Australasian Health Facility Guidelines

Design Guidance: Medical Services Panels and Pendants

October 2025

Version 1

AHIA australasian health infrastructure alliance

AusHFG Australasian Health Facility Guidelines

Copyright and Disclaimer

Copyright

Australasian Health Facility Guidelines

Website: http://www.healthfacilityguidelines.com.au

Email: HI-AusHFGteam@health.nsw.gov.au

The AusHFG are an initiative of the Australasian Health Infrastructure Alliance (AHIA). AHIA membership is comprised of representatives from government health infrastructure planning and delivery entities in all jurisdictions in Australia and New Zealand.

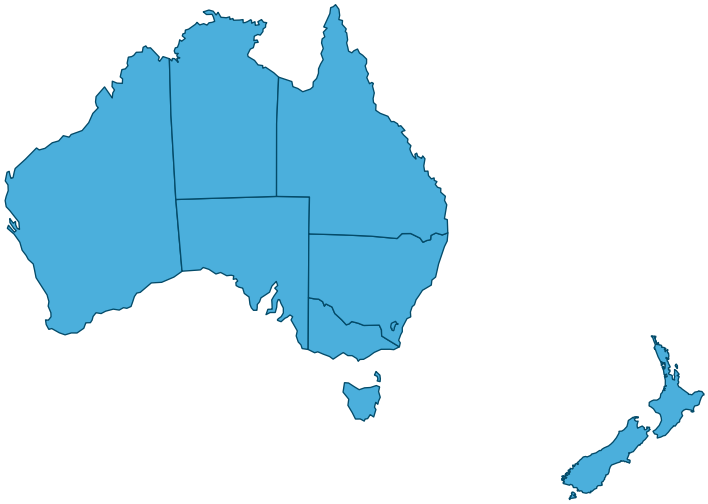
Disclaimer

AHIA gives no warranty or guarantee that the information in the AusHFG is correct, complete or otherwise suitable for use. AHIA shall not be liable for any loss howsoever caused whether due to negligence or otherwise arising from the use of or reliance on this information.

AHIA recommends that those seeking to rely on the information in the AusHFG obtain their own independent expert advice.

Cultural Acknowledgement and Terminology

The Australasian Health Facility Guidelines (AusHFG) are developed in collaboration with stakeholders across Australia and Aotearoa, New Zealand.



Acknowledgement of Country

We acknowledge Aboriginal Peoples and Torres Strait Islander Peoples as traditional owners and continuing custodians of the land throughout Australia and the Torres Strait Islands.

We acknowledge their connection to land, sea, sky and community and pay respects to Elders past and present.

Acknowledgement of Te Tiriti o Waitangi

Te Tiriti o Waitangi obligations have been considered when developing the AusHFG resources.

Terminology and Language in the AusHFG

Throughout the AusHFG resources, the term ‘Indigenous Peoples’ is used to collectively refer to both the Aboriginal and Torres Strait Islander Peoples of Australia and Māori of Aotearoa, New Zealand. Where references to specific cultural requirements or examples are described, the terms ‘Aboriginal and Torres Strait Islander Peoples’ and ‘Māori’ are used specifically. The AusHFG respect the right of Indigenous Peoples to describe their own cultural identities which may include these or other terms, including particular sovereign peoples or traditional place names.

Contents

Acronyms

Acronym	Definition
ABCB	Australian Building Code Board
AFFL	Above Finished Floor Level
AHIA	Australasian Health Infrastructure Alliance
AS	Australian Standard
AS/CA	Australian Standard / Communications Alliance
AS/NZS	Australian and New Zealand Standard
AusHFG	Australasian Health Facility Guidelines
BCA	Building Code of Australia – Volume 1 and Volume 2 of the NCC
CCU	Cardiac Care Unit
ECMO	Extracorporeal Membrane Oxygenation
ED	Emergency Department
EMR	Electronic Medical Records
EMI	Electromagnetic Interference
EPJ	Equipotential Junction
HD	High Definition
HFG	Health Facility Guideline
HID	Human Interface Devices
HIS	Health Information System
HPU	Health Planning Unit
HVAC	Heating, Ventilation, and Air-conditioning
ICU	Intensive Care Unit
IPC	Infection Prevention and Control
IV	Intravenous
LED	Light Emitting Diode
LIOM	Line Isolation and Overload Monitor
LPD	Leakage Protection Devices
MIS	Minimally Invasive Surgery
MRI	Magnetic Resonance Imaging
NIST	Non-interchangeable Screw Thread
NCC	National Construction Code (Australia)
NZBC	New Zealand Building Code
PACS	Picture Archiving and Communication System
PCG	Project Control Group
PES	Patient Entertainment System
PoE	Power Over Ethernet

Acronym	Definition
PVC	Polyvinyl Chloride
PUG	Project User Group
RCD	Residual Current Device
RTLS	Real Time Location Services
UHD	Ultra-High Definition
UPS	Uninterruptable Power Supply
VIS	Video Integration System
VoIP	Voice over Internet Protocol
WHS	Workplace Health and Safety

1 Introduction

Medical services panels (panels) and medical services pendants (pendants) are assemblies that support the delivery of electrical, communications, nurse call and medical gas services in healthcare settings, playing a fundamental role in providing essential services to support clinical workflows and patient care. Careful planning of these assemblies is vital to ensure efficiency and safety. When carefully considered, panels and pendants can enhance the functionality of healthcare environments, streamline processes, and improve patient outcomes. Conversely, inadequate consideration of their configuration can lead to significant risks, including increased potential for errors which can compromise patient safety and overall quality of care.

Provided extensively throughout a healthcare facility, panels account for a significant cost on any health capital project. Comparatively, the quantity of pendants in a typical facility is smaller, as they are generally only provided in operating suites, certain procedure rooms, resuscitation bays and intensive care spaces. While there may be fewer pendants, they are still a considerable package of work requiring coordination of architectural design, electrical and communications engineering, nurse call systems, medical gas engineering, medical equipment selection, as well as structural engineering.

Standardisation of panels and pendants across repeated and similar rooms is one step that can be taken to address the complexity of these packages of work by minimising the number of different panels or pendants required, while also increasing the future flexibility of rooms as the occupying service changes. Incorporating modularity into the design of panels and pendants can also be an effective approach to managing complexity and future flexibility. By allowing for modular components that can be easily reconfigured, healthcare facilities can adapt to changing needs over time without requiring a complete redesign – accommodating new technologies, evolving medical practices, changing room functions and different patient care scenarios, ultimately enhancing the longevity and relevance of the installations. Designing with modularity in mind also facilitates easier updates and repairs, reducing downtime and disruption in healthcare settings.

Project teams should engage all relevant stakeholders early in the design process to establish clear requirements for various services and spaces, while also identifying key principles and priorities for standardisation and flexibility. The design process requires robust communication and feedback loops to ensure coordination across the entire team and with clinical and operational stakeholders.

Figure 1 Example of a medical services panel in a CT imaging room

Figure 2 Example of medical services pendants in an intensive care bedroom

1.1 Purpose

This document provides terminology, information and considerations for the planning and design of medical services panels, medical services pendants and their associated elements used in healthcare infrastructure projects across Australia and New Zealand.

The intent of this document is to identify and provide guidance on:

- Terminology and components
- Layout principles, including ergonomics and accessibility
- Construction considerations and performance requirements.

1.2 Context

This is the first version of this resource and has been reviewed by AHIA following an extensive consultation process completed in 2025.

The AusHFG are comprised of a series of documents detailing a range of information that is intended to assist project teams to plan and design healthcare facilities (see Figure 3). This guidance document should be read in conjunction with the overarching guidance described in:

- Part A: Introduction and Instructions for Use
- Part B: Health Facility Planning and Briefing
- Part C: Design for Access, Mobility, Safety and Security
- Part D: Infection Prevention and Control

This document is intended to be a reference for general information on medical services panels and medical services pendants.

- For information regarding specific departmental requirements and considerations, refer to the individual Health Planning Unit documents.
- For information on specific room requirements, including guidance on specific panels and pendants, as well as considerations for different contexts, refer to the Room Data Sheets (RDS) and Room Layout Sheets (RLS) for individual Standard Components.
- For information on specific engineering requirements refer to jurisdictional engineering services guidance.

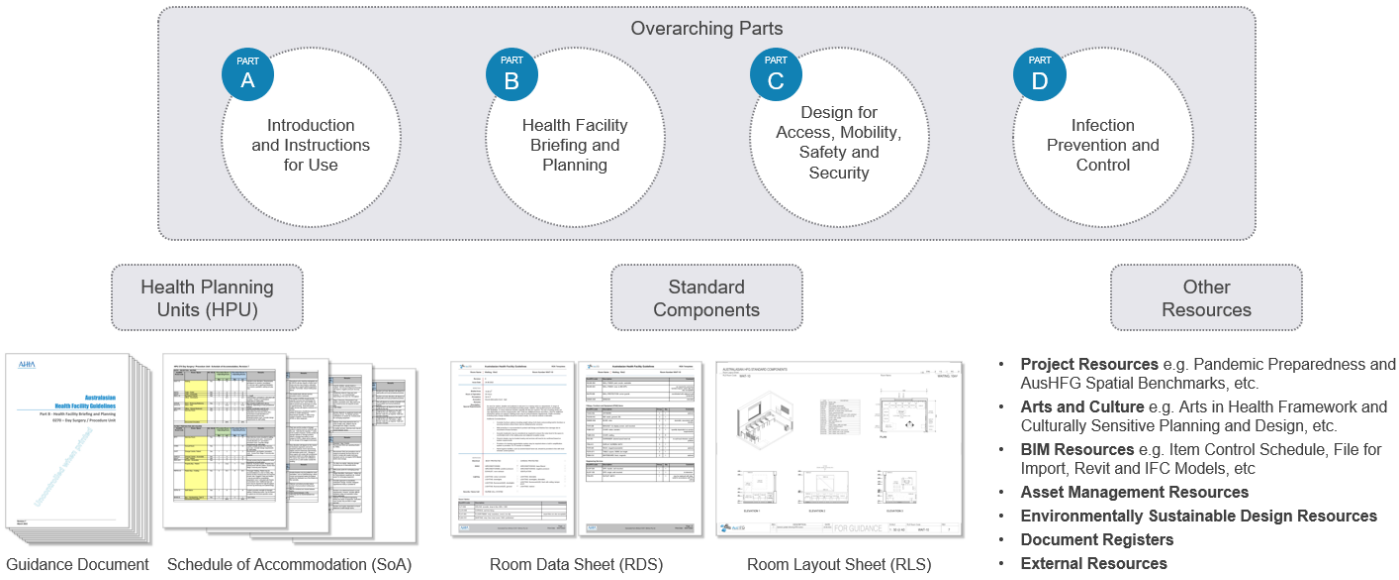


Figure 3 Structure of the AusHFG resources

1.3 Policy and Legislative Framework

The extent of application of the AusHFG on any health capital project in Australia or New Zealand will be dependent on the jurisdiction in which the project is taking place. Public health infrastructure authorities across Australia and New Zealand have varying policies on the application and use of the AusHFG on projects within their respective jurisdictions. Before undertaking a project, planners, project managers and project personnel should familiarise themselves with any jurisdictional policies, national/statewide/regional strategies, project reports and plans, and service specific guidance. Jurisdictions may require project teams to apply these jurisdiction-specific resources in conjunction with or overriding AusHFG guidance.

The AusHFG are to be used in conjunction with other resources that take precedence over the AusHFG. This includes, but is not limited to:

- Australian National Construction Code (NCC) or New Zealand Building Code (NZBC).
- Current Australian and New Zealand (NZ) Standards (where legislation mandates).
- Australasian, national and local jurisdictional policies, for example relating to infection prevention and control (IPC), and work health and safety (WHS).

2 Terminology

2.1 Medical Services Panels

A medical services panel (panel) is an assembly that is mounted on or recessed into the wall or integrated into a joinery unit such as a bedhead. These assemblies contain services required by clinical staff to provide care to patients such as medical gases, power outlets, data outlets, and nurse call buttons. They may also contain some services for patient use (e.g. connection to patient entertainment systems). Figure 4 below shows a diagram illustrating the components that may make up a panel assembly with descriptions provided for these components in Table 1 that follows.

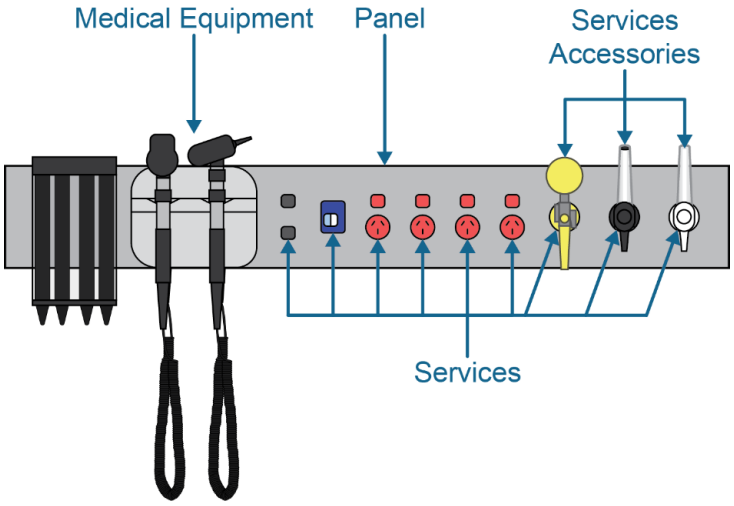


Figure 4 Diagram of a medical services panel with labelled components

Table 1 Medical services panel assembly component names and descriptions

Component Name	Description
Panel	When referring to the panel, this typically includes both the **cover plate** and the **mounting box** which may be recessed into a wall or joinery (see Figure 5 and Figure 7). Panels may also be surface mounted, duct type panels (see Figure 6 and Figure 8). The panel itself provides a mounting method for services connection outlets and supports the compliance and required segregation of outlets, wiring, cabling and pipework.
Services	The services connection points (also referred to as terminal outlets), as well as any buttons/switches that are mounted on or flush set into the panel (examples are shown in Figure 6, Figure 7 and Figure 8). This may include a combination of: • medical gas outlets • power outlets, status alarms electrical protection and testing points • data and other communications/AV outlets • Nurse call buttons and connection points for nurse call/patient entertainment system handsets • Light switches and isolation switches.
Services Accessories	Items that attach directly to the services connection points/terminal outlets to support the use of the service outlet or connection to medical equipment. For example, suction adapters, oxygen or medical air flowmeters, etc. (see Figure 8). Suction bottles and brackets, while not typically mounted directly on a panel, also fall under this category as a supporting component for the use of suction outlets. Patient handsets connecting to an outlet on a nurse call button faceplate are also an example of a services accessory.
Medical Equipment	Equipment such as diagnostic sets (which may be a combination of otoscope, ophthalmoscope, sphygmomanometer, thermometer, etc.) may be mounted on medical services panels in space such as consult rooms, treatment rooms, procedure rooms and emergency department bays (see Figure 9).

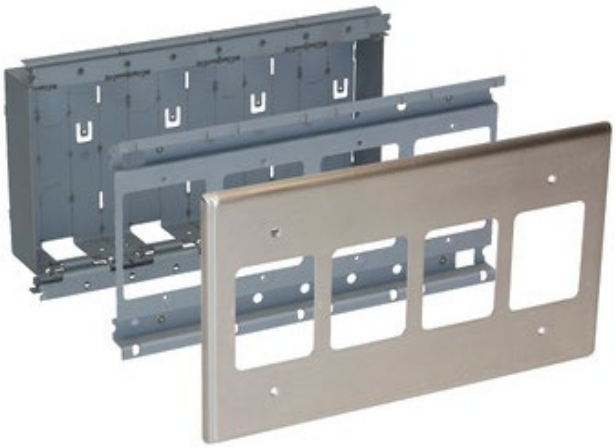


Figure 5 Example of face plate and wall box elements of a recessed medical services panel

Figure 6 Example of a surface mounted medical services panel

Figure 7 Example of services (connections/terminal outlets, switches and buttons) on a medical services panel

Figure 8 Example of services accessories (adapters and flowmeters) on a surface mounted medical services panel

Figure 9 Example of medical equipment mounted on a medical services panel

2.2 Medical Services Pendants

A medical services pendant (pendant) is an assembly that is mounted on the ceiling with articulated elements that allow for flexible positioning of services, lighting, screens for patient information/monitoring, radiation shielding panels, etc. This flexibility supports the clinical functions in operating rooms, certain procedure rooms, resuscitation and trauma bays, intensive care spaces, and some radiology spaces (particularly where interventional work is to be performed). Flexibility is fundamental where patient positioning and the range of procedures/treatments that might be undertaken is significantly variable.

Figure 10 below shows a diagram illustrating some of the components that may make up a pendant assembly with descriptions provided for these components in Table 2. Additional images are provided on page 8 and page 9 to illustrate other components of a pendant that are not illustrated in Figure 10.

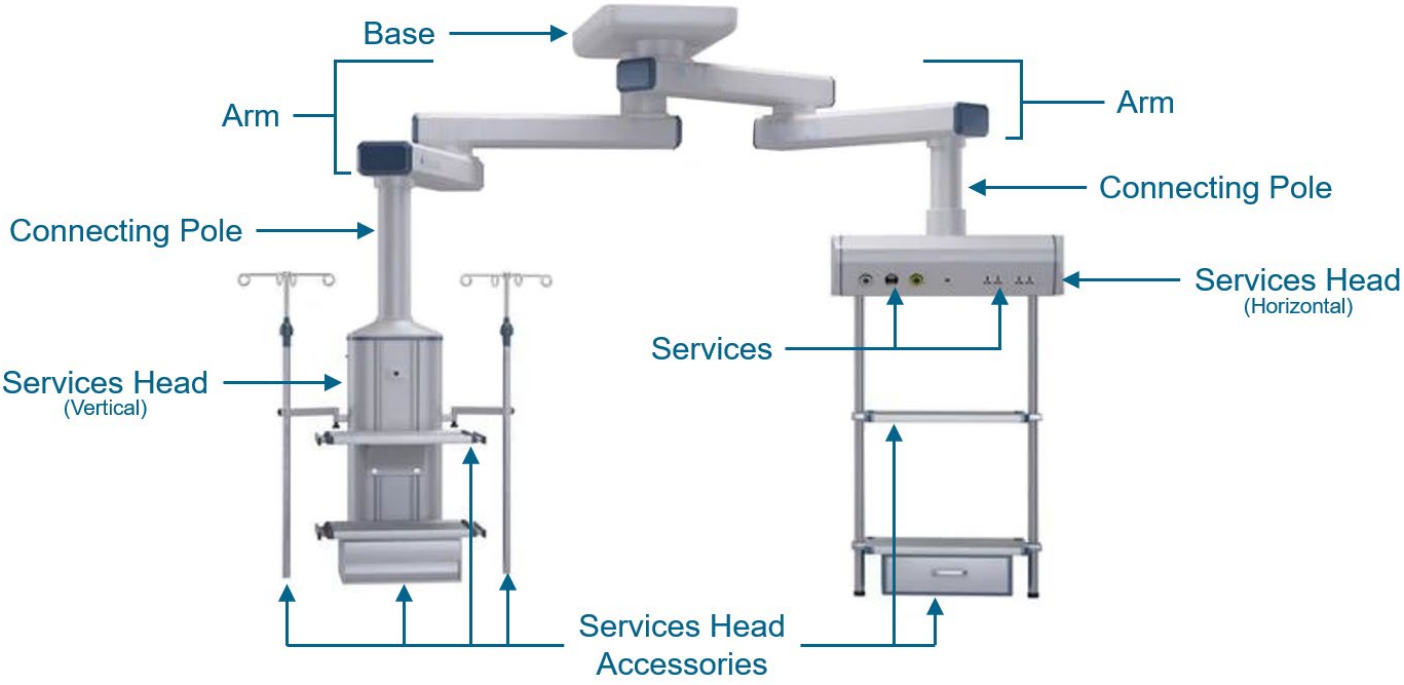


Figure 10 Diagram of a medical services pendant with labelled components

Table 2 Medical services pendant assembly component names and descriptions

Component Name	Description
Base	The term base refers to the under-ceiling component comprised of both the **fixing plate** for connection to the structural element in the ceiling (known as the cotton reel and mounting plate, see Section 5.1.2 for more information), as well as the **shroud** covering the fixing plate. Different pendant vendors may also refer to this element as the 'hub' or 'foundation' of the pendant.
Arm	An arm extends from the base of the pendant assembly and enables the flexible positioning of the services heads, operating/ procedure lights, display screens, equipment carriers, radiation shielding panels, etc. An arm may have multiple horizontal articulations and typically allow for 330°-360° rotation around the base. A 360°rotation is typically provided for surgical lights that do not incorporate gas or video cabling. For all other equipment, a 330-degree rotation is considered a reasonable upper limit. Some arms also allow for vertical articulation making the pendant height adjustable. Pendants may have multiple arms, with products available at this time that have up to five arms. The design of the arm, including braking systems must support staff to easily manoeuvre the pendant.

Component Name	Description
Connecting Pole	A vertical component of varying length which connects the arm to a services head, operating/procedure lights, display screens, equipment carriers or radiation shielding panels. This component may also be called a 'connecting bar'.
Services Head	The services head refers to a box that provides a mounting method for services connection outlets and supports the compliance and required segregation of services outlets, wiring, cabling and pipe work. The services head may also have connection points for various service head accessories which support custom configurations. The services head may also be called a 'services column', 'services supply unit', or 'services carrier'.
Services	The services connection points (also referred to as terminal outlets), as well as any buttons/switches that are mounted on or flush set on the face plate of the services head (examples shown in various images on pages 8-10). This may include a combination of: • medical gas outlets • power outlets, status alarms electrical protection and testing points • data and other communications/AV outlets • nurse call buttons and connection points for patient handsets • light switches and isolation switches.
Services Accessories	Items that attach directly to the services connection points/terminal outlets to allow for connections to medical equipment, for example, suction adapters, oxygen or medical air flowmeters, etc. (see Figure 12, Figure 13 and Figure 15). Suction bottles and brackets also fall under this category, supporting the use of suction outlets.
Services Head Accessories	Items such as pendant mounted rails, shelves, drawers, baskets, hooks, IV Poles, cable organisers, brackets, etc. that can be attached to the services head to support the mounting or placement of medical equipment, ICT equipment, Digital Operating Room (DOR) equipment and other clinical support items, such as sharps bins (see Figure 14, Figure 15, Figure 16 and Figure 17).
Medical Equipment	Medical equipment mounted on a pendant may include diagnostic equipment (e.g. sphygmomanometer, ophthalmoscope, thermometer, etc.), infusion pumps, patient monitoring equipment, ventilators, smoke evacuation systems, etc. Equipment may be mounted directly onto the services head with a suitable bracket or mounted on equipment rails/poles, shelves or IV poles with clamp attachments (see Figure 14 and Figure 15).
Workstation Equipment	Computer display screens – typically all-in-one display screens that do not require a separate CPU – and input devices such as keyboards and mice may be mounted on services heads via brackets (see Figure 18), or on a computer workstation that is directly mounted on the connecting pole (see Figure 19). All equipment must be clinical-grade and be able to be cleaned.
Digital Operating Room (DOR) Equipment	DOR equipment encompasses the hardware that supports any combination of: • Live access to patient records and medical imaging during procedures. • Recording and live display of video of the surgical field, both for viewing within the operating room to support clinicians during the procedure and potentially for streaming externally to education/training areas. • Display of images/live feeds from surgical and diagnostic equipment such as endoscopes, laparoscopes, ultrasound, patient monitoring, etc. Equipment can include display screens, cameras, microphones, touch screen control panels, etc. (see Figure 20 and Figure 21). Refer to Section 3.6 for more information.
Operating Lights	Also known as surgical lights, operating lights illuminate the operative site on a patient for optimal visualisation during a surgical procedure (see Figure 20, Figure 21 and Figure 22). Operating lights must provide consistent light levels for long periods without heating the patient or staff. Operating lights have handles that allow the perioperative team to adjust the position of the light for the best surgical site visualisation and reduce glare. The light intensity (lux) and colour temperature of operating light should be adjustable to suit procedure requirements. Lighting controls are typically on the light fitting itself, with a surgical light control panel able to be wall mounted as well.

Component Name	Description
Radiation Shields	Radiation shields, typically made of lead acrylic for rigid panels and lead covered with PVC fabric for flexible/curtain barriers, may be mounted on a pendant arm to support appropriate positioning (see Figure 22 and Figure 23). These shields are used in conjunction with mobile and table mounted shields as wells as lead aprons/gowns to protect staff and patients from radiation exposure. Radiation shields are commonly used in angiography rooms, cardiac catheter labs, interventional fluoroscopy rooms, operating rooms where mobile imaging devices are used, and in hybrid operating theatres with integrated imaging modalities.

Figure 11 Example of services outlets (medical gas, power, communications, and audio-visual outlets) on a vertical services head, alongside surgical lights and a display screen in an operating room

Figure 12 Example of services outlets (power, data and medical gas outlets), services accessories (flowmeter) and service head accessories (equipment rails) on a vertical services head

Figure 13 Example of services outlets (medical gases, power and data) and services accessories (suction adapters) on a horizontal services head in an operating room

Figure 14 Example of services head accessories (equipment rails and brackets), medical equipment (patient monitor, medical air/oxygen blender, and neonatal ventilator), and on a vertical services head in a Neonatal Intensive Care Unit

Figure 15 Example of services head accessories (equipment rails, IV poles, and brackets) and medical equipment (patient monitor and infusion pump) on a vertical services head in an Intensive Care Unit (ICU)

Figure 16 Example of services head accessories (equipment shelves, drawer, equipment rails and brackets) and medical equipment (patient monitor) on a horizontal services head

Figure 17 Example of services outlets (medical gas, power, audio-visual, and communications outlets), services head accessories (shelves) on a vertical services head in an operating room

Figure 18 Example of a display screen and a keyboard on a drawer shelf mounted directly on a vertical services head

Figure 19 Example of workstation shelf with articulated task light and integral power and data connections, mounted directly to a connecting pole of a medical services pendant in an ICU bedroom

Figure 20 Example of DOR equipment (camera integral to operating light with connection to wall mounted display screen for live display)

Figure 21 Example of DOR equipment (camera integral to operating light, two pendant mounted display screens and a wall mounted display screen), a 1-arm medical services pendant with horizontal services head (right) and a 2-arm medical services pendant with one horizontal services head and one vertical services head with three shelves for medical equipment (left)

Figure 22 Example of 2-arm medical services pendant with one operating light and one radiation shield made of lead acrylic

Figure 23 Example of a radiation shield made of a combination of a lead acrylic panel and a flexible fabric covered lead curtain with a mounting point for connection to a pendant arm

3 Services Components

3.1 Medical Gases

The complexity of medical gas systems demands careful planning and design, requiring expertise to ensure they meet rigorous safety and performance standards. Inadequate planning or poor implementation can lead to serious risks, including equipment failure and compromised patient safety, underscoring the necessity for meticulous attention to detail in every stage of the system's development and maintenance.

