditioning, filtration, air movement and pressure regimes between spaces.
Sustainable supply	Supply enabling service delivery to be sustained for extended periods commensurate with the category of the facility.
Switchboard	An assembly of circuit protective devices, with or without switchgear, instruments or connecting devices, suitably arranged and mounted for distribution to, and protection of, one or more submains or final sub circuits, or a combination of both.
Test reference year	An artificial annual climate used in thermodynamic building modelling, based on the interpolation of measurements of several (up to 30) years that can include maximum and minimum values that haven't been measured in the very same year.
The department	For the purposes of these documents the department shall mean the Victorian Health and Human Services Building Authority (VHHSBA)
Tolerance	The permitted difference between the upper limit and the lower limit of dimension, value or quantity.
Verification	Provision of evidence or proof that a performance requirement has been met or a default exists.
Vital and delayed vital loads	Those electrical loads as defined in AS3009 and any other emergency loads requiring priority restoration immediately upon availability of power from an emergency generator in the event of an interruption to supply.

Engineering design objectives

1.1 The designed systems and equipment will be robust and resilient, and suitable for the services delivered during normal operations, as well as the briefed hospital disaster scenarios.

1.2 The design of systems and equipment will be appropriate for the location in terms of climatic conditions, system complexity, and availability of maintenance support.

1.3 The designed systems will be reasonably adaptable to respond to changes in infrastructure planning and clinical health care models, and the likely changes in use.

1.4 The design of systems and equipment will consider sustainability, availability, reliability and life-cycle costs to achieve the overall targets and aspirations of the facility.

1.5 Designed infrastructure will have useful lives greater than 25 years and will integrate and embed future adaptability and low carbon strategies in line with VHHSBA Net Zero objectives.

1.6 Designers will not incorporate excessive / redundant ‘safety margins’ or ‘contingencies’.

The role of engineering services in healthcare

1.7 The prime objective of a healthcare facility is to improve the health and well-being of the occupants, the engineering services within a healthcare facility are a fundamental part of this process.

1.8 Patients and staff have a right to expect that engineering systems and equipment will be designed, installed, operated and maintained to standards that will enable them to function efficiently, reliably and safely. Compliance with the engineering services guidelines for healthcare facilities will help to meet these goals.

1.9 The unique nature of healthcare premises and dependency of patients on the provision of effective and efficient engineering services requires that engineering systems must be resilient in order to maintain the continuity of health services and ensure the ongoing safety of patients, visitors and staff.

Engineering design principles

1.10 The engineering services of a healthcare facility support the delivery of patient care and help to maintain a healing and safe environment.

1.11 Systems should be designed to have procedures and alternative equipment in place to allow for maintenance and unscheduled failure. This may be achieved through duplication, standby or portable alternatives to ensure a robust continuity of service.

1.12 All systems should work collectively and be resilient in the event of adverse conditions.

1.13 The engineering services, equipment and supports defined as non-structural building parts and components in AS1170.4, will be designed for an IL3 or IL4 in line with AS1170.4, as appropriately determined in line with BCA requirements and confirmed by the relevant Building Surveyor.

Plant and equipment

1.14 All engineering systems and equipment will be fit for purpose and designed to have an initial capacity to safely accommodate peak maximum loads plus an additional suitable allowance for future expansion.

1.15 Future expansion can take several forms; actual spare capacity or, physical space allowance to increase if required. The latter will be the preferred route, as this limits the installation of oversized and inefficient plant.

1.16 During refurbishment or expansion works, all connected site system capacities will be assessed to ensure that they can meet the additional demands required by the services being provided.

Table 1. Example assessment table

Service	Existing capacity	Existing demand	Proposed increase	New demand	Upgrade required
Generator capacity	400 kVA	300 kVa	100 kVa	400 kVa	Yes
Chiller capacity	100 kW	60 kW	50 kW	110 kW	Yes
Boiler capacity	100 kW	40 kW	30 kW	70 kW	No

1.17 All items of plant and equipment will have a life expectancy equal to or greater than the indicative life expectancies as described in AIRAH DA19 – HVCA-R maintenance or CIBSE Guide M – Maintenance and engineering management.

1.18 Healthcare premises will be fitted with adequate metering provisions to monitor all primary incoming and sub distribution engineering services enough to comply with legislation and to support energy efficiency requirements of the facility.

1.19 Building design should incorporate adequate space to enable the full range of engineering plant and services to be installed, maintained safely and kept operational.

1.20 Space for plant and services should provide easy and safe means of access and secure accommodation protected from unauthorised access. Accommodation will also provide adequate space around the plant and services to permit inspection, maintenance and replacement, and for the installation of further plant and services later where this is anticipated to be required.

1.21 Designers will embed Safety in design in all their designs. For all plant and equipment designers will consider safe access for operation and maintenance, including energy isolation in close proximity to the equipment and local isolation in close proximity of all moving machinery.

Infection control

1.22 Ventilation provisions will be adequately filtered with air changes and pressure differentials maintained in line with Volume 4 and Reference table 1

1.23 All exposed surface finishes of engineering services and equipment will be generally smooth, accessible and easy to wipe clean.

1.24 In clinical spaces exposed engineering services pipework, electrical trunking, luminaires accessories and specialist fixed control equipment are appropriately encased to present a smooth, exposed surface with gaps sealed with a suitable substance, such as anti-microbial coatings to control the potential harbouring and propagation of bacterial growth.

1.25 All engineering components and equipment that are regularly handled by clinical staff and or patients (such as light switches, nurse call units, door-entry controls, handsets and the like) are capable of being wiped clean and disinfected or sterilised between patient use.

1.26 Equipment that is surface mounted will have sloped surfaces instead of horizontal surfaces to reduce the build-up of dust.

Ventilation systems

1.27 Ventilation systems will be designed in line with the requirements of Volume 4 of these engineering guidelines.

1.28 Air movement induced by mechanical ventilation will follow the hierarchy of cleanliness. The design will allow for an adequate flow of air into any spaces having only mechanical extract ventilation via transfer grilles in doors or walls. However, such arrangements will avoid the introduction of untempered air and will not prejudice fire safety (through the introduction of uncontrolled air) or privacy (through the positioning of transfer grilles).

1.29 Natural ventilation is always the preferred solution for a space, provided that the quantity and quality of air required and consistency of control to suit the requirements of the space, are achievable. If this is not the case, a mechanical ventilation system will be required.

1.30 Local exhaust ventilation will be required where exposure (by inhalation) to substances hazardous to health cannot be controlled by other means.

Main Purpose (primary mode) of air conditioning systems

1.31 Air conditioning systems perform different functions in healthcare facilities simultaneously. For the purposes of fire mode operation and NCC classification, the systems are classified into three categories:

- infection control
- containment
- air conditioning.

Systems that are classified as Infection control or Containment systems are part of critical healthcare processes and will operate in their primary mode under all conditions

1.32 The main purpose of the services serving an area or space is identified in Reference table 1.

Hot and cold water systems

1.33 Hot and cold water storage and distribution systems will be designed and operated in line with AS3500 and Volume 5 of these engineering guidelines.

Internal drainage systems

1.34 Provision for inspection, rodding and maintenance will ensure ‘full bore’ access and be located outside user accommodation. The location of manholes within the building will be avoided.

1.35 Care will be taken in the routeing (avoiding diagnostic, IT equipment and so on) and the materials used for drainage. This will ensure that the risk from any possible leakage (jointing and pipework materials) is minimised and that drainage is suitable for the type of effluent that may be discharged.

1.36 All drainage that may be used for the passage of contaminated effluent will be clearly labelled and be suitably rated for the contaminants being discharged.

1.37 Installation of drainage and pipework over electrical switchboards and electrical switch rooms will not be allowed.

In-ground services

1.38 Underground distribution routes will be recorded. In-ground tracer tape will be installed to identify service routes and above ground markers will be installed at 10m intervals and any change of direction.

