National Construction Code

Commercial energy efficiency

Handbook

Australian Building Codes Board

Commercial energy efficiency Handbook

The Australian Building Codes Board

The Australian Building Codes Board (ABCB) is a standards writing body responsible for the National Construction Code (NCC), WaterMark and CodeMark Certification Schemes.

The ABCB is a joint initiative of all levels of government in Australia, together with the building and plumbing industry. Its mission is to oversee issues relating to health, safety, amenity, accessibility and sustainability in building.

For more information visit the ABCB website.

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Preface

This Handbook is one of a series produced by the ABCB developed in response to comments and questions raised by government, industry and the community that relate to the built environment. The topics of Handbooks expand on areas of existing regulation or relate to topics that are not regulated by the National Construction Code (NCC). They provide non-mandatory advice and guidance.

The Commercial Energy Efficiency Handbook (Handbook) assists in understanding the energy efficiency requirements for all non-residential buildings and provides examples where relevant. It addresses issues in generic terms and is not a document that sets out the specific compliance advice for developing solutions to comply with the requirements in the NCC, but rather aims to explain the intent of the provisions. It is expected that this handbook guides readers to develop solutions relevant to specific situations in accordance with the generic principles and criteria contained herein.

This Handbook was first published in 2006, revised in 2010, 2014, 2015, 2016 and 2018, and re-written in 2019 due to the significant changes made to the energy efficiency provisions in NCC 2019.

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Reminder

This Handbook is not mandatory or regulatory in nature and compliance with it will not necessarily discharge a user's legal obligations. The Handbook should only be read and used subject to, and in conjunction with, the general disclaimer at page i.

The Handbook also needs to be read jointly with the relevant legislation of the appropriate State or Territory. It is written in generic terms, and it is not intended that the content of the Handbook counteract or conflict with the legislative requirements, any references in legal documents, any handbooks issued by the Administration or any directives by the Appropriate Authority.

1 Introduction

1.1 Background

1.1.1 The NCC

The NCC is a performance-based code containing all Performance Requirements for the construction of buildings. To comply with the NCC, a solution must achieve compliance with the Governing Requirements and the Performance Requirements. These are the mandatory parts of the NCC.

The Governing Requirements contain requirements about how the Performance Requirements must be met. A building, plumbing or drainage solution will comply with the NCC if it satisfies the Performance Requirements.

1.1.2 Commercial energy efficiency requirements

Energy efficiency requirements were first introduced into the Building Code of Australia (BCA) in 2006. As a result of government policy initiatives[1], major changes to these requirements occurred in 2010, 2019 and 2022. When compared to NCC 2019 there are several changes to the energy efficiency requirements for non-residential buildings in NCC 2022. These include:

- changes to the clause numbering due to the introduction of a consistent volume structure (CVS) across all 3 volumes of the NCC
- a new Performance Requirement and Deemed-to-Satisfy (DTS) Provisions to facilitate electric vehicle (EV) charging and renewable energy equipment (solar photovoltaic and battery systems)
- expansion of the National Australian Built Environment Rating System (NABERS) energy verification method to hotels and shopping centres
- updates to Greenhouse Gas Emissions (GGE) coefficients for electricity
- changes to R-value of slab-on-ground floors without in-slab heating
- changes to typical R-values achieved by air films.

The overall intent of the energy efficiency requirements are to:

- reduce energy consumption and energy peak demand

[1] Policy initiatives include the National Strategy on Energy Efficiency, National Energy Productivity Plan, and the Trajectory for Low Energy Buildings.

- reduce greenhouse gas emissions
- improve occupant health and amenity.

1.1.3 Energy efficiency handbooks

Alongside other guidance and support materials available from the ABCB website, there will be a new series of energy efficiency handbooks. These new handbooks are intended to assist NCC users to understand and comply with the latest requirements.

The new handbooks:

- focus on available compliance options
- are easier-to-digest documents than previous handbooks on energy efficiency
- provide links to other guidance and support materials
- consider the needs of various types of practitioners.

This Handbook is the third handbook in the new series of energy efficiency handbooks.