Medical gas systems include the following:

- oxygen
- medical suction
- medical breathing air
- nitrous oxide
- gas scavenging
- surgical tool gas
- medical gases mixtures
- carbon dioxide.

3.1.1 Australian and New Zealand Standards

The design and installation of medical gas systems in Australia is governed by AS 2896, and in New Zealand, industry refers to the *UK Health Technical Memorandum 02-01 Medical gas pipeline systems*. Designers and installers must adhere to the requirements of these Standards. The critical nature of these services demands a high level of knowledge of the Standards by both designers and installers. Additional Standards have been noted in Table 3 below.

Table 3 Standards applicable to the design, installation and testing of medical gas systems in Australia and New Zealand

Code	Name
AS 2896	Medical gas systems – Installation and testing of non-flammable medical gases pipeline systems
AS 2473.1	Valves for compressed gas cylinders – Part 1: Specifications, type testing, and manufacturing tests and inspections
AS 2473.2	Valves for compressed gas cylinders – Part 2: Outlet connections (threaded) and stem (inlet) threads
AS 2473.3	Valves for compressed gas cylinders – Part 3: Outlet connections for medical gases (including pin-indexed yoke connections)
AS 2902	Medical gas systems – Low pressure flexible hose assemblies
AS 2120.1	Medical suction equipment – Part 1: Electrically-powered suction equipment Safety requirements
AS 2120.2	Medical suction equipment – Part 2: Manually-powered suction equipment
AS 2120.3	Medical suction equipment – Part 3: Suction equipment powered from a vacuum or pressure source
AS 3840.1	Pressure regulators for use with medical gases, Part 1: Pressure regulators and pressure regulators with flow-metering devices
AS 4484	Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding
ISO 7396-1	Medical gas pipeline systems – Part 1: Pipeline systems for compressed medical gases and vacuum
ISO 7396-2	Medical gas pipeline systems – Part 2: Anaesthetic gas scavenging disposal systems
ISO 9170-1	Terminal units for medical gas pipeline systems – Part 1: Terminal units for use with compressed medical gases and vacuum
ISO 9170-2	Terminal units for medical gas pipeline systems – Part 2: Terminal units for anaesthetic gas scavenging systems
ISO 10524-1	Pressure regulators for use with medical gases – Part 1: Pressure regulators and pressure regulators with flow-metering devices
ISO 10524-2	Pressure regulators for use with medical gases – Part 2: Manifold and line pressure regulators
ISO 10524-3	Pressure regulators for use with medical gases – Part 3: Pressure regulators integrated with cylinder valves (VIPRs)
ISO 10524-4	Pressure regulators for use with medical gases – Part 4: Low-pressure regulators
ISO 15002	Flow control devices for connection to a medical gas supply system
ISO 21969	High-pressure flexible connections for use with medical gas systems

3.1.2 Set Out Principles and Considerations

The following spacing requirements for medical gas outlets must be met when designing medical services panels and pendants (per AS 2896):

- When mounted on a wall or fixed surface (such as bedhead joinery), the height to the centre of any medical gas outlets should be within the range of 1200mm to 1600 mm from the floor.
- When mounted on medical services pendants, the height to the centre of any medical gas outlets will be varied to suit clinical needs and articulation of the pendant.
- A minimum clear space of 150mm shall be provided above and below medical gas outlets to any fixed obstruction (e.g. shelves, worktops, etc.) measured from the centre of the outlet.
- For outlets situated on panels, a minimum of 100mm shall be provided horizontally between individual medical gas outlet centres to facilitate equipment use.
- For outlets situated on pendants, the dimension provided horizontally between individual medical gas outlet centres may be reduced to a minimum of 70mm.
- A minimum of 200mm shall be provided vertically between individual medical gas outlet centres.

The above set out principles are illustrated below in Figure 24.

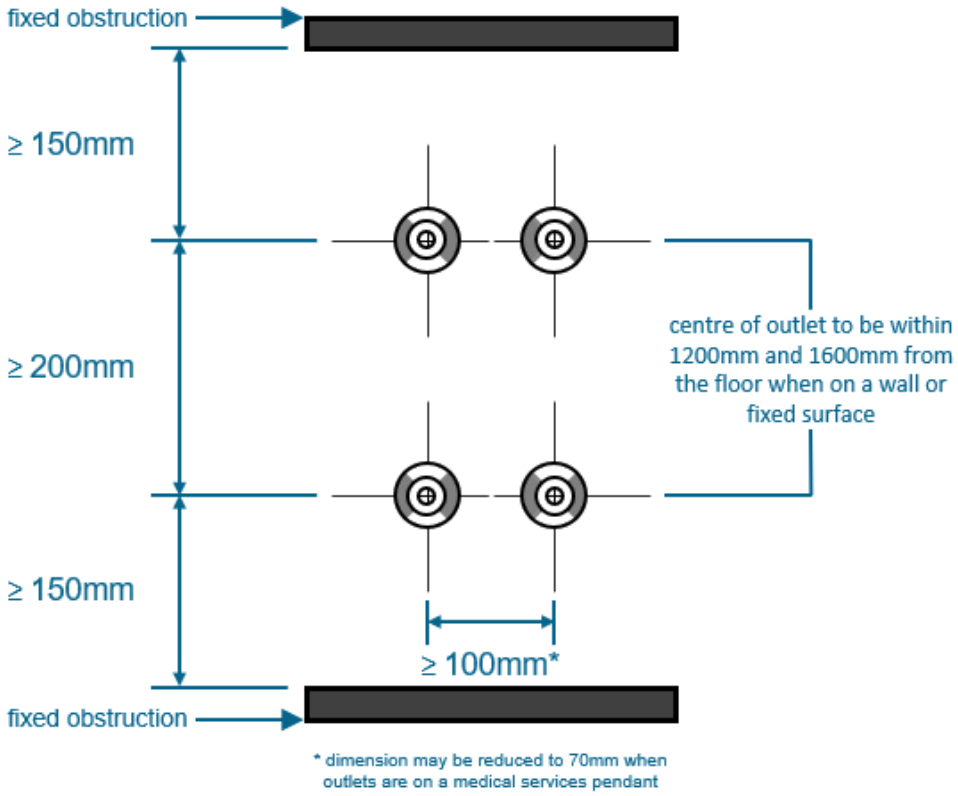


Figure 24 Set out dimensions for medical gas outlets as per AS 2896

In addition to the mandatory minimum spacing required by AS 2896, there are additional considerations relating to the size of attachments such as flowmeters, adapters, pressure gauges, and associated hoses. A panel arrangement should ensure, for example, that attachments and hoses do not block access to electrical equipment (see Figure 25). When outlets are directly aligned above each other and these accessories are accounted for, a 200mm vertical spacing is usually insufficient as flowmeters and gauges may clash. Accounting for this, a minimum 250mm vertical spacing should be considered, potentially with a staggered arrangement.

Between medical gas outlets and other services (electrical, data, nurse call, etc.) on panels and pendants, it is strongly recommended that a minimum of 100mm-150mm is provided horizontally (centre to centre) to ensure gas regulators and adapters can be used without impacting the adjacent outlets. A minimum horizontal clearance of at least 200mm from the centre of a medical gas outlet to a corner of a room is also recommended.

Spacing of medical gas outlets will also be influenced by the size and location of the 'backing boxes' behind the medical services panel that are required to meet the relevant wiring standards and cable segregation requirements.

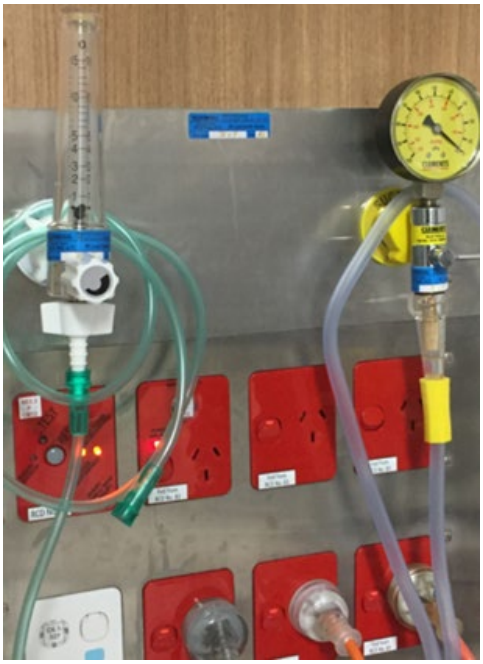


Figure 25 Example of insufficient vertical clearance between services with flowmeters and hoses blocking access to electrical outlets

3.1.3 Outlets, Accessories and Control Panels

Oxygen

The primary use of oxygen for patients in hospitals is to maintain adequate oxygen saturation in the blood. The clinical uses of oxygen include:

- Acute respiratory support in patients with conditions that impair their ability to breathe effectively, such as pneumonia, respiratory syncytial virus (RSV), COVID-19 and acute respiratory distress syndrome (ARDS).
- Surgical procedures, ensuring a patient has adequate oxygen while under anaesthesia that may suppress respiratory function.
- Emergency and critical care where patients may experience compromised respiratory function due to shock, or severe trauma. Oxygen quickly increases blood oxygen levels in patients who are hypoxic (have low oxygen levels), helping to prevent organ damage.
- Support for patients with chronic illnesses, such as severe asthma, pulmonary fibrosis, chronic obstructive pulmonary disease (COPD). Supplemental oxygen helps maintain adequate oxygen saturation, preventing complications, improving sleep quality and reducing breathlessness.

Oxygen supplied via a central piped system is connected to medical gas outlets and may be fitted with specific flowmeters (see Figure 26) to manage the flow of oxygen to patients.See local engineering services guidance documents for specific information on infrastructure requirements for plant and pipe systems.

Figure 26 Example of oxygen flowmeters

Suction

Medical suction, in combination with suction adapters (see Figure 27) and suction bottles/cannisters (see Figure 28), supports various clinical tasks that are essential for patient safety and effective treatment, such as:

- Airway suctioning to remove secretions from a patient's respiratory tract, especially in cases where they cannot clear it themselves due to anaesthesia, trauma, or other conditions that impair breathing.
- Surgical field maintenance, where suction is used to keep the surgical field clear of blood and bodily fluids, allowing surgeons to see and work accurately. This is essential for safety and precision.
- Drainage of Fluids: Suction devices are used postoperatively to drain fluids from surgical sites or body cavities, reducing the risk of infection, improving healing, and monitoring fluid output. Commonly, drainage tubes are placed and connected to suction devices in cases like chest surgeries or abdominal procedures.

Suction outlets provided on medical gas panels are often fitted with adaptors (see Figure 27), either gauged or non-gauged, which are used to connect suction equipment or a suction bottle/cannister (see Figure 28). The suction adapter serves as an on/off tap for the outlet.

Reusable suction bottles/cannisters, typically made from clear polycarbonate, come in various sizes and are fitted with disposable liners. They may be mounted on brackets or equipment rails below a medical services panel, on IV poles, on dedicated suction bottle trolleys, or mounted on medical services pendants.

Medical suction supplied via a central piped system requires a specialised plant. See local engineering services guidance documents for specific information on infrastructure requirements for plant and pipe systems.

Figure 27 Example of a suction Adapter

Figure 28 Example of a suction bottle/canister

Medical Air

Medical air, also referred to as ‘medical breathing air’ and in the Standards as ‘air for breathing’, refers to a clean supply of compressed air (primarily composed of nitrogen and oxygen) used for patient treatment and for calibration of medical respiratory devices (separate from surgical tool air).

Medical air is used for:

- Ventilators, where medical air is mixed with oxygen and delivered to patients who need respiratory support. The air-oxygen mixture ensures appropriate oxygen levels without causing oxygen toxicity.
- Nebulizers to deliver medications as fine mist particles to patients’ lungs. This is crucial for asthma, COPD, and other respiratory conditions where medications are inhaled directly into the airways.
- Anaesthetic machines to help control gas mixtures during surgery. Medical air also often serves as a carrier gas for inhaled anaesthetic agents. The controlled air mixture ensures that anaesthetic gases are delivered evenly and in consistent concentrations, helping to maintain a stable level of anaesthesia throughout the procedure.

When needed, medical air outlets may be fitted with a flowmeter (see Figure 29) for accurate measurement and control of medical air flow. To get the right mix of medical air and oxygen for a patient, an oxygen-air blender (see Figure 30) may need to be connected to the medical gas outlets.

The source of medical air may be a manifold with a bank of compressed air cylinders; however, most hospitals use a compressor system with associated drying and cooling plant. See local engineering services guidance documents for specific information on infrastructure requirements for medical air plant and pipe systems.

Outlet Colour: Black and White

AS 2700 Colour Code: —

PMS Colour: —

Figure 29 Example of a medical air flowmeter

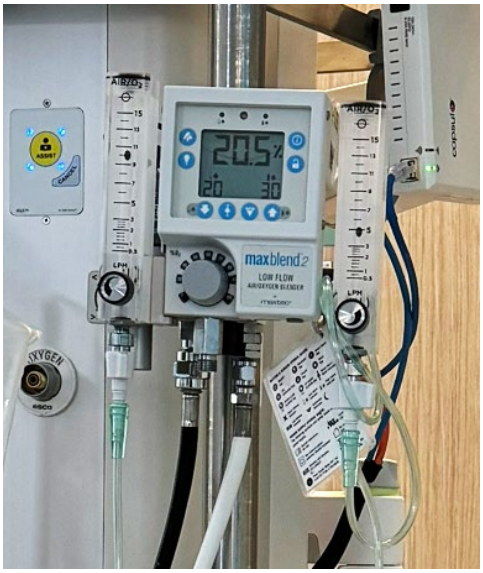


Figure 30 Example of an oxygen and medical air blender

Nitrous Oxide

Nitrous oxide is used for its analgesic (pain-relieving) and anaesthetic (sedative) properties, however, its use has been declining in most clinical areas. Clinical uses include:

- To relieve pain and reduce anxiety during minor procedures, for example, in dentistry and for treatment of paediatric patients. Nitrous oxide's rapid onset, ease of administration and short duration of effect is useful for quick procedures where full anaesthesia isn't necessary.
- Pain management during labour. Nitrous oxide allows mothers to remain alert and active in the birthing process while experiencing pain relief, with minimal side effects compared to stronger anaesthetics like epidurals.
- General anaesthesia in combination with other anaesthetic agents, helping induce sedation quickly and calming patients before stronger anaesthetics are administered.
- For emergency and trauma situations where rapid pain relief and minimal sedation are required. It provides analgesia without causing significant respiratory depression, allowing patients to remain conscious and responsive.

Outlet Colour: Blue (Ultramarine)

AS 2700 Colour Code: B21

PMS Colour: Pantone 293

Nitrous oxide is typically delivered to patients using an oxygen-nitrous oxide mixer (see Figure 31) which allows the ratio of gases to be adjusted.

Figure 31 Oxygen and nitrous oxide blender

Associated scavenge outlets are required where nitrous oxide outlets are provided (see Section 3.1.7 Scavenge for more information).

Due to its high global warming potential and ozone-depleting properties, the nitrous oxide emissions related to healthcare are being increasingly scrutinised. Considering environmental concerns alongside declining clinical use, healthcare infrastructure project teams need to assess the necessity for reticulated nitrous oxide systems and determine if point of care cylinders can meet clinical requirements. The decision should be based on an assessment of expected clinical need and associated risk assessment, particularly for services with high utilisation such as birthing suites. For example, birthing suites may have a dedicated reticulated nitrous oxide system, whilst the rest of a facility is supplied by point of care cylinders. Seeking advice from dangerous goods and engineering consultants on the infrastructure requirements for portable cylinders is recommended. Due consideration must be given to a range of operational factors including:

- monitoring and measurement of usage
- management of leakage
- work health and safety (WHS) requirements relating to the use of cylinders, including how they will be secured during use to prevent tipping or damage
- approach to provision of scavenge where cylinders are used
- appropriate storage and management for cylinders
- security of storage areas, given nitrous oxide can be used as a recreational drug
- whole of life financial and environmental costs.

Scavenge

Exposure to waste anaesthetic gases can pose health risks to healthcare personnel. To minimize occupational exposure, scavenge outlets are used to remove waste anaesthetic gases.

Where nitrous oxide outlets are provided, scavenging outlets must also be provided. Where cylinders of nitrous oxide cylinders are to be used the provision of scavenging outlets or portable scavenging systems is to be considered.

Use cases for scavenge outlets include the following:

- During procedures requiring general anaesthetic, scavenge outlets are connected to extraction ports on anaesthetic machines to collect the excess gases that a patient does not inhale and to ventilators to collect the waste gases that the patient exhales.
- Nitrous oxide delivered to a patient by a breathing apparatus such as a face mask or nasal hood, may be used for sedation and pain relief in clinical areas such as birthing suites, dental surgeries and emergency procedure rooms. The breathing apparatus allows for a nitrous oxide and oxygen mixture to be breathed in by the patient, with one-way valves that then allow exhaled gases to be collected by the scavenge system (see Figure 32).

As scavenge outlets are the same colour as suction outlets (as required by AS 2896) it is recommended that, where possible, there is physical separation of scavenge outlets away from the suction outlets, and clear collocation of scavenge outlets with nitrous oxide outlets to reduce the potential for confusion.

Scavenged gases are collected by a facility's gas disposal system and vented in a safe location outside the building. See local engineering services guidance documents for specific information on infrastructure requirements for plant and pipe systems.

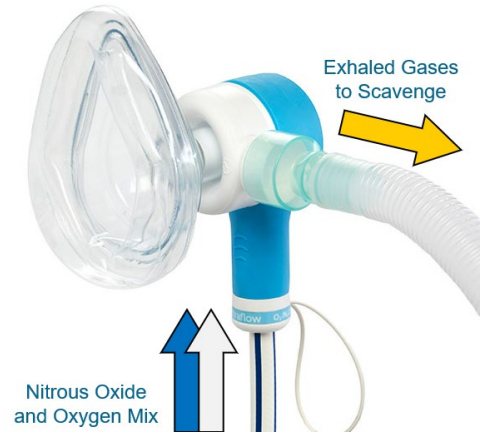


Figure 32 Face mask with exhalation valve for administration of analgesic gases

Carbon Dioxide

Carbon dioxide is an odourless, colourless, non-flammable gas. It may be provided via a reticulated system in some large hospitals but more likely comes from a cylinder.

Clinical uses include:

- Insufflation, where carbon dioxide is blown into a body cavity to inflate and stabilise the body cavity for greater visibility and access to surgical areas. For example, carbon dioxide is used to insufflate the abdomen during laparoscopic (keyhole) surgery and used to inflate the gastrointestinal tract during endoscopic procedures.
- When combined with oxygen, carbon dioxide can be used to stimulate breathing. Carbon dioxide may be used for this purpose after apnoea or after relief of chronic respiratory obstruction.

Outlet Colour: Green Grey

AS 2700 Colour Code: N32

PMS Colour: Pantone 5935

As outlets for carbon dioxide are predominately provided in operating theatres and procedure rooms, the location of the associated plant infrastructure should be as close as practical to the area of use. See local engineering services guidance documents for specific information on infrastructure requirements for plant and pipe systems.

Surgical Tool Air

In operating rooms and procedure rooms, compressed air can be used for powering pneumatic surgical tools such as drills, saws and shavers. In recent times, there has been a trend towards battery powered tools and devices, however requirements will need to be carefully assessed on a case-by-case basis. Tool air is usually supplied via centralised cylinders but can also be provided via centralised compressed air plant, and there is a significant capital and recurrent cost to install and maintain reticulated tool air associated with the compressors and air dryers. Consultation with the clinical teams is essential to confirm the need for reticulated tool air or the use of alternative solutions such as battery powered tools or access to gas cylinders (including considerations for storage, management, and safety) for ad hoc use as required.

Tool air pressure regulator and indicator panels will be provided at the point of use (see Figure 33) and are typically wall mounted but may be integrated on a medical services pendant.

Where reticulated tool air is provided, the location of the plant will be as close as practical to the areas of use while allowing for easy cylinder delivery. See local engineering services guidance documents for any specific information on infrastructure requirements for plant and pipe systems.

Outlet Colour: Aqua

AS 2700 Colour Code: B25

PMS Colour: Pantone 632

Figure 33 Example of a surgical tool air control panel on wall

Tourniquet Air

Tourniquets consist of four basic components: a cuff that is wrapped around a patient's limb prior to being inflated, connective tubing, a compressed gas source, and a mechanism with a pressure gauge that is designed to maintain pressure in the cuff at a set value.

- In surgical settings, a tourniquet is used to provide a clear operative field and limit intraoperative blood loss during extremity surgery.
- In emergency settings, a tourniquet is used to stop traumatic bleeding.
- In rehabilitation settings, a tourniquet is used to restrict arterial blood flow at a consistent and safe pressure for short periods of time during low intensity exercise to more rapidly increase muscle size and strength.

Figure 34 Example of tourniquet air outlets and control panel

Reticulated tourniquet air outlets and associated control panels (see Figure 34) may be used, and are found in orthopaedic and trauma settings, however, their use has largely been replaced by mobile tourniquet equipment that has an integral air supply. Where they are provided, it is recommended tourniquet air panels (including control dials for pressure regulation) are installed on a wall or integrated on a wall mounted medical service panel. It is not recommended that the outlet not is fitted to a services head on a pendant away from the tourniquet control and the overall panel is too large to be fitted to a services head on a pendant.

3.1.4 System Context

The following sections provide an overview of some important components in the wider medical gas system context into which the components panels and pendants are integrated. While these components do not directly impact design or configuration of panels and pendants, awareness of these elements supports a comprehensive understanding of the medical gas system.

Medical Gas Isolation Valve Boxes

Medical gas isolation valve boxes (see Figure 35) are recessed wall boxes designed to allow for gas sampling, purging, testing and emergency supply connection.

- Valve isolation boxes should be mounted at a convenient height such that they can be operated comfortably by staff without needing to stoop or overreach.
- In high dependency areas, such as CCU or ICU, dual circuits or subdivision of circuitry (or both) will occur to ensure that gases are always available to rooms and beds.
- Terminal units must be identified as being associated with the specific valve isolation boxes. Correspondingly, valve isolation boxes will be similarly labelled to identify the terminal units controlled.

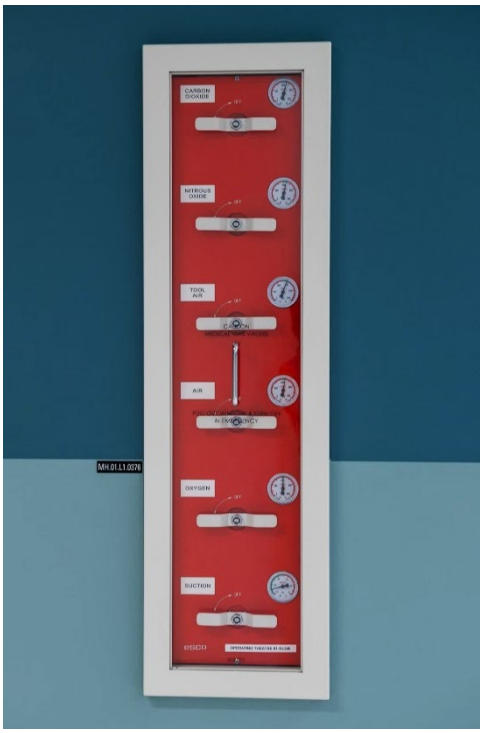


Figure 35 Example of a medical gas isolation valve box with 6 valves

As per AS 2896 Medical gas systems, a zone isolation valve shall be provided serving:

- Each anaesthetising location (where an operating room and associated anaesthetic prep/induction room would be considered one anaesthetising location) and each special care location.
- A birthing area (where separate isolation valves may be used for each delivery room).

AS 2896 does not provide specific mounting heights for isolation valve boxes however it is recommended that mounting is between 1000mm and 1400mm to the centre of the box (with the top of the box no higher than 1800mm) to ensure the valves can be reached to be operated. The mounting height and set out of isolation valve boxes should be confirmed at project level to suit local jurisdictional policies and engineering standards and guidelines.

Medical Gas Alarm Panels

The medical gas system is continuously monitored by sensors. Medical gas alarm panels (see Figure 36), connected to the building management system (BMS), raise alarms upon sensing low pressure within the medical gas pipework on the outlet side of the isolation valve panel. These panels should be positioned where they can be supervised. Where the location suits, the alarm panel can be combined with the isolation valve box.

AS 2896 does not provide specific mounting heights for alarm panels however it is recommended that the panels are mounted between 1000mm and 1500mm to the centre of the panels to ensure the panel can be visualised and the buttons on the panel can be operated. This height may be lower where a panel is integrated into joinery, for example, at a staff station. The mounting height and set out of alarm panels should be confirmed at project level to suit local jurisdictional policies and engineering standards and guidelines.

Figure 36 Example of a medical gas alarm panel

3.2 Power, Status Indicators, Electrical Protection and Testing

In healthcare facilities, a reliable and continuous power supply is essential for patient safety. To ensure this, a variety of power sources are required, including non-essential, emergency, and uninterruptible power supply (UPS) systems, all of which can be integrated onto panels and pendants to provide access close to patient care and treatment areas. With colour-coding of switched outlets, clinicians can quickly identify which outlets are connected to non-essential, emergency, or UPS power, streamlining responses during power disruptions.

In addition to switched power outlets, other electrical services located on or associated with panels and pendants can include:

- residual current devices (RCDs)
- UPS status indicators and alarms
- equipotential junction test points
- lighting controls
- data outlets (see Section 3.3)
- nurse call buttons (see Section 3.4)

3.2.1 Australian and New Zealand Standards

In Australia and New Zealand, the design and installation of electrical services for medical services panels and pendants is primarily governed by a number of Standards noted in Table 4 below.

