Australasian Health Facility Guidelines

Isolation Rooms – Engineering and Design Requirements

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Australasian Health Facility Guidelines

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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 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
AHIA	Australasian Health Infrastructure Alliance
ACH	Air Changes Per Hour
AS	Australian Standard
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
BMS	Building Management System
CCTV	Closed Circuit Television
CFD	Computational Fluid Dynamics
DDA	Disability Discrimination Act
ESD	Environmentally Sustainable Development
FF&E	Furniture, Fittings and Equipment
GPO	General Power Outlet
HPU	Health Planning Unit
HEPA	High-Efficiency Particulate Air
HVAC	Heating, Ventilation, and Air Conditioning
ICT	Information and Communication Technology
ICU	Intensive Care Unit
IPU	Inpatient Unit
IP&C	Infection Prevention and Control
ISO	International Standards Organization
MDRO	Multidrug-Resistant Organism
MME	Major Medical Equipment
NCC	National Construction Code (Australia)
NZBC	New Zealand Building Code
Pa	Pascal
PPE	Personal Protective Equipment
PPVL	Positive Pressure Ventilated Lobby
RH	Relative Humidity
UV	Ultraviolet
WHS	Workplace Health and Safety

1 Introduction

1.1 Preamble

The Australasian Health Facility Guidelines (AusHFG) are freely available resources for health services and project teams across Australia and New Zealand to support better planning, design, procurement and management of health facilities.

The AusHFG are an initiative of the Australasian Health Infrastructure Alliance (AHIA), a cross-jurisdictional collaboration of all health authorities across Australia and New Zealand. Part A of the AusHFG provides further information relating to the purpose, structure and use of these resources. It is acknowledged that the application of the AusHFG varies between jurisdictions across Australia and New Zealand.

This AusHFG resource has been developed by AHIA following an extensive consultation process completed in 2026 including clinicians, engineering experts and infection, prevention and control specialists.

1.2 Introduction

This Guideline describes and identifies the engineering and design requirements for rooms used to manage patients who require:

- transmission-based precautions. Transmission-based precautions are used in addition to standard precautions for patients known or suspected to be infected or colonised with certain infectious agents for which additional measures are needed to prevent infection transmission, or
- protection from external sources of infection.

This information should be read in conjunction with:

- AusHFG Part D Infection Prevention and Control
- AusHFG Resource ‘Pandemic Preparedness - Health Infrastructure Planning & Design Guidance’
- relevant Australian and New Zealand Standards including AS1668.2: 2024 ‘The use of ventilation and air-conditioning in buildings, Part 2’ and NZS 4303: 1990 ‘Ventilation for acceptable air quality’
- jurisdictional engineering services guidelines (accessed via the AusHFG External Resources link)
- other local policies and guidelines.

2 Types of Isolation Rooms

There are five types of isolation rooms that can be used to accommodate patients. These room types include:

Isolation Room Type	Isolation Room Use
Class S - Standard	Standard isolation
Class P – Positive Pressure	Patient protection
Class N – Negative Pressure	Respiratory isolation
Class Q – Quarantine	Quarantine isolation
PPVL – Positive Pressure Ventilated Lobby	Patient protection and patient isolation

2.1 Class S – Standard Isolation Room

A Class S isolation room is a single room with an ensuite that is not shared. The room is used for patients who require isolation to minimise the potential for infectious agents being transmitted by contact or respiratory particles to other patients and staff.

Self-closing doors to help control room temperature are recommended. A PPE bay may be provided outside the door and may be shared with an adjacent room.

A Type B handwash basin should be positioned for easy access by staff within or directly outside the room based on local Infection Prevention and Control team assessment (refer to AusHFG Part D for further information).

Standard airflow requirements for patient care areas are appropriate for Class S rooms (i.e. a minimum of 6 air changes per hour) and rooms will generally be operating close to neutral differential pressure to the corridor.

2.2 Class P – Positive Pressure Isolation Room

A Class P isolation room is a single room with an ensuite that is not shared. This room is used to provide clean filtered air and reduce infection risk to highly immunocompromised patients e.g. haematopoietic stem cell recipients in the pre-engraftment phase and severe burns patients.

A Type A (in ICU) or B (in IPU) handwash basin should be positioned for easy access by staff within or directly outside the room based on local Infection Prevention and Control team assessment (refer to AusHFG Part D for further information). Access to alcohol-based hand rub (ABHR) is required at the entry point.

Self-closing doors are recommended to control room pressures.

An enclosed anteroom is not required, but sufficient and appropriate storage space should be provided outside the room for PPE. Waste disposal should be provided inside the room.

2.3 Class N – Negative Pressure Isolation Room

A Class N isolation room is a single room with an ensuite that is not shared. It is used for patients who require isolation to reduce airborne transmission of disease (e.g., varicella, measles, pulmonary or laryngeal tuberculosis).

A Type A (in ICU) or B (in IPU) handwash basin within the room and a self-closing door are required, with sufficient and appropriate storage for clinical waste. An anteroom is essential for staff access to and from the room to minimise air leakage out of the room, and to support donning and doffing of PPE. For most Class N rooms it is appropriate for the patient bed to be transferred directly from the corridor to the bedroom rather than needing to traverse the anteroom given patient movement in and out of the room is minimised.

The interlocking of anteroom doors will reduce the escape of infectious respiratory particles by not allowing both doors to be opened at the same time. Providing a time delay between the opening of each door will also assist in providing containment within the patient room and anteroom. This should not impact staff workflows given the time for health care workers to doff their PPE. An emergency break glass release switch will mitigate the potential for staff being entrapped within the patient room or anteroom. Hospitals should develop a workplace instruction for this feature, including a process to check negative pressure gauges (where applicable) to prevent work, health and safety issues.

In specialised circumstances consideration may be given to a room that provides a higher level of protection than a Class N room for facilities that are significant travel distances from a Class Q room to manage patients presenting with suspected high consequence infectious diseases. For these rooms the provision of an anteroom for bed access i.e. between bedroom and corridor may be considered. Where such an anteroom is provided, hospitals should develop an operational policy for the transfer of infectious patients from the room via the bed access anteroom, noting the potential for contaminated room air escaping into the corridor.

Inclusion of an electronic communication system (intercom) between the isolation room and the anteroom will assist in eliminating or reducing unnecessary traffic into the room. Where patient monitoring is required a slave monitor may be included in the anteroom to also minimise traffic into the room.

Refer to the AusHFG 1 Bed Room – Isolation, Negative Pressure Standard Components for further information.

2.4 Class Q – Quarantine Isolation Room

A Class Q isolation room is a single room with a dedicated ensuite that is not shared and includes all design requirements as described for a Class N room. In addition, the quarantine isolation room will require an anteroom designed to function as an absolute airlock.

Class Q rooms provide facilities for patients with highly infectious pathogens such as haemorrhagic fevers and pneumonic plague. These patients require a further level of containment over and above the standard negative pressure isolation room.

Inclusion of an electronic communication system (intercom) between the isolation room and the airlock will assist in eliminating or reducing unnecessary traffic into the room. Where patient monitoring is required a slave monitor may be included in the anteroom to also minimise traffic into the room.

Refer to Section 5.9 for further information.