1.2 Scope

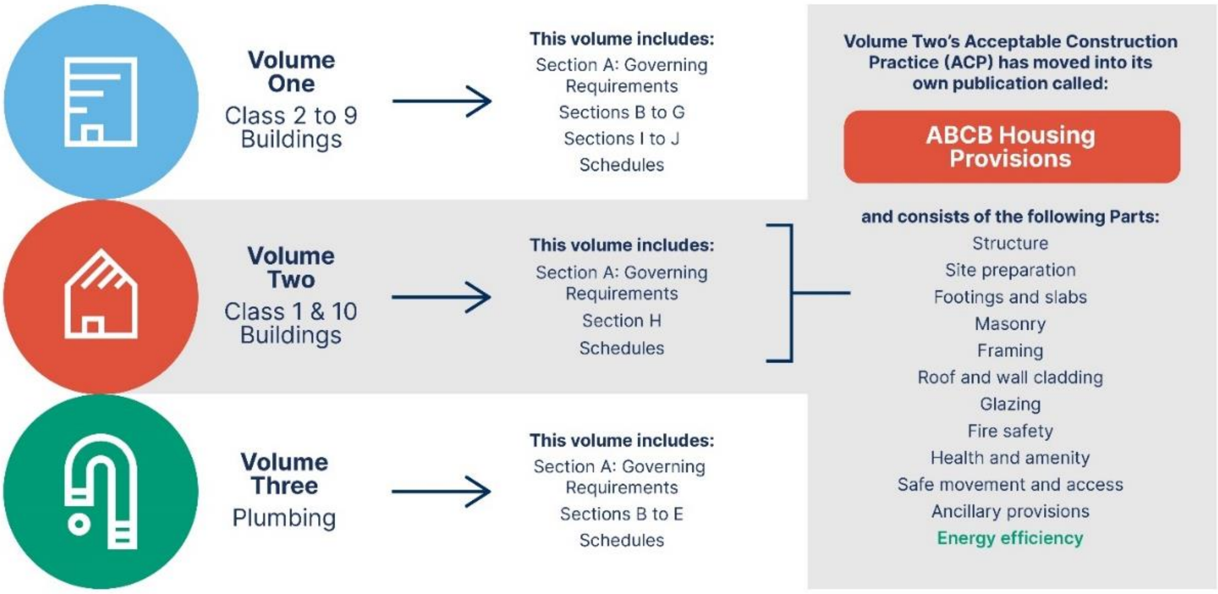
This Handbook has been developed to assist NCC users in understanding and applying the energy efficiency requirements in NCC Volume One, Section J. It will be of interest to all parties who are involved in designing, selecting or assessing elements of buildings that must comply with the NCC.

To specify particular requirements for different types of buildings, the NCC uses a building classification system. Building classifications are labelled ‘Class 1’ through to ‘Class 10’. Some classifications also have sub-classifications, referred to by a letter after the number (e.g. Class 1a).

The scope of this document addresses all non-residential classes of buildings. The separate Apartment Energy Efficiency Handbook (AEEH) addresses Class 2 buildings. Therefore, although included in NCC Volume One, Class 2 and Class 4 parts of buildings are not discussed, except where referred to specifically in the NCC itself, for example in the title of a Performance Requirement or in an NCC extract.

More information on building classifications and access to the NCC is available from the ABCB website. See Figure 1.2.1 to understand the structure of the NCC.

Figure 1.2.1 How the NCC is structured



1.3 Using this document

1.3.1 Structure

Chapter 2 provides an overview of the Performance Requirements for energy efficiency and the compliance options that can be used.

Chapters 3 to 8 each describe an individual compliance option, with the intention to enable an NCC user to focus on the compliance option(s) they will likely use to meet the Performance Requirements. For each compliance option there is an introduction, a method (that includes the key requirements), useful tips, and information on demonstrating compliance. Typically, one or more examples are provided in Appendix D.