Table 4 Standards applicable to the design, installation and testing of electrical services for patient areas in Australia and New Zealand

Code	Name
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 Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV – Typical Australian conditions Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV – Typical New Zealand conditions
AS/NZS 3009	Electrical installations - emergency power supplies in hospitals
AS/NZS 2500	Safe use of medical electrical equipment in health care
AS/NZS 3190	Approval and test specification for residual current devices (current-operated earth-leakage devices)
AS/NZS 61008.1	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)
AS/NZS 61009.1	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)

3.2.2 Set Out Principles and Considerations

The following spacing requirements for electrical services must be met when designing medical services panels and pendants (per section 2.7 of AS/NZS 3003):

- A minimum spacing of 60 mm horizontally and 100 mm vertically between socket-outlets should be considered when plug packs are likely to be used.

Another important distance that must be maintained is included in AS/NZS 3000 (the Wiring Rules), clause 3.9.8.4 (b) proximity to non-electrical services:

- Wiring systems shall maintain a separation of not less than 25 mm from any above-ground gas or water piping.

3.2.3 Non-essential Power Outlets

Non-essential power outlets (see Figure 37) are connected to a power source that has no inherent backup power supply. These are provided for use with equipment for which a loss of power would not adversely impact patient care.

Non-essential power outlets, referred to as standard power outlets in the AusHFG resources, are coloured white as required by AS/NZS 3003.

Dedicated leakage protection devices (LPDs) will be required for protection of non-essential power circuits on medical services panels or pendants in accordance with AS/NZS 3003. Quantities of LPDs will vary based on project requirements and to suit the room function.

Electrical services mounted on medical services panels and pendants will be labelled to identify supply location and connections in accordance with AS/NZS 3003. Outlets on panels and pendants must include a 'power available' LED, as per AS/NZS 3003, allowing users to easily identify when a power source is not available.

Figure 37 Example of a medical services panel with three white, non-essential power outlets

3.2.4 Emergency Power Outlets

Emergency power outlets (see Figure 38), also known as essential power outlets or standby power outlets, are connected to a power source with an alternative backup supply, such as a standby generator. These outlets are provided on panels and pendants for medical equipment that is essential in delivering patient care to critical care areas. Standby generators can typically start within up to a minute of an outage, supplying power to essential services and life-sustaining equipment.

The extent of emergency power provided on medical services panels and pendants will need to be determined to suit the requirements of the space and confirmed based on a risk assessment considering the impact of a power outage on patient care.

Emergency power outlets are coloured red as required by AS/NZS 3003.

Dedicated leakage protection devices (LPDs) will be required for protection of emergency power circuits on medical services panels and pendants in accordance with AS/NZS 3003. Quantities of LPDs will vary based on project requirements and to suit the room function.

Electrical services mounted on medical services panels and pendants will be labelled to identify supply location and connections in accordance with AS/NZS 3003. Outlets on panels and pendants must include a 'power available' LED, as per AS/NZS 3003, allowing users to easily identify when a power source is not available.

Figure 38 Example of a medical services panel with four red, emergency power outlets

3.2.5 Uninterruptible Power Supply (UPS) Outlets

UPS systems provide immediate, short-term power to critical equipment, bridging the gap between the power loss and generator start-up. Unlike generator power, which may take up to a minute to come online, UPS systems maintain power supply without interruption, ensuring that vital life-support and diagnostic equipment plugged into UPS, like ventilators, monitors, and anaesthetic machines, experience zero downtime.

UPS power outlets are coloured blue (see Figure 39) as required by AS/NZS 3003.

Dedicated leakage protection devices (LPDs) will be required for protection of UPS circuits on medical services panels and pendants in accordance with AS/NZS 3003. Quantities of LPDs will vary based on project requirements and to suit the room function.

Electrical services mounted on medical services panels and pendants will be labelled to identify supply location and connections in accordance with AS/NZS 3003. Outlets on panels and pendants must include a 'power available' LED, as per AS/NZS 3003, allowing users to easily identify when a power source is not available.

Where UPS outlets are used in patient areas, a UPS status indicator (see Figure 40), is required per AS/NZS 3003 where there is continuous patient observation. This provides an audio-visual alarm upon the failure of mains power to notify staff that power is now running on UPS. Status indicators for UPS outlets on a medical service panel or pendant may be located separately on the wall or integrated onto the medical services panel or pendant.

Figure 39 Example of a medical services pendant with six blue, UPS power outlets

Figure 40 Example of a UPS status indicator on a medical services panel

3.2.6 Electrical Protection

Body Protected Areas

Australian and New Zealand Standards require patient areas that do not require cardiac protection to be wired as Body Protected Electrical Areas (BPA), including the use of leakage protection devices (LPDs) to protect all electrical sockets in the patient area as per AS/NZS 3003. LPDs provide increased protection against electric shock to staff and patients. This can be achieved either via residual-current devices (RCDs) or line isolation and overload monitors (LIOM) and transformers.

Figure 41 Example of the signage required for a body protected area

A "Patient Area" is any location where it is intended that low voltage medical electrical equipment will be used on a patient. This includes spaces within hospitals and medical clinics, as well as other relevant specialist treatment clinics such as dental, physiotherapy, dermatology, orthopaedic clinics and many others. The identification and classification of patient areas will be determined by the responsible bodies, based on the type of procedures carried out in each space and specific for each project.

A Body Protected Electrical Area sign (see Figure 41), with certification and verification labels, must be mounted on a readily visible surface in a patient treatment area. The top of the sign should be 2 meters from the floor.

Cardiac Protected Areas

A cardiac protected electrical area in a healthcare facility, while also requiring RCDs to all power outlets, also have strict controls for using medical equipment that interacts the heart. The responsible health care organization determines whether an area requires body or cardiac protection based on the types of medical procedures performed there. Cardiac protected areas require equipotential bonding in accordance with AS/NZS 3003. This requires all exposed conductive parts or extraneous conductive parts to be connected to a common point – an Equipotential Junction (EPJ) or node. The EPJ may be in the ceiling space, but an Equipotential Junction Test Point is required to be mounted within the cardiac protected area in an accessible location in accordance with AS/NZS 3003. Equipotential Test Points are typically located on a wall or medical services panel (see Figure 42).

Figure 42 Example of an equipotential junction (EPJ) node testing point on a medical services panel

A Cardiac Protected Electrical Area sign (see Figure 43), with certification and verification labels, must be mounted on a readily visible surface in a patient treatment area. The top of the sign should be 2 meters from the floor.

Figure 43 Example of the signage required for a body protected area

Leakage Protection Devices (LPDs)

Residual-Current Devices (RCDs)

RCDs (see Figure 44) are electrical safety devices that automatically switch off electrical power to one or more electrical loads when the earth leakage reaches levels that are deemed hazardous, as per requirements in AS/NZS 3190, AS/NZS 61008.1 and AS/NZS 61009.1.

Project engineers select the RCD equipment, location and circuiting arrangement that best suits the application. As a minimum, the designers are required to provide RCD protection for all socket outlets in a body protected space or cardiac protected space in accordance with AS/NZS 3003. For example, an RCD mounted to a medical services panel may be used to protect a group of up to 12 socket outlets on the same panel, subject to compliance with AS/NZS 3003 and AS/NZS 3000.

It is recommended that, where possible, RCDs serving power outlets on pendants are located on the wall or a medical services panel within the room. Inclusion on a pendant is possible but must be coordinated with the pendant supplier to ensure compatibility and compliance.

Figure 44 Example of an RCD to emergency power outlets on medical services panel

Line Isolation and Overload Monitors (LIOMs) and Transformers

Certain medical procedures require that equipment be powered from an isolated supply, determined for each project area and procedure in accordance with AS/NZS 2500. Typically, this will be for applications where loss of supply cannot be tolerated even for a very brief period. Examples may include providing a LIOM to serve the UPS outlets on a pendant within an operating room or for the UPS connection for medical electrical equipment.

LIOMs are traditionally used for an isolated supply arrangement, as an alternative to RCDs because under a fault condition an isolated supply has insufficient leakage current to trigger the RCD protection function. LIOMs do not automatically interrupt supply upon a fault condition. Instead, the LIOM will alert clinical staff within the patient care area, via an audible and visual alarm, of either an overload or hazardous current within the monitored circuit. In response to an alarm, medical staff may choose to shut down non-essential equipment to reduce load or disconnect equipment they may suspect of causing the isolation fault.

LIOMs must be wall mounted independent of the medical services panels and medical services pendants (see Figure 45).

Isolation transformers provide the isolated supply to the associated electrical circuits and are often located in nearby electrical cupboards (see Figure 46).

Figure 45 Example of a line isolation and overload monitor located above a medical services panel

Figure 46 Example of an isolation transformer in an electrical cupboard

3.3 Data and Communications Systems

Data and communication systems provide wired connectivity to the building and campus communications network infrastructure, and it is critical that they are installed in accordance with regulatory, industry and site-specific standards to ensure network connectivity functionality and availability in healthcare facilities.

By supporting the connectivity of patient monitoring devices and medical equipment, data outlets on medical services panels and medical services pendants are essential to the safety and efficacy of patient care, for example:

- Devices connected via data outlets can continuously monitor vital signs, such as heart rate, oxygen saturation, and blood pressure, and immediately alert staff to critical changes. Automated alerts sent through data outlets ensure rapid intervention during emergencies, reducing response times.
- Data outlets allow immediate transfer of diagnostic imaging, lab results, and other critical data to healthcare teams, speeding up diagnosis and treatment.
- Communication outlets facilitate telemedicine consultations, enabling specialists to provide timely input without needing to be physically present.
- Patients in isolation or remote areas can be monitored and supported by healthcare providers via secure data connections, ensuring continuous care.

Data and communications outlets include the following:

- Copper data outlets
- Fiber optic outlets
- Audio-visual outlets

3.3.1 Australian and New Zealand Standards and Industry Standards

All data outlets irrespective of where they are mounted and installed (wall, ceiling, pendant, MSP, desk box floor box, etc.) must comply with the relevant Australian and New Zealand Standards, as well as telecommunications industry standards to ensure functional operation. Relevant Standards are noted in Table 5 below:

Table 5 Standards applicable to the design, installation and testing of data and communications services for patient areas in Australia and New Zealand

Code	Name
AS/NZS 11801.1	Information technology – Generic cabling for customer premises, Part 1: General requirements (ISO/IEC 11801-1:2017, MOD)
AS/NZS 14763.2	Information technology – Implementation and operation of customer premises cabling, Part 2: Planning and installation (ISO/IEC 14763-2 (ED. 2.0) MOD)
AS/NZS 14763.3	Information technology - Implementation and operation of customer premises cabling, Part 3: Testing of optical fibre cabling (ISO/IEC 14763-3:2014, MOD)
AS/NZS 3084	Telecommunications pathways and spaces for commercial buildings
AS/NZS 60950.1	Information technology equipment - Safety Part 1: General requirements (IEC 60950-1, Ed. 2.2 (2013), MOD)
AS/NZS 61935.1	Specification for the testing of balanced and coaxial information technology cabling Part 1: Installed balanced cabling as specified in ISO/IEC 11801-1 and related standards
Mandatory Australian Government legislation and regulation	Telecommunications Act 1997
	ACMA Telecommunications Cabling Provider Rules 2014
	Communications Alliance AS/CA S008:2020 Requirements for Customer Cabling products
	Communications Alliance AS/CQ S009:2013 Installation requirements for customer cabling (Wiring rules)

Jurisdictions may also have local policies in relation to security, clinical communications, cabling, and medical device connectivity that are to be read in conjunction with the above Standards.

3.3.2 Set Out Principles and Considerations

Panels and pendants may contain a variety of connection outlets for data, audio-visual or other point to point services in addition to general network connectivity. These services are required to be within a confined cavity enclosed within the panel/pendant structure.

The following considerations should be accounted for when planning and designing a panel or pendant containing data/communications outlets:

- All data outlets shall form part of the building structured communications system and installed by a certified installer adhering to the relevant cabling installation standard.
- Physical separation and or channel segregation of copper data cabling/wiring and electrical power cabling/wiring must be observed in accordance with industry standards per Table 5 as well as local engineering services guidance. The mounting box of a panel or services head and arm of a pendant will typically be designed with channels built in for the segregation of services.
- Data outlet failure may occur during use of the panel or pendant resulting in disruption to patient care due to downtime of medical equipment. Modular serviceable components that can be isolated easily are highly desirable. Redundant and spare data outlets may be installed in critical care settings as backup should failure occur, minimising clinical downtime and disruption to patient care.
- Over time, the faceplate or bezel of a data outlet may break due to material strain/stress, particularly for high repeat use outlets (i.e. cables are disconnected and reconnected frequently) which results in sockets “sinking” or being pushed into the wall. Cable strain relief options must be explored to reduce material stress on the outlet. This is a common issue post installation, and it is recommended that modular components are used that can be replaced with minimal downtime in critical clinical areas.
- The bending radius of the network cabling/wiring into the back of the data outlet within panels and pendants should be considered. Where the angle exceeds industry compliance, angled cable termination brackets may be used to alleviate cable stress. Shielded data cabling, such as the cabling required in MRI areas, is particularly challenging as these cables are thicker in diameter and less flexible when compared to unshielded data cabling. Where shielded data cabling is used, matching shielded data cords must be used or risk damaging and compromising the data outlet and structured cabling system voiding the relevant manufacturer’s site-specific certification.
- Where Power Over Ethernet (PoE) devices are connected to the panel or pendant, for example, for powering Voice over Internet Protocol (VoIP) handsets, the maximum operating ambient temperature of PoE cables is 60°C and for the components it is 50°C. The single cable carries electricity and data from the same data outlet, increasing the load for the communications channel. This usually results in increased cabling bundle temperature as heat is generated in the cable. Smaller bundles of cables, shielding, patch cords and airflow all help to dissipate heat. Assessing the number of outlets in a room that would be expected to provide PoE can support designing for this heat generation.
- The cabling through the arm of a pendant must be stranded (see Figure 47) to withstand use over 20 years of movement. The flexibility of stranded cables helps prevent breakage and damage. Solid cables can become brittle and break when bent repeatedly, while stranded cables can withstand more bending and twisting.
- The interface between the stranded pendant cable and the solid core permanent link cable must occur within 2 meters of the pendant entry point inside the ceiling space. The components used within the data cabling link must be sufficiently robust to avoid breakage or failure over 20 years of use.

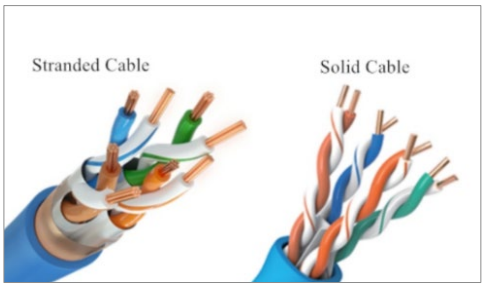


Figure 47 Comparison between stranded cable and solid cable

- In deciding the type of connections needed in a given space (including assessing the type of output connections of selected equipment) consideration regarding the length of the different cable solutions is required to ensure that you are only using these to their maximum length (as per spec sheets for the cabling products) before any loss of signal and dithering. For example, if a continuous copper cable run is longer than recommended for the connection type the use of a fibre optic solution may be required for best performance.

3.3.3 Copper Data Outlets

The most common kind of copper data outlet is the RJ45 (see Figure 48); which is an 8-pin connector used for providing wired internet connections for devices like computers, medical equipment, and monitoring systems (digital data transmission), while also being capable of providing power to some devices as a PoE connection. An RJ11 is a 4-pin or 6-pin connector that is used for telephone cables (analogue data transmission). AS/NZS 11801 states that for structured cabling, an 8 position 8 connector plug must be used when plugging into data outlets.

Figure 48 Example of typical modular shielded RJ45 data outlet that supports copper cabling

A shielded jack must be used with shielded copper cabling to protect the communications channel from external interfering signals such as electromagnetic interference (EMI) exposure and noise interference. Electrical noise and EMI affect the performance of electrical circuits via electrostatic coupling, electromagnetic induction. Noting the end-to-end channel must be grounded to earth.

The outer face of the outlet is typically grey or white (see Figure 49), however other colours may be provided where it is advantageous to distinguish between outlets that are dedicated to different functions.

Shutters to outlets in sterile areas are required to comply with safety requirements in AS/CA S009, protect from damage and maintain warranty. Cleaning activities in these areas will render the outlet unusable if shutters are not in place.

Figure 49 Example of a medical services panel with four RJ45 data outlets

3.3.4 Optical Fibre Data Outlets

Fiber Optic data outlets are used for high-speed data transmission, especially in settings requiring large bandwidths. For example, they are essential for Picture Archiving and Communication Systems (PACS), which store, transfer and retrieve diagnostic images, and DOR systems for high quality imaging.

Fiber optic cables utilise a few different connector types. While they do bear some similarities, each kind is different enough in size and shape that they are not interchangeable. It is important to ensure the correct outlets are provided for the equipment that is intended to be used to provide seamless integration with the chosen imaging devices. Selecting a “universal” outlet and determining if converters for equipment that does not directly connect to this outlet, may be a feasible approach where equipment connections vary significantly.

Typically, optical fibre cabling is terminated into the jack/plug on a LC socket/connector. Optical fibre termination connectors may also be ST or SC types depending on equipment needs, and local/project ICT cabling standards.

The outer face of the outlet is typically white or grey however other colours may be provided where it is advantageous to distinguish between outlets that are dedicated to different functions.

Shutters/covers to outlets in sterile areas are required to comply with safety requirements in AS/CA S009, protect from damage and maintain warranty. Cleaning activities in these areas will render the outlet unusable if shutters are not in place.

3.3.5 Audio-visual Outlets

Outlets for the input and output of video and audio may be provided on medical services panels and pendants for where a recording device, monitoring device or medical imaging output is required to be shared on a screen. For example, a HDMI outlet is often provided on or near the medical services panel in an ultrasound room so the ultrasound machine can be connected to it and the images can be displayed on a wall/ceiling mounted display screen for viewing by the patient. Audio-visual outlets may similarly be provided in operating rooms (see Figure 50) for connection to intra operative cameras so the camera feed can be seen on a display screen by the clinicians in the room.

There are various types of audio-visual outlets (see Table 6 for information on common outlets). The type of outlets required will be dependent on the equipment to be used and must be confirmed by project teams.

Figure 50 Example of audio-visual outlets (including VGA and DVI outlets) on a medical services pendant

Table 6 Types of audio-visual outlets used on medical services panels and pendants

HDMI	HDMI Mini	HDMI Micro
		
HDMI (High-Definition Multimedia Interface) is a widely used connection point that transmits both high-definition video and audio signals from a source (camera, medical equipment) to a display or recorder over a single cable. This is currently the most common connection for most consumer electronics. The latest version (HDMI 2.1) supports resolutions up to 10K, as well as increased refresh rates, making it extremely versatile for high-quality digital display requirements.	HDMI Mini (Type C) was introduced in 2006 as a small form factor version of the HDMI primarily used in portable devices. It has full HDMI functionality capable of transmitting both high-definition video and audio signals from a source (camera. medical equipment) to a display or recorder over a single cable. This is currently used in consumer electronics requiring a compact form factor connector. These are commonly found in camcorders, digital cameras and some tablets.	HDMI Micro (Type D) is the smallest version of the HDMI connector family, introduced in 2009. It has full HDMI functionality capable of transmitting both high-definition video and audio signals from a source (camera, medical equipment) to a display or recorder over a single cable. This is currently used in consumer electronics requiring an ultra-compact connector. Despite its size, this connector is still equipped with 19pins like the standard HDMI.
DisplayPort	**DisplayPort Mini**	**Thunderbolt**
		
Designed to replace VGA and DVI, DisplayPort is a digital display interface developed by the Video Electronics Standards Association (VESA). It can carry high-definition video and audio signals, as well as data. DisplayPort is favoured for its ability to support high resolutions (up to 16K in the latest version) and its compatibility with multiple monitors through a single connection.	The display port mini is a compact version of the display port introduced by Apple in 2008. It can carry high-definition video and audio signals as well as data with the same functionality as a standard display port. It is also uses the same physical connector used for thunderbolt which adds high speed data transfer to the mix.	Thunderbolt combines data transfer, video output, and power delivery capabilities into a single compact connector. Thunderbolt provides greater bandwidth than USB-C and therefore supports faster data transfer. Older versions have the connector shown in the image above, while the most recent versions (Thunderbolt 4) use a USB-C connector as the interface with devices.

USB-C	USB-A	Mini USB and Micro USB
		
USB-C (Universal Serial Bus Type-C) can carry data as well as video and power over a single connection, making it an increasingly common choice for modern laptops and smartphones. USB-C can support various display protocols, including HDMI and DisplayPort, making it a highly flexible option for both data transfer and display requirements.	USB-A (Universal Serial Bus Type A) is gradually superseded by USB-C. It is capable of transmitting data, power and audio only. It does not natively support video transmission where additional hardware adapters are required. USB-A is generally used in legacy devices such as older printers and flash drives.	Mini USB and Micro USB are compact versions of the USB connector widely used for charging and data transfer on smaller devices. It is capable of transmitting data, power and audio only. It does not natively support video transmission where additional hardware adapters are required. Micro USB is generally used in consumer electronics such as Bluetooth speakers, power banks and smartphones.

SDI	VGA	DVI
		
Serial Digital Interface (SDI) is a family of interface developed by the Society of Motion Pictures and Television Engineers (SMPTE). It is often used in professional broadcast and video production environments to transmit uncompressed digital video and audio signals over co-axial cable, or over optical fibre cable with an SDI-optical fibre converter. It uses a BNC coaxial cable connector. The latest standard 24G-SDI is capable of 8K video resolution at 60fps, and the 12G-SDI standard is capable of 4k video resolution at 60fps. Typical use case for SDI includes connecting 4k/8k medical imaging diagnostic cameras to live broadcast streams as well as video and audio recording/processors and storage devices.	VGA (Video Graphics Array) is a 15-pin connector that for transmitting analogue video signals and was used in computer monitors and televisions. A separate connection is required for audio. While VGA has largely been superseded by HDMI and DisplayPort, it is still found on some legacy devices.	DVI (Digital Visual Interface) is a 29-pin connector that can transmit both digital and analogue video signals and was used in computer monitors and televisions. A separate connection is required for audio. While DVI has largely been superseded by HDMI and DisplayPort, it is still found on some legacy devices.

3.3.6 Face Plates

The face plate, also known as a mounting plate, are covers that sit over the data sockets/outlets and secure them to the medical services panel or pendant.

The face plate may be:

- **integral** with the cover plate of the panel (see Figure 51) or face of the services head of the pendant.
- **flush** with the cover plate of the panel (see Figure 52) or face of the services head of the pendant.
- **surface mounted** on the cover plate of the panel (see Figure 53) or face plate of the services head of the pendant (see Figure 54).

Infection prevention and control considerations, including cleanability of the services on the medical service panel or pendant should be considered when selecting a mounting option.

There may be multiple spaces, referred to as gangs, for outlets on each face plate (1-gang, 2-gang, 3-gang, 4-gang, 5-gang and 6-gang). Typically, face plates on medical services panels have no more than three data outlets to limit the size of cable bundles.

Local ICT infrastructure naming policies will determine labelling requirements for data outlets. Labels may be required to include identifiers for site, building, floor, communication room, cabinet and outlet. Outlet labelling must be securely attached to the face plate for example, on self-adhesive plastic sheet laminate that is suitable for engraving (see Figure 52 and Figure 54). An alternative is to dedicate a gang in a multi-gang face plate for a printed label secured behind a clear window (see Figure 53).

Figure 51 Example of a medical services panel with integral data outlets

Figure 52 Example of a medical services panel with a 2-gang, flush face plate for data outlets

Figure 53 Example of a 6-gang surface mounted face plate on a medical services panel, with 3 x gangs used for data outlets and 3 x gangs used for associated labels

Figure 54 Example of two 2-gang surface mounted face plates for data outlets on a medical services pendant

3.3.7 System Context

To provide a brief overview and context of the wider system into which the data and communication services outlets connect, the diagram in Figure 55 shows the components that make up an end-to-end permanent link/communications channel and their relationships. The components are described in Table 7.

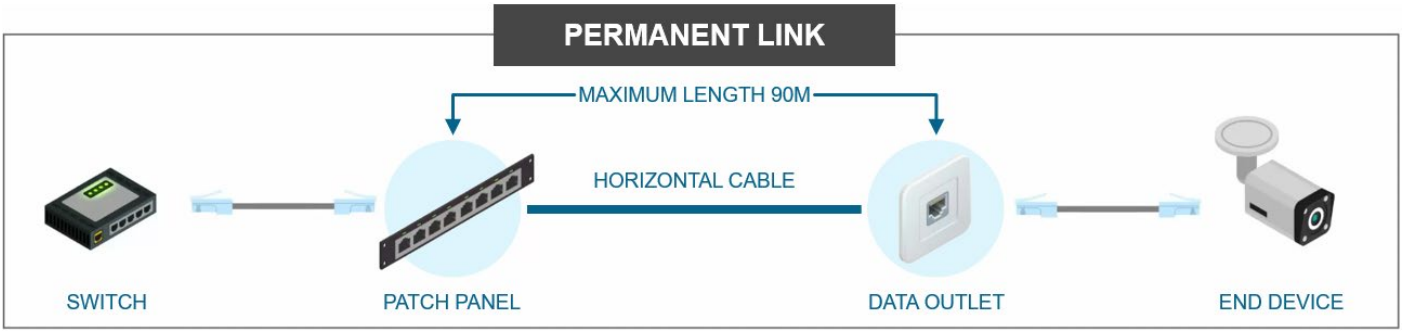


Figure 55 Diagram of the components and relationships in a permanent link/communications channel

Table 7 Permanent link/communications channel component names and descriptions

Component Name	Description
End Device	Any health facility approved device requiring wired connection to the communications network i.e. computers, VoIP telephones, patient monitors, medical equipment, etc.
Data Outlet	Shown in the diagram as an RJ45 socket connecting the end device to the communications network, the type of outlet will vary according to the connection requirements of the end device.
Horizontal Cable	This is the communications wiring which can be copper (preferably shielded) or optical fibre cabling. The copper cable length must not exceed 90 metre as the signal begins to degrade beyond that point, which can reduce the speed and reliability of the connection.
Patch Panel	The wiring from each data outlet is terminated into a patch panel for ease of management and identification typically located in a dedicated ICT communications room.
Switch	This is the network communications switch which connects each data outlet to the building and campus communications network via the patch panel. The network switch also services as a power supply to power over ethernet (PoE) enabled devices such VoIP telephone handsets and wireless access points.

3.4 Nurse Call Systems

A nurse call system is a crucial communication tool in healthcare facilities. Nurse call system technology is evolving to further support staff and patient safety and care with comprehensive integration to other messaging services. This supports staff workflow, patient centred care and improves patient experience.