Electrical services systems

1.39 Electrical systems will be designed in line with the requirements of volume 2 of these engineering guidelines.

1.40 Electrical installations will comply with the current edition of the

- AS/ANZ 3000 Electrical installations
- AS/ANZ 3003 Electrical installations – Patient areas
- AS/ANZ 3009 Standby power systems

1.41 During the design, a full assessment will be made of the clinical and business continuity risks, the range of room types (including equipment requirements), occupation levels and resilience requirements. This will influence the extent and location of electrical services, the availability of alternative sources of electrical supply and the need for secondary power sources if appropriate.

1.42 Steps will be taken to prevent mains-borne and electrical radio frequencies from affecting diagnostic and monitoring equipment, computers or other sensitive electronic equipment; and these types of equipment affecting systems in their vicinity.

1.43 The primary electrical infrastructure, comprising the utility electrical supply and electrical distribution system equipment for the facilities, will be an integral part of the whole site/building network. It will provide adequate capacity for both normal and all assessed business-critical needs.

1.44 Electrical infrastructure will be designed and located away from hydraulic services and will consider rising water (flood) levels.

Lighting systems

1.45 Lighting systems will be designed in line with the requirements of volume 2 of these engineering guidelines.

1.46 To achieve energy efficiency, lighting systems will be designed to maximise use of natural daylight, avoid unnecessarily high levels of illumination, incorporate efficient luminaires, control gear and lamps and incorporate effective controls.

1.47 Where artificial lighting is provided in spaces where patients are examined or treated, it will enable changes in skin tone and colour to be clearly defined and easily identified. The quality of lighting will need to be considered if video consultation is likely to take place. Care will also be taken to ensure that patients subject to light sensitivity are not adversely affected.

1.48 When positioning light fittings, consideration will be given to ease of lamp replacement and to ensure that any single lamp failure will not create hazards.

1.49 External lighting will provide adequate lighting levels for safety and security of patients, staff and visitors and to support CCTV.

1.50 External lighting will avoid excessive lighting and where possible use sensor-activated luminaires.

Call systems

1.51 Call systems will be designed in line with the requirements of volume 3 of these engineering guidelines.

1.52 Staff emergency call points are for a member of staff to call for assistance from another member of staff. They will be provided in all spaces where staff consult, examine and treat attendees or patients.

1.53 Patient and staff call points will be provided in all spaces where a patient or attendee may be left alone temporarily, for example clinical rooms and Water Closets.

1.54 Consideration will be given to the location of staff emergency call points to ensure that the risk of accidental operation is minimal and where necessary, they can act as a deterrent to potential aggressors in addition to enabling a response to an incident.

Security systems

1.55 Security systems will be designed in line with the requirements of Volume 3 of these engineering guidelines.

1.56 Measures will be incorporated into the design of all healthcare facilities to help protect the safety of patients, staff and visitors and the security of the premises. These measures include the use of access control, CCTV and alarms.

1.57 CCTV systems will be installed to monitor internal and external areas where there is a risk of attack or vandalism. Areas such as receptions, external entrances, medical gas cylinder storage areas, car-parking and pedestrian walkways may be at particular risk at night.

1.58 Door-access control systems will be implemented in conjunction with other measures (such as linking them to CCTV systems and/or alarm monitoring systems).

1.59 Internal and external lighting schemes will not allow any areas of shadowing/pooling and must support CCTV coverage to enable identification.

1.60 Natural ventilation and night-time cooling of spaces will not compromise security measures.

1.61 Where premises do not operate over a 24-hour period, external engineering plant and equipment, particularly security cameras and engineering service supplies, will be positioned and suitably protected to minimise the risk of damage or interference when the premises are closed.

1.62 Healthcare facilities will generally require controlled access to the building at the staff entrance and, internally, to staff areas. Control of access and egress will be required in special patient areas (for example, maternity, baby care and critical care areas) and for infection control.

1.63 The access control system should be part of an integrated security solution that interlinks other physical security measures such as alarms, motion detectors, lift controls and CCTV systems.

1.64 Access control arrangements must consider the fire safety strategy and must not compromise the means of escape at any time.

IT systems

1.65 IT systems will be designed in line with the requirements of Volume 3 of these engineering guidelines.

1.66 Modern hospitals will likely use structured wiring systems. Where upgrades to wiring systems are planned, therefore, a structured wiring system will be provided. This will permit a unified approach to the provision of cabling for voice systems, data systems, imaging systems and alarm systems.

1.67 Where appropriate, specialists will be employed to assist in the design and installation of IT and telephone systems, including interfacing with service wiring and equipment suppliers to ensure a fully operational and reliable system.

Audio induction loop systems

1.68 Audio induction loop systems will be designed in line with the requirements of volume 3 of these engineering guidelines and BCA requirements.

1.69 Audio induction loops will be provided in main receptions, seminar rooms and waiting areas.

1.70 Audio loop systems will be able to provide an interface with any public address or music system. In areas with televisions, they will be interfaced to provide TV sound into the local area loop system.

1.71 Entertainment facilities, such as television and radio/music systems, may be provided in waiting areas to mask sound transfer for confidentiality purposes or in staff rest areas to create a relaxing atmosphere. Whenever background music or public address systems are installed, the sound quality should be such that it is intelligible and not subject to unwanted reverberations.

Medical gas systems

1.72 Medical gas systems will be designed in line with the requirements of volume 6 of these engineering guidelines.

1.73 Provision of medical gases may require supplies from cylinders, bulk storage or on-site equipment and may be supplemented by specialist equipment for vacuum and scavenging systems.

1.74 It is important to maintain continuity of supply and where appropriate have standby and contingency supplies available.

1.75 Verification of quality is a fundamental requirement for the delivery of systems and will be maintained at all stages of installation and maintenance.

Fire safety systems

1.76 To conform to the appropriate fire safety standards, the design and operation of healthcare buildings will meet the principles set out in volume 5 of these engineering guidelines.

1.77 Fire safety standards in healthcare premises need to be high owing to the vulnerability of occupants, loss of services, business continuity and reputation risk.

Fire engineering

1.78 The design of the holistic fire safety strategy for the building including consideration of the various fire safety systems including but not limited to, the fire suppression system, fire detection and alarm system, passive protection, mechanical systems operation, fire evacuation strategy, management and operational procedures. It is important that the architect, design engineer and fire safety engineer work together to ensure all fire risks are properly understood, addressed and incorporated into the overall design strategy. The overall design strategy and the development of this strategy is to meet the requirements of the Department of Health and Human Services capital development guidelines – series 7. Refer to Volume 5 of these guidelines.

Atrium design

1.79 Unless specifically briefed, atrium spaces will be designated as transient spaces, with relaxed temperature profiles. Refer to Reference table 1.

1.80 Where possible atrium spaces will be naturally ventilated, or mixed mode ventilation will be employed where natural forces do not provide appropriate ventilation. Fully conditioned atrium spaces should be avoided where possible.

1.81 Where traditional air locks cannot be installed to prevent uncontrolled natural ventilation, and revolving doors are to be used as the building air locks, they will be designed with consideration of healthcare user cohorts, number of revolving leaves and revolving door diameter.

1.82 Acoustic requirements of the atrium will be in line with AS/NZS2107 – refer to Reference table 1

Building management systems

1.83 Building management systems will be designed in line with the requirements of volume 4 of these engineering guidelines.

1.84 Building management and control systems will be reliable systems, with components which have been in commercial or industrial use prior to any project delivery.

1.85 The system architecture will be flexible, expandable and backward compatible throughout the given life expectancy of the project. Systems will be configured to maximise energy efficiency without detriment to environmental conditions with all proposed control strategies pre-approved and tested.

1.86 The control system and mechanical switchboards will be arranged such that in the event of a failure or disaster which causes the general BMS to fail, it is possible for all critical and essential areas of the facility to run all plant in a ‘manual’ mode from the local mechanical switch board, without relying on the BMS interface.

Acoustics

1.87 Consideration should be given at the earliest opportunity to the requirements for privacy and noise control. The acoustics in healthcare buildings should meet the principles set out in Volume 6 of the engineering guidelines.

1.88 These guidelines give guidance on noise levels in rooms – both from mechanical services and other sources within the building, and from noise coming from outside. It is important to create an acoustic environment that allows rooms to be used for resting, sleeping, treatment, consultation and concentration.

Design for whole of life

1.89 An important evaluation when considering a new installation or replacement of equipment is the overall cost impact or whole life cost of the choices being made.