2.5 Positive Pressure Ventilation Lobby (PPVL) Rooms

Positive Pressure Ventilated Lobby (PPVL) Isolation Rooms are commonly provided internationally and may be considered on a project-by-project basis. These rooms can be used for patients requiring respiratory isolation and/or are immunocompromised without changing the pressure regime. It provides flexibility of use and has the benefit of avoiding the risk of operator error associated with rooms that switch between positive and negative pressure.

These are specialised rooms and will require justification for their provision from a clinical perspective, acknowledging the impact on floor area and capital and recurrent cost requirements.

The lobby (anteroom) operates under positive pressure with HEPA filtered supply only air provided. The air is transferred into the patient room that operates at neutral pressure with exhaust provided within the ensuite operating at negative pressure.

Operational considerations for cleaning protocols shall be developed, particularly when transitioning a room from accommodating a patient with an infection to accommodating an immunocompromised patient. Clear signage shall be provided so that staff are aware of the patient type within the room.

3 Alternating Pressure Isolation Rooms

Combined alternating positive and negative pressure rooms are NOT recommended due to concerns such as:

- the difficulty in the configuration of appropriate airflow for two fundamentally different purposes
- the risk of operator error
- the need for complex engineering
- the absence of failsafe mechanisms.

3.1 Use of Class N Rooms for Non-Infectious Patients

Occupancy rates in hospitals are typically high, and it is not possible to leave specialised rooms, such as Class N isolation rooms, unoccupied. Health services may decide at a local project level to promote the utility of these rooms by enabling them to switch between negative and neutral pressure modes. It is not appropriate to leave the door open and disarm the negative pressure alarms when accommodating non-infectious patients as this may expose them to environmental pathogens and can contribute to filters blocking quickly, compromising the system.

Class N Rooms used for patients not requiring respiratory isolation should include a control mechanism that allows them to operate at neutral pressure when used as standard patient rooms. This flexibility should be considered for areas such as intensive care units, emergency departments and general inpatient units that frequently care for non-infectious patients. Such a feature is not necessary for infectious diseases units where maintaining negative pressure in all rooms always remains critical.

The mechanism should allow seamless switching between negative and neutral pressure modes. The pressure sensing alarms shall be disabled when the room is switched to neutral pressure. It is essential that the current room pressure status is clearly and visibly indicated at the point of care to ensure that clinical staff are fully informed.

Management regimes will need to be implemented to minimise risks associated with changing between negative and neutral pressure modes including establishment of approval records and workplace instructions.

4 Isolatable Units or Pods

Isolatable units or pods managing high risk patients during pandemics and other acute respiratory infection cases and surges outside of pandemics should be designed with targeted ventilated strategies as described in the AusHFG Pandemic Preparedness – Health Infrastructure Planning & Design Guidance.

The mechanical ventilation and air conditioning systems for these applications shall include an isolation mode of operation that provides negative flow into the area and individual rooms, operating on full outside air. The return air system shall operate as a full exhaust system during isolation mode of operation. The air flow balance between the supply and exhaust system shall automatically adjust to provide negative flow during the isolation mode of operation. Exhaust discharge points should ideally comply with isolation room code requirements. However, alternate performance-based solutions can be considered on a case-by-case basis with relevant stakeholders.

There are benefits in breaking down a clinical unit into a number of areas or pods with each pod comprising a number of patient rooms being served by a separate air handling unit and return air system. Upon supply or exhaust system failure only a portion of the clinical unit is impacted.

5 Design Features

5.1 Overview

This section details design and engineering considerations for isolation rooms. A summary of requirements is provided in the table below.

Table 1: Isolation Room Features

Room Features	Class S (Standard)	Class N (Negative)	Class P (Positive)	Class Q (Quarantine)	PPVL
Hand basin in room	Yes (within room or directly outside)	Yes	Yes (within room or directly outside)	Yes	Yes
Ensuite bathroom	Yes	Yes	Yes	Yes	Yes
Door on room with door closer	Yes	Yes	Yes	Yes	Yes
Anteroom	-	Yes	-	Yes	Yes
Sealed room, with barometric dampers, for controlled air flow	-	Yes	Yes	Yes	Yes
12 air changes per hour (ACH) or 145 liters per patient whichever is the greater	-	Yes	Yes	Yes	Yes
100% outside air ventilation	-	Yes	Yes	Yes	Yes
Local differential pressure monitoring	-	Yes	Yes	Yes	Yes
Independent supply air	-	Yes	-	Yes	Yes
HEPA filters on supply air	-	-	Yes	-	Yes
Exhaust - ceiling level above the bed head (Unless alternate, more effective air distribution system can be demonstrated)	-	Yes	Yes	Yes	-
Independent exhaust discharging vertically at 10 m/s according to AS 1668.2 Type A exhaust	-	Yes	-	Yes	Yes
Exhaust duct under negative pressure within building with duplex fans	-	Yes	Optional	Yes	Yes
HEPA filters on exhaust	-	May be required as a performance solution where a AS1668.2 compliant discharge position cannot be achieved.	-	Yes	May be required as a performance solution where a AS1668.2 compliant discharge position cannot be achieved.

The plant and engineering systems should be designed so that maintenance access is from outside the isolation room and preferably within a plant room. This improves the safety of maintenance staff while maintaining containment and therefore patient safety.

5.2 Pressure Gradients

Class N and Q isolation rooms will provide a negative pressure gradient from the isolation room to the anteroom and corridor. The most negative pressure environment will be the patient bedroom.

Class P isolation rooms will provide positive pressure relative to the corridor.

The minimum differential pressure between the isolation room and adjacent ambient pressure areas should be 20 to 25 Pa if the isolation room has an anteroom and 10 to 15 Pa when there is no anteroom. In both cases, the pressure gradient relates to the differential from the corridor. Barometric dampers will be needed to achieve these pressure gradients. Any barometric dampers shall be located so as not to cause draughts over the patient bed. Where acoustic treatment is required for barometric damper systems, the acoustic treatment material shall allow for duct cleaning and shall not be affected by chemicals used in fumigation processes.

Table 2: Pressure Gradients Relative to the Adjacent Corridor

	Class S (Standard)	Class N (Negative)	Class P (Positive)	Class Q (Quarantine)	PPVL
Patient Room	-	-20 to -25 Pa	+20 to +25 Pa	-20 to -30 Pa	0
Ensuite	-	-20 to -25 Pa	+20 to +25 Pa	-20 to -30 Pa	-5 Pa
Anteroom	-	-10 to -15 Pa	-	-10 to -15 Pa	+10 Pa

5.3 Principles Of System Configuration

In typical inpatient units where there are no more than one or two Class N or P isolation rooms, each room should be provided with an individual fan coil unit for temperature control and an associated individual exhaust fan. Both the fan coil unit and the exhaust fan should be provided with variable speed controllers for commissioning purposes and to allow for flow adjustments to compensate for increased room air leakage that might occur during the life of the room. The outside air supply shall be provided with appropriate dampers for both shut-off and balancing purposes.

In clinical units with a high number of isolation rooms, the preferred arrangement would be as per the above. Alternatively for economy and ease of ceiling spatial coordination, all the Class P rooms can be provided from a common but dedicated full outside air handling system with terminal trimming reheat.