The core function of a nurse call system is to provide the following:

- **Patient Communication:**
  - Patients can press a button or pull a cord to request assistance, triggering an alert at the staff station and to annunciators located in the corridors that indicates the patient's location and the nature (call vs emergency) of the request.
  - Some systems allow for direct voice communication between the patient and the nurse, enabling nurse to assess the situation before arriving.

- **Alerting Staff:**
  - The system generates visual and audible alerts to notify staff of a patient's call. Different colours or sounds may indicate different types of requests or emergencies.
  - Some systems can send alerts to staff members via mobile devices, ensuring they receive notifications when away from the staff station.

- **Emergency Response:**
  - In critical situations, staff can use a specific button to call for immediate assistance from other medical staff.
  - The nurse call system can be integrated with other safety systems like bed pad alarms or smoke detectors to provide integrated emergency alerts.

- **Patient Amenity:**
  - Where patients are expected to stay for long periods of time or benefit from distraction during treatments (e.g. paediatrics), nurse call systems are often integrated with patient entertainment systems.
  - In addition to staff communication buttons, the patient handset can provide control of video and sound levels for the patient entertainment display screen, with the speaker being provided within the handset itself. Control of reading lights may also be provided on the patient handset.

The nurse call system must:

- Allow patients and staff to raise audible and visual assistance alarms at destinations where there will always be competent assistance resources available.
- Identify the source of the alarm.
- Maintain the emergency alarms until cancelled at the source.
- Be zoned to maintain full department functionality.

Nurse call buttons and sockets for nurse call handsets are often integrated into the medical services panel and pendants to ensure ease of access for patients and staff. Nurse call services include the following:

- Emergency call buttons
- Staff assist call buttons
- Patient to staff call buttons
- Patient handsets, including controls and speakers for patient entertainment systems and lighting
- Orderly/porter call buttons
- Presence call buttons
- Indicator lights and annunciators

3.4.1 Australian and New Zealand Standards

In Australia and New Zealand, the design and installation of nurse call systems and patient entertainment systems (PES) must comply with several Standards noted in Table 8 below.

Table 8 Standards applicable to the design, installation and testing of Nurse Call systems for patient areas in Australia and New Zealand

Code	Name
AS 3811	Hard-wired patient alarm systems
AS/NZS CISPR 22	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
AS 60529 (IP65)	Degrees of protection provided by enclosures

3.4.2 Call Buttons

The nurse call buttons are customisable human interface devices (HID) that are available in a variety of formats for staff and patients to initiate workflows within the nurse call system. The nurse call buttons may be connected in series to form a chain of consecutive buttons or set up individually. These devices are usually directly connected to a network switch and powered via PoE or connect to a proprietary consolidation point.

All nurse call buttons should:

- Include a LED light that illuminates when a call is active.
- Include a cancel button that is at least 10mm away from the call button. When pressed, the cancel button will turn off the indicator lights, disable the audible tone and clear the notification from the annunciators.
- Be coloured to comply with AS 3811 Hard-wired patient alarm systems.
- Raise visual and audible alarms that comply with AS 3811 Hard-wired patient alarm systems.
- Be in consistent positions in like rooms throughout the facility.
- Be waterproof if located in areas where they may get wet.
- Be connected to an uninterruptable power supply capable of supporting full functionality under all load conditions.

The information provided on individual nurse call buttons in the following sections provides terminology for and descriptions of the various call buttons that are provided on medical services panels and pendants, as well as contextual information about each button's clinical/functional use and its connection to the wider nurse call system.

Patient to Staff Call

Patient to staff call buttons are green (see Figure 56) and while a button is usually located on a medical services panel or pendant, the call is most often activated by the patient from the button on the patient handset which plugs into the face plate of the patient to staff button panel (see Section 3.4.3 Patient Handsets). When a patient initiates a call from their handset or patient to staff call button to request assistance from a clinical staff member, the indicator light above the bed (in a multi-bed room) or outside the entry to the room will light up, an audible tone will be triggered and the location and call type will be displayed on the annunciator panels/monitors across the clinical area (see Figure 57).

Regarding the audible tone mentioned above, many hospital units are moving towards being configured as "quiet wards" whereby the alert for patient to staff calls is sent directly to an allocated staff member and the tone only sounds after a configurable elapsed time if not cancelled to reduce the amount of noise pollution on the wards.

Patient to staff call buttons may be combined on the same face plate as staff assist call buttons and potentially with other functions such as patient entertainment system speakers (see Call Button Combinations).

Assistive devices may be connected to the patient to staff call button plate in addition to or instead of a patient call handset (see Section 3.4.4 Assistive Devices).

Patient to staff call buttons are generally positioned on a panel so that either the button can be within easy reach of the patient, or the handset can comfortably reach to the patient in the bed or on a patient chair. In many scenarios, the patient's right-hand side or the side closest to the door is considered the 'clinical side' of the bed (although care can be administered from any side as required). While placing the patient to staff call on the patients' left/further from the door may be an option to free up space on the 'clinical side' for power and medical gases, the staff still need to be able to readily press the cancel button on the face plate. Therefore, the patient to staff call button, or an additional slave call point (see Master and Slave Call Points), should be located within easy reach of staff.

See Section 4 Panel Layout Considerations for further information on patient to staff call button placement.

Figure 56 Examples of patient to staff call buttons

Button Colour: Green

Audible Alert: Unique Tone (Conditional)

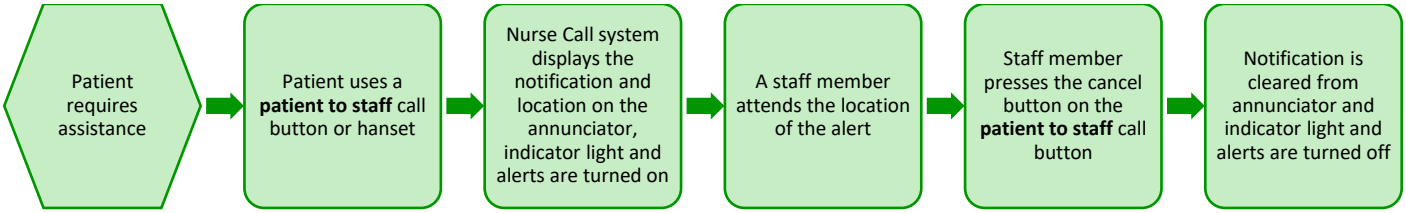


Figure 57 Diagram of a typical patient to staff call activation and cancellation workflow

Staff Assist Call

Staff assist call buttons are yellow (see Figure 58) and are used where clinical staff member requests assistance from another clinical staff member in a non-urgent situation. When the staff call button is pressed the indicator light above the bed (in a multi-bed room) and/or outside the entry to the room will turn on and flash, an audible tone will be triggered, and the location and call type will be displayed on the annunciator panels/monitors across the clinical area (see Figure 59).

Staff assist call buttons may be combined on the same face plate as patient to staff call buttons and potentially with other functions such as patient entertainment system speakers (see Call Button Combinations).

Staff assist call buttons are generally positioned on a panel so that the activation and cancel buttons are within easy reach of staff from the 'clinical side' of the bed (the side closest to the door or the patient's right). If possible, locating the button to ensure reach from both sides of the bed is recommended. Where a panel is concealed (see Concealed Medical Services Panels) the staff assist call button should not be concealed to ensure quick access when needed.

See Section 4 Panel Layout Considerations for further information on staff assist call button placement.

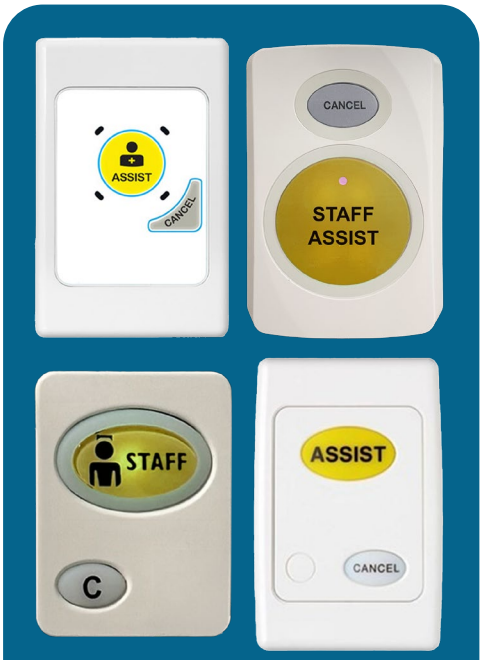


Figure 58 Examples of staff assist call buttons

Button Colour: Yellow

Audible Alert: Yes - Unique Tone

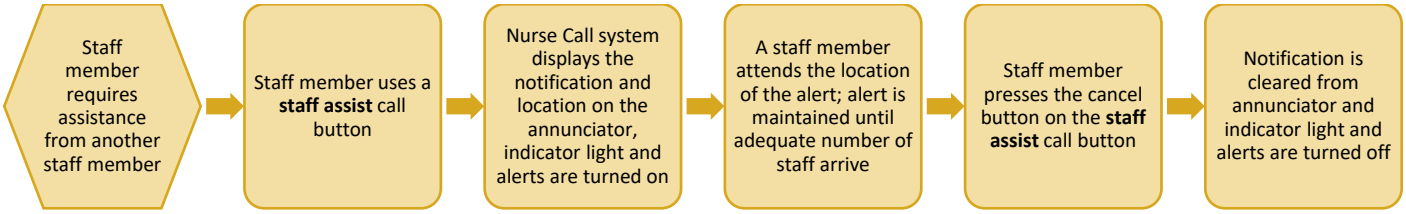


Figure 59 Diagram of a typical staff assist call activation and cancellation workflow

Emergency Call

Emergency call buttons are red (see Figure 60) and they are activated by a staff member in an urgent situation where a patient's condition is deteriorating and rapid assistance from staff (including the medical emergency response team) is required. Once the emergency call button is pressed, the indicator light above the bed (in a multi-bed room) and/or outside the entry to the room will turn on and flash, an audible alert tone will be activated, and the location and call type will be displayed on the annunciator panels/monitors across the clinical area (see Figure 61).

It is recommended that emergency call buttons are kept separate from staff assist call buttons and patient to staff call buttons to provide clarity and reduce erroneous calls.

Emergency call buttons are generally positioned separately above a panel to ensure there is clear delineation between the staff assist button and the emergency call button. On a bed head in a patient bedroom or in a patient bay, placement of the emergency call button should support access from either side of the patient bed/plinth. Where a panel is concealed (see Concealed Medical Services Panels), the emergency call button should not be concealed to ensure quick access when needed.

See Section 4 Panel Layout Considerations for further information on emergency call button placement.

Figure 60 Examples of emergency call buttons

Button Colour: Red

Audible Alert: Yes - Unique Tone

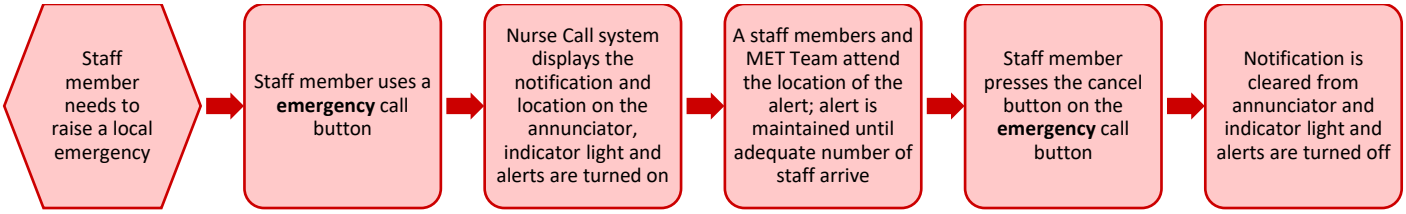


Figure 61 Diagram of a typical emergency call activation and cancellation workflow

Duress Call

While not typically placed on medical services panels, it is worth noting for clarity and completeness of information that fixed duress buttons and personal mobile duress tags provide a separate function to the emergency call and are provided in addition to the emergency call buttons.

Duress buttons are activated by staff to call for immediate assistance in situations where they feel unsafe or are faced with a personal threat or physical assault. The activation workflow of a duress button may involve the nurse call system, e.g. duress call or "code black" notification is shown on annunciators or indicator lights are activated to direct the responding team to the location of the duress call's source.

Presence Call

Presence call buttons (see Figure 62) are not used in all jurisdictions and can have different workflows attached to them.

You may find 'presence' call buttons referring to:

- A patient requesting the presence of staff; some countries use this term instead of 'patient to staff'.
- A clinical staff member requesting the presence of additional clinical staff members; some countries use this term instead of 'staff assist'.
- To request the presence of specific non-clinical staff, e.g. this button may be used to call for wards persons/orderlies/ porters or for cleaners. This function is being phased out as workflow terminals (see Workflow Terminals) are now being provided for non-standard workflows.
- To indicate that a nurse is attending to a patient (see Figure 63) and/or as additional step in the workflow of responding to a 'patient to staff' call (see Figure 64).

Project teams must confirm if presence buttons are to be used in a project and define the workflows that are associated with them. Placement of buttons in rooms must then support the agreed workflows.

Presence call buttons are typically either a light green or blue colour but this can vary and requirements must be confirmed with the facility at project level.

Figure 62 Examples of presence call buttons

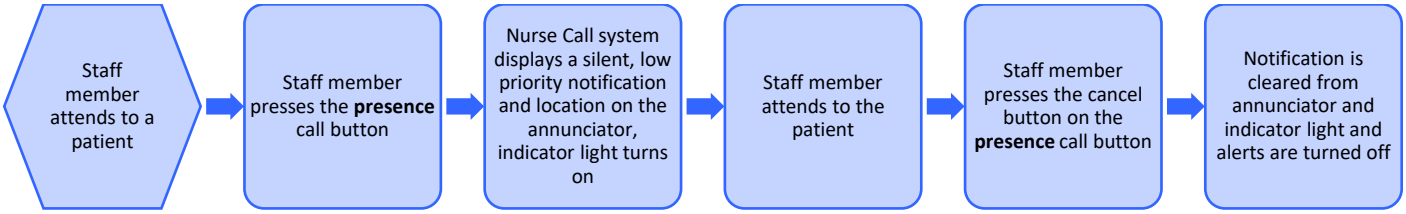


Figure 63 Diagram of a possible nurse-initiated presence call activation and cancellation workflow

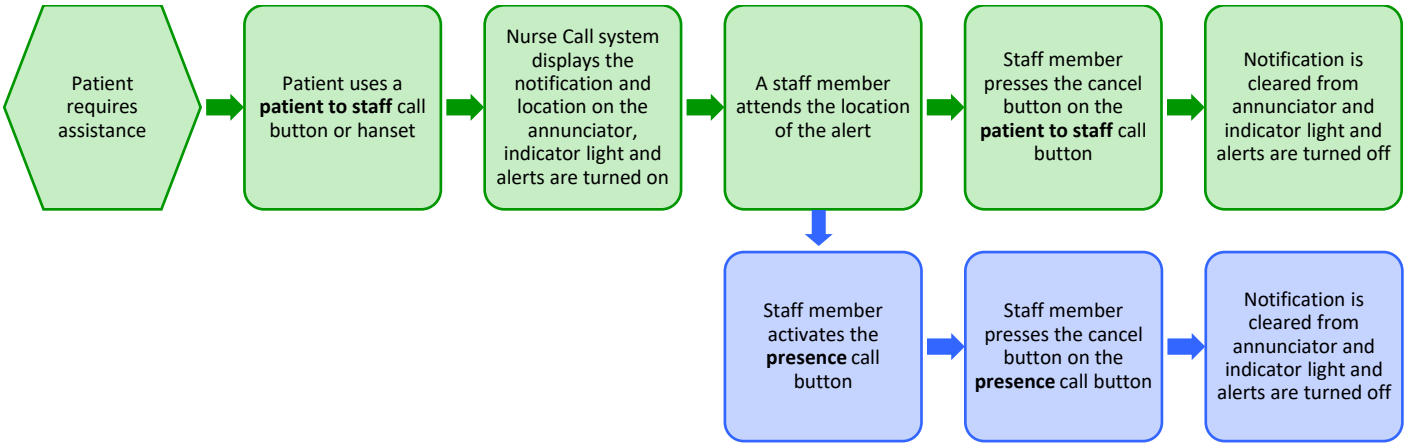


Figure 64 Diagram of a possible patient-initiated patient to staff call and presence call activation and cancellation workflow

Orderly / Porter Call

Orderly/porter call buttons to request assistance from wards persons, orderlies and porters are found on pendants or wall mounted/on panels in operating rooms, endoscopy procedure rooms, and in anaesthetic preparation/induction bays.

While the buttons can be any colour, they are typically purple to avoid confusion with other call buttons (see Figure 65).

In some instances, the use of specific call buttons for assistance from wards persons/orderlies/porters are being phased out as workflow terminals (see Workflow Terminals) are now being provided for non-standard workflows.

Figure 65 Examples of orderly/porter call buttons

Face Plates

Nurse Call buttons may be:

- **flush** with the cover plate of a panel (see Figure 66) or face of the services head of the pendant (see Figure 67).
- **surface mounted** on the cover plate of the medical services panel or face plate of the services head of the medical service pendant (see Figure 68).

Infection prevention and control considerations, including cleanability of the services on the medical service panel or pendant should be considered when selecting a mounting option.

It is also important to consider the serviceability of panels and pendants. Where surface mounted faceplates are provided it is recommended that the button component is directly mounted to the internal mounting box while the faceplate of the nurse call button is able to be removed. This allows the faceplate of the button and the cover plate of the panel or services head to be removed for maintenance of any services without requiring the presence of a technician from the nurse call provider to disconnect and isolate the nurse call buttons.

Figure 66 Example of a medical services panel with flush nurse call buttons

Figure 67 Example of a medical services pendant with flush nurse call buttons

Figure 68 Example of a medical services pendant with surface mounted nurse call buttons

Master and Slave Call Points

"Master call points" refers to the face plates/panels containing the primary call buttons in a room. These buttons communicate directly to the system to generate the effect of notifications and alarms on annunciators and at a staff station console, illumination of indicator lights where provided, etc. Secondary call buttons, or “slave call points”, within the same room are connected to the master call point, relaying the call through the master call point without needing a separate dedicated connection to the system. A slave call point will not have a unique identification on the annunciator display.

In an inpatient bedroom or patient bay, the master call point is usually located on the bedhead. Slave call points, if provided, may be located to allow for access to activate or cancel calls from different positions within the room or within an adjacent ensuite.

Call Button Combinations

It is common to see patient to staff call buttons and staff assist call buttons combined on the same face plate (see Figure 69). They may also be combined with additional elements such as speakers (e.g. for a patient entertainment system or two-way communication with staff) and connection points for patient call handsets (see Figure 70).

It is recommended that the emergency call button remains separate to other call buttons to ensure its location is clearly visible and to avoid the emergency call being pressed in error.

Figure 69 Example of a patient to staff call and staff assist call provided on a single face plate

Figure 70 Example of a medical services panel with a combined patient to staff call, staff assist call, patient call handset connection and speaker

3.4.3 Patient Handsets

Patient handsets (sometimes called call cords) connect to the face plate of a patient to staff call button, or a panel with a combination of nurse call buttons, to act as a semi-portable extension of the nurse call system. This provides patients with access to the patient to staff call function while in a bed, on a recliner or patient chair, or on an examination table/plinth, allowing them to call for assistance as needed via the handset.

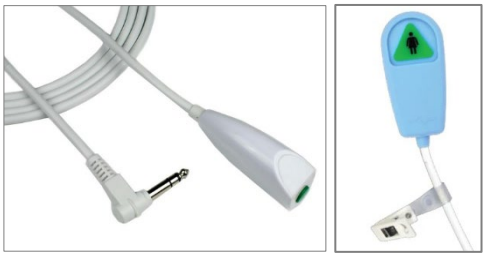


Figure 71 Examples of patient handset with patient to staff call button only

The patient handsets come in various configurations:

- patient to staff call button only (see Figure 71).
- patient to staff call button and lighting control, e.g. to reading light over bed/recliner (see Figure 72).
- patient to staff call button, lighting control, and patient entertainment system (PES) controls, e.g. on/off, home/menu, navigation of channel options, volume control, etc. (see Figure 73).

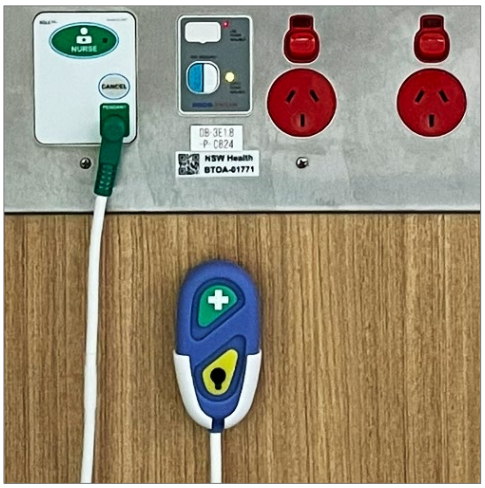


Figure 72 Example of patient handset mounted in a holder under a medical services panel, with patient to staff call button and light control (on/off)

Configurations may also include a speaker depending on the set up for sound from the patient entertainment system. Inclusion of a microphone and speaker to provide an intercom function to speak to staff (e.g. for a patient within an isolation room to an intercom in the anteroom or corridor) can also be provided by some products. Where the handset includes a speaker function, the whole handset is sometimes referred to as a "pillow speaker" (see Figure 73).

The patient handset may also include other functionality that can assist patients such as providing a small torch light or including a headphone jack to plug in headphones for the patient entertainment system, etc. Some handsets provide backlit or glow in the dark buttons for ease of use in the dark, which may be preferred for bedrooms/bays where patients stay overnight.

Figure 73 Example of patient handsets with patient to staff call button, light control and basic controls for patient entertainment systems

As patient handsets are a high frequency use items, the materials the handset is made from and the ability to clean and decontaminate the handset requires careful consideration during selection.

A holder/cradle is typically mounted on the bedhead or wall for the handset to be stored when a bed is not in a room or bay (see Figure 72 and Figure 74a). Holders can also be provided to allow the patient handset to be mounted on the side rails of a patient bed or trolley (see Figure 74b) to keep the handset within easy reach of the patient.

Figure 74 Examples of patient handsets with light control and patient entertainment system controls, and speakers in holders a) clipped to side rails of a patient bed, and b) mounted on a medical services panel

Different cable lengths can be chosen to allow for appropriate reach depending on the space the handset is provided to. When selecting cable lengths for different spaces, it is important to consider:

- Length of the handset cable allows for adequate reach to the patient in the bed or recliner. In patient bedrooms this may also include ensuring adequate reach to the patient chair.
- Accessories, such as hooks, clips or loops may be used to assist with management of the handset cable, particularly when it is not in use, removing a potential trip hazard.

The type of connection point required for a patient handset will vary depending on the nurse call system products procured (see Figure 75). Connection types can include:

- copper data outlets such as RJ45 outlets shown in Figure 78 (see Section 3.3.3 Copper Data Outlets for more information).
- auxiliary ports (various types) also called auxiliary jacks, auxiliary input, or audio/stereo outlets.
- 8-pin DIN outlets
- 20 pin and 26-pin outlets

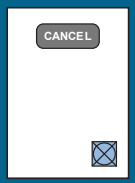
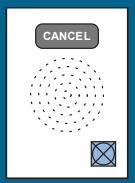
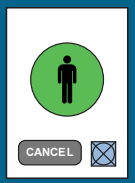
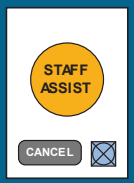
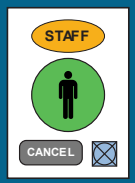
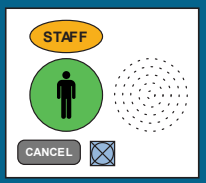
Figure 75 Examples of patient handsets (from left to right) with a) RJ45 copper data outlet connection, b) auxiliary port connection, c) 8-pin outlet connection, and d) 26-pin outlet connection

Multiple outlet types may be provided on the same face plate to support flexibility and to allow for the use of assistive devices in conjunction with patient handsets (see Section 3.4.4 Assistive Devices). The example shown in Figure 76 includes one RJ45 outlet for a patient handset and two auxiliary port connections for other corded devices.

As noted in the section on Call Button Combinations the face plates for nurse call buttons can be provided with buttons in various configurations. Common arrangements that include patient handset connections are illustrated below in Table 9. Projects will select different configurations to suit the requirements in different rooms and departments.

Figure 76 Example of nurse call button face plate with multiple connection points for patient handsets and assistive devices

Table 9 Possible configurations for nurse call button face plates providing a patient handset connection

⊠ = represents any patient handset connection (this symbol is not indicating a requirement for a specific type of connection and the face plate may include more than one connection type)					
					
Patient handset connection and cancel button only*	Patient handset connection, cancel button, and speaker*	Patient to staff call button, patient handset connection, and cancel button	Staff assist call button, patient handset connection, and cancel button*	Patient to staff call button, staff assist call button, patient handset connection, and cancel button	Patient to staff call button, staff assist call button, patient handset connection, cancel button, and speaker

*Patient to staff call function is only provided by the patient handset only in this configuration.

3.4.4 Assistive Devices

Assistive devices or specialty call devices can be connected to outlets on the nurse call button face plates either alongside or as a replacement for a patient call handset. For example, for a patient with limited mobility, large buttons or pressure pads can be placed on the pillow and are pressed by the patient turning their head. Buttons or pressure pads may also be placed on an overbed table or directly on a patient's bed if a patient's fine motor skills are limited. These devices typically require only a small amount of pressure to activate and can be set up to be pressed with the hand, elbow, head, knee or foot, while some may only require a gentle squeeze to activate (see Figure 77). Often these devices will come with clips that can be fastened to bed linen or clothing to keep the device within reach.