- Chapter 3 describes the compliance options for a DTS approach.
- Chapter 4 describes the compliance options for J1V1 NABERS Energy.
- Chapter 5 describes the compliance options for J1V2 Green Star.
- Chapter 6 describes the compliance options for J1V3 Verification using a reference building.
- Chapter 7 describes the compliance options J1V4 Verification of building envelope sealing.
- Chapter 8 describes the compliance options for other performance solutions.

1.3.2 Appendices

This document contains 6 appendices, as follows:

- Appendix A contains a list of abbreviations used in this document
- Appendix B is a glossary of key terms used in this document
- Appendix C provides general information about complying with the NCC and responsibilities for building and plumbing regulations
- Appendix D contains worked examples cross referenced from the main text
- Appendix E contains a summary of types of air-conditioners
- Appendix F provides a list of references, relevant reports and standards.

1.3.3 Document styles

NCC defined terms are italicised when used in this document. See Appendix B for further information.

Different styles are used in this document. Examples of these styles are below.

NCC extracts[2]

Examples

Alerts or Reminders

[2] NCC extracts italicise defined terms as per the NCC. See Schedule 1 of the NCC for further information.

2 Performance Requirements and compliance options

2.1 Introduction

The purpose of this Chapter is to explain the energy efficiency Performance Requirements, J1P1 and J1P4 in Section J of NCC Volume One.

This Chapter reviews the intent of the energy efficiency requirements in Section J via the Objective and Functional Statement of the section and the mandatory Performance Requirements J1P1 and J1P4.

2.2 Objective and Functional Statement

Objectives and Functional Statements are used in the NCC to provide guidance on the intent and interpretation of the Performance Requirements. They are provided with the Performance Requirements in Part J1 of NCC Volume One.

Compared to NCC 2019, the Objective and Functional Statements for energy efficiency have been expanded to align with policy set by governments in the Trajectory for Low Energy Buildings.

Reminder

Objectives and Functional Statements are used to provide guidance on the intent and interpretation of the Performance Requirements.

2.2.1 Objective

Objective J1O1

The Objective of this Section is to—

a) reduce energy consumption and energy peak demand; and

b) reduce greenhouse gas emissions; and

c) improve occupant health and amenity.

2.2.2 Functional Statement

The Functional Statement, J1F1 Energy efficiency, applies to non-residential buildings. An extract of J1F1 (removing reference to Class 2 buildings and Class 4 parts of buildings) is shown below.

J1F1 Energy efficiency

A building must—

a) reduce the energy consumption and energy peak demand of key energy using equipment; and

b) reduce the greenhouse gas emissions that occur as a result of a building's energy consumption and energy source; and

c) […]

d) […] protect occupant health and amenity by ensuring the building envelope assists in the maintenance of acceptable internal conditions while the building is occupied; and

e) be able to accommodate the future installation of distributed energy resources.

2.3 Performance Requirements

There are four mandatory Performance Requirements. This Handbook only addresses two: J1P1 and J1P4. The AEEH addresses J1P2 and J1P3, which relate to the thermal performance and energy usage of sole occupancy units of Class 2 buildings or Class 4 parts of buildings.

2.3.1 J1P1 Energy use

J1P1 is the key Performance Requirement for the efficient use of energy for commercial buildings. An extract of J1P1 is shown below.

J1P1 Energy use

A building, […] including its *services*, must have features that facilitate the efficient use of energy appropriate to—

a) the function and use of the building; and

b) the level of human comfort required for the building use; and

c) solar radiation being—

(i) utilised for heating; and

(ii) controlled to minimise energy for cooling; and

d) the energy source of the *services*; and

e) the sealing of the building *envelope* against air leakage; and

f) for a *conditioned space*, achieving an hourly *regulated energy* consumption, averaged over the annual *hours of operation*, of not more than—

(i) for a Class 6 building, 80 kJ/m2.hr; and

(ii) for a Class 5, 7b, 8 or 9a building other than a ward area, or a Class 9b school, 43 kJ/m2.hr; and

(iii) for all other building classifications, 15 kJ/m2.hr.

2.3.2 J1P4 Renewable energy and electric vehicle charging

J1P4 Renewable energy and electric vehicle charging is a new Performance Requirement for NCC 2022.