Where a number of Class N isolation rooms are provided within a clinical unit an arrangement can be considered where rooms are grouped with each group of isolation rooms served from a duty/standby air handling plant, rather than each room having its own plant. The exact grouping and room split shall be informed by a risk assessment to ensure the best outcome for system reliability, i.e. that the operational impact (number of isolation rooms affected) in the event of equipment failure is acceptable. The risk assessment should be undertaken through consultation between the clinicians and engineers so there is clear understanding of the risks and level of reliability required. This will vary depending on the number of isolation rooms and patient cohort.

The air handling system for Class P isolation rooms should have a duty and standby fan coil unit arrangement to provide redundancy and reliability. Dedicated duty/standby exhaust fans with variable speed controllers, for commissioning purposes should be provided to each Class N isolation room.

It is important to understand the objectives for each type of isolation room, to realise where the plant redundancy is most needed. For Class N and Q isolation rooms the need for negative pressure and air flow demands that any redundancy as a minimum should be on the exhaust system whereas with the Class P isolation room requiring positive pressure any redundancy should be on the supply air side.

In any arrangement, all equipment such as fan coil units, filters, coils, dampers and fans shall be located outside the isolation rooms for ease of maintenance access and preferably within a plant room.

5.4 Supply Air and Exhaust System Design

Exhaust ducts from Class N and Class Q isolation rooms shall be separate from the common building exhaust system so that cross contamination is avoided. Air from these rooms should be exhausted directly to the outside of the building. Discharge points for exhaust air should comply as a minimum to AS1668.2 and be located as far as possible from air-intakes, ideally positioned above the roof line at a height that avoids possible re-entry of the exhausted air into the outside air intakes of the building. As a performance solution a HEPA filtered exhaust may be terminated out the side of a building at a lower level.

In order to prolong the life of a HEPA filter a suitable pre-filter shall be installed on the upstream side of the HEPA filter installation. The location of HEPA filters shall ensure that they can be tested and replaced safely and without impacting on patient areas. Where possible HEPA filters on exhaust systems shall be placed close to the exhaust fan. For Class N isolation rooms HEPA filters are optional and are only required where a complying exhaust discharge point cannot be achieved. For Class Q isolation rooms, a HEPA filter shall always be provided on the exhaust. HEPA safe change systems must be provided to minimise risk associated with changing potentially contaminated filters. Within Class P isolation room systems, a HEPA filter shall be provided to the supply air.

UV disinfection lighting within an air stream is effective in combating pathogens and can be considered for Class P isolation rooms based on the risks associated with the installation or regional location. Where provided, adequate space in the plant room should be considered for accessibility to UV light ports, as these lamps may require maintenance or replacement over time.

Consideration should be given to modelling (computer or physical) of internal and external air flow to assess risks associated with potential outside air supply contamination. This includes an assessment of the location of outside air intakes and points of exhaust discharge points where there is a high level of risk and recirculation could occur impacting high risk patient units, such as haematology and oncology units, or units at risk of outbreak such as respiratory units.

Supply and exhaust fans shall be provided with variable speeds to facilitate future adjustments to maintain differential pressures and room air change rates. Exhaust fans shall be located as near as possible to the discharge point.

The supply air fan coil units shall control the room temperature to the set point 24ºC plus or minus 1.5ºC. Humidification and de-humidification control shall be provided where needed to achieve 40 – 60% RH range. Special consideration for outside air preconditioning (<10g/Kg moisture content) of single pass systems (100% outside air) serving N and Q isolation rooms, must be incorporated in the design for areas within tropical climate zones to ensure appropriate internal humidity control and minimise risk of mould growth.

It is important to minimise equipment that can cause system failure. This includes the installation of fire and smoke dampers. Where possible exhaust ductwork to Class N isolation rooms and outside air ductwork to Class P isolation rooms should not pass through fire and smoke walls.

5.5 Air Distribution

Air distribution systems should be designed to provide highly effective ventilation to the space and in a Class N and Q isolation room to promote containment. Air distribution principles should be considered during the initial design phases so that outcomes are optimised. Air distribution must be designed for the type of isolation room, and the location and air flow direction from / to supply and exhaust registers must be considered accordingly. Patient comfort shall also be a prime consideration with regards to room temperature, humidity, noise and air flow so as not to cause undue drafts in the vicinity of the patient.

The ventilation system should be designed to ensure the air flows from less contaminated areas to more contaminated areas.

Supply air should be provided to the isolation room so that air turbulence is minimised near the patient. The exhaust air flow however should be maximised near the patient in a Class N and Q isolation room to capture contaminated air.

CFD (Computational Fluid Dynamics) studies have shown that airborne contaminants produced by the patients in the form of aerosols are carried within the air flow paths and circulate around the room. This happens regardless of where the exhaust is located and because of this the entire room must be considered to be an infectious space, requiring health care workers to wear appropriate PPE. Recommendations relating to the optimal location of the exhaust vary between different international guidelines however in recent years, there is increasing recognition that locating the exhaust at a low level behind the bed head is no longer considered best practice. Locating the exhaust on the ceiling above the patient at the head of the bed with the supply air diffuser located on the ceiling close to the wall at the foot of the bed (with air directed to the walls and away from the door rather than directed towards the patient) has been shown through CFD analysis to be effective in capturing aerosols rising from a patient as outlined in the diagram below and further detail provided at Appendix 1.