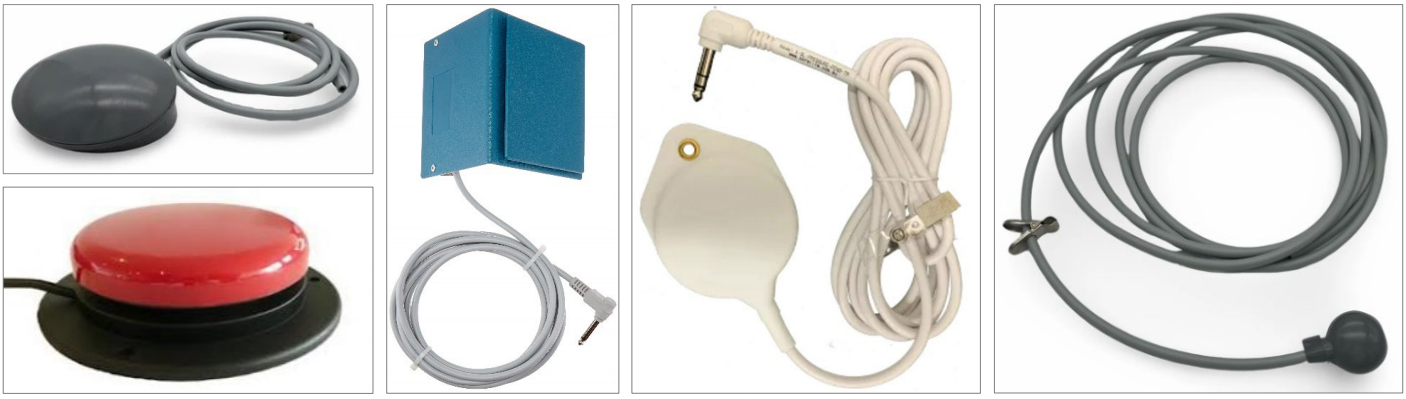


Figure 77 Examples of assistive devices that may be connected to an outlet on a nurse call button face plate to support a patient to activate a patient to staff call workflow with only light pressure

Devices that allow the patient to staff call to be activated by the patient breathing into the opening are another option for patients with limited mobility. These items typically have a disposable straw and filter assembly connected to flexible arm that can be clamped onto the side rails of the patient's bed, the arm or side of a patient chair, or an IV pole (see Figure 78).

Devices that rely on the movement of air (pneumatically activated), such as some of the press/squeeze buttons shown in Figure 77 and some of the breath activation tubes shown in Figure 78 can be used in MRI imaging rooms where all items need to be non-ferrous to be safe around the MRI magnet.

Figure 78 Examples of assistive devices that may be connected to an outlet on a nurse call button face plate to support a patient to activate a patient to staff call workflow with only a light breath or sip of air

Falls prevention technology may be used in various departments, particularly in departments for the care of older persons. Some falls prevention devices contain pressure sensors to detect when a patient is exiting the bed or chair, triggering a patient to staff call or perhaps a custom 'falls risk' call so staff can respond and help patients move around safely (see Figure 79). Depending on the device, they may be placed on top or underneath mattresses or chair cushions, and sensitivity and time delays can be adjusted to reduce false alarms. These devices may be wired or wireless, i.e. with either a cord or a wireless receiver connected directly into an outlet on the faceplate of a nurse call button.

Alternatively, or perhaps in conjunction with pressure sensors, passive infrared (PIR) 'curtain' beams are another form of falls prevention technology that may be connected to the nurse call system (see Figure 80). The device projects an invisible beam to the end of the bed. When a patient moves their legs over the side of the bed to stand up their legs break this beam an alarm call is generated. These devices typically also need an additional power outlet. While some PIR beam devices can be placed on the floor or include clamps to allow them to be attached low on a patient's bed, others require mounting brackets to be secured to the wall, making them less of an ad hoc option for falls risk patients.

The type of connection socket required on the nurse call button faceplate will vary depending on the assistive device(s) that may be used in a department. When a device is purchased, it may be possible to request that it has a specific connection type to suit the available outlets provided on the nurse call button face plate, but this is not always the case. While project teams must determine the specifications required for the nurse call systems to suit service and equipment needs, as well as future flexibility, they will not be able to account for every connection option that may be required, and adapters may be needed to support flexible use of assistive devices and specialty call accessories.

Additional considerations include:

- infection prevention and control considerations should be included when a project is considering the use of assistive devices, particularly as a number of these assistive devices will come into contact with the patient.
- cable lengths to ensure adequate reach for patient use.
- cable management and storing/mounting assistive devices while the bed or recliner is away from the room or bay should be considered for removing potential trip hazards.

Figure 79 Examples of falls prevention devices such as chair pressure pads and under-mattress pressure pads, that may be connected to an outlet on a nurse call button face plate to trigger an alert to staff when a patient who is at risk of falls is exiting a bed/ chair

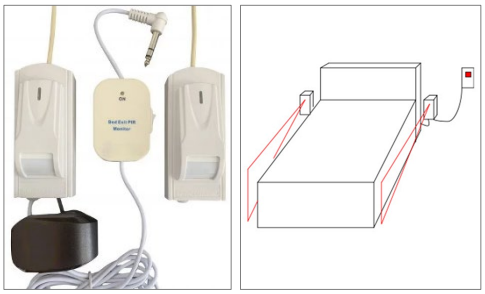


Figure 80 Example of a passive infrared sensor system that may be connected to an outlet on a nurse call button face plate to trigger an alert to staff when a patient who is at risk of falls is exiting a bed

3.4.5 System Context

The following sections provide an overview of some important components in the wider nurse call system context into which the components panels and pendants are integrated. While these components do not directly impact design or configuration of panels and pendants, awareness of these elements supports a comprehensive understanding of the nurse call system.

Annunciators

Annunciators are audiovisual displays that show colour-coded nurse call alert information and emit audible tones, serving as the primary means for staff to quickly identify the location, type and priority of a raised call. When a call button is activated, a signal is sent to the nurse call system's central processing unit (CPU), which prioritises the signal and displays the message on the annunciators across the department/zone simultaneously. An audible alert also sounds from the annunciator to alert staff (or from an associated tone sounder/speaker).

Figure 81 Example of a ceiling mounted, single line, double sided LED nurse call annunciator display panel

Incorporation of workflows for duress calls (from both fixed buttons and personal tags) into the nurse call system to display information on annunciators is recommended where possible.

Mounted either on the ceiling or on walls in corridors and in locations that are visible from staff stations, annunciators come in a Light-emitting Diode (LED) format or a Liquid Crystal Display (LCD) format.

- The LED variants are typically single line displays that support three to four colours and calls are displayed on them using the colour corresponding to the active call (see Figure 81). LED panels may be single or double sided.
- The LCD variants, depending on their dimensions, may support the display of multiple calls at the same time with the highest priority call displayed at the top of the list of calls (see Figure 82).

Figure 82 Example of a ceiling mounted LCD nurse call annunciator display screen

LCD panels may be configured to show hospital or service information when there are no active calls (see Figure 83).

Figure 83 Example of ceiling mounted nurse call annunciator display screens in front of a staff station

Indicator Lights

The indicator lights, sometimes referred to as corridor lights or call lights, are coloured lights that can be customised to illuminate in different colours and flash at different rates (as required) that are used to quickly identify the location of an alert from the activation of various nurse call buttons (see Figure 84).

When a call is initiated by pressing a nurse call button, the indicator light at the corresponding bed (in a multi-bed setting) or above the entrance to the room illuminates in a colour that corresponds to the call type (colours are determined as per AS3811). When the call is cancelled, all indicator lights associated with the call turn off.

Indicator lights are generally a prism or dome shaped so they protrude from the wall and are typically surface mounted (i.e. not flush mounted). They may be mounted on walls or ceilings with the mounting location selected to ensure visibility from a distance (e.g. along busy department corridors and from staff stations). Where indicator lights are used outside of rooms to indicate calls coming from inside the room, it is recommended to place them in consistent locations (e.g. directly over the centre of the door/entrance) and to mount them at uniform heights to ensure they are easy to locate.

Figure 84 Examples of nurse call indicator light fittings with whole light colour changes and segments for specific colours

Workflow Terminals

Workflow terminals are small touch screen panels that can be used in addition to the call buttons to initiate standard workflows or can be set up to initiate other, non-standard workflows (see Figure 85 and Figure 86). These workflows may include bed cleaning, room cleaning, nurse rounding, etc. and are customisable to suit facility and department operational workflows.

Some workflow terminal products can interface with electronic medical records (EMR) systems and as part of the configured workflows they can be set to automatically include notes in a patient record when certain workflows are initiated or set as completed. Similarly, the workflow terminal function may be provided by digital bed card products which update with patient information from EMR systems.

Figure 85 Example of a workflow terminal wall panel with integral speaker

Figure 86 Example of a workflow terminal wall panel

Nurse Call Consoles

Situated at staff stations, the nurse call console (also called a staff console, central staff hub or a central care station) provides a clear display of the type, location and priority of active calls and supports connectivity to portable devices carried by staff (see Figure 87, Figure 88 and Figure 89). Where a nurse call console is planned to be used, an additional, dedicated data outlet should be provided.

Connection to intercom systems in patient handset intercoms can also be provided through the nurse call console where this functionality is required.

Figure 87 Example of a touch screen nurse call console with phone connection to staff devices and patient intercoms (if provided)

Figure 88 Example of a nurse call console with phone connection to staff devices and patient intercoms (if provided)

Figure 89 Example of a touch screen nurse call console

Real Time Location Services (RTLS)

Some nurse call systems include Real time Location Services (RTLS) technology that allows devices worn by staff (see Figure 90) and patients to interact with the nurse call system. For example, the nurse call system may be programmed to automatically cancel a patient to staff call when a staff member wearing an RTLS badge with the appropriate credentials enters the room. As the badges have staff credentials associated with them, the system can determine whether a staff member's presence should cancel the patient to staff call alert.

Figure 90 Example of real time location services (RTLS) badges that can be worn by staff

Care must be taken when using these systems to cancel nurse calls, as absolute certainty is required that a staff member has actually entered the room. The exact position of an RTLS device can drift with standard Wi-Fi based RTLS systems, which could accidently cancel a nurse call in an adjacent room. For this reason, beacons (also referred to a locators and anchors) that are placed near the doorway and detect an RTLS badge entering the zone of a room are preferred for RTLS integration.

RTLS functions for nurse call systems need to be considered in conjunction with other RTLS systems, such as those used for personal duress tags, to ensure they work together seamlessly.

3.5 Medical Equipment

Medical equipment may be mounted on and around medical services panels, as well as on rails, shelves and brackets on medical services pendants. For medical service panels, the equipment that is mounted on them or nearby, is often equipment that is more regularly used, such as diagnostic equipment and patient monitoring devices, as opposed to mobile equipment that is brought into a patient bedroom/bay as needed. Similarly, for medical services pendants, medical equipment that is mounted on equipment rails, brackets or shelving.

3.5.1 Diagnostic Sets

Diagnostic sets may be portable, on a mobile stand or mounted on a wall, medical services panel or a wall mounted rail. They are typically provided in rooms and patient bays that have a high turnover of patients requiring medical assessment, including in ambulatory care areas and emergency departments.

A diagnostic set (see Figure 91) can be a combination of any of the following items:

- ophthalmoscope
- otoscope
- sphygmomanometer (which may include associated basket to hold the blood pressure cuff)
- thermometer
- accessories e.g. dispensers for ear specula, holders for tongue depressors, etc.

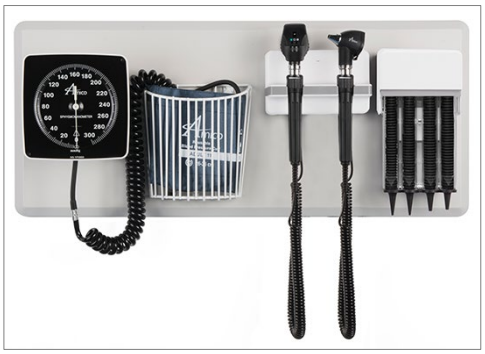


Figure 91 Example of a panel mounted diagnostic set with sphygmomanometer and basket for cuff, ophthalmoscope, otoscope and ear specula dispenser

It is worth noting that the use of manual sphygmomanometer is reducing in some clinical settings, replaced with vital signs monitors (see 3.5.2 Patient Monitoring).

The diagnostic equipment may be connected to the holder via cords or charged by the holder when not in use and therefore the diagnostic set will require a power connection, typically a GPO rather than a direct connection. Where diagnostic sets are mounted on the wall or on a medical services panel near a patient trolley/bed or exam couch, it is best to provide a dedicated power outlet in close proximity to the base unit/charger to keep cords tidy and avoid taking up outlets on the medical services panel that are intended for mobile equipment (see Figure 92).

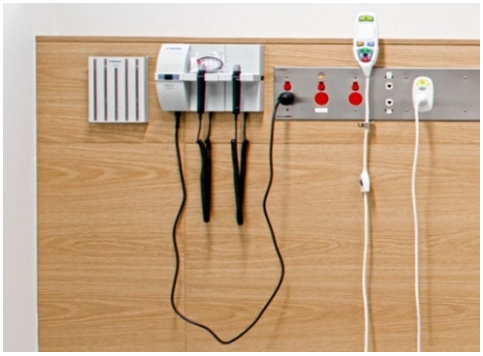


Figure 92 Example of a joinery mounted diagnostic set with an ophthalmoscope, an otoscope and an ear specula dispenser, adjacent to a medical services panel occupying an outlet on the panel

It is also important to ensure the mounting location:

- allows for adequate reach to the patient if corded diagnostic equipment is used
- does not cause the set or cords to restrict access to services or other equipment
- is ergonomic for staff use of instruments, including reading any dials/outputs from the devices that are fixed to the wall.

3.5.2 Patient Monitoring

Patient monitors, which can be configured to show various combinations of vital signs for monitoring by staff depending on a department's service requirements, are typically mounted:

- On wall brackets with fixed or articulated arms above medical services panels in some patient bays/bedrooms (see Figure 93).
- On brackets on medical services pendants in resuscitation bays, intensive care bays/rooms, and in operating and procedure rooms as required.

Figure 93 Example of a patient monitor on an articulated arm attached to a wall bracket

With consideration of the reach of the arm, brackets should be mounted at a height that allows for optimal reach and visualisation of the display by the users, while not obstructing access to services or access to the patient by staff. Bracket and arm must support easy adjustment of height and location and allow the monitor to be moved out of the way as needed. Structural support (i.e. noggings) in the wall or joinery must be provided where monitors are mounted.

Patient monitors require power and data, and these should be provided by dedicated outlets and not detract from provision of power on a medical services panel or pendant that is intended for mobile/interchangeable equipment. Where a slave monitor is required, e.g. in resuscitation and trauma bays, a display port (or similar, dependent on manufacturer) will also be required.

The bracket/arm for mounting the patient monitor should include integrated cable management channels to keep power and data cords tidy. If the mounting bracket includes an articulated arm, cables must be run to ensure there is no tension when the arm is moved through its complete range of motion.

To display patient vital signs information (e.g. heart rate, oxygen saturation, blood pressure, etc.), patient monitors require electrodes and sensors to be placed on the patient and connected via cables. There are various baskets, brackets and hooks that may be procured with the patient monitor for holding these accessories and they may be mounted on the bracket or arm, or separately nearby on the wall or bedhead (see Figure 94).

Provision of structural support, power and data to future proofing certain spaces to contain patient monitoring may to be considered at project level.

Figure 94 Examples of cable management and storage solutions for accessories that connect to patient monitors

3.5.3 Equipment Rails

Equipment rails provide mounting points for portable equipment to be hung (for horizontal rails) or clamped (for horizontal and vertical rails). Equipment rails allow equipment, that would otherwise be mounted on an IV pole or on a stand, to be provided within a smaller footprint, which is particularly useful in areas such as intensive care and neonatal care (see Figure 95), where there can be a significant amount of mobile equipment brought into the patient space.

The mounting location should ensure easy access to the panel and support staff access to the rail without any change in bed position where possible. The distance from the panel to the rail should be such that there is no physical interference for flowmeters, suction adapters, power cords, etc. connecting to the services outlets.

While they are often provided in a metallic finish, they are available in a variety of surface treatment colours to support their integration into an interior design scheme whilst maintaining compliance with infection prevention and control requirements.

Figure 95 Example of a horizontal equipment rail in a neonatal care unit, mounted underneath a medical services panel, with medical air and oxygen mixer clamped on the rail under medical gas outlets

3.5.4 Service Head Accessories

As described in Section 2 Terminology under 2.2 Medical Services Pendants the shelves, drawers, equipment rails, IV poles, brackets, holders, etc. that can be selected for medical services pendants are referred to as 'Service Head Accessories'. These items support the mounting of medical equipment directly on the medical services pendant, typically with the aim of consolidating mobile equipment and freeing up floor space (see Figure 96 and Figure 97).

It is important that the project team in conjunction with the pendant supplier consider the type of medical equipment that is likely to be mounted on any equipment rails or placed on shelves on a pendant to ensure the equipment is compatible with the mounting solutions, and the services are laid out on the pendant appropriately to support the equipment and clearances are allowed for access to the services by staff as required. Cable management accessories should also be considered to keep pendants tidy.

Figure 96 Example of medical services pendant with service head accessories such as vertical equipment rails and bracket for a patient monitor

Figure 97 Example of medical services pendant configured with shelves for medical equipment in an operating room

3.6 Digital Operating Room (DOR) Equipment

A Digital Operating Room (DOR) (also referred to as an integrated operating room) includes technology to enhance surgical procedures and improve patient outcomes, such as through enhanced visualisation with high-definition imaging equipment and display monitors. The intention is to improve the accuracy of surgical procedures and streamline patient care. DOR systems can provide collaboration opportunities through real-time communication and data sharing with specialists and increased safety through advanced monitoring and control systems. Table 10 Provides some key terms for DOR system capabilities.

Table 10 Digital Operating Room (DOR) component names/capabilities and descriptions

Component Name/Capability	Description
Scope Image Capture	Any images captured on an 'image capture device' (e.g. endoscope, laparoscope, etc.). This does not refer to radiology images.
Scope Video Capture	Any videos captured on an 'image capture device' (e.g. endoscope, laparoscope, etc.). This does not refer to radiology images.
Image/Video Switching (in-room)	This is the ability to view still images or videos taken on an image capture device (e.g. endoscope, laparoscope, etc.) or from PACs computer on any display screen in the room. This also includes any images captured on radiology equipment located in the theatre (e.g. from a mobile C-arm unit). • Latency of the video integration system (VIS) is an item for consideration but generally does not include the latency of the scopes or the ceiling mounted display screen. • Latency provided by vendors can be for direct feed to ceiling mounted display screen or indirect feed through the AV system to a ceiling mounted display screen.
Image/Video Streaming (external to the room – possibly with bi-directional audio)	This is the ability to stream still images or live video external to the operating theatre. This includes image capture devices and radiology equipment located in the theatre. • External locations can include to other locations within the hospital, within the local health service/network, state-wide, nationally or internationally. • This feature is generally only required if the facility has teaching requirements. • To enable full functionality, bi-directional audio is also required. This means that a fixed microphone may be required in the room or a connection to a headset worn by a surgeon is enabled.
Image Storage (short term)	The short-term storage of still images taken from an image capture device (e.g. endoscope, laparoscope, etc.). This does not relate to radiology images which are stored in on a PACS.
Video Storage (short term)	The short-term storage of videos taken from an image capture device (e.g. endoscope, laparoscope, etc.).
Image Storage (long term) and Interface with Electronic Medical Records (EMR)	This functionality requires an interface from short term storage to long term storage for any still images taken on an 'image capture device' (e.g. endoscope, laparoscope, etc.) during a procedure. To then link the still image to a patient's record, an additional interface is required with the EMR system to access the patient record. This does not relate to radiology images which are stored on a PACS.
Video Storage (long term) and Interface with Electronic Medical Records (EMR)	This functionality requires an interface from short term storage to long term storage for any videos taken on an 'image capture device' during a procedure. To then link the video to a patient's record, an additional interface is required with the EMR system to access the patient record.

Component Name/Capability	Description
Latency of Ceiling and Wall Display Screens	The time lag between when an image is created and when is it transferred to the display screens. Ceiling mounted display screens should be medical grade.
Operating Light Integral Camera	Operating lights may include integral cameras for displaying a view of the surgical site on a screen.
Ceiling Mounted Camera	A camera may be mounted on the ceiling for streaming for telehealth or education purposes (e.g. post-procedure analysis). May also be used to obtain objective recordings for legal purposes.
Camera Control	Ability to control cameras that are integrated in operating lights, mounted on the ceiling, or worn by clinicians.
Operating Light Control	Ability to control the lighting (brightness, colour temperature, etc.) of the operating lights, typically provided via controls directly on the light fitting and via a wall mounted control panel.
Room Light Control	Ability to control the general room lighting, typically via a wall mounted control panel.
Microphones	Provision of clinician-worn lapel or headset microphones and/or a room microphone which may be used for streaming for telehealth or education purposes.
Entertainment System Control	An entertainment system providing the ability to play music during a procedure. The music can be controlled from a touch panel or from a headset worn by a surgeon.
Operating Table	The operating table can be fixed or mobile and can come in a range of configurations. Selection will be dependent on the types of procedures being undertaken and surgeon preference. The table may or may not be supplied as part of the DOR supplier's package.
Theatre Scheduling	This is the ability to see all patients scheduled in theatres and/or only the patients scheduled for a specific theatre.
Patient Demographics	This is the ability to see the patient information details of any patient scheduled for a procedure. • A patient's details must be shown on all the display screens during a procedure. • A patient's details must be shown on any still images or video captured during an operation.
Planning and Workflow Integration	This is the ability to see information shared between departments such as Operating Rooms, Sterilising Services, Emergency, Intensive Care, Recovery, etc. to support planning and workflow integration.

Figure 98 Example of a digital operating room (DOR) with 2 x ceiling mounted display screens, 1 x wall mounted display screen, 1 x standard surgical light, 1 x surgical light with integral camera, and 2 x medical services pendants (1 x with a vertical services head and 1 x with a horizontal services head)

3.6.1 Surgical Display Screens

Surgical displays are high definition, medical grade monitors that support real-time visualisation of the surgical field (e.g. from an operating light integral cameras or from a camera on a headset worn by a surgeon), images and video from other image/video capture devices and in-room cameras, information from patient monitoring devices as well as information from patient records (see Figure 99 and Figure 100). Primarily, the purpose of a surgical display screen within a DOR system is to support minimally invasive surgery (MIS), however they generally improve precision and support surgeons to make accurate decisions during a wide range of procedures.

Figure 99 Example of surgical display screens showing a real-time view of the surgical field and information from patient monitoring devices.

Images and video sources that connect to the display screens may include endoscopic systems, laparoscopic systems, ultrasound, and robotic surgery platforms. Surgical displays increase precision and support surgeons to make accurate decisions during procedures.

Figure 100 Example of a surgical display screen with four inputs displayed (from laparoscopic camera, operating light integral camera, in room camera, patient monitor)

Key features of surgical display screens:

- **High Resolution:** surgical display screens are typically high definition (HD) (1080p), 4K ultra high definition (UHD), or even 8K. Higher resolution improves contrast and sharpness this ensures images are clear and detailed, allowing surgeons to see fine structures like nerves, blood vessels, and tissue layers. Surgeons often need to zoom in on specific areas during procedures. A high-resolution screen ensures that zoomed-in images remain clear and detailed, preventing misinterpretation of anatomical structures.
- **Colour Accuracy:** accurate colour reproduction helps surgeons identify subtle colour changes in tissues, which can indicate bleeding, infection, or abnormalities.
- **High Brightness and Contrast:** ability to adjust the brightness and contrast of the display screen ensures clear visibility under bright surgical lights.
- **Anti-Reflective and Anti-Glare Coatings:** coatings on the display screen can reduce reflections from the various light sources in the operating room for better image quality and reduced eye strain.
- **Medical-Grade:** the display screen must be designed for use in sterile environments with rigorous cleaning requirements and comply with medical safety regulations. The design should have smooth, sealed surfaces to prevent contamination.
- **Multiple Input Compatibility:** to ensure flexibility as technology changes, the surgical display screens should support various imaging source connection requirements (e.g. HDMI, DVI, SDI, etc.).
- **Ergonomic Design:** it is important that the height and viewing angle of the ceiling mounted display screens are easy to adjust with minimal effort.

3.6.2 Operating Light Integral Cameras

Operating light integral cameras (also called in-light cameras and surgical field cameras) are mounted in the middle of the lighthead to provide an overhead view of the surgical field (see Figure 101 and Figure 102). The view can then be streamed to any of the display screens within the room to be visualised by various team members as well as to external locations for education and collaboration with specialists.

By providing a shared perspective of a procedure, streaming the view of the surgical field can support clear communication between members of the surgical team, improving coordination and efficiency.

Figure 102 Example of an integral camera in the centre of an operating light

Figure 101 Example of an integral camera in the centre of an operating light

3.6.3 Video Integration Systems

A video integration system (VIS) provides a central platform for connecting the various input sources (cameras, medical imaging equipment, patient information, etc.) for displaying on the surgical display screens. Wall mounted touchscreen control panels (see Figure 103) may be provided as an interface between the VIS and the display screens.

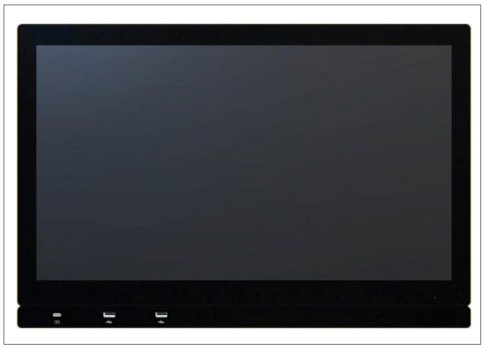


Figure 103 Example of a wall mounted touchscreen control panel for VIS in a digital operating room (DOR)

3.6.4 High Speed and Real-Time Data Network Considerations

Optical fibre cabling in lieu of copper data cabling is commonly used in digital operating rooms for the following reasons:

- **High Speed data transmission:** optical fibre cables can handle large amounts of data at high speeds which is essential for transmission high-resolution images and real time video feeds during surgeries in 4K/8K resolution.
- **Elimination of Electromagnetic Interference (EMI):** optical fibres are ideal for use in environments with sensitive electronic equipment.
- **Signal Integrity:** signals are maintained over long distances for secure and reliable communications and data transfer.
- **Fire Safety:** optical fibre is non-conductive making it safer in medical environments by eliminating the risk of electrical fires compared to copper cables.

3.6.5 Cable Management in Operating Rooms

Effective cable management in operating rooms is crucial for maintaining a safe, efficient and sterile environment. Some design considerations are below:

- Ensure optimal cable routes are mapped, and cable route is protected. Maintain documentation (e.g. records of cable routes, connections, etc.) and update with any changes made.
- Plan for expansion by designing the cable management system with future upgrades and expansions in mind such as installing extra conduits or pathways to accommodate new and emerging technologies to minimise downtime if reconfiguration is required. Modular design of conduits and pathways also supports easy reconfiguration.
- Include clear labelling of each cable at each end to facilitate easy identification and troubleshooting. Segregate different types of cables and use colour coding to differentiate various types of cables and their functions.
- Use easy to clean cable covers that do not collect dust easily in a sterile environment.
- Minimise clutter by keeping cables organised and out of way to maintain a sterile environment and reduce tripping hazards. For example, using integrated cable management channels to organise cables and cords on pendants to keep cables hidden from view.
- Use articulated arms with integrated cable management channels and allow for additional cable length when adjustable arms are at maximum extension to avoid cable stress.
- Work area cables (patch leads) must be compatible with any cleaning products used to prevent against damage (as per AS/CA S009 Australian Standard for telecommunications customer cabling installation requirements).