1.90 When selecting equipment considerations will include, compatibility with other equipment, the initial procurement and installation cost of each option. Consideration will also include the annual cost in use including energy, maintenance, product-related supplies, and the life expectancy before renewal or replacement including the cost of disposal.

Building information modelling (BIM)

1.91 The use of BIM is an important factor in the design, procurement, construction and ongoing maintenance of buildings.

1.92 BIM is a process that results in the digital representation of a facility in 3D format. The resulting models support decision-making about a facility from the earliest conceptual stages, through design and construction and through its operational life.

1.93 The outputs of BIM will link to the commissioning data, as-fitted drawings and manuals that are made available by the design team/contractor on completion of the scheme.

Thermal modelling

1.94 During the design process there can be multiple thermal models created, all have a specific purpose, refer to Volume 4 of these guidelines. The three most common types of model are:

- Compliance Modelling for National Construction Code Part J
- Design Thermal Modelling for sizing of plant and equipment
- Energy Modelling for prediction of operational energy performance

Commissioning

1.95 Commissioning is a critical element of project delivery and plays an integral role in enabling good designs to be good operational systems, refer to Volume 4 of these guidelines. It is vitally important to the safe and energy efficient operation of buildings. It must be carried out systematically.

1.96 The builder will allow the appropriate programming allowance of time in the delivery and handover process. Commissioning times will not be reduced to fit into a construction programme that is running late.

Air conditioning to essential or critical areas

1.97 These will be defined on a project by project basis, but will normally as a minimum include:

- peri-operative areas
- ICU/CCU
- neonatal intensive care
- CSSD
- emergency department
- imaging department
- pathology

1.98 In essential operation mode, these areas will be maintained with full environmental control. The ventilation to other areas will operate to meet the ventilation rates indicated in reference table 1 and AS1668, environmental temperature control will not necessarily be maintained.

Future technologies

1.99 It is expected that designers will keep themselves aware of trends and advances in technology within the healthcare environment. Where new technologies or health care models are introduced to new facilities it is expected that competent designers will be able to assess the potential impacts of the technology on the facility infrastructure, services and the application of these Guidelines.

Certification and compliance

1.100 The design guidelines are to be used in conjunction with all applicable legislation, regulations, Australian Standards, and other relevant accepted industry good practice.

1.101 Designers should be aware of the nature of health facilities and some of specialist nature will be subject to codes, standards, regulations or legislations not normally encountered by experienced practitioners. Hence, compliance with these guidelines is a minimum requirement.

1.102 It is expected that design consultants will freely offer creative, innovative and alternative solutions which support the department at the forefront of healthcare.

1.103 Designers will have appropriate qualifications, registrations and practice certificates, and insurance in applicable disciplines.

1.104 Designers will be responsible for ensuring all relevant requirements are incorporated into a project's design reports and tender documents.

1.105 Designers must obtain written approval from VHHSBA to vary the requirements of these guidelines before implementing the change into the project design.

1.106 The design consultants will provide statement compliance to this guideline during the design phases of the project signed by a professional engineer.

1.107 Any changes or deviation from these guidelines will be documented and agreed and approved by the project team and or PCG. (refer approval and departure sheet).

Refurbishment

1.108 In refurbishment or re-configuring projects it is unusual for engineering services systems to be confined solely within the area of the facility being modified. At all stages of the project from feasibility and cost planning through to delivery, it is expected that designers fully consider the potential effects of refurbishment works on the wider facility.

1.109 For all refurbishment or re-configuring projects the designers and cost planners will either factor into, or formally discount from, a project the potential changes to the engineering systems for example:

- existing system capacities from their ultimate source in the facility
- obsolete or life limited infrastructure and equipment that may be relied on to serve project area
- diversions to existing infrastructure that may be required to accommodate the project
- ability of existing systems to cope with new thinking (such as low flow appliances and existing drain runs)
- invocation of new or updated regulations by altering existing systems

1.110 Potential changes that are discounted from a project will be confirmed in formal report or written dispensation from the relevant authority, submitted to the facility management or the department.

1.111 Existing system capacities to be reviewed in line with section 1.16.

Infection control during construction

1.112 Infection control is one of the key priorities in Australian hospitals. Patient wellbeing can be diminished due to construction related infection.

1.113 Infection prevention and control precautions during construction and renovation should be integrated into the design and documentation of the facility from the beginning of the design stage.

1.114 It is important that the dust control and infection prevention and control principles developed during the pre-design stage are integrated from the initial stages of design development until the completion of the activity.

1.115 Pre-construction activities (surveys and the like) and construction practices can impact on patient wellbeing by disseminating bacteria and filamentous fungi that can cause hospital acquired infections, to counter this, a formal approach to risk management should be part of all construction, renovation and maintenance activities within a health care facility. Under the direction of the project principal or manager, the designers should:

- identify the at-risk population

- identify the location of the at-risk population in relation to the construction
- identify ventilation system types and potential impact
- know the transmission route of a likely pathogen
- determine air monitoring requirements, methodology and frequency, including taking of air quality samples to establish a baseline
- mitigate the risk in the planning stages
- most importantly, educate others in the process throughout the design and construction phases of the project.

1.116 Lack of planning, risk identification and risk control practices to abate airborne contaminants during construction can lead to serious environmental contamination within a health care facility. Cross education between infection control, engineering and construction is encouraged.

1.117 Risk identification is the most difficult stage of the risk management process. It is generally more difficult to identify patient safety issues that can create an adverse event than it is to devise systems to overcome the adverse event once it is identified.

1.118 Sources of contamination can be anywhere, including:

- soil
- water
- decaying vegetation
- bird droppings
- cement dust and concrete
- brickwork
- roofs
- accumulated dust in ceiling voids

Building and maintenance activities disturb these reservoirs and can send potential infections, such as fungal spores throughout the health care facility, often assisted by the HVAC systems. These spores can infect any person whose immune system is severely compromised. Humid spaces such as riser shafts, wall cavities with plumbing, and ceiling spaces with services provide the ideal environment for the proliferation of fungi.

1.119 Designers should refer to Australasian health facility guidelines (AusHFGs) Part D – Infection control for further guidance.

1.120 Designers should refer to the *Infection control principles for the management of construction, renovation, repairs and maintenance within healthcare facilities* on the Health.vic website for more information <https://www2.health.vic.gov.au/about/publications/policiesandguidelines/Infection-Control-Principles-for-the-Management-of-Construction-Renovation-Repairs-and-Maintenance-within-Health-Care-Facilities>.

Pandemic preparation and readiness

1.121 The clinical response, HVAC provisions, Medical service panels and medical gas provisions in areas to be used to support pandemic patients will vary and will need to be assessed based on the contagion.

1.122 Ideally, areas used/converted or designed for treating pandemic effected patients should:

- include a reception area that is separate from the rest of the facility and, if feasible, have a separate entrance/exit from that for the rest of the building,

- not be used as a thoroughfare by other patients, visitors or staff, including patients being transferred, staff going for meal breaks, and staff and visitors entering and exiting the building,
- be separated from non-segregated areas by closed doors, and
- have signage displayed warning of the segregated area to control entry.
- Have 100% outside air ventilation and exhaust to outside at high level.

1.123 Where possible, a designated self-contained area or wing of the healthcare facility should be used for the treatment and care of pandemic effected patients.

1.124 Pandemic designated rooms used for aerosol-generating procedures such as tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, and bronchoscopy have been associated with an increased risk of transmission of infectious diseases. These rooms will be negatively pressurised refer to Reference Table1 “bronchoscopy, sputum collection and pentamidine”.

1.125 Respiratory Pandemic Infections. It is recommended that pandemic ready ICU zones deigned for respiratory type infections will have the following bed-side services.

Pandemic ICU bedside services

Services (pendant or Medical Services Panel)	Pandemic ICU	ICU - AHFG	IPU bed	Sub-acute bed
UPS GPO	0	4	0	0
Essential GPO	8	16	4	4
Non-Essential GPO	2 (ideally)	0	4	2
Data	2	6	2	2
Oxygen	2	4	1	1
Suction	2	4	1	1
Medical Air	1	3	1	1
Nurse Call	1	1	1	1
Staff Assist	1	1	1	1
Emergency Call*	1	1	1	1

*Emergency Call buttons to be installed separately on wall.