The intent is to enable the future installation of on-site renewable energy generation and storage, as well as electric vehicle charging equipment. J1P4 is shown below.

J1P4 Renewable energy and electric vehicle charging

A building must have features that facilitate the future installation of on-site renewable energy generation and storage and electric vehicle charging equipment.

2.4 Compliance options

2.4.1 Compliance with the NCC

Compliance with the NCC is achieved by complying with the NCC Governing Requirements and relevant Performance Requirements. There are 3 types of solutions available to demonstrate compliance with the Performance Requirements:

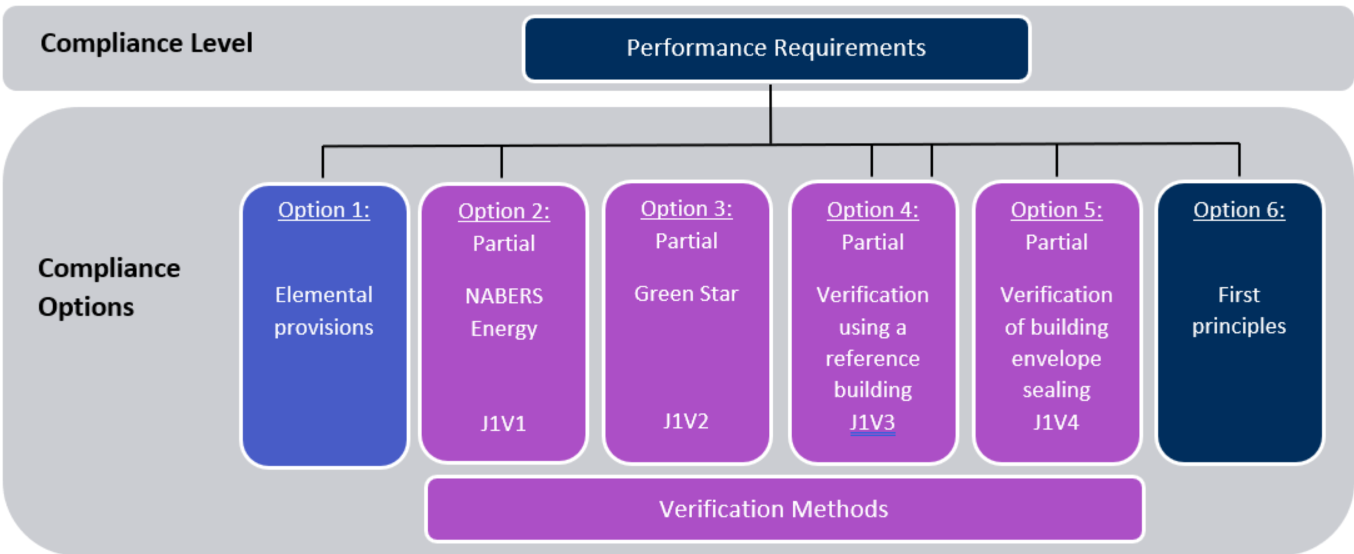
- a Performance Solution
- a DTS Solution
- a combination of a Performance Solution and a DTS Solution.

General information on compliance with the NCC is contained in Appendix C.

2.4.2 Overview of compliance options for commercial buildings

There are several compliance options available for commercial buildings to meet one, both or part of the relevant energy efficiency Performance Requirements, J1P1 and J1P4. A simplified overview of the available options is provided in Figure 2.4.1.

Figure 2.4.1 Simplified overview of compliance options



Notes to Figure 2.4.1:

(1) Blue shading indicates a DTS Solution, while purple shading indicates a Performance Solution and associated Verification Methods.

(2) 'Partial' means that a compliance option only partly meets the relevant Performance Requirements, and additional compliance options will need to be used to achieve full compliance with the relevant Performance Requirements.

3 Compliance Option 1: Deemed-to-Satisfy

3.1 Introduction

The DTS compliance option is a set of DTS Provisions that can be used to meet the energy efficiency Performance Requirements. Each building element and service element must achieve a specific performance. As with all other aspects of the DTS Provisions, each element within Section J of NCC Volume One is designed to work as part of a system to ensure the building achieves the minimum or desired level of energy efficiency. Accordingly, if there is any variation from the DTS Provisions in one part, then the entire set of energy efficiency requirements for the building will need to be checked to ensure that there is no unintended effect on the other parts because of a Performance Solution being adopted for one part. See subclause A2G2 and A2G4 of NCC Volume One for further information.