4 Panel Layout Considerations

4.1 Overarching Considerations

For the recommended location and configuration of medical services panels within specific rooms, see the AusHFG Standard Components and information contained within the AusHFG Health Planning Units.

4.1.1 Standardisation

Standardisation of medical service panel layouts across room types within and across departments provides consistency that supports staff workflows and can help reduce errors. It is recommended that projects adopt an approach that ensures continuity of design throughout departments. This includes the order of services outlets, and provision of split panels where this may support ease of access and the location of required electrical safety outlets (RCDs, UPS indicators, etc.).

4.1.2 Construction and Coordination

Noting that the Standard Components do not provide construction detail and are not shown within a context of a building, the following considerations will need to be resolved during project deployment:

- **Coordination with joinery:** as medical services panels are often recessed within joinery, their design and installation must be coordinated with joinery packages as well as services contractors. Access for maintenance and/or replacement should be considered.
- **Segregation of services:** segregation boxes and separators between services are required to ensure installation is compliant (see Section 4.1.3 Cable Segregation below).
- **Partition (internal/external) fire and acoustic ratings:** installation of medical services panels, including location within the room, should maintain fire and acoustic ratings of walls / partitions. Medical services panels installed in external walls should not impact on the required performance of the external façade system.
- **Confirmation of medical equipment:** to determine the interfacing requirements between medical services panels and medical equipment and to ensure sufficient space is provided, specifications for medical equipment associated with the panel should be provided to designers as early as possible.

4.1.3 Cable Segregation

Cable segregation between data, electrical, medical gas and other services must be maintained within the partition and the wall box within the medical service panel. The key requirements for cabling management and segregation are designed to minimise interference and ensure safety.

- **Separation distances:** maintain adequate separation between power and data cables.
- **Physical barriers:** use physical barriers like conduit or partitions to separate different types of cables. Consider using modular panels (see Figure 104 and Figure 105) to allow for easy segregation of services. These panels have pre-defined sections for different types of cables and outlets. Physical barriers inside the medical services panel mounting box may result in increased panel width and this should be considered as part of the design.
- **Shielding:** employ shielding for cables to reduce electromagnetic interference (EMI).

Figure 104 Example of a modular medical services panel with one module for data and another for electrical outlets

Figure 105 Example of a modular medical services panel with one module for electrical outlets and another for medical gas outlets

- **Routing:** plan cable routes and layout to avoid parallel runs of power and data cables. Design the layout to maintain the required separation distances between different types of cables (data, power, medical gases).

Refer to AS/NZS 3000:2018 (also known as the Wiring Rules) which provides comprehensive guidelines for electrical installations, including the segregation of different types of cables to ensure safety and minimise interference.

4.1.4 In-wall Panels

Panels are often provided with the mounting box recessed into the wall with a flush mount cover panel. This can either be directly on plasterboard or to be flush with other materials, such as wall protection materials/panels of various thicknesses (see Figure 106).

The provision of panels directly within the walls between bedrooms can impact on the acoustic ratings achieved by the bounding wall. The partition may require upgrading to a higher specification to ensure that the acoustic rating is achieved with the medical services panel installed.

In-wall panels may also impact on fire and smoke walls, which often end up being one of the bounding walls between bedrooms. In most instances where an in-wall panel is planned to be installed in a wall that is then determined to be a fire or smoke wall, the building surveyor will require an additional wall be built in front of the fire or smoke wall to maintain the integrity of the fire or smoke wall. This increases the overall thickness of the wall and impacts the dimensions and size of the room.

In addition to acoustic requirements and fire/smoke compartment requirements, shielding requirements of the partition must also be considered where an in-wall panel is provided. The composition of the partition must ensure that the bounding wall still provides adequate shielding where the penetration is made for the medical services panel (see Figure 107).

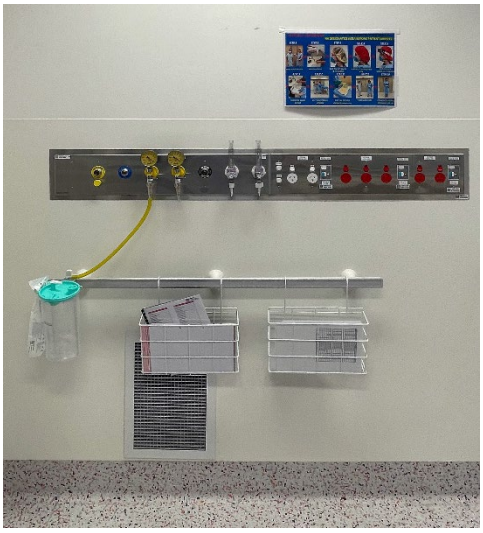


Figure 106 Example of in-wall panel installed with cover plate flush to wall vinyl

Figure 107 Example of in-wall panel installed flush to plasterboard (with mural finish) in a general x-ray room where radiation shielding must be maintained to the boundary walls

4.1.5 Single Row, Double Row and Multi Row (Vertical) Layout Options

Depending on the clinical context, extent of services required, and the available space, medical services panels may be arranged in a single-row, double-row or multi-row layout. While in imaging rooms and procedure rooms, single-row layouts are the most common, double row layouts are regularly provided in bedrooms and bays where bedhead widths are limited.

Single-row panel layouts allow access to each services outlet with less overlap of cords and cables. However, single-row arrangements can result in services being located behind the patient bed or being placed at a greater distance from the patient.

Double-row arrangements (see Figure 108) are commonly adopted in lieu of the single row arrangement to reduce the overall width of the medical services panel and keep services outlets closer to the patient whilst eliminating any overlap of services behind the bed. The reduced panel width also allows for a narrower bedhead joinery panel if desired for aesthetic or cost reasons.

Multi-row (vertical) medical services panels are sometimes provided on the sides of bedhead joinery (see Side Mounted Medical Services Panels in Section 4.2.2 Bedhead Joinery). These bedhead panels require a greater depth to accommodate the services and will impact clearances at the foot of the bed. It should also be noted that the mounting boxes and fixing systems that are commonly available will impact mounting heights in a multi-row/vertical arrangement and height and reach issues can become an issue.

The maximum and minimum heights of the highest service outlet on a panel should follow standard guidelines for occupational health and safety. There should be no service outlet where equipment is plugged in above 1500mm high unless it is dedicated to specific equipment and is unlikely to be plugged in/unplugged regularly (such as monitoring equipment). Medical gas outlet heights are typically located at 1400mm high so that the associated flowmeters and adaptors can be easily read by all clinical and nursing staff. The minimum height of the lowest service outlet on a panel should be 600mm high (to centre of outlet).

The design of panels in double-row and multi-row configurations should consider the overall size of the panel, the ability to easily plug in/unplug equipment without interrupting the use of adjacent outlets, associated equipment such as flowmeters and adaptors for medical gases and its functionality to ensure that cables and tubes are not crossing over or entangling other equipment.

Figure 108 Example of a double-row medical services panel layout (to clinical side/patient's right) and a multi-row/vertical medical services panel (to patient/visitor side) in an inpatient bedroom

Figure 109 Example of a multi-row medical services panel layout to a patient bay

4.2 Patient Bedrooms and Bays

The considerations described in this section apply to the following room types:

- Inpatient bedrooms (acute, sub-acute, isolation, bariatric, etc.)
- Holding bays (e.g. for medical imaging, preoperative, etc.)
- Recovery bays (e.g. post-operative stage 1 and 2 recovery)
- Medical day treatment bays (e.g. for infusions, renal dialysis, chemotherapy, etc.)
- Emergency treatment bays (including acute ambulatory, acute, non-acute, etc.).

Each room/space will have specific requirements that will need to be overlaid alongside the generic considerations noted in the section to follow, and the extent of services and equipment required will vary. For guidance on specific rooms see the AusHFG Standard Components.

4.2.1 General Considerations

See Table 11 for information on the considerations highlighted by the letters in Figure 111 on page 69. To keep information succinct, where the descriptions in Table 11 refer to a "bed", the consideration also applies to a patient trolley, plinth/examination couch or recliner.

It is important to note that not every element in Table 11 will be applicable to all bedrooms and bays. Inclusion will be informed by clinical service requirements based on the model of care of the units the bedrooms and bays are designed within. Additionally, operational practices, work health and safety risk assessments, and infection prevention and control policies will inform selections.

Table 11 Considerations (as illustrated in Figure 116) for medical services panel and bedhead configuration in a patient bedroom or bay

Panel or Bedhead Element	Considerations
A **Wall protection / Joinery**	Wall protection in the form of a rigid panel material or joinery bedhead, is provided to protect the wall from damage caused by the movement of the bed. • The wall protection/joinery bedhead may extend to the ceiling (typically with a shadow gap or equivalent detailing at the top to allow for installation tolerances). Full height wall protection panels/joinery bedheads are often provided where patient monitors or other items are installed above the medical services panel. • Where there are no items mounted at a high level, 1700mm high wall protection panels/joinery bedheads are regularly provided. This height allows for a small amount of clear area above the medical services panel for small items such as the emergency call button (see row F) while keeping the surface/ledge at the top of the wall protection panel/joinery bedhead within reach for cleaning. • Lower joinery bedhead heights, usually no lower than 1500, may be provided, particularly where there are high-level external windows or internal glazing (to support observation across bays and transfer of natural light). It should be noted however that there will be flow on effects for the heights of various elements on the bed head that should be considered carefully (e.g. raising the height of the emergency call to be above the joinery while still ensuring it is easily accessible). The decision to provide joinery for hosting medical services panels or providing in-wall panels will be determined to suit the context of the bedrooms/bays being designed. For more information see Section 4.1.4 In-wall Panels and Section 4.2.2 Bedhead Joinery.

Panel or Bedhead Element	Considerations
B **Panel and Mounting Height**	The panel (cover plate and the mounting box) provides a mounting method for services connection outlets and supports compliance and requirements for segregation of services outlets, wiring, cabling and pipe work. It is recommended that the centreline of a single-row medical services panel is 1400mm AFFL. This height supports easy access to services by staff, an appropriate height for reading flowmeters and adapters and provides sufficient height for most cables from mobile medical equipment to be kept off the ground. See Section 4.1.5 for information on double-row and multi-row (vertical) medical services panel layouts.
C **Medical Gas Outlets and Accessories**	Medical gas outlets are typically placed on the clinical side of the patient bed/trolley, though may be allocated to both sides depending on the clinical function of the bedroom/bay. Medical gas outlets are typically ordered so that any oxygen outlets are closest to the patient, followed by medical air, and then medical suction. While this is not a fixed rule, it does assist with management of tubing, particularly for medical suction and its connection to a suction bottle (see row K) that needs to be easily accessed. Type and quantity of medical gas outlets provided will vary to suit the clinical requirements of the bedroom/bay. See Section 3.1 Medical Gases for more information. For clearance requirements between medical gas outlets see Section 3.1.2.
D **Electrical Services and Leakage Protection Devices**	Where possible, keeping like services together in the layout of a medical services panel is preferred to support cabling segregation. For electrical services, this includes both power outlets and leakage protection devices (LPDs) such as residual current devices (RCDs). Electrical outlets are typically ordered so that any UPS outlets are closest to the patient, followed by emergency power outlets, then non-essential/standard power outlets. Type and quantity of power outlets provided will vary to suit the clinical requirements of the bedroom/bay. See Section 3.2 Power, Status Indicators, Electrical Protection and Testing for detailed information. For the clearance requirements between electrical services see Section 3.2.2.
E **Data and Communications Outlets**	Data outlets are frequently provided for connecting medical equipment that requires a direct connection for network connectivity or for those that require a power over ethernet (POE) connection. As the cords connecting into the data outlets are not bulky, 2-3 data outlets may be provided in a space on a medical services panel. The quantity of data outlets provided will vary to suit the clinical requirements of the bedroom/bay. See Section 3.3 Data and Communications Systems for more information.
F **Emergency Call Button**	Emergency call buttons are generally positioned separately above the medical services panel, in the clear area behind the bed (see row 2 in Table 12) to ensure there is clear visualisation of the button rather than being concealed by cords/tubes connected to the services outlets. Placement of the emergency call button is often closer to to the clinical side of the patient bed (see row 1 in Table 12), but where possible, placement should support access for staff to activate and cancel the alert from either side of the patient bed. While the centre line of the bed may be considered, it can be a difficult location for staff to reach and requires reaching over the patient so is not recommended. See Section 3.4.2 Call Buttons Emergency Call for more information.

Panel or Bedhead Element	Considerations
G **Staff Assist Call Button**	A staff assist call button, when not combined with a patient to staff call button or other type of patient call panel, is often positioned directly below an emergency call button. Placement of the staff assist call button may be skewed to the clinical side of the patient bed, but where possible, placement should support access for staff to activate and cancel the alert from either side of the patient bed. While the centre line of the bed may be considered, it can be a difficult location for staff to reach and requires reaching over the patient so is not recommended. See Section 3.4.2 Call Buttons Staff Assist Call for more information.
H **Patient to Staff Call Button and Patient Handset**	Patient to staff call button panels, with connection points for patient to call handsets are typically placed on the patient/visitor side of the bed. It is often placed close to the patient so that the cord for the patient handset does not need to cross over the cords for any medical equipment plugged into power outlets. The cradle for the patient handset may be mounted directly on the medical services panel or on the bedhead in close proximity to the connection point. See Section 3.4.2 Call Buttons Patient to Staff Call and Section 3.4.3 Patient Handsets for more information.
I **Indicator Light**	In single bed rooms and enclosed bays, indicator lights are typically located directly outside the door, and over the ensuite (if provided). In multi-bed rooms and open areas with bays (e.g. emergency, perioperative holding and recovery, etc.) the indicator lights for each bed are usually located on the ceiling just outside the curtain rail at the foot of the bed. This ensures the light is visible and reduces the coordination needed with privacy curtains and patient entertainment screens. Coordination with ceiling mounted bed number signs must also be considered. See Indicator Lights under Section 3.4.5 System Context for more information.
J **Lighting Control**	Light switches may be provided on medical services panels where an examination down light, reading light, and/or night light are provided in a bedroom/bay. Typically, light switches are located on the clinical side of the medical services panel, at the outer most end of the panel for easy access. Articulated examination/procedure lights are sometimes provided in bedrooms/bays but typically have controls directly on the light fitting and do not require a separate switch to be provided to the medical services panel. General room lights, and potentially the other light sources mentioned above as well, will be controlled from switches located near the door (in a bedroom or enclosed bay). Some light sources may also be controlled by the patient from the patient handset (see row H).
K **Suction Bottles/Cannisters**	Suction bottles/cannisters are made from clear polycarbonate in various sizes and are fitted with disposable liners. They may be mounted on brackets or on equipment rails below the medical services panel. It is often preferred to align the suction bottle beneath the medical suction outlet to reduce the need to cross suction tubing over other cords/tubes, however there is flexibility with this placement within the limitations of standard tube length. Hooks and clips may be mounted on the wall above the suction bottle for managing the suction tubing or storing sealed bags of suction tubing prior to use.

Panel or Bedhead Element	Considerations
L **Patient Monitors**	Patient monitors are typically mounted on the clinical side of the bed. Some workflows in certain clinical settings may result in the patient monitor being mounted on the opposite side of the bed. This does support viewing the monitor while looking across the patient instead of turning around, however, it would require a staff member to be working from that side when the monitor needs to be used or moved. Where support persons are likely to be accompanying a patient, placement of the monitor on the patient/visitor side of the bedroom/bay can make it difficult to access. Dedicated power and data outlets should be provided to the patient monitor to avoid use of outlets on the medical services panel that are allocated for mobile equipment. Where possible, outlets should be located no higher than 1700mm high to the centreline to ensure they can be easily accessed as needed. See Section 3.5.2 Patient Monitoring for more information.
M **Hand Hygiene and Personal Protective Equipment (PPE)**	Alcohol-based hand rub dispensers/holders and personal protective equipment (PPE) dispensers, typically glove dispensers, are often provided on the clinical side of the bed for ready access by staff. The exact placement will vary (e.g. alcohol-based hand rub holders may be hung on the end of the bed instead of being wall mounted, and areas for PPE may be provided in shared locations between bays). When these dispensers and holders are wall mounted within the bay, it is important to consider their relationship to the medical services panel. Placement of an alcohol-based hand rub must ensure it is not placed where it may drip onto any services, switches, medical equipment, or consumables. Clear area to the top or side for loading the hand rub or PPE into the dispensers/holders must be considered on top of the area required for the fitting itself. Ready access for patients and visitors to use the alcohol-based hand rub should also be considered when determining the appropriate location. Further detail on provision of hand hygiene facilities and PPE is provided in AusHFG Part D: Infection Prevention and Control.
N **Equipment Rails**	Equipment rails provide flexible mounting points that allow portable equipment, that would otherwise be mounted on an IV pole, to be provided within a smaller footprint within a patient bedroom/bay. Baskets and containers for the storage of medical equipment accessories or clinical consumables may also be mounted on equipment rails. While equipment rails are typically mounted between 600mm and 1000mm high, the mounting height will vary, as will the length of the rail, as required to support the clinical requirements of the space. See Section 3.5.3 Equipment Rails for more information.
O **Reading Light**	Reading lights may be provided as wall/bedhead or ceiling mounted fittings. Wall/bedhead fittings may provide with up (ambient) and/or down (direct) lighting. Where provided, reading lights are typically able to be controlled from the patient handset (see row H) and may have multiple setting options (e.g. high and low light levels).
P **Night Light**	Night lighting is a small light fitting mounted at a low level (approximately 300-400mm AFFL), typically located so it is on the clinical side of the room/bay and/or the ensuite side of the room (if not the same side as the clinical side). This light allows staff to navigate the patient area without disturbing patients with the general room lighting. They also enable patients to navigate the room at night (e.g. to use the ensuite) when they may be unfamiliar with other lighting control locations. Night lights can be controlled with switches and/or programmed to turn on in low light conditions or at certain times.

Panel or Bedhead Element	Considerations
Q **Bed Numbers / Signs and Bed Cards**	All bedrooms and bays will be numbered for patient flow tracking and wayfinding, and this number is typically displayed on a sign mounted on the wall over the bed and/or on the ceiling at the foot of the bed just outside the curtain. A bed card is a small sign which provides a quick reference point for patient identity and contains basic patient information (e.g. name, date of birth, doctor, admission date, estimated discharge date, etc.). This function is sometimes provided by a whiteboard/care information board. The bed card or whiteboard may be filled in manually or it may be digital and connected to hospital information systems (HIS) / electronic medical records (EMR) systems that automatically populate the information. Where digital bed cards are provided, they may also include nurse call workflow terminal functions (see Workflow Terminals under Section 3.4.2 Call Buttons) and may be configured to include important patient information such as allergies, language/interpreter requirements and dietary restrictions. Bed number signage and bed card information may be provided as a combined element on the bed head or the elements may be separate.
R **Power for Bed/Recliner and Mattress**	A power outlet, mounted at 600mm high, is provided in bedrooms/bays to supply power to the bed/recliner. Depending on the requirements for power to items such as pressure relieving mattresses or patient handling devices such as air assisted lateral transfer devices, a double power outlet may be provided. Emergency power may be provided to ensure the bed can be lowered to a safe height for a patient to exit in the event of a power failure. Typically, the power outlet is offset from the centre of the bed towards the entry/approach side of the bedroom/bay for easy access. Where smart beds are utilised (i.e. beds with integrated features such as patient monitoring sensors, bed exit alert systems and audible safety prompts, automatic pressure mattress adjustment, moisture and heat management, etc.), outlet specifications will be dependent on equipment requirements and may include additional connections for integration with other systems such as nurse call and patient entertainment systems.
S **Outlet for Telephone**	The provision of telephones in patient bedrooms is decreasing with many patients and visitors having access to their own mobile phones and staff able to bring in a phone where someone does try to contact the patient via the hospital line. However, where telephones are provided in individual patient spaces, it is recommended that provision of a telephone outlet is separate to the data outlets allocated on the medical services panel.
T **Patient/Visitor Device Charging**	Where patients and visitors are staying for extended periods, or where their visit may be unplanned, it is common for power outlets to be provided for phone and device charging. These outlets are usually non-essential power outlets and are always located separate to the medical services panel. It is recommended that these outlets are clearly identified as available for patient/visitor use. Typically, standard power outlets are provided (requiring a charger with a power adapter) for device charging, though some facilities may choose to provide USB outlets. USB outlets provide an option for staff to loan charging cords (which are easier and cheaper to provide than whole chargers with power adapters). However, USB outlets are not supported by all facilities for installation as the type of USB ports in use change quickly and become outdated. It is often more feasible for USB outlets to be integrated into furniture items (that are in turn connected to standard power outlets), than for them to be built into joinery/walls. Local ICT policies will inform provision of USB outlets.

Panel or Bedhead Element	Considerations
U **Patient Property Storage**	Bedside lockers are typically provided in patient bedrooms for patient property storage and may have a lockable top drawer for medications. In patient bays, there may be wire baskets (or a similar storage solution) for a small amount of patient property storage as required. Location of wall mounted patient property storage solutions should not interfere with access to the medical services panel.
V **Patient / Visitor Chair**	Depending on the clinical context of the bedroom/bay, patients will likely have at least one support person with them. A visitor's chair is provided in most bedrooms/bays, as well as for other support personnel such as interpreters. In longer stay areas, patient chairs with back support and arm rests are provided, in addition to visitor's chairs, to provide an alternative location for the patient to sit within the room. The clear area on each side of the bed and the configuration of the medical services panel should support patients to sit in appropriate seating and visitors to be present while still allowing staff to access medical equipment and associated services as needed. See more information on clearances and dimensions for access to medical services panels in a patient bedroom or bay in Table 12.
W **Patient Entertainment System Mounting**	While patient entertainment system (PES) display screens are often mounted on the ceiling at the end of the bed (or on the wall opposite the bed in a single bedroom), they may also be provided on an articulated arm extending from the wall or bedhead joinery (see Figure 110). Adequate structural support must be included within the wall/bedhead joinery to provide this configuration, including accounting for the pushing/pulling forces required to manoeuvre the articulated arm. Where this type of patient entertainment system is provided, dedicated power and data outlets on the bedhead, as would be provided if the display screen was ceiling mounted, are to be provided separate from the services on the medical services panel. Space for the display screen to be pushed out of the way without limiting access to the medical services panel is also required when using this patient entertainment system configuration.  *Figure 110 Example of patient entertainment system display screen mounted on a bedhead on an articulated arm*
X **Diagnostic Sets**	The area taken up by a diagnostic set will vary depending on the combination of equipment provided. The most common configuration for a diagnostic set in a bedroom/bay is an ophthalmoscope and an otoscope, possibly with an associated ear specula dispenser. Where patient monitors are not provided, a sphygmomanometer and associated basket for the blood pressure cuff may be provided as well, though this is more often a shared mobile item to reduce duplication of equipment across patient bedrooms/bays. While some sets provide cordless equipment, cords are often preferred to ensure equipment does not get lost. The location of the diagnostic set must allow for cords to reach to the bed for patient assessment. See Section 3.5.1 Diagnostic Sets for more information.
Y **Consumables Storage**	Items that are required close by such as emesis bags, tissues, cleaning wipes, and emergency airway packs (oropharyngeal airway, EDDs,

Panel or Bedhead Element	Considerations
	ETTs, high flow oxygen masks, etc.) are often stored in wire baskets that mount on wall panels/brackets. The extent and type of storage required will vary depending on the clinical context of the bedroom/bay. Operational policies on the centralisation and decanting of stock, as well as infection prevention and control policies will also inform storage configuration. When determining the location for consumables storage, interaction with mobile medical equipment and associated cords and tubes connecting to the medical services panel should be considered.
Z **Sharps Bins**	All sharps bins must meet AS/NZS 4261 Reusable containers for the collection of sharp items used in human and animal medical applications or AS 4031 Non-reusable Containers for the Collection of Sharp Medical Items used in Healthcare Areas. The Australian Commission on Safety and Quality in Healthcare provides the following information in the Australian Guidelines for the Prevention and Control of Infection in Healthcare: "*It is good practice to dispose of single-use sharps immediately into an approved sharps container at the point-of-use. The person who has used the single-use sharp must be responsible for its immediate safe disposal."* *"Sharps containers must be appropriately placed so that they are at an accessible height for the healthcare worker but out of reach of children and others to prevent hands and fingers entering the disposal unit. They should also be placed in a secure position or mounted on the wall to prevent tipping (approx. 1300 mm minimum off the ground). Placement of wall-mounted units should be away from general waste bins to minimise the risk of incorrect disposal.*" In some clinical contexts, the above requirement can be met with the provision of sharps bins on mobile carts or on brackets attached to procedure trolleys that are brought into the bedroom/bay as required. This allows them to be positioned close to the point-of-use for disposal. Wall mounted sharps bins are mostly provided in bedrooms/bays where the use of sharps is frequent to ensure that a sharps bin is always readily available. When sharps are wall mounted: • adequate structural support must be included within the wall/bedhead joinery. • Clearance for opening the lid of the bin for sharps disposal without clashing with services or medical equipment. • Clearance for staff accessing the bin, i.e. positioning of mobile medical equipment and associated cords and tubes connecting to the medical services panel may block the path to the sharps bin, increasing the time staff may be handling the sharps and therefore increasing the risk of injury.