1.126 Fire Risk assessments for pandemic zone converted areas. The fire risk assessment for the area being converted should be reviewed in view of a higher life safety sleeping risk cohort and the additional issue of more oxygen being in use.

1.127 As there is likely to be enriched oxygen in respiratory pandemic treatment areas, the level of air changes through natural and mechanical ventilation must be maximised to lower the oxygen level and the risk of combustion. Oxygen enrichment is to be maintained below 23.5 per cent. Ensure that the rooms that could be subject to oxygen enrichment are adequately ventilated by mechanical and/or natural means.

1.128 Maintaining an adequate oxygen supply. To establish if medical oxygen source supply and distribution systems can cope with increased demand from a pandemic zone the following should be considered:

- the flowrate capability of each evaporator,
- the flowrate capability of each pressure regulator,
- sizing of mains distribution pipe sizes,
- sizing of departmental distribution pipe sizes, and
- plant alarms may alert due to pipeline pressure reductions.
- A robust review of the medical oxygen source supply is critical to establish that the storage capacity of the liquid and/or the oxygen cylinder source supplies is adequate and that the medical oxygen supplier can replenish for extended periods of time.

Sustainability

1.129 The Victorian Climate Change Act (2017) sets a legislated target of net zero emissions for Victoria by 2050, all new facilities will need to take this into account as a key element of their design, making due allowance to enable the facility to transition to net zero operation whenever practical.

1.130 The design considerations will be set out in a transition report produced as part of the facility design. The report will identify measures that can be taken, and allowances made in the design to enable them (such as space for future plant, or alternative fuel strategies).

1.131 The inclusion of onsite renewables and low or zero GWP refrigerants, partnered with low energy high efficiency equipment, is now regarded as standard practice for facility and engineering design to lower a facilities operational demand.

1.132 Traditional hydro-carbon fuels, natural gas, LPG and diesel, will be minimised in new facility design. Reliance on grid electricity is encouraged as the supply of electricity transitions to renewable zero carbon generation.

1.133 Use of the thermal properties of the building to enhance its energy efficiency is to be maximised. The main construction of a healthcare building (thermal mass) can absorb and release slowly the heat and cold temperatures to which it has been exposed.

1.134 Where appropriate, the movement of air in these areas can benefit the heating or cooling cycles at lower energy costs.

1.135 Installed Engineering plant and equipment solutions should offer recycling potential rather than landfill disposal.

Climate change adaptation

1.136 Designers will consider the potential effects of a changing climate and should refer to the Government's climate change website at the feasibility and schematic design stages of the project, and assess the potential risks posed to the project.

1.137 For more information refer to Climate Change in Australia's climate projections page <https://www.climatechangeinaustralia.gov.au/en/climate-projections> and the *Guidelines for sustainability in capital works*.

Standards and other guidance documentation

1.138 These guidelines refer to the latest applicable statutory requirements and other standards. Designers must verify and use the latest statutory requirements and other standards available at the time work is to be carried out.

1.139 These guidelines are one of several guidelines and standards developed by VHHSBA to guide the design and delivery of healthcare facilities in Victoria.

1.140 Other relevant documents include:

- NCC and Australian Standards, legislation and regulations
- Australian health facilities guidelines.

1.141 It is a pre-requisite that designers make themselves familiar with the above documents as well as the relevant parts of these guidelines.

1.142 Designers should note the existence of the following documents and be familiar with them, where appropriate.

- VHHSBA – Guidelines for sustainability in capital works
- NHS Estates health technical memoranda (HTM)
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
  - HVAC hospitals and clinics
  - 170 – Ventilation
  - HVAC hospital design manual
- Chartered Institute of Building Services Engineers (CIBSE)
- Building Services Research and Information Association (BSRIA)
- Health technical guidelines (HTGs)
- Health technical advice (HTAs)

Australian Standards regularly referenced in healthcare design

Standard	Subject
AS 1074	Steel tubes
AS 1158	Pedestrian area lighting
AS 1228	Pressure equipment Boilers
AS 1324	Air filters for use in general ventilation and airconditioning
AS 1345	Identification of the contents of pipes conduits and ducts
AS 1386	Cleanrooms and clean workstations
AS 1428	Design for access and mobility
AS 1432	Copper tubes for plumbing gas fitting and drainage applications
AS 14644	Cleanrooms and associated controlled environments
AS 1668	The use of ventilation and air conditioning in buildings
AS 1670	Fire detection warning control and intercom systems - design install commissioning
AS 1677	Refrigerating systems
AS 1680	Interior lighting
AS 1735	Lifts, escalators and moving walks
AS 1768	Lightning protection

Standard	Subject
AS 1894	Storage and handling of non-flammable cryogenic and refrigerated liquids
AS 1940	Storage and handling of flammable and combustible liquids
AS 2033	Installation of polyethylene pipe systems
AS 2067	Substations and high voltage installations exceeding kv a.c.
AS 2107	Acoustics recommended design sound levels and reverberation times for building interiors
AS 2118	Automatic fire sprinkler systems
AS 2120	Medical suction equipment - suction equipment powered from a vacuum or pressure source
AS 2201	Security intruder systems
AS 2243	Safety in laboratories
AS 2252	Controlled environments
AS 2252.5	Controlled environments: Part 5 Cytotoxic
AS 2381	Electrical equipment for explosive atmospheres
AS 2419	Fire hydrant installations
AS 2430	Classification of hazardous areas
AS 2441	Installation of hose reels
AS 2444	Portable fire extinguishers and fire blankets
AS 2500	Guide to the safe use of electricity in patient care
AS 2567	Laminar flow cytotoxic drug safety cabinets
AS 2593	Boilers safety management supervision systems
AS 2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings
AS 2756	Low-voltage switchgear and control gear assemblies
AS 2865	Confined spaces
AS 2896	Medical gas systems installation and testing of non-flammable medical gas pipeline systems
AS 2941	Fixed fire protection installations pumpset systems
AS 2982	Laboratory design and construction
AS 3780	The storage and handling of corrosive substances
AS 3786	Smoke alarms
AS 3814	Industrial and Commercial Gas Fired Appliances
AS 3864	Medical refrigeration equipment – For the storage of blood and blood products
AS 3892	Pressure equipment – Installation
AS 4041	Pressure piping
AS 4083	Planning for emergencies – Healthcare facilities
AS 4118	Fire sprinkler systems
AS 4187	Cleaning disinfecting and sterilizing reusable medical and surgical instruments

Standard	Subject
AS 4214	Gaseous fire-extinguishing systems
AS 4254	Ductwork for air-handling systems in buildings
AS 4260	High efficiency particulate air (HEPA) filters – Classification, construction and performance
AS 4273	Design, installation and use of pharmaceutical isolators
AS 4282	Control of the obstructive effects of outdoor lighting
AS 4289	Oxygen and acetylene gas reticulation systems
AS 4312	Atmospheric corrosivity zones in Australia
AS 4326	The storage and handling of oxidising agents
AS 4332	The storage and handling of gases in cylinders
AS 4417	Regulatory compliance mark for electrical and electronic equipment
AS 4426	Thermal insulation of pipework ductwork and equipment
AS 4458	Pressure equipment
AS 4485	Security for healthcare facilities
AS 4510	Isolated electrical supply systems for medical use
AS 4645	Gas distribution network management
AS 4681	Storage and handling of Class 9 dangerous goods and articles
AS 4775	Emergency eyewash and shower equipment
AS 4777	Grid connection of energy systems via inverters
AS 4806	Closed circuit television
AS 5601	Gas installations
AS 61800	Adjustable speed electrical power drive systems
AS 62040	Uninterruptible power systems
AS 7240	Fire detection and alarm systems
AS/NZS 1221	Fire hose reels
AS/NZS 2032	Installation of PVC pipe systems
AS/NZS 3000	Electrical installations (known as the Australian New Zealand Wiring Rules)
AS/NZS 3003	Electrical installations – Patient areas
AS/NZS 3008	Electrical installations – Selection of cables
AS/NZS 3009	Electric installations – Emergency power supplies in hospitals
AS/NZS 3010	Electrical installations – Generating sets
AS/NZS 3011	Electrical Installations – Secondary batteries installed in buildings
AS/NZS 3013	Electrical installations – Classification of the fire and mechanical performance of wiring system elements
AS/NZS 3017	Electrical installations – Verification guidelines
AS/NZS 3084	Telecommunications installations – Telecommunications pathways and spaces for commercial buildings