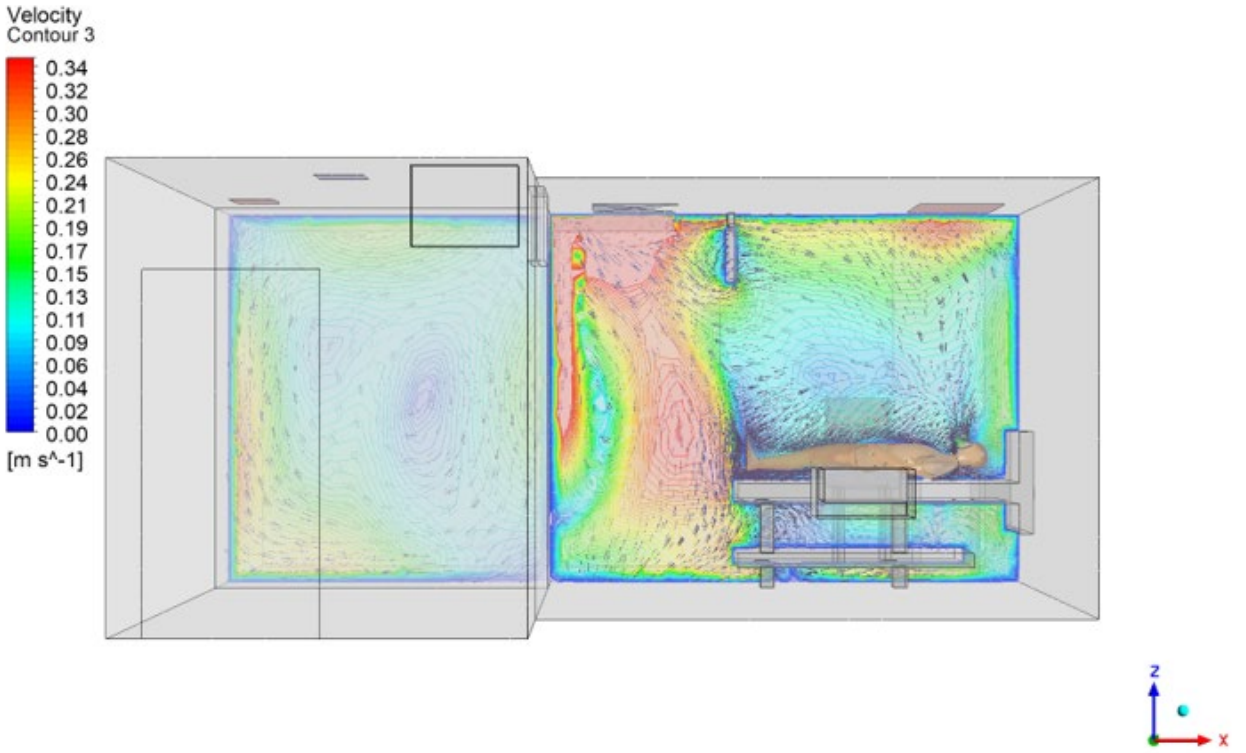

Figure: CFD model with recommended supply and exhaust locations. Refer to Appendix 1 for further detail.

The recommended supply and exhaust locations outlined in this guideline for Class N and Q isolation rooms are based on expert mechanical engineering advice and evidence established through CFD studies. It is acknowledged that this does not align with that suggested in AS1668.2 2024. At the time of writing this guideline AS1668.2 2024 has not been adopted by the National Construction Code (NCC) 2022. Should it be adopted in a future version of the NCC it is recommended that designers seek updated advice in line with the evidence noted in this guideline and pursue a performance solution where required.

Ensuites will be on the same dedicated exhaust that serves the patient bedroom with minimum rates as detailed in AS1668.2.

The placement of ceiling mounted exhaust grilles and supply air diffusers within ICU patient isolation rooms needs to be carefully coordinated with the design and location of ceiling mounted equipment.

5.6 Air Change Rates

The total quantity of air supplied into Class P, N and Q isolation room should be a minimum of 12 air changes per hour (ACH). For typical inpatient bedrooms this is expected to be able to cope with most heat gain and thermal comfort requirements, however if the room needs additional supply air to meet the comfort requirements this will need to be allowed for.

For Class N and Q isolation rooms, the quantity of outside air should be based on the air change rate of 12 ACH and will be constant. In all cases it shall be 100% outside air.

Class S isolation rooms will have air change rates at similar levels to general patient care areas (a minimum of 6 ACH) and will include sufficient outside air to meet occupancy needs.

For Class P isolation rooms, the supply air velocity shall be monitored within the supply air duct with the set point being the velocity to achieve the 12 ACH within the bedroom. The supply air fan speed shall be adjusted to maintain the set point velocity to compensate for dust build up within air filters.

5.7 Controlling Room Pressures

The differential pressure between isolation rooms and the adjacent corridor and an anteroom and the adjacent corridor shall be controlled by barometric dampers. The pressure differential between the room and the adjacent corridor shall be monitored by the building management system (BMS) to alert staff that the pressure is lower than that required. Door sensors in the form of magnetic reed switches shall be provided to ensure that pressure monitoring only occurs when the anteroom and patient access doors are closed. The variable speed drives installed to the supply and exhaust fans shall be used to commission these to meet the air flow and pressure differential requirements and to make any future adjustments to air flow that might be needed.

5.8 Monitoring Room Pressure

The pressure of Class P, Class N and Class Q isolation rooms shall be monitored, both electronically and through physical observation. Indication of the isolation room status shall be provided in the form of illuminated indicator panels to show:

- negative pressure, room status is normal
- positive pressure, room status is normal
- low pressure, alarm
- door open, caution.

Indication shall be provided at eye level within a prominent location outside and adjacent the room. The indication shall also provide an audible alarm with alarm mute ability. By default, the alarm will be activated when the room pressures drop below the specified range. A repeater panel shall be provided at the staff station to show the same indication with audible signal and mute together with identification of which room is in alarm. Remote monitoring shall be provided via a BMS as a secondary measure for monitoring compliance. The actual airflow should be monitored with a flow switch and a local audible alarm fitted in case of fan failure or a change in pressure outside acceptable parameters.

Monitoring sensors should be located away from doorways to avoid false readings due to air displacement.

With Class N and Class Q isolation rooms control systems will be required to stop the supply (intake) air system if there is flow failure of the exhaust air system. Motorised dampers will need to be positioned at supply air entry and exhaust exit points in the room. In Class N and Class Q isolation rooms, dampers will need to automatically shut if the associated fan stops.

With Class P isolation rooms, the control system will be required to stop the exhaust system if the supply air system fails.

The time that it takes for safety shut off dampers to close and for safety shut down to occur must ensure patients and staff are not at risk.

Air-conditioning and ventilation plants will need to have suitable, permanent and highly visible labelling which include the following:

- warning on systems shutdown and adjustment effects
- warning on working on exhaust systems, particularly internal ductwork and fans
- notification and special operational procedure for maintenance.

The interlocking of fan systems to prevent reverse air flow from occurring within isolation rooms shall be hard wired to ensure reliability in operation.

5.9 Quarantine Isolation Rooms

Where these rooms are planned, they should provide:

- dedicated air-conditioning, supply and exhaust systems, exhausts shall include duty/standby fans
- a safe change and access HEPA filter (fitted with differential pressure gauge) at each room exhaust fan location and monitored by the BMS. The HEPA filter assembly shall include a pre-filter, cold DOP aerosols injection port on the upstream side of the HEPA filter and an inbuilt leak detection scanner on the downstream side of the HEPA filter
- ducts damper with edge and blade seals immediately upstream and downstream of each exhaust HEPA filter for duct isolation prior to HEPA filter removal and room cleaning. Location of filter is important. A low-level location should be avoided so the filter does not collect dust
- alarms that are activated on loss of differential pressure. However, as the required pressure differential may be lost during entry/exit from the isolation room, some form of delay or isolation of such an alarm will be necessary.

To enable Class Q isolation rooms to be adequately and safely fumigated when required, airtight dampers will be:

- installed in the supply air ductwork between the supply air fan and the room
- installed in the exhaust air ductwork, downstream of any HEPA filter installed in the room exhaust. HEPA filters are required (Refer to Table 1)
- purpose designed and fitted with airtight seals and closed tight while fumigation is in progress. Standard balancing dampers shall not be used as airtight shut off dampers.

After completion of fumigation the exhaust damper and exhaust fan may be operated to remove fumigant gases from the isolation room. If fumigation canisters are to be used no further provisions are required. If externally generated fumigants are to be used, then sealed ports are to be installed into the room to allow fumigant generators to be connected to the port. Ports are to be sealed when not in use.

Contaminated HEPA filters should be bag sealed, decontaminated with a suitable cleaning agent in line with manufacturer's instructions, and secondary bag sealed prior to removal for appropriate disposal. If possible, fumigate prior to removal. Maintenance staff shall be made aware of the associated risks when changing potentially contaminated HEPA filters and shall wear appropriate PPE.

Where rooms are to be fumigated, they will need to be pressure tested and provided with appropriate seals to meet maximum leakage rates. Ductwork will also need to be sealed airtight up to the airtight shut off dampers, fully welded ductwork is usually the best solution.