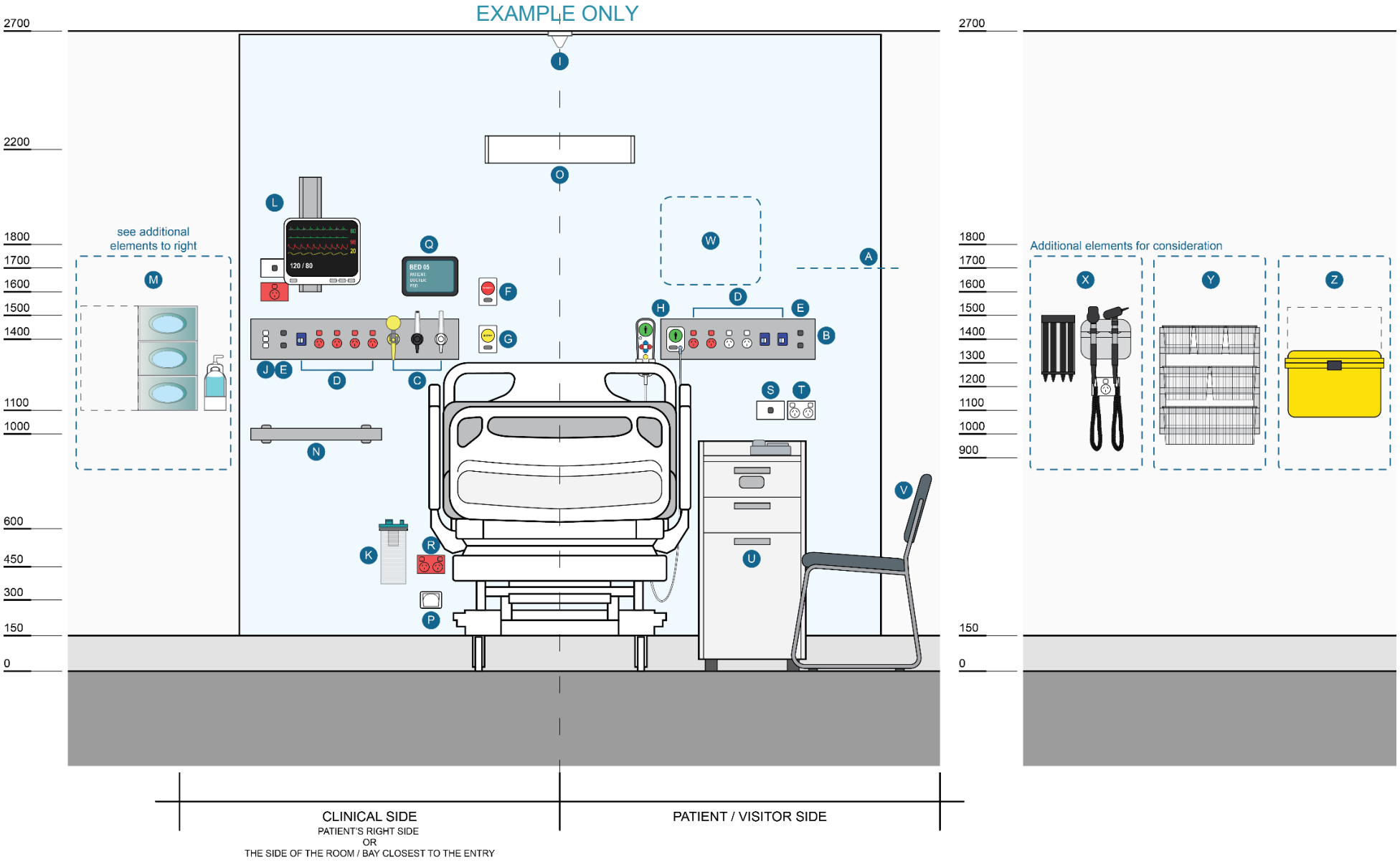


Figure 111 Diagram illustrating typical elements of a medical services panel and bedhead configuration provided in a patient bedroom or bay. Refer to Table 11 for detailed information on each element and refer to Table 12 for information on dimensions and clearances

Table 12 below provides further information on important clearances that have been indicated in Figure 111 on page 69.

Table 12 Considerations (as illustrated in Figure 111) for clearances and dimensions for access to medical services panels in a patient bedroom or bay

Clearances / Dimensions	Considerations
Clinical Side and Patient/Visitor Side	Consideration for the "clinical side" and "patient/visitor side" of beds in bedrooms and patient bays is critical in hospital design. Typically, the patient's right-hand side is nominated as the clinical side however where bedrooms/bays are mirrored, the clinical side is typically nominated as the closest side to the entry to the room. Each project should confirm the approach to orienting and mirroring rooms, and by extension, confirm the clinical side and patient/visitor side of a room design with the appropriate key stakeholders.
Clear Area Behind the Bed	Space that is clear of services and equipment should be allowed for behind beds, stretchers and trolleys so that access is not impeded to services outlets, associated wall mounted equipment, and in the event of a medical emergency, access by a staff member to the patient's head and airway. In Figure 111 nurse call buttons (emergency call and staff assist call) and the patient handset are shown within this space behind the bed. • The emergency call and staff assist call buttons are shown in this zone to indicate the need to keep them separate to the medical services panel to ensure they are easy to find amongst the other services (see row F and G in Table 11). • Where the staff assist call button includes a patient handset connection or is integrated into a combined face plate, e.g. with patient to staff call, handset connection, speaker, etc. (see Call Button Combinations under Section 3.4.2 Call Buttons) it is recommended that this combined plate is not located in the space behind the bed. • The patient handset is mainly in the holder/cradle when the bed is not in the room and is otherwise in a holder on the side rails of the bed, therefore minimal access behind the bed is required to reach the handset. The holder/cradle may also be placed lower, beneath the patient/visitor side medical services panel as noted in row H of Table 11.
Clear Area to Sides of the Bed	Clear area to each side of the bed is required and the required dimension will vary depending on the intended clinical function of the room/bay. In particular, it is recommended that WHS clearance requirements for the use of patient lifting and transfer devices are confirmed at a project level. For example, documents such as 'A Guide to Designing Workplaces for Safer Handling of People' by WorkSafe Victoria outline clear area requirements to be met by Victorian projects. The measurements indicated in the WorkSafe Victoria document include the caveat that any furniture/equipment within the clear space zones should be easily moveable (i.e. no fixed or large/heavy furnishings within this clear area).

4.2.2 Bedhead Joinery

Concealed Medical Services Panels

Birthing Rooms

In birthing rooms, it is common for medical services panels (both to the bed and the infant resuscitaire) to be concealed to make the environment feel less clinical (see Figure 112). The Birthing Unit Design Spatial Evaluation Tool (BUDSET) includes the criteria of having 'medical gases available and obscured from view' and 'trolleys and emergency equipment obscured from' view as elements of evaluation under the domain of "fear cascade". The "fear cascade" is based on the premise that if women feel less fear and anxiety, the labour process will be enhanced, and less medical interventions will be required thus potentially improving women's experience and outcomes. An unfamiliar and highly technical medical environment can cause unnecessary stress, and research indicates that women feel reassured knowing that equipment and services are available, but do not want them to be visible as their presence reminds of the potential for emergencies.

Figure 112 Example of concealed medical services panels in a birthing room in closed and opened position

Mental Health

Bedrooms and bays dedicated to mental health care do not often require medical services panels, however, where they are required for treating patients with combined mental health concerns and physical illness/injury, the medical services panels should be designed to be concealed and locked (with staff only access) when not in use (see Figure 113 and Figure 114).

Medical services panels located within mental health facilities need to be designed to ensure that they meet all local jurisdictional policies and operational service requirements regarding access, concealment and anti-ligature and tamper proof design.

Patient to staff call, staff assist, and emergency buttons are often located outside of the concealed section of the bedhead to ensure access to these buttons at all times (see Figure 113).

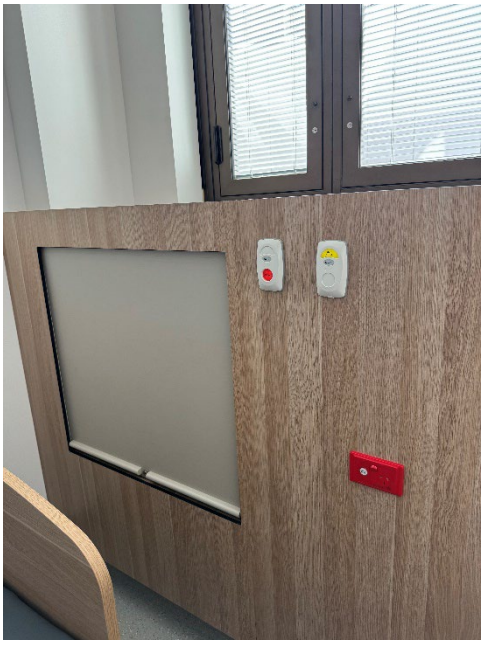


Figure 113 Example of medical services panel concealed by a lockable roller door in a Mental Health emergency treatment room

Access to in-ceiling services that supply the medical services panel also need to be considered. Ceiling access panels are to be anti-ligature and tamper proof and should be located to allow access for maintenance and repair while being mindful of the consumer environment. Where possible, these panels should be located outside of patient bedrooms/bays to reduce risk of self-harm. Where this is not possible, installation should not be over a patient bed or any fixed joinery that allows a consumer to potentially reach the ceiling. Movable furniture within the room must also be considered as to how it may be used to access ceiling services.

RCDs are typically located outside of patient area in accordance with AS/NZS 3003. Generally, they are consolidated in a common location within a staff-only access area. Arrangement and location to be confirmed through project coordination.

Figure 114 Example of medical services panel concealed by a lockable hinged door (with swipe card access) in a Mental Health emergency treatment room

Side Mounted Medical Services Panels

A multi-row/vertical medical services panel arrangement mounted on the side of a deeper joinery bedhead panel may be considered in some clinical contexts. However, the depth of the bedhead panel makes it difficult to apply this arrangement in some bedroom types, as it would reduce the clear dimension between the foot of the bed and the opposite wall.

Side mounted medical services panels can be arranged on the outside of a bedhead as per Figure 115 or they may be provided in a configuration where the medical services panel is facing the bed, and the bedhead has been design to be a 'portal' (see Figure 116).

When considering application of this type of arrangement, the following issues must be addressed:

- easy access to the medical services panel by staff, including to read medical gas flowmeters, etc.
- the size/depth of the bedhead or portal and the impact on clearances at the foot of the bed.
- maintenance/replacement of the medical services panel/outlets.

Side mounted panels should only be considered in inpatient accommodation settings where the length of the room can allow for:

- the depth of the bedhead (which could be up to 400mm deep)
- the length of the bed and clear access at the head (which could be between 2000mm and 2400mm depending on the bed procured)
- the clear access from the foot of the bed to the wall (which should be a minimum of 1000mm).

Figure 115 Example of a multi-row/vertical medical services panel arrangement on the outside of a bedhead joinery unit in a patient bedroom

Figure 116 Example of a multi-row/vertical medical services panel arrangement on the inside of a 'portal' bedhead joinery unit in a patient bedroom

4.3 Imaging Rooms

The considerations described in this section apply to rooms for following imaging modalities:

- General X-ray
- CT
- MRI
- Fluoroscopy
- Mammography
- Ultrasound.

Each room/imaging modality will have specific requirements that will need to be overlaid alongside the generic considerations noted in the section to follow, and the extent of services and equipment required will vary. For guidance on specific rooms see the AusHFG Standard Components.

4.3.1 General Considerations

Proximity to the patient undergoing diagnostic testing is the driving factor for the location of the medical services panel. The location must allow for the patient to receive continuous support from connected equipment whilst undergoing imaging and must not impact on the functionality of the equipment. Consideration for reach to all services is paramount to the design and configuration of the medical services panel in an imaging room.

Table 13 below provides a summary of considerations for medical services panels in imaging rooms as illustrated in Figure 117 on page 77. It is important to note that not every element in Table 13 will be applicable to all imaging rooms, and inclusion will be informed by service requirements as per the model of care of the unit, as well as operational practices, work health and safety risk assessments, and infection prevention and control policies.

Table 13 Considerations (as illustrated in Figure 112) for medical services panel configuration in an imaging room

Panel or Associated Element	Considerations
A **Wall protection / Joinery**	Medical services panels are typically recessed into the wall with a flush mount face panel within Imaging Rooms. Wall protection in the form of wall vinyl or rigid wall sheeting may be provided around the room to protect walls from movement of beds trolleys and mobile equipment. The height of the wall protection and the height of the top of the medical services panel should be coordinated to ensure that where the wall protection is higher than the medical services panel, the height is such that enough material is able to be used above the medical services panel to securely fix the material without risk of it peeling.
B **Panel and Mounting Height**	The panel (cover plate and the mounting box) provides a mounting method for services connection outlets and supports compliance and requirements for segregation of services outlets, wiring, cabling and pipe work. It is recommended that the centreline of a single-row medical services panel is 1400mm AFFL. This height supports easy access to services by staff, an appropriate height for reading flowmeters and adapters and provides sufficient height for most cables from mobile medical equipment to be kept off the ground. See Section 4.1.5 for information on double-row and multi-row (vertical) medical services panel layouts.
C **Emergency Stop Button**	An emergency stop button is typically provided in imaging rooms to provide a method for stopping the imaging machine in an emergency. The emergency stop button should be located so that is it clearly differentiated from the nurse call button for an emergency call.

	Panel or Associated Element	Considerations
D	**Medical Gas Outlets and Accessories**	In an imaging room, medical gas outlets are typically placed so they are closest where the patient's head will be during image acquisition. If equipment that is attached to the patient during image acquisition is connected to the medical services panel, the length and path or cables and tubes must be considered – particularly if the patient moves as part of the process (e.g. patient on the table moves through a CT scanner). Medical gas outlets are typically ordered so that oxygen outlets are closest to the patient, followed by medical air, and then medical suction. While this is not a fixed rule, it does assist with management of tubing, particularly for medical suction with its connection to a suction bottle (see row I) that needs to be easily accessed. Where it has been determined that point of care cylinders cannot meet clinical requirements and it has been determined that reticulated nitrous oxide is to be provided (see Nitrous Oxide under Section 3.1 Medical Gases), the nitrous oxide and scavenge outlets are typically located close to the oxygen outlet(s) to support the use of oxygen-nitrous oxide mixers for delivering a mixture of gases to the patient. As suction outlets and scavenge outlets are the same colour (dictated by AS 2896), clear physical separation of scavenge outlets away from suction outlets, and clear collocation of scavenge outlets with nitrous oxide outlets is recommended to reduce the potential for confusion. The type and quantity of medical gas outlets provided on the medical services panel will vary to suit the clinical requirements of the imaging room. Confirming the medical gas services required will include determining if any interventional services are intended to be undertaken within the room, and any clinical requirements for provision of anaesthetic services. See Section 3.1 Medical Gases for more information. For the clearance requirements for medical gas services see Section 3.1.2.
E	**Electrical Services and Leakage Protection Devices**	Where possible, keeping like services together in the layout of a panel is preferred to support cabling segregation. For electrical services, this includes both power outlets and leakage protection devices (LPDs) such as residual current devices (RCDs). Electrical outlets are typically ordered so that any UPS outlets are closest to the patient, followed by emergency power outlets, then non-essential/standard power outlets. Type and quantity of power outlets provided will vary to suit the clinical requirements of the imaging room. See Section 3.2 Power, Status Indicators, Electrical Protection and Testing for detailed information. For the clearance requirements between electrical services see Section 3.2.2.
F	**Data and Communications Outlets**	Data outlets are frequently provided for connecting medical equipment that requires a direct connection for network connectivity or for those that require a power over ethernet (POE) connection. As the cords connecting into the data outlets are not bulky, 2-3 data outlets may be provided in a space on a medical services panel. The quantity of data outlets provided will vary to meet the clinical requirements of the imaging room. See Section 3.3 Data and Communications Systems for information.
G	**Emergency Call Button**	Emergency call buttons are generally positioned separately above the medical services panel to ensure there is clear visualisation of the button rather than it being concealed by the cords and tubes connected to the services outlets. While often associated with the medical services panel, placement of the emergency call button will vary in an imaging room so that it is optimally placed to be pressed from anywhere in the room. See Section 3.4.2 Call Buttons Emergency Call for more information.

Panel or Associated Element	Considerations
H **Staff Assist Call Button**	A staff assist call button, when not combined with a patient to staff call button or other type of patient call panel, is often positioned directly below an emergency call button. While often associated with the medical services panel, placement of the staff assist call button will vary in an imaging room so that it is optimally placed to be pressed from anywhere in the room. See Section 3.4.2 Call Buttons Staff Assist Call for more information.
I **Suction Bottles / Cannisters**	Suction bottles/cannisters are made from clear polycarbonate in various sizes and are fitted with disposable liners. They may be mounted on brackets or on equipment rails below the medical services panel. Suction bottles are typically mounted higher in imaging rooms that in bedrooms/bays to make them more visible and less likely to be damaged by mobile equipment and beds. It is often preferred to align the suction bottle beneath the medical suction outlet to reduce the need to cross suction tubing over other cords/tubes, however there is flexibility with this placement within the limitations of standard tube length. Hooks and clips may be mounted on the wall above the suction bottle for managing the suction tubing or storing sealed bags of suction tubing prior to use.
J **Equipment Rails**	Equipment rails provide flexible mounting points that allow portable equipment that would otherwise be mounted on an IV pole to be quickly mounted within the imaging room. While equipment rails are typically mounted between 600mm and 1000mm high, the mounting height will vary, as will the length of the rail, as required to support the clinical requirements of the space. See Section 3.5.3 Equipment Rails for more information.
K **Shielding**	The medical services panel location and installation needs to consider the shielding requirements of the imaging room that it services. Requirements are to be determined by a radiation consultant and achieving the necessary shielding may, for example, require the use of multiple layers of plasterboard or use of lead sheets. MRI imaging rooms have unique requirements for magnetic and radio frequency shielding, which the services to the medical services panel will interact with as they feed into the room. The use of non-ferrous materials is also required.
L **Patient Monitors**	Patient monitors are often mounted near the medical services panel to be collocated with other equipment, and in a location that supports viewing from the control room. A connection to a slave display screen within the control room may also be provided. Dedicated power and data outlets should be provided to the patient monitor to avoid use of outlets on the medical services panel that are allocated for mobile equipment. Where possible, outlets should be located no higher than 1700 high to the centreline to ensure they can be easily accessed as needed. See Section 3.5.2 Patient Monitoring for more information.

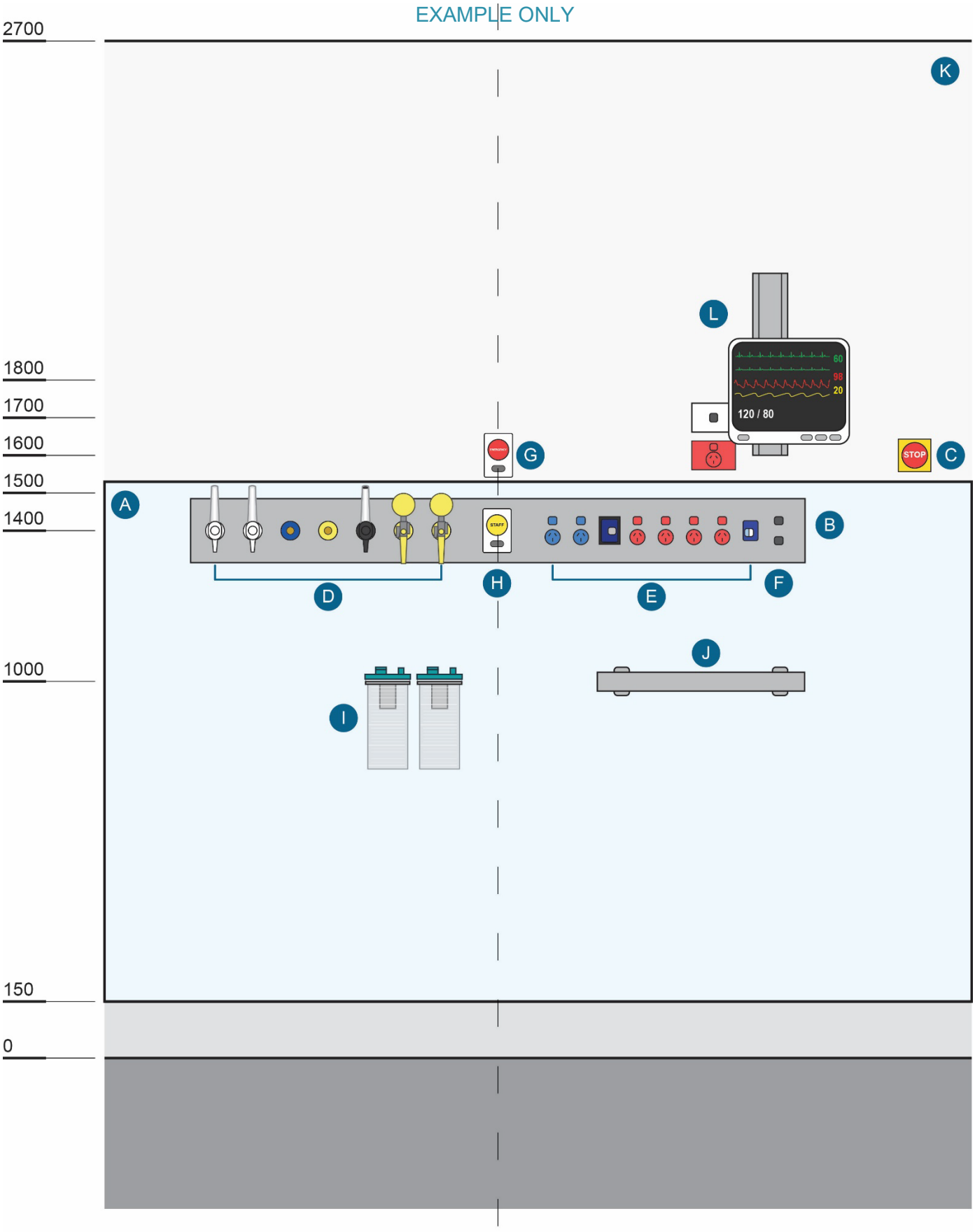


Figure 117 Diagram illustrating some typical elements of a medical services panel provided in an imaging room. Refer to Table 13 for detailed information on each element

4.4 Procedure Rooms and Operating Rooms

Medical services panels are typically recessed into the wall with a flush mount face panel within procedure rooms and operating theatres. The location is typically determined to suit the requirement of the services provided on the medical services panel, with consideration of proximity to the patient undergoing treatment usually the driving factor. The location must allow for the patient to receive continuous support whilst undergoing the procedure and must not impact on the functionality of the equipment in use.

Consideration for reach to all services, including medical gases, power outlets, data outlets and nurse call buttons, is paramount to the design and configuration of the medical services panel. The medical services panels are also required to be 'sealed' within procedure room and operating theatres to prevent air leakage and the imbalance of the required air conditioning system (number of air changes per hour required). This requires special 'back box' to be installed within the wall structure and fully sealed, which impacts on the design layout of rooms as it limits the opportunity for back-to-back services.

Medical services panels may also be used to provide specific services to procedure rooms and operating theatres, including higher spec power outlets (15A, 20A, 32A) for use with major medical equipment.

4.5 Outdoor Medical Services Panels

Medical services panels can be used outdoors to allow the continuous access to medical gases, power and data services for patients that are able to be taken out to courtyards or terraces (see Figure 118). A metal enclosure for the panel (typically rated to IP66 for protection against dust and water) is installed within the façade of the building or on a plinth, with piped gases, electrical wiring and cables installed to the enclosure. It is recommended that the enclosure is lockable with controlled access by the staff who will be required to monitor patients that use the outdoor panel.

Figure 118 Example of an outdoor medical services panel in a courtyard associated with an intensive care unit

5 Pendant Layout Considerations

5.1 Overarching Considerations

For the recommended location and considerations for medical services pendants within specific rooms see the AusHFG Standard Components and information contained within the AusHFG Health Planning Units.

5.1.1 Standardisation

Standardisation of medical service pendants across rooms of the same type provides flexibility of use. For example, providing standardised configurations for pendants between operating rooms in a facility, with the ability to customise the pendant for specific specialities through the addition of modular accessories, allows for the use of the room by different specialties to change over time. It is recommended that projects adopt an approach that ensures flexible use throughout a department.

Consideration for standardisation of medical services pendants *within* a room can also increase flexibility. For example, where operating rooms previously had a clear “anaesthetic pendant” and “surgical pendant”, more often now the differences between the pendant at either end of an operating room is minimal, allowing the patient to be positioned with their head to either end of the table depending on the procedure to be performed.

5.1.2 Construction and Coordination

Structural Design

Medical services pendants are fixed to the underside of the concrete slab or roof structure above. Structural design loading allowances for the underside of the concrete slab must account for the combined weight of the pendant (including applied off centre torques of the pendants with loading weight allowances), the pendant’s supporting structure, and any associated bracing. The structural engineer must ensure the concrete slab or roof structure, and any fixings can accommodate both the static and dynamic loads, including lateral forces from pendant movement.

Cotton Reel Installation

The fixed ridged structure which allows a pendant to be securely fixed to the concrete slab or roof structure above is generally referred to as the “cotton reel” or the “structural mounting frame” (see Figure 119). The design and weight loading requirements will dictate the required specifications for fabrication of the cotton reel.

Factors that impact the design of a cotton reel include, but are not limited to:

- Distance between the concrete slab above to the finished ceiling surface
- Positioning of post tensioning cables in the concrete slab above
- Weight and force tolerance requirements
- Supplier’s pendant mounting requirements
- On pendant service requirements.

The cotton reel is installed above the finished ceiling, and positioning is dependent on the final pendant location within the room based on the required functionality, with additional consideration of mitigation of clashes with other in-ceiling services.

Figure 119 Example of a structural mounting frame (cotton reel) secured to a concrete slab for installation of a medical services pendant

In most instances, the mounting plate of the cotton reel establishes the demarcation of responsibility between the main contractor installing the cotton reel and the supplier installing the pendant. Therefore, requiring careful coordination between the pendant supplier and contractor throughout design, delivery and installation. See Table 14 for information on the typical breakdown of installation responsibilities, noting that there may be some variation between projects and suppliers, and this must be confirmed at project level.

Table 14 Overview of typical medical services pendant installation tasks and responsibilities

Installation Task	Responsibility	Coordination Notes
Fabrication and installation of the cotton reel mounting assembly	**Builder**	• Pendant/DOR supplier informs the builder of the required tolerances and provides the pendant mounting plate hole pattern. • Cotton reels must be designed and certified by an engineer to meet the relevant Australian / New Zealand Standards.
Installation of the pendant mounting plate	**Builder**	• Pendant/DOR supplier supplies the pendant mounting plate to the builder.
Installation of in-ceiling services	**Builder**	• Final pendant services quantities and configurations (confirmed by project user groups) will dictate the extent of services that are required to be pulled to the cotton reel mounting assembly. • Builder installs the electrical wiring, data cabling, and medical gas plumbing, etc. that is required for the pendant, in the ceiling space and up to the cotton reel. Installation, connection, testing and certification must be carried out by licensed and qualified trades. • Builder installs all conduits required for services to be brought to the pendant. This includes conduits for DOR cabling which must be confirmed with the pendant/DOR supplier.
Mounting and installation of the pendant	**Pendant/DOR Supplier**	• Pendant/DOR supplier installs the pendant to the pendant mounting plate. • Pendant/DOR supplier install any accessories and equipment on the pendant, including installing DOR equipment. This will involve running cabling through in-ceiling conduits that have been installed by the builder.
Connection of pendant mounted electrical, data, and medical gas services to in-ceiling services	**Builder**	• Builder connects the electrical, data and medical gas services in the ceiling space to the outlets on the pendant. Connection, testing and certification must be carried out by licensed and qualified trades. • Pendant/DOR supplier commonly provides the required non-interchangeable screw thread (NIST) fittings to the builder to terminate medical gases. • Pendant/DOR supplier to provide certificate of electrical compliance of Australian / New Zealand Standards to electrical contractor. • Pendant/DOR supplier to provide certificate of medical gas hose compliance of Australian / New Zealand to medical gas contractor.