Standard	Subject
AS/NZS 3112	Approval and test specification – Plugs and socket-outlets
AS/NZS 3200	Approval and test specification – Medical electrical equipment – General requirements for safety
AS/NZS 3500	Plumbing and drainage
AS/NZS 3666	Air handling and water systems of buildings – Microbial control
AS/NZS 3992	Pressure equipment – Welding and brazing qualification
AS/NZS 5033	Installation and safety requirements for photovoltaic (PV) arrays
AS/NZS 5149	Refrigerating systems and heat pumps – Safety and environmental requirements
AS/NZS 60079	Explosive atmospheres
AS/NZS 60598	Luminaires
AS/NZS 61000	Electromagnetic compatibility (EMC)
AS/NZS 6400	Water efficient products
AS/NZS 61439	Low voltage switchgear and control gear assemblies

Essential services

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

Essential engineering services

1.144 Essential engineering services (EES) are those critical engineering infrastructure services that are required for an agency to maintain continued health service delivery.

- The essential engineering services discussed in this guideline are:
- building automation and control
- communications – external
- communications – internal
- electricity distribution and reticulation
- electricity supply
- electricity uninterruptible power supply (UPS)
- emergency generators
- fuels for essential engineering services plant
- heating, ventilation and air-conditioning
- water
- sewerage and drainage
- fire safety systems

1.145 The following engineering services have not been specifically addressed in these guidelines, but the principles are still applicable:

- security and access control
- storm water drainage
- trunk reticulation of piped services.

Facility risk management and planning

1.146 The ability of any health service or associated services facility to meet its service-delivery objectives is heavily dependent upon the continued supply of ESS.

1.147 It is important that risks associated with the delivery of ESS are identified and either eliminated or mitigated. Agencies should also have contingency plans in the event the back-up systems fail.

1.148 A facility risk management plan should be prepared and maintained by the agency as part of the overall health service risk management plan. It is a vital component of the governance of the facility and should be included in any planning or undertaking of development or refurbishment works. It should be reviewed regularly throughout all stages of a project and the ongoing operation and maintenance of the facility.

1.149 A quantitative, risk-based assessment for the provision of ESS should consider things such as:

- probability of failure
- likely impact of a failure and the seriousness of the impact, should the failure occur
- life-cycle costing
- the location of the hospital
- category of the hospital

Responsibilities

1.150 The responsibility to provide ESS to conform to the requirements of this guideline lies with each facility, and hence, with the Chief Executive Officer of the facility.

Classification of facilities

General

1.151 Disruption of supply of ESS may arise through equipment failure or credible events over which the agency may have no control.

1.152 While some health services may hold 'last-off, first-on' status with electricity and other utilities, all agencies should verify their status with the relevant distribution companies. Note that some credible events may limit the ability of external providers to give priority to providing service to facilities, and this must be considered in the planning of ESS.

1.153 Levels of criticality range from facilities that provide critical and trauma care or provide the bulk of services to the State of Victoria and must continue to deliver services for a period of not less than two weeks (category 1) to those facilities for which it would be more practical to comply with healthcare standards only for as long as necessary to allow patients and clients to be moved in a controlled manner to an alternative facility (category 3).

Facility category

1.154 The business continuity requirements of each of the three categories are detailed in Table 2.

Table 2: ESS – facility category

Category	Requirement
Category 1	Able to continue to operate and provide all clinical services during extended outages (for a period not less than 2 weeks); likely to continue to accept new patients or clients (including from other agencies)
Category 2	Able to continue to operate and provide all clinical services (48 hours) whilst arrangements are made to transfer patients or clients to other agencies so that other (higher category) facilities are not inundated
Category 3	Able to continue to operate and provide all clinical services for about 8 to 12 hours whilst arrangements are made to transfer patients or clients to other agencies

1.155 To meet the requirements specified in Table 2, facilities must have:

- ESS installations that are all constructed and maintained to withstand credible events as determined by risk analysis and defined by the agency
- redundancy, consumables storage, operation and maintenance services, back-up personnel, and skill training to enable operation and maintenance of ESS to the extent required to support the delivery of health and associated services through all credible events, and for a subsequent period as prescribed for each category.

1.156 It is possible and acceptable to have multiple facilities with different categories on the one site. For example, a category 1 acute facility may be co-located with a category 3 aged care facility. In such instances the provision of ESS to each facility on that site should correspond with the relevant requirements of this guideline, that is, the facility with the lower category does not need to meet the requirements for the higher-category facilities on the site, unless the facilities share common infrastructure.

1.157 Details of the requirements for each category are provided in the next section, and a listing of facilities by classification is provided in **Appendix A**.

Control restoration

1.158 To regain control and recover from potentially adverse outcomes arising from failure or reduced capacity of ESS, it is necessary to:

- enable critical loads to be met immediately and automatically
- restore supply to vital loads within a short time (typically less than one minute)
- progressively restore supply to emergency loads over a period of up to 30 minutes and continue supply under these conditions.
- increase the supply capacity over time following a failure or reduction in capacity, to enable service delivery to be sustained for extended periods, according to the category of the facility (sustainable supply).

Provision of ESS

1.159 Following the loss or unavailability of ESS from the usual source of supply, a facility needs to be able to continue service delivery according to the requirements of its category.

1.160 Contingencies to be considered in the design and provision of ESS systems should be determined as part of a risk management process conducted in line with AS/NZS ISO 31000 and documented in the facility's risk management plan. These contingencies include but are not limited to:

- normal utilities source failure
- normal consumables source failure
- equipment and plant module failure
- credible events

1.161 When planning or implementing ESS in facilities the following should be considered:

- A single point of failure in a supply or reticulation system within a category 1 facility should be able to be bypassed within a short period of time to restore supply.
- Designs that cause minimal disruption to health service delivery during maintenance or replacement of the plant and equipment.
- For essential engineering services that are produced onsite (such as boilers, electricity generation), adequate redundancy should be provided to accommodate equipment malfunction, maintenance and repair. The capacity of these systems should be audited at intervals of not more than five years to ensure that the systems remain adequate to meet the peak demand of the site.
- Emergency generators are generally designed for emergency loads only. They should not be considered within the calculation of redundancy if they are not capable of powering the total hospital load.
- Where the continued provision of ESS depends on external suppliers and contractors (such as electricity, fuel oil, LP gas, natural gas, emergency water supplies, equipment hire and repair), the agency should have in place formal contracts or supply agreements that include provision of priority of supply under emergency conditions.
- To divert capacity to, or maintain reliability of, required critical services, non-critical clinical services may be curtailed or closed down. Such diversion of capacity should be part of the facility's risk management, which will define:
  - circumstances in which the diversion is permitted

- conditions and precautions associated with the diversion and reinstatement of normal operation
- who is authorised to direct that the diversion take place.

1.162 In the interests of both capital and recurrent cost, and wherever technically feasible, ESS generation and distribution systems should be shared by all users on any one site or adjacent sites. Separate metering can be provided where the need exists to allocate costs of such services between entities.

1.163 When master-planning sites consideration should be given to locating acute services within the same, or adjacent buildings, thereby simplifying the provision and back-up of vital and critical loads. For example, it may be more practical to provide 100 per cent redundancy to a single acute building, rather than providing 100 per cent redundancy to vital and critical loads across multiple buildings.

Location and accessibility of ESS

1.164 The design, construction and any subsequent modification of ESS location, layout and access should consider:

- Geographical separation where practicable, between the entry points of utility supply, ESS reticulation routes and items of ESS plant and equipment for a category 1 facility.
- Physical protection of ESS systems. Civil and structural elements that house or support ESS plant and equipment should be designed to withstand and protect against all credible events
- Safe, secure and efficient access and egress for all service personnel and providers and vehicles, cranes and other items of plant in order to minimise delays in accessing ESS plant and equipment. Allowance should be made for location and connection of temporary ESS plant (such as boilers and emergency generators).
- Climate adaption modifications such as increased flood levels and increased temperatures.