5.10 Minimum Fresh Air Requirements

Fresh air supply detailed in Table 1.

5.11 Minimising Room Air Leaks – Class N And Q Isolation Rooms

There is no standard on the amount of room leakage unless the room will be subjected to room fumigation, however for energy efficiency and longevity this should be minimised. A generally accepted level of leakage is a maximum of 10% of the supply air required to the room when operating at the design room pressure differential. To achieve this all elements of the room construction will need to be adequately sealed. The mechanical contractor should not be expected to increase air volumes to overcome poor workmanship in other trades.

A UK BSIRA standard BTS 03/2018 'Air permeability testing of isolation facilities', is a suitable reference document when testing isolation rooms for leakage. This document suggests a maximum leakage rate of $2.5 m^3/(h.m^2)$ at a test pressure of 50Pa.

Air pressure leak testing should be conducted wherever practical at stages during construction and upon completion of the room, and sealing works undertaken until this leakage is brought within design parameters. Leakage should be tested by pressurising the room above the required design pressure and using smoke pencils to find the air paths of leakage. This can be very difficult / costly if the room was not designed to be airtight in the first place.

Details of how room features and services will be sealed shall be prepared by the designers as a guide for installers to follow. These shall provide detailed construction and installation methods to achieve a sealed room. Construction hold points shall be determined to allow inspection of potential air leakage points before being concealed. Progressive room testing shall be established where it is practical, to ensure staged witnessing of air tightness within acceptable leakage rates as the work progresses. This safeguards both the client and contractor in delivering a compliant room within the agreed timeframe.

Every window, door, wall joint and fitting inserted into the room is a potential source of leakage that needs to be sealed properly. Consideration needs to be given to all items within the isolation room design, and a list of some of these items is provided below for guidance on the main sources of air leakage. It is by no means a comprehensive list.

The problems in building and testing sealed rooms are nearly always caused by two factors:

1) Lack of adequate detailing and specification of the various trades in the tender documents (sometimes this is due to inexperience of the architect or engineer). It is not good enough to assume that each of the parties will detail the required standards. Proactive coordination of the detailing is essential.
2) Lack of experience by the building and services trades in construction of sealed rooms. A typical wall framer, plasterer, painter, electrician etc may not appreciate what it takes to achieve a maintainable pressure in a room. Good documentation will assist, post-tender interviews and a comprehensive briefing with the builder or head contractor will also be needed.

Getting it right at the time of documentation and appropriate planning and installation by ALL of the various construction trades is a lot easier than trying to retrospectively fix problems on site.

A room can be made airtight by:

- detailing wall joints at wall to wall, wall to ceiling and wall to floor. If there is no confidence in the plaster system, detail expressed joints with stopping beads for accurate edges and fill with sealant. Plaster to plaster joints between sheets should have doublers at the back to prevent cracking with gaps sealed to prevent air leaks between sheets.
- sealing door frames to the wall (significant source of leak), particularly the rarely used corridor/room door. This is often best managed by an expressed gap between the two (e.g. 4 to 6mm) which can be positively filled with sealant.
- sealing doors to door frames and seals including adjustment of door seals on all edges of each door. Doors from the corridor direct into the room will not be used for general access (only for bed entry and exit). These doors should be well sealed.
- sealing window frames to the wall as this is a significant source of leaks. This is often best managed by an expressed gap between the wall and window frame (e.g. 4 to 6 mm) which can be positively filled with sealant. Select windows with solid frames.
- fitting suitable door hardware and improving sealing of the hardware in the process.
- specifying doors with wide jambs to allow for fitting of an improved seal.
- fitting door seals to all faces of the door with compressible seals on the jambs and drop- seals on the bottom.
- ensuring that if door closers are installed to the anteroom and corridor doors, they are adequate to close the door against the seal and do not cause too much pressure to prevent easy operation by staff. Also check the direction of swing as pressure against the swing assists the seal to work. The sealing of doors is best achieved when, with Class N and Q isolation rooms, the doors open outwards and with a Class P isolation room the door opens inwards, where room planning permits.
- specifying and fitting of welded boxes behind door frame for door hardware (as for fire doors) to minimise leaks through hardware.

- improved sealing of the light fittings, supply diffusers and exhaust registers. The specification and approved samples should require adequate sealing of diffusers to frames and frames to ceiling. If the seals offered are inadequate, then improved sealing will be required. This could include screw fixing of the diffuser frame with captive studs to allow adjustment of the seal pressure, and installation of a compressible closed cell rubber seal between the diffuser and ceiling. Pressed steel frames are often inadequate.
- reducing penetrations into rooms by:
    - where possible, constructing the walls of Class N and Q rooms to full height (underside of slab or create a second sealed ceiling if under roof) and sealing / leakage testing the perimeter extremity before installation of the ceiling and services panels in false walls. This will also provide less risk of disturbance to the room seal during future maintenance and upgrades to services fixtures in room.
    - minimising penetrations through the perimeter walls. Group cables etc to a few locations and seal thoroughly.
    - improving sealing of the light fitting. Select fittings that have a wide flat edge that can be sealed against the ceiling/wall. All cable holes to be sealed or specify clean room light fittings or similar. It may be necessary to seal the diffuser to the flanges and flanges to the carcass if the carcass can't be properly sealed.
    - improving sealing of supply air diffusers and exhaust grilles. Ensure cushion heads, filter frames, duct edges are specified/detailed to be sealed to the plaster ceiling – flanges etc.
    - adequate detailing of plumbing penetrations, particularly hand-basin waste through wall. Chrome cover plates are inadequate. Positive sealing is required.
    - re-fitting of some fittings in service plates to improve the seal (e.g. RCD's), where there are gaps.
    - using wall boxes for medical gas outlets, power outlets and ICT. Seal major holes in wall boxes where fittings are mounted (e.g. cable entries). Silicon sealant or similar is usually adequate at these pressures.
    - sealing all pendants against the ceiling. The internal gap needs to be filled with an expanding sealant to stop air leaking down the pendant column.
    - sealing of wall boxes behind GPOs.
- painting or sealing the tops and bottoms of doors for the control of infection.

5.12 Energy Conservation

The external venting of air from Class N and Class Q rooms is relatively energy intensive but is important in controlling potentially infectious respiratory particles. Energy conservation should not interfere with optimal infection prevention and control practice.

5.13 Plant Back-Up System

The power supply to all plant and systems shall be derived from an emergency power supply. In most cases this will be backed up by the standby generator. In some cases, this will be a secondary supply from the authorities.

5.14 Operating in Fire Mode

The system will continue to run in the event of a fire trip. This will obviate false alarms causing loss of pressure control regimes. AS 1668.1 allows for this under the definition of minor systems.

Where a site is on bushfire prone land, the requirements for the treatment of air intakes and the maintenance of isolation room pressure regimes need to be considered. This may require performance solutions for compliance with the bushfire requirements of the NCC.

6 Commissioning and Ongoing Maintenance

Proper commissioning of isolation rooms is essential to ensure that the room delivers the required containment and complies with relevant guidelines and regulations. Commissioning data will also provide a reference point for the future when the isolation room is being maintained, or the performance is being re-checked. The following is a recommended list of commissioning procedures. All testing data and commissioning procedures should be witnessed and recorded for future reference.