The DTS Provisions that form the DTS compliance option are used to demonstrate NCC compliance using a DTS Solution. See Appendix C for more information on how to comply with the NCC.

Part J2 provides a directory to the different DTS Provisions.

The DTS Provisions are based on eight NCC climate zones. They divide Australia into broad regional areas with similar climatic conditions, allowing the requirements to be applied on a national basis. Each climate zone will have similar thermal requirements irrespective of the State or Territory where the building is located. NCC climate zones are explained in more detail in the Guide to Volume One.

Alert

Note that a combination of DTS Solutions is permitted. For example, NABERS could be used to meet J1P2 and the Elemental provisions used to meet J1P3.

3.2 Method

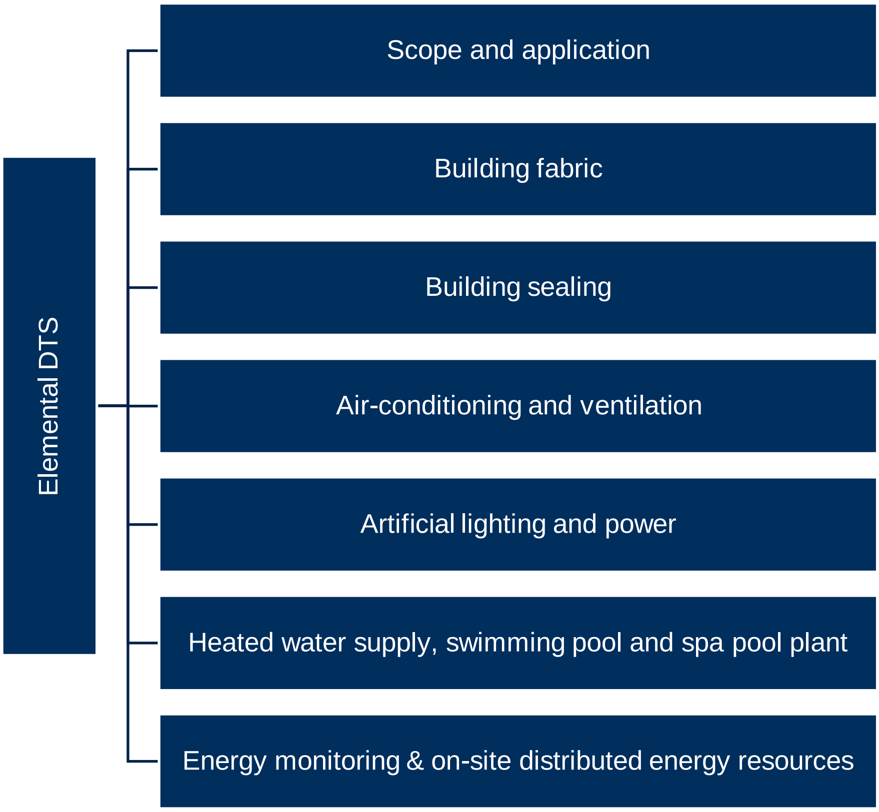
3.2.1 Intent

The intent of this method is to provide a step-by-step approach to comply with the energy efficiency Performance Requirements. To do this, the method requires each element to meet a minimum level of thermal performance or energy use, for example, the floors, walls, glazing, roof, ceiling, air-conditioning and mechanical ventilation systems.

The DTS Provisions when followed in their entirety form a DTS Solution, i.e. they are deemed to meet the energy efficiency Performance Requirements. Where a Performance Solution is proposed, the relevant Performance Requirements must be determined in accordance with A2G2(3) and A2G4(3).

Figure 3.2.1 outlines the relevant DTS Provisions that form the DTS compliance option. The DTS Provisions are in Parts J4 to J9.