Reliability of ESS

1.165 External parties appointed to provide essential engineering services need to undertake effective, documented and ongoing consultation with the agency's key stakeholders, as nominated by the Chief Executive Officer, and with utility to ensure that the essential engineering services provided are reliable and secure.

1.166 ESS should be designed, constructed and commissioned so that they are:

- based on simplicity and reliability, rather than sophisticated, complex solutions that may lead to reliability or 'repair under pressure' issues during the life of the facility (for example, increasing the site's generating capacity or reducing energy demand through efficiency measures may result in the elimination or reduction in complexity of a load-staging system that may be otherwise required)
- capable of being operated manually or in a manual mode in the event of failure of automatic control systems
- technically capable of continuing to reliably provide the required level of performance over the expected design life of the ESS plant and equipment
- designed with consideration for low environmental impact and in a sustainable manner in compliance with the statutory Building Code of Australia and other mandatory requirements, consistent with achieving the required levels of reliability and performance.

1.167 The pursuit of sustainability targets or innovation should not compromise the reliability of ESS.

Testing and training

1.168 ESS should be tested regularly to Australian standards where available, so that an agency can have a high level of confidence in the satisfactory operation under emergency conditions, and so that operations and maintenance staff are familiar with the demands that will be placed on them under such conditions.

1.169 In addition to regular testing, full-scale exercise to simulate the failure of normal ESS supplies, particularly electricity (often referred to as 'black-start testing') should be conducted at the completion of commissioning and afterwards at intervals of not less than 12 months or following any significant modifications to equipment. Black-start testing can be initiated by deliberate disconnection of incoming electricity feeders to simulate a supply failure.

1.170 While disruptive to day-to-day operation, black start exercises provide testing of ESS under a realistic emergency scenario.

1.171 Black start exercises:

- demonstrate the facility's emergency systems and procedures ability to perform as intended under realistic condition
- reveal any deficiencies in the performance of systems throughout the facility – particularly the ability to restart mechanical and electrical services
- provide facility staff and plant operators with training and familiarisation with emergency procedures under realistic and controlled conditions.

1.172 Testing and commissioning should be formally documented and submitted to the VHHSBA, via the Communities of Practice portal, and reports of all tests should be provided to the agency's Chief Executive Officer for review on completion of these tests.

1.173 Information on black-start testing of emergency generators is provided in **Appendix B**.

As-installed data and operating manuals

1.174 At the conclusion of testing and commissioning of new, modified or refurbished ESS, complete and accurate as-constructed drawings, operating manuals and other information should be provided to the facility.

1.175 This documentation should be site-specific and held by the agency in an accessible and known location at the site for any party needing to use this information. Any alterations or additions to ESS should be updated by the agency immediately.

Service-specific requirements by facility category

Electricity supply requirement

Requirement	Category
• Two separate feeders with automatic changeover in the event of the failure or non-availability of one feeder. **Or** • One feeder and onsite generation capable of supporting the site and (for example cogeneration) subject to the conditions set out under Note 4 below. • Ring mains and duplicated supplies are to be physically separated and protected to minimise the likelihood of accidental physical damage to both supplies in the one event.	Category 1
Single feeder	Categories 2 and 3

Notes:

1. 'Separate feeders' are those that originate from the supply authority's zone substations and arrive at the facility via geographically separated routes.
2. Electricity feeders should (in order of preference) originate from:
    a. separate zone substations
    b. feeders supplied from separate bus sections at the zone substation
    c. feeders originating from the same bus section at the zone substation
3. Entry points for each feeder should be:
    a. separated from the other feeder to minimise the possibility of damage to both in the event of any credible event, including vehicle impact, fire or flood
    b. run underground from a location that is sufficiently removed from the site as to make the point of supply as inconspicuous as practicable, in order to minimise the likelihood of accidental or malicious damage
4. Onsite electricity generation (gas fuelled) capacity as an alternative to a second feeder for category 1 facilities is acceptable providing the power generation and auxiliary plant is:
    a. able to meet the full electrical demand and operate continuously for the time required to meet the requirements for category 1
    b. equipped with sufficient onsite storage of fuel, lubricants and other consumables to allow continuous operation for a sufficient period of time until supplies can be replenished under pre-arranged service contracts
    c. located to allow for ready access for maintenance and replacement, including provision for the ready connection of temporary, transportable generation plant
    d. arranged and connected such that the single feeder and associated equipment can be shut down and accessed safely for maintenance
5. Where electrical distribution is at high voltage, distribution of power should be undertaken at low voltage. This is to permit part or all of the high-voltage system to be isolated for maintenance or repair while maintaining electricity supply.

Electricity distribution and reticulation requirements

Requirement	Category
• Detailed investigation should be undertaken prior to committing to high-voltage reticulation within the facility. This should examine the impact on whole-of-life costs and operability arising from the need to have immediate access to trained and certified high-voltage operations and maintenance personnel. • Where the decision is made to distribute at high voltage, it is recommended that generation and distribution of the generated power is undertaken at low voltage. This is to provide independence of the generated power from the high-voltage distribution system if the high-voltage system fails. • Provision should be made for temporary connection of alternative supplies to major switchboards, to facilitate the connection of generators or alternative supplies.	Categories 1, 2 and 3

Electricity uninterruptible power supply (UPS) requirements

Requirement	Category
Uninterruptible power supply systems should be provided to maintain critical loads for the duration specified by statutory or regulatory requirements, but not less than the time required for clinical staff to make necessary arrangements to minimise risk to patient life safety in the event of unavailability of power. • Uninterruptible power supply systems should: • be installed as close as practicable to the critical load that they support • have adequate levels of redundancy, including consideration of the provision of multiple inverters • be able to be maintained and tested on load without compromising the operation of the critical load	Categories 1, 2 and 3

Notes:

1. Uninterruptible power supply and battery packs are designed for short-term power-loss situations and are unable to contribute to an extended outage situation.
2. To optimise the whole-of-life costs in the provision of UPS systems, consideration should be given during design to the selection of multiple distributed (local) systems or a single centralised system with reticulated UPS supplies. Issues may include:
    a. reliability and potential vulnerability of larger reticulated systems and associated reticulation including cost premium for provision of colour-coded outlets for UPS supplies
    b. cost of and responsibility for maintenance of a large number of distributed UPS systems compared with that for a single centralised system
3. Testing of UPS systems is to be carried out at regular intervals in conjunction with generator black-start testing.

Heating ventilation and air-conditioning

Requirement	Category
• Ability to manage ingress of contaminants throughout the duration of **credible events** (for example dust storms, bushfires, industrial plumes). • Ability to vent areas in the event of spills or gas leakage . • Air-conditioning and heating systems serving clinical areas should be connected to emergency generator system.	Categories 1, 2 and 3
• Ventilation to sterile, procedural, isolation and patient-care areas connected to emergency power.	Categories 1 and 2
Ventilation to:	Category 3

Requirement	Category
• sterile and procedural areas connected to emergency power. • patient-care areas restored within 30 minutes.	

Building automation system

Requirement	Category
Control systems that essential engineering plant rely on (such as emergency generators and boilers) are to be: • independent of any building automation system installed at the site (including any sensors that collect data for monitoring and recording by the building automation system). Where building automation system is used for remote or time-based control of essential engineering plant (such as boilers, chillers), provision should be made to allow for manual override in the event of failure of the building automation system • arranged such that the lack of availability or malfunction of any component of the building automation system will not have any impact on the performance or effective operation of essential engineering plant. This should include any load staging or shedding required for emergency power generation plant • regularly maintained, including replacement of back-up batteries where fitted.	Categories 1, 2 and 3

Communications – external

Requirement	Category
Planning and implementation of external communications systems for both emergency management and service delivery teams at a facility should accommodate all credible events and should provide for: • alternative two-way communication paths that are not reliant on external terrestrial communications infrastructure in the immediate vicinity of the facility and are capable of operation without support of a facility's emergency power generators under emergency conditions • continued communication by the agency with emergency services and with the department • reception of general community emergency warning and information broadcasts (such as ABC Local Radio in Victoria). Reception should be possible under all conditions that may exist at the facility, including loss of power • ability to provide sufficient capacity during credible events and the subsequent recovery period.	Categories 1, 2 and 3

Notes:

1. Reliable communications networks from the facility to external sites are critical for the continuity of service delivery and for coordination under emergency conditions.
2. Statewide emergencies have demonstrated that many external communication networks are vulnerable to failure or extremely limited capacity during emergency events. Such failures may take a considerable time to rectify by external providers and are well beyond the direct control of agencies.