Warning signs shall be provided at maintenance points along the exhaust ductwork for both Class N and Q isolation rooms warning that the ductwork, component and equipment may be contaminated and appropriate measures shall be taken to ensure safety of maintenance personnel.

6.1 Initial Setup Test

With all doors closed, the air quantities and pressures in each compartment should be checked to test if they meet the required specifications. This initial test will reveal whether there is a satisfactory room leakage rate and if not, whether rectification of the various building and engineering elements is needed to address points of leakage.

6.2 Air Quantities

Measure and record the air flows at each supply air diffuser and exhaust grille. Acceptable measurement equipment includes flow hoods or vane anemometers. Any flow measurement equipment must be calibrated with an up-to-date calibration certificate.

6.3 Pressure Differentials

With doors closed and the specified supply and exhaust air quantities confirmed, check and record the pressures in each compartment and the pressure differentials between each compartment including the isolation room, anteroom, ensuite and adjoining corridor. Pressures should be measured using calibrated pressure gauges or liquid manometers. The pressure readings should be checked and confirmed against the installed room pressure measuring and indicating equipment.

6.4 Air Flow Direction Between Compartments

Check the movement of air is in the correct direction according to the category/class of room. Doors should be opened, one at a time, and air flow direction checked with a smoke pencil/smoke tube. If the pressure differentials are correct, the air flow should be from higher pressure to lower pressure compartments.

6.5 Air Distribution

Air distribution within the isolation room should be checked using a smoke pencil/smoke tube. This will require sampling air movements at points near the doors, near the patient and in the distant corners of the room. Acceptable air movements should include:

- air flow near the doors should be in the direction of the pressure differential (i.e. towards or away from the doors in Class P and Class N/Q rooms respectively)
- air flow near the patient should be towards the patient in a Class N or Q isolation room or away from the patient in a Class P room
- air in other parts of the room and in the corners of the room, including the ceiling, should be sampled and should be moving, not stagnant nor short-circuiting.

Sufficient sampling to ensure movement throughout the room is required to ensure that the room air is being exchanged as per specified air change rates and there is no retention of infected air within the room. Sampling points, air movement and velocities should be recorded.

6.6 Containment

While there is no definition of containment in this Guideline, it is useful to check that an operational room achieves a level of 'containment' as per the objectives of this document. Useful checks include:

- checking the impact on air pressures and the recovery time as doors are opened and closed. Room pressure should be restored within a short period to ensure that isolation is provided
- checking air displacement around doors when they are opened as staff move in and out of rooms. This can be achieved by observing smoke paths when doors are opened. Displaced air can move through a doorway when a door is opened rapidly, compromising containment.

The interlocking of anteroom doors will assist with this by not allowing both doors to be opened at the same time. This should not impact staff workflows given the time for health care workers to don and doff their PPE. An emergency break glass release switch will support clinical emergencies and ensure that staff, visitors and contractors are not entrapped within the patient room or anteroom. A workplace instruction and associated education should be developed.

Providing a time delay between the opening of each door will also assist in providing containment within the patient room and anteroom.

6.7 Room Leakage

Excessive room leakage is not acceptable and is a potential risk. If the tests outlined above show that the room pressures cannot be achieved with the specified air quantities, this indicates excessive leakage. Leaks can usually be found using a number of techniques. The minimum approach should be to use smoke to detect leakage paths. With the room under pressure, use smoke pencils/smoke tubes, puff smoke in the region of all fittings in the rooms, including doors, door hardware, windows, light fittings, electrical and communications fittings, medical gases, hydraulics fittings and fixtures. When smoke is observed entering or leaving the room (according to room pressures), rectification of detected leaks should be undertaken until the specified room pressures are achieved within acceptable tolerances of the specified room supply and exhaust air flows.

Where a site is on bushfire prone land, requirements will need to be considered as outlined in Section 5.14. Variable speed supply and exhaust fans should be used to deliver the required air flow rate, which will achieve the specified room pressure differentials. This will take into account the excess air leakage which needs to be eliminated in order to achieve a compliant room.

6.8 HEPA Filter Commissioning

HEPA filters must be commissioned by qualified testers and shall include challenge tests, flow and pressure drop tests as set out in in AS1807.6:2000 Cleanrooms, workstations, safety cabinets and pharmaceuticals isolators. Test certificates shall be provided and retained.

It should be noted that the HEPA filter performance must be reviewed regularly to ensure ongoing performance and pressure differentials are maintained. To assist with this the differential pressure across the HEPA filter shall be monitored by the BMS. The HEPA filter housing and ductwork shall be designed to accommodate cold DOP testing.

6.9 Controls

All controls and instrumentation shall be commissioned to specification, including:

- pressure monitoring instruments/gauges at the room barriers and also any at the staff bases and any connected to BMS
- failure of room pressures should be simulated, and the operation of visual and audible alarms should be checked.
- simulated failure of supply and exhaust fans shall be undertaken to test the alarms and, where fitted, the automatic change-over to standby fans
- simulated power failures to ensure that the controls for fans and electronic pressure monitors and alarms continue to operate as required

- for Class P isolation rooms, check that if the supply system fails the exhaust system shuts down. On startup after plant shutdown ensure the supply system starts before exhaust is enabled for Class P rooms
- for Class N and Q isolation rooms, check that if the exhaust system fails the supply air system shuts down and the supply air shut off dampers close tight. On startup after plant shutdown ensure the exhaust system starts before supply is enabled for Class N and Q rooms
- for PPVL rooms consider BMS automated start and shutdown control sequence to maintain appropriate pressure grades between boundary zone and the isolation room
- check by simulation that in the case of a Class P isolation room the air flow velocity remains constant as filters become more blocked.

6.10 Thermal Comfort

Thermal comfort should be checked and recorded (noting that patients may be bed-bound for considerable periods), including:

- temperature should be checked in the vicinity of the bedhead
- air in the vicinity of the patient should have a velocity below 0.25m/sec to minimise impact of drafts on patient comfort. This can be checked with electronic sensor, vane or hot wire anemometer
- where relative humidity control is provided the room RH should be checked.

6.11 Records

All commissioning results shall be recorded and retained by the hospital maintenance staff.

6.12 Annual Performance Monitoring and Validation

Performance protocols should be established prior to commissioning.

Health workers working with Class N and P rooms will need to be oriented so they understand when they should be used, how to assess if the room is operating effectively, and requirements relating to documentation.

Engineering staff shall implement a planned maintenance system to assess if the room is functioning correctly. This will be supported by staff training. Maintenance activities shall include a review of:

- air change rate (verify against design)
- supply air and exhaust flow rates (verify against design)
- terminal HEPA filters (annual integrity and performance validation testing)
- pre-filters and intermediate filters (check condition, cleanliness, and replacement schedule)
- supply air diffuser or registers, return/exhaust air grilles and ductwork (inspect and clean as required to prevent particulate build-up)
- differential pressures being achieved
- barometric dampers functioning correctly
- duty/standby fan changeover operation
- Fan coil unit (FCU) operation in response to room temperature
- FCU operation in response to room humidity where included
- correct operation in the event of partial system failure
- room pressure gauges and alarms (operation and calibration)
- BMS alarms, setpoints, and trend logs (verify pressure setpoints and tolerances)
- calibration of instruments (manometers, anemometers, BMS sensors)
- interlocked doors and door closers/seals (verify correct function)
- damage to room interior
- supply and exhaust fans, and dampers
- room and door seals and door closer
- clinical hand basin and ensuite plumbing
- ductwork and ceiling spaces - inspection for mould or condensation near damp areas

- verification after building works or maintenance in adjacent areas to ensure performance not compromised.