Requirements for engineering certification, including requirements for design and engineering for seismic activity, must be confirmed by the project team. In Australia and New Zealand, the design, engineering, installation and certification of structural mounting frames/cotton reels must comply with the Standards noted in Table 15 below. Reference to the Australian Steel Institute Design Guide 7 – Design of Pinned Column Baseplates is also recommended.

Table 15 Standards applicable to the engineering, installation and certification of structural mounting frames in Australia and New Zealand

Code	Name
AS/NZS 1170.0	Structural design actions, Part 0 – General Principles
AS 1170.4	Steel Structures
NZS 1170.5	Structural design actions - Part 5: Earthquake actions
AS/NZS 5131	Structural steelwork – Fabrication and Erection

Services Coordination

In-ceiling services that reticulate around the structural support of the medical services pendant will require careful coordination. The structural support for the pendant – typically a robust mounting system fixed to the building structure – must remain clear of obstructions and should be procured and installed on-site early in the construction process to ensure there are no clashes with services. Poor coordination can lead to clashes with mechanical, electrical, medical gas, fire or hydraulic services, and delayed installations.

On-ceiling services coordination is equally as important as in-ceiling services, with the coordination of large mechanical HVAC systems, specialised lighting requirements, audio-visual requirements and recessed fire detection systems needing detailed coordination with the location and configuration of the medical services pendants. The hierarchy of on-ceiling services design should follow medical services pendant location, then mechanical HVAC system, lighting and finally other on-ceiling services.

Ceiling Access Panels

Where medical services pendants are installed, infection prevention and control requirements often determine that a flush set ceiling is required to provide a smooth, cleanable surface. Therefore, the provision of access panels near the base of the medical services pendant is required for maintenance. Access panels should be allowed for on reflected ceiling plans early in the design process so that they are included and not missed, thus not impacting on final coordination. Planning for access for maintenance and replacement in the design phase is incredibly important to allow for facilities to plan for the life of different components.

Ceiling Height

To ensure adequate clearance for use and safe installation, it is recommended that rooms with medical services pendants have a ceiling height of 3000mm. This is the standard height recommended by many medical services pendant suppliers. Minor changes to the height within the rooms requiring medical services pendants should confirm that the operation of the medical services pendant is not impacted prior to proceeding.

Lead Time

The procurement of medical services pendants and operating lights are a priority item to be confirmed and purchased early in the project programme. As they are often sourced from an overseas manufacturer, sufficient lead time for medical services pendants and operating lights should be allowed for in the project programme. The design of the room layouts to suit the location and type of pendants could change dependent on the vendor and medical services pendant configuration, which has subsequent flow-on effects for the completion of design.

Braking Systems

Pneumatic Braking Systems

Some medical service pendants are equipped with pneumatic braking systems that require a compressed air supply to operate. These systems use compressed air to engage or release mechanical brakes that lock the pendant in place, preventing unintended movement and allowing precise positioning. To ensure reliable operation, a dedicated compressed air plant may be required. Consultation with medical services pendant manufacturers is recommended to determine any plant requirements.

Electro-Magnetic braking systems.

Pendants may alternatively be equipped with electro-Magnetic braking systems which require a separate power supply connection to operate. Each pendant requires its own brake circuit to engage or release mechanical brakes that lock the pendant in place, preventing unintended movement and allowing precise positioning. Consultation with medical service pendant manufacturers is recommended to determine any electrical requirements.

5.1.3 Future Proofing

Approaches and prioritisation for future proofing should be determined at a project level. However, it is worth noting that the spaces where pendants are provided are highly technical with new technology being developed and adopted regularly, and there are approaches to future proofing that can support this. Some examples include:

- Where future outlets are likely to be required, conduits can be pre-installed. This will minimise service disruptions with future upgrades.
- Provision of a blank plate and draw-wire through the arms for future communication services wiring/connector types.
- Provision of clear space on the services head to introduce addition services components in the future (without specific cutouts as you may not know exactly what will be needed in the future).

5.1.4 Configurations

The configuration of medical services pendants is typically described by the number of arms extending from the base of the assembly, followed by the main items that are on each arm such as services heads, lights, display screens and radiation shields. While medical services pendants can have four or more arms, single arm and double arm pendants are the most common. It is important to note that, as mentioned in Section 2 Terminology, the arm is the entire element from the base of the pendant on the ceiling to the item attached to it, and the arm may have multiple articulations.

Different mounting plates (see Cotton Reel Installation for more information) will be required for different pendant configurations (see Figure 120 and Figure 121) and it is best practice for the builder to confirm the mounting plate required for the selected configuration with the pendant supplier.

Figure 123 on the following page shows various single arm and double arm pendant configurations and the terminology used to refer to them. Where a pendant has more than one arm a "/" is used to separate references to the items on each arm. For example, a pendant that has two arms with an operating light on one and a display screen on the other, is referred to in AusHFG documentation as "PENDANT: 2-arm, 1 light head, operating / display screen"

The description becomes more complex when referring to a pendant with branches on an arm. For example, the configuration shown in Figure 122 shows a pendant that has a services head on one arm, while the other arm has two branches, one with an operating light and one with a display screen; this item would be named "PENDANT: double arm, vertical pendant head / 1 light head, operating **and** display screen"

Pendants that have more than two arms are limited to a maximum of two services heads due to the maximum clearance available in the arms for running services.

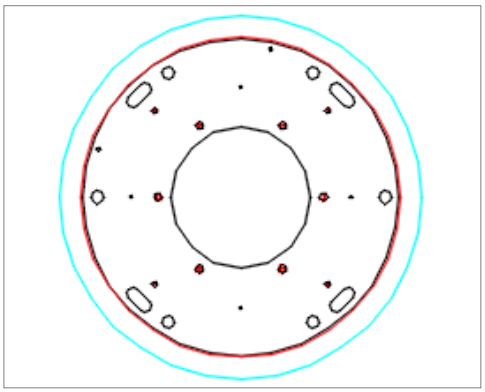


Figure 120 Example of a mounting plate designed to hold a pendant with one arm with a services head

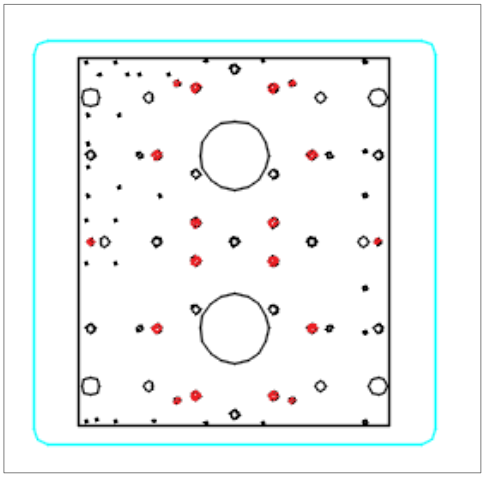


Figure 121 Example of a mounting plate designed to hold a pendant with two arms with a services head and an operating light

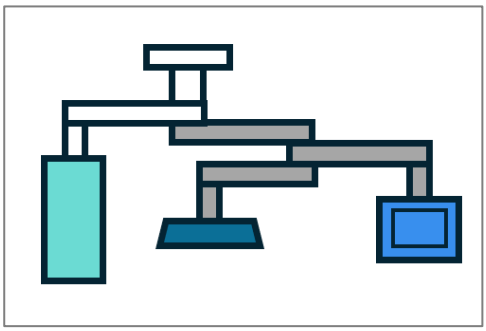


Figure 122 Configuration of double arm pendant with one branched arm

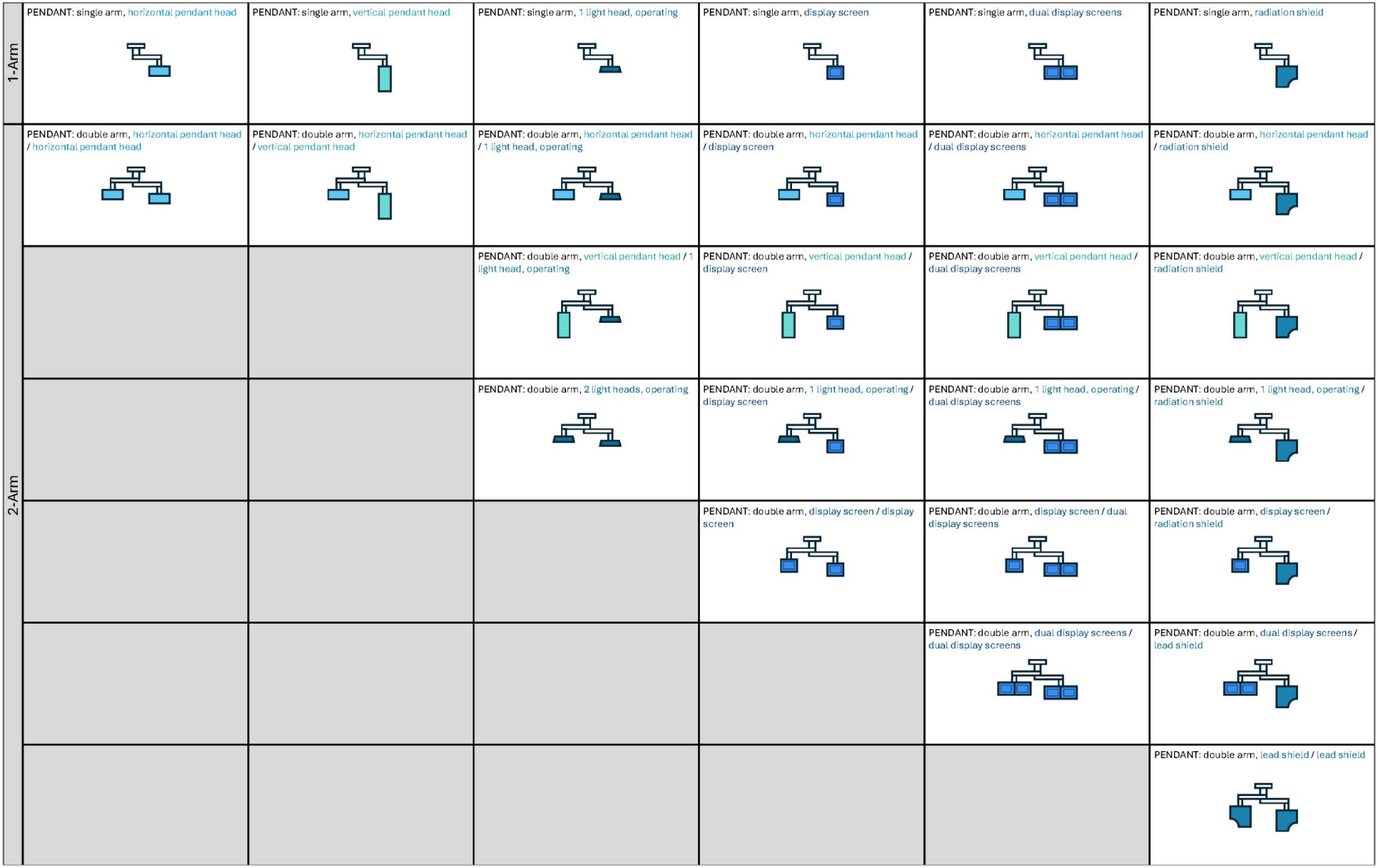


Figure 123 Medical services pendant configuration terminology

5.2 ICU Bedrooms and Bays

In ICU bedrooms/bays, the main, medical services pendant, typically a double arm pendant with 2 services heads, is located at the head of the bed. It is vital that the arms of the pendant provide adequate reach around the bed to support clinical care.

Configuration of the medical services pendants will need to be confirmed at project level to suit clinical service requirements and will vary depending on clinical needs (as dictated by service level determined by jurisdictional health authorities) and the selection of mobile vs pendant mounted equipment. Tertiary facilities that act as Extracorporeal Membrane Oxygenation (ECMO) retrieval centres or otherwise perform a significant number of ECMO procedures, may consider including a pendant located at the foot of the bed to enhance delivery of this treatment by supporting femoral access and connection to the required medical equipment.

Consideration of a ceiling mounted arm at the foot of the bed with a computer and keyboard mounting bracket, as an alternative to a workstation on wheels (WoW) or computer based on a fixed bench, may be assessed at project level and provision may be dependent on alignment with local ICT strategies, policies and workflows as well as cost impact.

Coordination with other ceiling mounted items such as procedure lights and tracks for patient lifters must be carefully considered (see Figure 124). Some manufacturers provide options where a patient lifter, for transfers from bed to a wheelchair or commode, is mounted on the pendant (see Figure 125). This design removes the issue of clashes between the two items; however, these lifters do not provide full coverage of the room for transfer or transfer to an ensuite. Therefore, their inclusion will be dependent on local approach to manual handling for patient transfers.

Figure 124 Example of double arm pendant in ICU bed room coordinated with a track for a patient lifter

Figure 125 Example of a 3-arm pendant with two service heads and a patient lifter

For guidance on pendant location, services quantities and other design considerations for medical services pendants within specific rooms please refer to the following AusHFG Standard Components:

- 1 Bed Room - Intensive Care
- Patient Bay - Intensive Care

5.3 Imaging Rooms

While it is most common for medical services panels to be provided in imaging rooms, there are some instances where pendants are considered instead of or in conjunction with panels, particularly where interventional imaging is being undertaken. Pendants may be provided for various functions, from the provision of services for anaesthesia, to supporting ceiling mounted display screens for live image viewing.

The inclusion, configuration and location of the pendants will need to be confirmed at project level to suit clinical service requirements.

5.4 Resuscitation Bays

Medical services pendants are located at the head of the bed in resuscitation and trauma bays (see Figure 126). The configuration is typically a single arm pendant, but services may be provided on smaller services heads on a double arm pendant.

While it is more common for services and equipment to be provided on pendants in resuscitation and trauma bays, it is also acceptable for the medical services panel to be used instead of a pendant. While medical services panels do not provide flexible positioning, they also do not encroach on the space directly adjacent to the patient where pendants can be quite bulky, particularly once a significant amount of equipment is mounted on them.

Coordination with other ceiling mounted items such as procedure lights must be carefully considered.

For guidance on pendant location, services quantities and other design considerations for medical services pendants within specific rooms please refer to the following AusHFG Standard Components:

- Patient Bay - Emergency, Resuscitation

Figure 126 Example of a single arm medical services pendant at the head of the bed in a resuscitation bay. The pendant has been coordinated with a ceiling mounted procedure light that is mounted behind it

5.5 Procedure Rooms and Operating Rooms

Within procedure rooms and operating rooms, medical services pendants allow for flexibility in locating services and equipment in close proximity to the patient during the procedure. Both single arm and double arm pendants, located at both ends of the operating table, are common configurations used in operating rooms. Procedure rooms, such as endoscopy procedure rooms, are simpler and typically only require services and equipment to be located at one end of the room.

In addition to services, equipment and operating lights, medical services pendants in operating rooms and procedure rooms often support elements of DOR systems such as display screens, cameras and connection points. See Section 3.6 Digital Operating Room (DOR) Equipment for more information.

For guidance on pendant location, services quantities and other design considerations for medical services pendants within specific rooms please refer to the following AusHFG Standard Components:

- Operating Room - General
- Procedure Room - Endoscopy

6 Appendices

6.1 References

Australia and New Zealand

- **Australian Building Codes Board** (2022) *National Construction Code*. Canberra: ABCB. Available at: https://www.abcb.gov.au (Accessed: 27 August 2025).
- **Australian Commission on Safety and Quality in Health Care** (2024) *Australian Guidelines for the Prevention and Control of Infection in Healthcare*. Sydney: ACSQHC.
- **Australian Communications and Media Authority** (2014) *Telecommunications Cabling Provider Rules 2014*. Canberra: ACMA. Available at: https://www.legislation.gov.au (Accessed: 27 August 2025).
- **Australian Steel Institute (Hogan, T.J.)** (2011) *Design Guide 7: Pinned base plate connections for columns*. North Sydney, NSW: Australian Steel Institute.
- **Commonwealth Department of Health and Aged Care** (n.d.) *Detecting and reducing nitrous oxide leaks in healthcare facilities – A practical guide*. Canberra: Department of Health and Aged Care.
- **Commonwealth of Australia** (1997) *Telecommunications Act 1997*. Canberra: Federal Register of Legislation. Available at: https://www.legislation.gov.au (Accessed: 27 August 2025).
- **Communications Alliance** (2002) *AS/CA S008:2002 Requirements for customer cabling products*. Sydney: Communications Alliance.
- **Communications Alliance** (2013) AS/CA S009:2013 Installation requirements for customer cabling (Wiring Rules). Sydney: Communications Alliance.
- **International Organization for Standardization** (2007) ISO 7396-2:2007 Medical gas pipeline systems – Part 2: Anaesthetic gas scavenging disposal systems. Geneva: ISO.
- **International Organization for Standardization** (2008) ISO 10524-4:2008 Pressure regulators for use with medical gases – Part 4: Low-pressure regulators. Geneva: ISO.
- **International Organization for Standardization** (2008) ISO 9170-2:2008 Terminal units for medical gas pipeline systems – Part 2: Terminal units for anaesthetic gas scavenging systems. Geneva: ISO.
- **International Organization for Standardization** (2009) ISO 21969:2009 High-pressure flexible connections for use with medical gas systems. Geneva: ISO.
- **International Organization for Standardization** (2016) ISO 7396-1:2016 Medical gas pipeline systems – Part 1: Pipeline systems for compressed medical gases and vacuum. Geneva: ISO.
- **International Organization for Standardization** (2017) ISO 9170-1:2017 Terminal units for medical gas pipeline systems – Part 1: Terminal units for use with compressed medical gases and vacuum. Geneva: ISO.
- **International Organization for Standardization** (2018) ISO 10524-1:2018 Pressure regulators for use with medical gases – Part 1: Pressure regulators and pressure regulators with flow-metering devices. Geneva: ISO.
- **International Organization for Standardization** (2018) ISO 10524-2:2018 Pressure regulators for use with medical gases – Part 2: Manifold and line pressure regulators. Geneva: ISO.
- **International Organization for Standardization** (2019) ISO 10524-3:2019 Pressure regulators for use with medical gases – Part 3: Pressure regulators integrated with cylinder valves (VIPRs). Geneva: ISO.
- **International Organization for Standardization** (2023) ISO 15002:2023 Flow control devices for connection to a medical gas supply system. Geneva: ISO.
- **Ministry of Business, Innovation & Employment – Hīkina Whakatutuki [MBIE]** (2014) *New Zealand Building Code Handbook*. Wellington: MBIE. Available at: https://www.building.govt.nz (Accessed: 27 August 2025).
- **Standards Australia** (1992) AS 2120.1–1992 Medical suction equipment – Part 1: Electrically-powered suction equipment – Safety requirements. Sydney: Standards Australia.
- **Standards Australia** (1992) AS 2120.2–1992 Medical suction equipment – Part 2: Manually-powered suction equipment. Sydney: Standards Australia.
- **Standards Australia** (1992) AS 2120.3–1992 Medical suction equipment – Part 3: Suction equipment powered from a vacuum or pressure source. Sydney: Standards Australia.
- **Standards Australia** (1998) AS 2902–2005 Medical gas systems – Low pressure flexible hose assemblies. Sydney: Standards Australia.
- **Standards Australia** (1998) *AS 3811:1998 Hard-wired patient alarm systems*. Sydney: Standards Australia.
- **Standards Australia** (2004) AS 4484–2004 Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding. Sydney: Standards Australia.
- **Standards Australia** (2005) AS 2473.1–2006 Valves for compressed gas cylinders – Part 1: Specifications, type testing, and manufacturing tests and inspections. Sydney: Standards Australia.
- **Standards Australia** (2007) AS 1170.4:2007 Structural design actions – Part 4: Earthquake actions in Australia. Sydney: Standards Australia.

- **Standards Australia** (2011) AS 2896–2011 Medical gas systems—Installation and testing of non-flammable medical gas pipeline systems. Sydney: Standards Australia.
- **Standards Australia / Standards New Zealand** (1998) *AS/NZS 3009:1998 Electrical installations – Emergency power supplies in hospitals*. Sydney/Wellington: Standards Australia/Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2015) *AS/NZS 60950.1:2015 Information technology equipment – Safety Part 1: General requirements*. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2002) *AS/NZS 1170.0:2002 Structural design actions – Part 0: General principles*. Sydney: Standards Australia.
- **Standards Australia / Standards New Zealand** (2015) AS/NZS 61008.1:2015 Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2015) AS/NZS 61009.1:2015 Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2016) AS/NZS 3190:2016 Approval and test specification for residual current devices (current-operated earth-leakage devices). Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2016) *AS/NZS 5131:2016 Structural steelwork – Fabrication and erection*. Sydney: Standards Australia.
- **Standards Australia / Standards New Zealand** (2017) AS/NZS 14763.3:2017 Information technology — Implementation and operation of customer premises cabling, Part 3: Testing of optical fibre cabling. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2017) AS/NZS 3008.1.1:2017 Electrical installations – Selection of cables – Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV – Typical Australian conditions. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2017) AS/NZS 3008.1.2:2017 Electrical installations – Selection of cables – Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV – Typical New Zealand conditions. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2018) *AS/NZS 3000:2018 Electrical installations – Known as the Australian/New Zealand Wiring Rules*. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2018) *AS/NZS 3003:2018 Electrical installations – Patient areas*. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2019) *AS/NZS 11801.1:2019 Information technology – Generic cabling for customer premises Part 1: General requirements*. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2019) AS/NZS 61935-1:2019 Specification for the testing of balanced and coaxial information technology cabling Part 1: Installed balanced cabling. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2020) AS/NZS 14763.2:2020 Information technology — Implementation and operation of customer premises cabling, Part 2: Planning and installation. Sydney/Wellington: Standards Australia / Standards New Zealand.
- **Standards Australia / Standards New Zealand** (2020) *AS/NZS 2500:2020 Safe use of medical electrical equipment in health care*. Sydney/Wellington: Standards Australia/Standards New Zealand.
- **University of Technology Sydney** (2009) *Birthing Unit Design Spatial Evaluation Tool (BUDSET)*. Sydney: UTS.

Individual Jurisdictions

Australian Capital Territory (ACT)

- **ACT Health Directorate** (2020) St-14 Nurse Call ICT Specification Version 2020.2.1. Canberra: ACT Government [Online]. Available at: https://www.act.gov.au/__data/assets/pdf_file/0009/2412558/St-14-Nurse-Call-ICT-Specification-2020.2.1.pdf.

New South Wales (NSW)

- **NSW Health** (2023) Engineering Services Guidelines. Sydney: NSW Ministry of Health.
- **NSW Health** (2024) Patient Nurse Call Conceptual Architecture. Sydney: NSW Ministry of Health.
- **NSW Health** (2024) NSW Health Cabling and Rooms Standard Document ID: HD24/25811. Sydney: NSW Ministry of Health.

- **NSW Health** (n.d.) Design Guidance DGN 069 Digital Operating Theatres. Sydney: NSW Ministry of Health.
- **NSW Health** (n.d.) Campus Wired and Wireless Network Standard Version 3.0. Sydney: NSW Ministry of Health.
- **NSW Health** (2024) Guidance for the Reduction of Nitrous Oxide Waste in Existing Healthcare Facilities. Sydney: NSW Ministry of Health [Online]. Available at: https://www.health.nsw.gov.au/netzero/Pages/Guidance-for-the-reduction-of-nitrous.aspx.
- **NSW Health** (2023) Guidance for the Supply of Nitrous Oxide in New Healthcare Facilities. Sydney: NSW Ministry of Health [Online]. Available at: https://www.health.nsw.gov.au/netzero/PagesGuidance-for-the-supply-of-nitrous-oxide.aspx.

New Zealand

- **Health New Zealand Te Whatu Ora** (2022) *National Digital Facilities Framework*. Wellington: Te Whatu Ora [Online]. Available at: https://www.tewhatuora.govt.nz/publications/national-digital-facilities-framework.

Northern Territory (NT)

- **Department of Infrastructure, Planning and Logistics** (2023) *Minimum Design Standard – Architectural Design*. Darwin: Northern Territory Government [Online]. Available at: https://dli.nt.gov.au/__data/assets/pdf_file/0007/1233439/minimum-design-standard-docid420v202312.pdf.
- **Northern Territory Government** (n.d.) Generic Design Guidelines for Remote Health Centre Infrastructure Category 1 & 2 Health Centres. Darwin: NT Government.

Queensland (QLD)

- **Queensland Health** (2020) *Capital Infrastructure Requirements: Volume 1–4*. Brisbane: State of Queensland (Queensland Health). Available at: https://www.health.qld.gov.au/system-governance/policies-standards/doh-policy (Accessed: 27 August 2025).

Victoria (VIC)

- **Victorian Health Building Authority** (2020) *Engineering Guidelines for Healthcare Facilities*. Melbourne: VHBA. Available at: https://www.vhba.vic.gov.au/engineering-guidelines-healthcare-facilities (Accessed: 27 August 2025).
- **WorkSafe Victoria** (2007) *A Guide to Designing Workplaces for Safer Handling of People: For Health, Aged Care, Rehabilitation and Disability Facilities*. 3rd edn. Melbourne: Victorian WorkCover Authority. Available at: https://www.yumpu.com/en/document/view/11703436/a-guide-to-designing-workplaces-for-safer-worksafe-victoria (Accessed: 27 August 2025).

Western Australia (WA)

- **Department of Health Western Australia** (2018) *Health Facility Guidelines for Architectural Requirements*. Perth: WA Health. Available at: https://www.health.wa.gov.au/~/media/Files/Corporate/general-documents/Licensing/PDF/standards/building-guidelines-architectural-requirements.pdf.

6.2 List of Tables

6.3 List of Figures