Communications – internal

Requirement	Category
• Systems relating to patient and staff safety and business continuity can continue to operate at all times, even without the support of emergency generating plant.	Categories 1 and 2

Requirement	Category
• Multiple communication paths to critical elements within the facility. These paths should be via geographically separated routes. • Communication-system equipment distributed geographically across the site to address the contingency of physical damage as a result of fire, flood, collision et cetera. • Redundancy in servers (including separate locations), network hubs and separate cable runs is to be considered. • Emergency control room requirements (if present) are to be considered.	

Emergency generators

Requirement	Category
• Sufficient onsite emergency power generation should be provided to allow restoration of electricity to vital loads within a period of 30 seconds, and the balance of emergency loads within five minutes. • A point for the convenient and safe connection of additional portable generation plant should be provided.	Categories 1 and 2
• Capacity should be provided to meet required service delivery outcomes, but in any case, not less than 100 per cent of critical loads required for continued delivery of clinical services. • Consideration should be given for the designed capacity to be provided from two generators, each being capable of individually supplying the **emergency load**.	Category 1
• Capacity should be provided to deliver required service delivery outcomes, but in any case, not less than 100 per cent of **emergency load.**	Category 2
• Compliant with **AS3009**. • A point for the convenient and safe connection of additional transportable generation plant should be provided.	Category 3
Designated bushfire-prone areas: Where category 2 and category 3 facilities are in designated bushfire-prone areas, consideration must be given to provision of additional generating capacity to that normally required for these categories.	

Notes:

1. Distribution of power produced by emergency generators should be at low voltage.
2. Essential plant and equipment serving clinical areas should be connected to the emergency generator system (such as lifts or chillers).

Information on black-start testing of emergency generators is provided in **Appendix B**

Fuels for ESS plant

Requirement	Category
• Onsite storage for 48 hours' continuous operation. • Connection points and continuously accessible accommodation for temporary boiler supplies and/or ability to draw from alternative fuel storage (diesel). • Formal contracts or supply agreements in place which guarantee service levels to ensure continuity and priority of supply under emergency conditions.	Category 1

Requirement	Category
• Dual-fuel plant (for example diesel, synthetic natural gas) should be considered for meeting emergency needs (for example one boiler or up to 50 per cent of load). • Mechanisms in place for providing sterile equipment required for continued delivery of clinical services.	
• Onsite storage for 24 hours' continuous operation. • Provide connection points for alternative fuel. • Formal contracts or supply agreements in place that guarantee service levels which ensure continuity and priority of supply under emergency conditions.	Category 2
• Onsite storage for not less than eight hours continuous operation. In remote or bushfire-prone areas, consideration must be given to delays that may arise in replenishing fuel supplies under emergency conditions.	Category 3

Notes:

1. For category 1 hospitals in the event that onsite storage for 48 hours continuous operation is not available, onsite storage should be for no less than 24 hours continuous operation. Written confirmation is to be provided by fuel suppliers that fuels for essential engineering services plant can be provided at least daily in the event of a credible event.

Water

Requirement	Category
• Two independent tapping points (where possible). • A risk assessment of the reliability of supply to determine if onsite storage is required to meet critical needs for four hours. • Minimise the need for pumps (where not possible, connect pumps to emergency power and/or provide diesel-driven pumps). • Connection point and continuously accessible accommodation for tanker supplies and means of providing mains-pressurisation (this may be by means of pumps fitted to tankers, rather than fixed plant).	Category 1
• Minimise the need for pumps (where not possible, connect pumps to emergency power and/or provide diesel-driven pumps). • Connection point for tanker supplies and means of providing mains-pressurisation (this may be by means of pumps fitted to tankers, rather than fixed plant).	Categories 2 and 3

Sewerage and drainage

Requirement	Category
• Emergency power available to pumps. • Access and connection point for removal of waste by tanker. • Emergency overflow and retention capability.	Category 1
• Capability to deploy emergency pumps. • Access and connection point for removal of waste by tanker. • Emergency overflow and retention capability.	Category 2
• Access and connection point for removal of waste by tanker. • Emergency overflow and retention capability.	Category 3

Appendix A: Classification of facilities

General

(a) The category assigned to a facility may change over time in response to redevelopment, changes in service-delivery policy or changed demographic characteristics of the area it serves. The category assigned to facilities is to be confirmed with the Department.

(b) This list was current at the date of issue of this revision (see footer).

(c) A number of non-acute facilities have been included on the basis of their characteristics such as:

  (i) location (for example remote location)

  (ii) potential adverse impacts on health service delivery should they be unable to continue to function (for example major aged care that would require decanting).

Category 1 facilities

Metropolitan – category 1

Alfred Hospital (Prahran)

Austin Hospital (Heidelberg)

Box Hill Hospital

Dandenong Hospital

Footscray Hospital

Frankston Hospital

Maroondah Hospital

Mercy Hospital for Women (Heidelberg)

Monash Children's Hospital (Clayton)

Monash Medical Centre Clayton

Monash Heart Hospital

Northern Hospital (Epping)

Peter McCallum Cancer Centre (Parkville)

Royal Children's Hospital (Parkville)

Royal Melbourne Hospital (Parkville)

Royal Women's Hospital (Parkville)

St Vincent's Hospital (Fitzroy)

Sunshine Hospital

Victorian Institute of Forensic Mental Health

Rural category 1

Albury Wodonga Health (Albury campus)

Bairnsdale Regional Health

Ballarat Regional Health (Ballarat Hospital)

Barwon Health – University Hospital Geelong

Bendigo Health Care Group (Bendigo Hospital)

Central Gippsland Hospital (Sale)

Goulburn Valley Health – Shepparton campus

Latrobe Regional Hospital

Mildura Base Hospital

Northeast Health Wangaratta

South West Healthcare (Warrnambool)

Wimmera Health Care Group (Horsham}

Category 2 facilities

Metropolitan – category 2

Angliss Hospital (Upper Ferntree Gully)

Austin Health – Heidelberg Repatriation Hospital

Broadmeadows Heath Service

Bundoora Extended Care Centre

Calvary Health Care Bethlehem (Caulfield)

Caritas Christi Hospice (Kew)

Casey Hospital (Berwick)

Caulfield General Medical Centre

Kingston Centre (Cheltenham)

Healesville and District Hospital

Melbourne Health – Royal Park campus

Mercy Werribee Hospital

Moorabbin Hospital

Peter James Centre (Forest Hill)

Rosebud Hospital

The Royal Talbot Rehabilitation Centre (Kew)

The Royal Victorian Eye and Ear Hospital (East Melbourne)

Sandringham Hospital

St George's Hospital (Kew)

The Mornington Centre (Mt Eliza)

The Williamstown Hospital

Wantirna Health (Knox)

Rural – category 2

Albury Wodonga Health (Wodonga campus)

Alexandra District Hospital

Ballarat Regional Health – Queen Elizabeth Centre

Barwon Health – McKellar Centre (Geelong)

Bass Coast Regional Health (Wonthaggi)

Benalla and District Memorial Hospital

Castlemaine Health

Colac Area Health (Colac)

East Grampians Health Service (Ararat)

Echuca Regional Health

Gippsland Southern Health Service (Leongatha)

Kyneton District Health Service

Maryborough District Health Service

Portland and District Hospital

Seymour and District Memorial Hospital

Stawell Regional Health

Swan Hill District Hospital

West Gippsland Healthcare Group (Warragul)

Western District Heath Service (Hamilton)