Figure 3.2.1 Elemental DTS



3.2.2 Scope and application

The scope and application of the DTS Provisions of this compliance option are located in the DTS Provisions of Volume One Part J2 and Parts J4 to J9.

To achieve the intended outcome, the DTS Provisions must be applied in accordance with the Governing Requirements and any state and territory variations, additions and deletions.

3.2.2.1 Part J4 – Building fabric

DTS Provisions for building fabric require minimum acceptable level of thermal efficiency of the building envelope including roofs, ceilings, roof lights, walls, glazing and floors.

Part J4 has different clauses for each element of the building fabric, as shown in Table 3.1.

Table 3.1 Building fabric clauses

Building element	Clause reference
Application	J4D2
Thermal construction	J4D3
Roofs and ceilings	J4D4
Roof lights	J4D5
Walls and glazing	J4D6
Floors	J4D7

The other relevant aspects of Part J4 are the Specifications 36, 37 and 39. These specifications contain detailed information that contribute to complying with certain DTS Provisions. They are referenced through the related clause in the DTS Provision. The Specifications provide more detailed requirements than can be accommodated in an NCC clause. Accordingly, the specifications are integral to Part J4.

Application

The DTS Provisions of Part J4 apply to building elements forming the envelope of a building.

Reminder

Envelope is a defined term in the NCC. As described in Schedule 1 Definitions, for the purposes of Section J in NCC Volume One, envelope means the parts of a building's fabric that separate a conditioned space or habitable room from either:

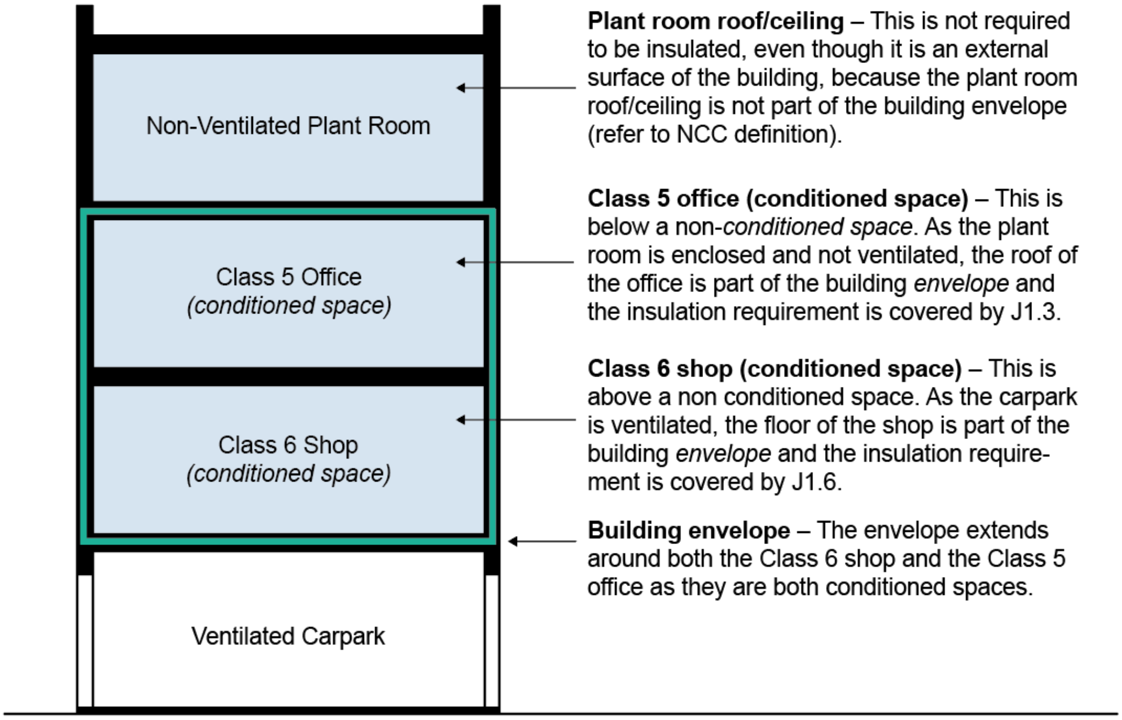
- the exterior of the building, or
- a non-conditioned space.