Maintenance logs of monitoring and validation will be needed including details on results, when the maintenance was undertaken and by whom

For further detailed information refer to:

- AS ISO 14644:2017 Cleanrooms and associated controlled environments
- AS/ NZS 3666.2:2011 Air-handling and water systems of buildings – Microbial control – operation and maintenance, Australian Standards, Sydney
- Victoria Government, 2014 Maintenance standards for critical areas in Victoria Health facilities, Department of Health.

7 References and Further Reading

References

- Australasian Health Infrastructure Alliance (AHIA), 2025, AusHFG Part D: Infection Prevention and Control, St Leonards, Australia.
- Australasian Health Infrastructure Alliance (AHIA), 2023, Pandemic Preparedness - Health Infrastructure Planning & Design Guidance, St Leonards, Australia.
- AS1668.2:2024 The use of ventilation and air conditioning in buildings - Ventilation design for indoor air contaminant control (2024 version not adopted by the NCC 2022 at the time of writing this guideline).
- AS1807.6:2000 Cleanrooms, workstations and safety cabinets – Methods of tests - Determination of integrity of terminally mounted HEPA filtered installations.
- AS/NZS 3666.2:2011 Air-handling and water systems of buildings – Microbial control – Operation and maintenance, Australian Standards, Sydney.
- ASHRAE / ASHE Standard170-2021 Ventilation of Health Care Facilities.
- ASHRAE / ASHE Standard 241-2023 Control of Infectious Aerosols.
- AS ISO 14644-1:2017 Cleanrooms and associated controlled environments.
- Victoria Government, 2014 Maintenance standards for critical areas in Victoria Health facilities, Department of Health.

Further Reading

- Australian Commission on Safety and Quality in Health Care (ACSQHC), 2022, Optimising ventilation for infection prevention and control in healthcare settings, Sydney, Australia
- NHS England, 2024, HBN 04-01 Supplement 1: Special Ventilated Isolation Facilities for Patients in Acute Settings, UK.

Appendix 1: Computational Fluid Dynamic (CFD) Study

CFD study based on Class N Room with exhaust (noted in red) located on the ceiling above the patient at the head of the bed and the supply air diffuser (noted in blue) located on the ceiling close to the wall at the foot of the bed (with air directed to the walls and away from the door rather than directed towards the patient). Refer to Section 5.5 for further details.

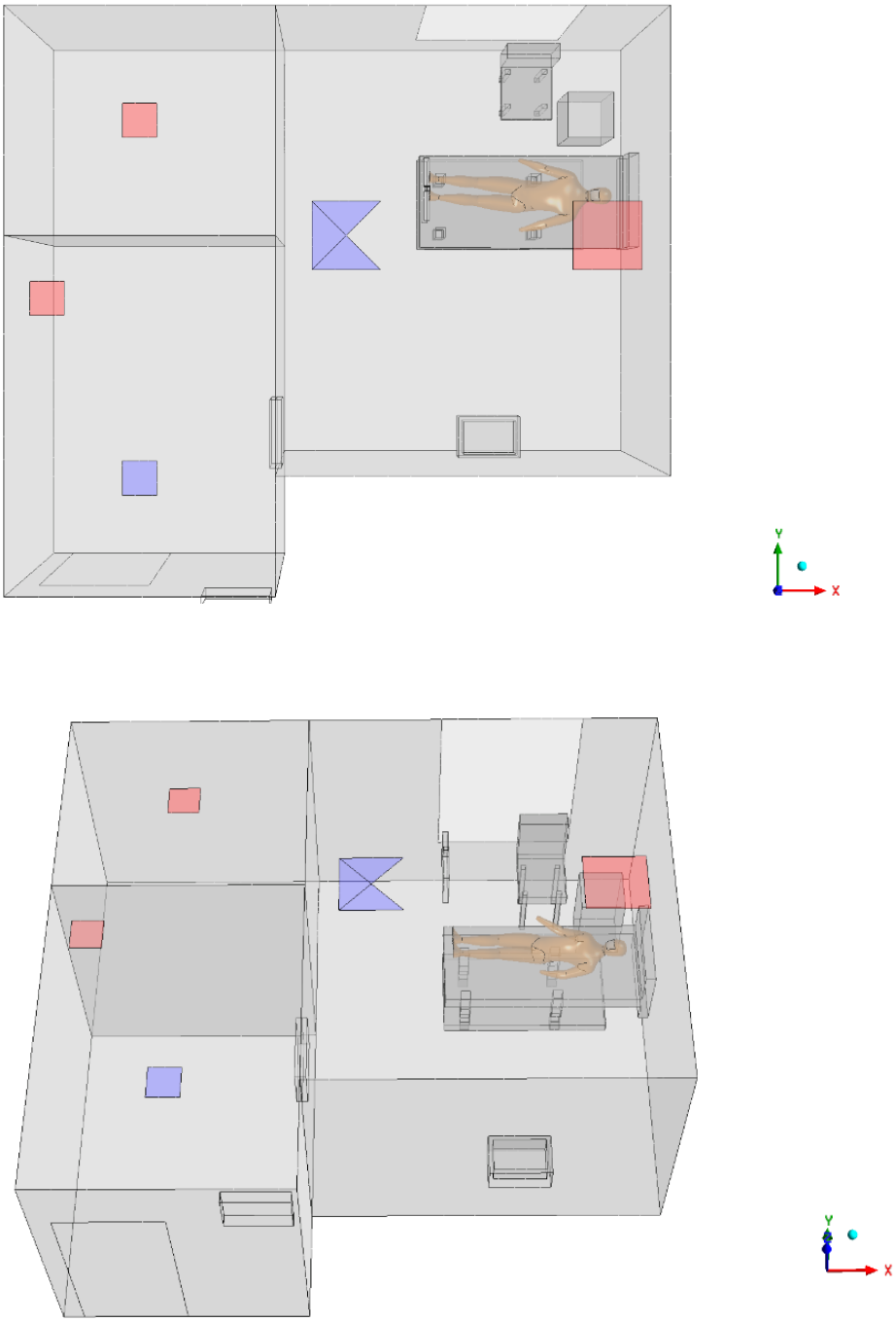

Figure 1: Class N Room Arrangement in line with AusHFG Standard Component and recommended indicative supply (blue) and exhaust (red) locations.