Yarram and District Health Service

Category 3 facilities

Metropolitan – category 3

Craigieburn Super Clinic

Gisborne Super Clinic

Lilydale Super Clinic

Melton Super Clinic

Sunbury Day Hospital

Rural – category 3

Alpine Health (Bright, Mt Beauty, Myrtleford)

Beaufort and Skipton Health Service

Beechworth Health Service

Boort District Hospital

Casterton Memorial Hospital

Central Gippsland Health Service (Maffra)

Cobram District Hospital

Cohuna District Hospital

Djerriwarrh Health Services (Bacchus Marsh)

East Wimmera Health Service (Birchip, Charlton, Donald, St Arnaud, Wycheproof)

Edenhope and District Hospital

Gippsland Southern Health Service (Korumburra)

Goulburn Valley Health (excluding Shepparton)

Heathcote Health Service

Hepburn Health Service (Creswick, Daylesford)

Hesse Rural Health Service (Winchelsea)

Heywood Rural Health

Inglewood and District Health Service

Kerang District Health

Kilmore and District Hospital

Kooweerup Regional Health Service

Kyabram and District Health Service

Lorne Community Hospital

Maldon Hospital

Mallee Track Health and Community Service (Ouyen)

Mansfield District Hospital

Moyne Health Services (Port Fairy)

Nathalia District Hospital

Numurkah District Health Service

Omeo District Health

Orbost Regional Health

Otway Health and Community Services (Apollo Bay)

Robinvale District Health Services (Manangatang, Robinvale)

Rochester and Elmore District Health Service

Rural Northwest Health (Warracknabeal)

South Gippsland Hospital (Foster)

South West Healthcare, Camperdown Campus

Tallangatta Health Service

Terang and Mortlake Health Service

Timboon and District Healthcare Service

Upper Murray Health and Community Services (Corryong)

West Wimmera Health Service (Jeparit, Kaniva, Natimuk, Nhill)

Western District Health Service, Coleraine Campus

Wimmera Health Care Group (Dimboola)

Yarrawonga District Health Service

Yea and District Memorial Hospital

Appendix B: Black start testing

Introduction

Black-start testing is the full test of the installed emergency electricity generating and switching systems designed to operate on the occasion of a break in the supply of mains-generated electricity to the facility.

A black-start test commences with the opening of the circuit breakers on the incoming mains feeders and concludes with the successful reconnection of the facility to the mains feeders and restoration of all services to the facility.

A simulation of a system failure, where the emergency generators are manually caused to start without the incoming circuit breakers being opened, is not considered an acceptable black-start test.

Purpose

The purpose of the black-start test is to demonstrate that the facility's emergency electricity generation and distribution elements perform in an orderly manner and as an integrated system in the restoration and continued delivery of power supplies to critical areas.

It is also used to prove the ability to restore supplies in an orderly manner once the normal source of power supply has been restored. A black-start test must be planned, designed and executed to demonstrate the proper operation of the entire system, rather than to demonstrate the correct operation and exercise of its component parts only.

Preparation and contingency planning

All staff (including health staff) must be briefed on the proposed scope and areas of the test. These exercises do disrupt normal service delivery, but they are designed to demonstrate any system weaknesses under conditions of heightened preparedness, with stand-by arrangements including health staff in attendance. In a true emergency, options for recovery may be limited.

In some instances, systems may not respond as intended or difficulties may be encountered in restoring normal operations. Accordingly, procedures to cope with such contingencies must be put in place before the test is commenced.

Conduct

The test should be conducted with all normal loads connected and operating to replicate, as far as possible, the circumstances that may exist at the time of a random failure.

While some suppliers and insurance companies will not warrant or insure against operation of certain items of equipment (particularly medical equipment), it is important not to isolate critical items, as the test should be used to monitor the performance of all hospital equipment and procedures under conditions of power failure and restoration. It is also imperative that loads should be representative of actual operations to demonstrate the capability of generators and ancillary systems such as load staging.

The suggested sequence of actions in the form of a checklist is provided. It is not prescriptive and should be adapted to suit the requirements of each facility.

Success of test

A test is only deemed successful if, under normal operating conditions, the system works as designed, results in power being supplied to the emergency and sustainable supply loads, continues to operate satisfactorily for at least one hour, then successfully restores supply to the site from the normal mains feeders.

Where a test does not succeed, remedial action should be taken and the test repeated.

Review and report

The test report is to be submitted to the agency's Chief Executive Officer for review on completion of these tests and the test record be retained in the agency.

The report is to contain details of the test results, comment on the operation of the contingency plans, and any human resources, staff and customer communications and management issues. The report is also to include a statement of any remedial action taken as a result of the test.

Example black-start test checklist

The suggested sequence of actions for the conduct of a typical black-start test is provided in the following checklist. It is not prescriptive and should be adapted to suit the requirements of each facility.

Black-start test - activity checklist	Date	Initials
1. Preparation 1.1 Emergency procedures a. Review emergency procedures with all involved staff. b. Amend procedures where necessary. c. Communicate reviewed procedures to all staff. d. Require all departments to review their internal emergency procedures to ensure compatibility.		
1.2 Plan a. Gain approval of facility senior management for the black-start test. b. Consult staff. c. Agree on the most suitable time for the test (when most staff are available, such as shift changeover). d. Document the test sequence and timings. e. Agree on and document actions to be taken in the event of an unsuccessful first attempt. f. Agree on and document the circumstances that will require a test abort. g. Agree on and document any ancillary tests to be conducted at the same time as the emergency generator test. h. Nominate the test controller. i. Distribute plan to all staff, giving them sufficient time to read the plan and provide further input.		
1.3 Staff issues a. Ensure all staff concerns are considered and responded to. b. Roster any additional staff required for the test period. c. Encourage staff to record all incidents for subsequent review.		
1.4 External liaison a. Agree on support arrangements with the grid distributor. b. Advise on the possibility of service disruption to local area.		
1.5 Preparatory tests a. Test all battery back-up supplies. b. Test all UPS systems. c. Perform emergency generator start-up simulations.		
1.6 Final review a. Final management review meeting to ensure that all preparations have been properly completed. b. Confirm authority of test controller to order the test to commence and to abort the test if necessary.		

Black-start test - activity checklist	Date	Initials
2. Conduct of test 2.1 Control room a. All parties involved to have a copy of the test instruction. b. Ensure control room is staffed. c. Test all emergency communication systems. d. Test communications with engineers conducting test. e. Ensure representative of medical services (or equivalent) department is located with test controller. f. Obtain confirmation from the medical director (or equivalent) of final agreement for the test to proceed. g. Test controller orders the test to start at the designated time.		
2.2 Medical service departments a. Final check of battery and UPS systems. b. Advice to patients of impending test. c. Prepare to report unexpected events to control room. d. Note all incidents as they occur. e. Request test abort if necessary.		
2.3 Engineering department a. Check all staff are at designated locations. b. Prepare to note all unexpected incidents. c. Open the incoming circuit breakers when instructed to do so by test controller. d. Observe and record the operation of the emergency generator and the switching systems. e. If the emergency system has succeeded in powering the emergency and sustainable supply loads allow the generator to run long enough to conduct all necessary ancillary tests. f. If the emergency system has not succeeded check with the test controller for further instructions. g. At the designated time return the facility to the grid supplies and shut down the emergency generator. h. Stand down any external staff brought in for the test such as operators from the grid supply authorities.		
3. Post-test review 3.1 Operation of emergency supplies a. Collect and collate all incident reports relating to the operation of all emergency power supplies, including the emergency generator, battery back-up/UPS supplies. b. Compile report for management with recommendations for actions to be taken.		

Black-start test - activity checklist	Date	Initials
3.2 Operation of contingency plans a. Collect and collate all incident reports relating to the operation of the contingency plans, including the operation of the control room, communications, staff procedures and patient procedures. b. Compile report for management with recommendations for actions to be taken.		
3.3 Management review a. Review reports relating to the black-start test and the operation of the contingency plans. b. Determine actions to be taken as a result of the tests. c. Decide date for next test. d. Review risk management plans.		
4. Black-start test report 4.1 Report a. Black-start test report prepared and presented to CEO. b. Report endorsed and annotated with management decisions on the recommendations made. c. Report sent to all sections of the facility for staff information.		