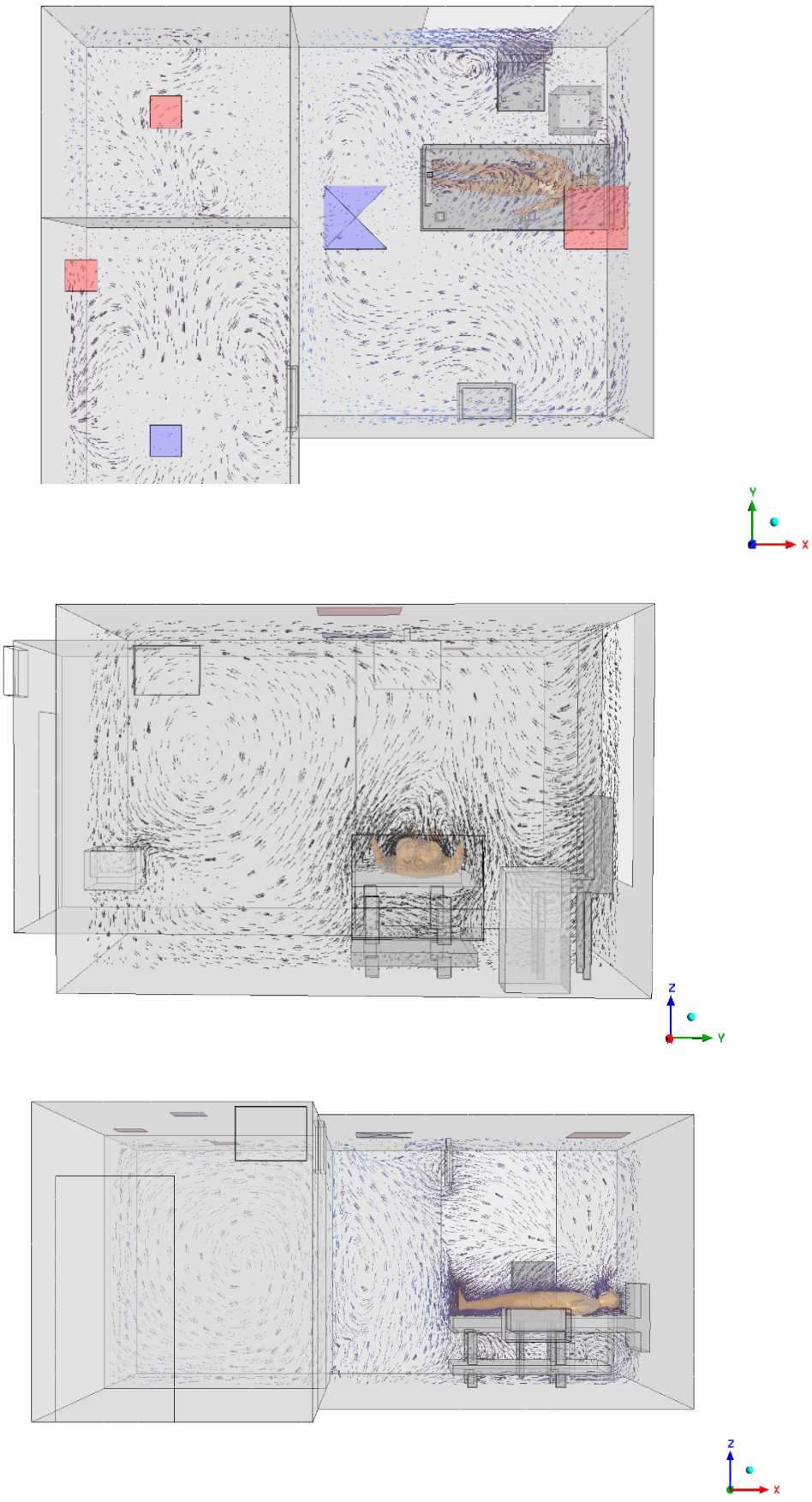

Figure 2: CFD modelled airflow paths in response to recommended supply and exhaust locations

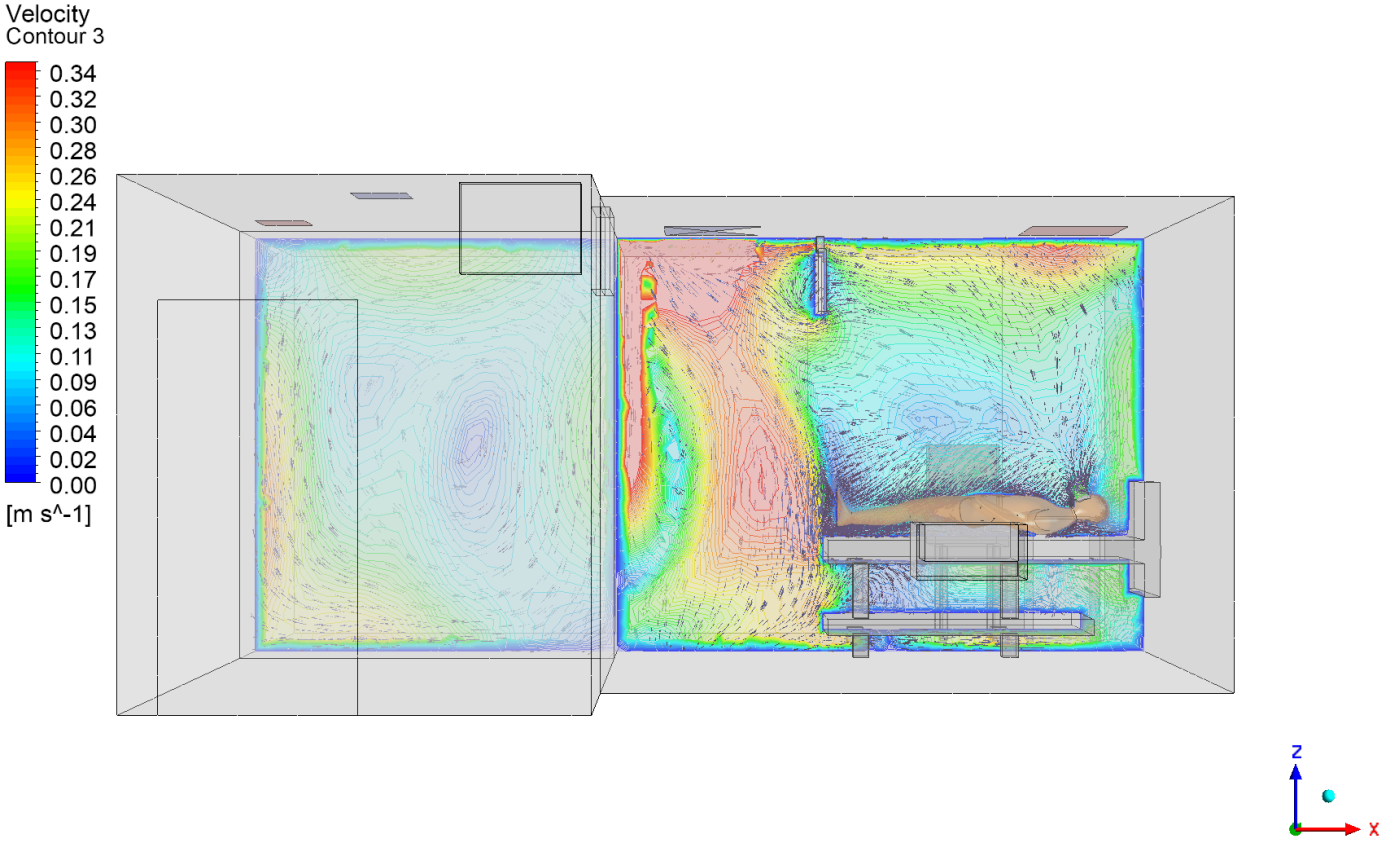

Figure 3 CFD modelled airflow velocity visualisation