A non-conditioned space includes the:

- floor of a rooftop plant room, lift-machine room or the like
- floor above a carpark or warehouse
- common wall with a carpark, warehouse or the like.

The fabric provisions not only focus on the external fabric, but include internal walls, floors and ceilings where they separate a conditioned space from a non-conditioned space. This means designers will need to consider the provision of conditioned air to each room or space within the building to determine where the envelope is located, and subsequently, the appropriate level of insulation required. See Figure 3.2.2 describing the building envelope below.

Figure 3.2.2 Building envelope



In practice, occupied spaces are likely to be conditioned at some time over the life of the building and their external elements will form the building envelope*.* The envelope can extend through multiple floors of a building encompassing any number of conditioned spaces that are located side by side or one above the other. However, the floor or wall between two conditioned spaces is not part of the envelope by definition because very little energy transfer is expected to occur.

The fabric requirements are based on recognition of occupant response to the predominant annual external climatic conditions. For instance, in Hobart, where the climate is considered ‘cool temperate’, the energy used for heating exceeds the energy used for summer cooling.

The DTS Provisions of Section J are designed to ensure that the building uses less energy to heat the occupied areas. This is achieved by installing insulation or by increasing the capacity of the building structure to resist heat loss. For Darwin, the situation is reversed with cooling being the predominant mode. It is recognised that for most commercial buildings in most climate zones, cooling is the predominate mode due to the high internal heat loads. Therefore, a greater emphasis is on Total System Solar Heat Gain Coefficient (SHGC) over Total System U-Value.

Alert

The phrase "likely by the intended use of the space to be air-conditioned" is in the definition of a conditioned space.

Class 6 and 9b buildings cover wide ranges of uses and could reasonably be expected to be air-conditioned at some time in the future. In these cases, the building fabric requirements would need to be met. Some Class 6, 7, 8 and 9b buildings that are not a conditioned space by definition, may be excluded from controls for building fabric. Similarly, the external elements of an atrium or solarium that is not a conditioned space may also be excluded.

Atriums may be attached to certain buildings. Therefore, they would inherit some of the requirements appropriate for that building type. In this case, there is often no energy saving to be made by thermally treating the elements, or the saving is below the minimum threshold and so not cost-effective.

When deciding whether a space is inside the envelope, consider the temperature differential, extent of ventilation, and how a space will be used. Internal, non-conditioned space is considered outside the envelope if thermal loads are not addressed by air conditioning and ventilation services. For example, a bathroom that draws make-up air from the neighbouring conditioned space could be within the envelope. Conversely, a bathroom that is directly connected to outside and draws make-up air from outside would likely be outside the envelope.

The provisions of Part J4 do not apply to Class 8 electricity network substations as the air-conditioning systems in these buildings are designed to maintain the efficient operation of sensitive electrical equipment.

Thermal construction-general

Clause J4D3 specifies the general requirements for thermal construction. These requirements aim to ensure that when insulation, either bulk or reflective is installed, it:

- performs thermally as intended
- does not interfere with the safety or performance of plumbing or electrical components.

Table 3.2 summarises the key requirements of J4D3.

Table 3.2 Key requirements for thermal construction

J4D3 reference	Key requirements
(1) Insulation	• Where required, insulation must comply with Australian Standard (AS) 4859.1 and be installed so that it: – abuts or overlaps to adjoining insulation, other than where other elements prevent it from doing so, such as studs or furring channels – forms continuous barrier with ceilings, walls, bulkheads floors or the like – does not affect the safe effective operation of a service or fitting
(2) Reflective insulation	• When required, reflective insulation must be installed with: – the necessary airspace to achieve the required R-Value between the reflective side of the insulation and a building lining or cladding – the reflective insulation closely fitted against any penetration, door or window opening – adequate support from framing members – an overlap of not less than 50mm or taped together
(3) Bulk insulation	• Required bulk insulation must be installed: – so that it maintains position and thickness, other than where compressed between cladding and supporting member or services within the wall – when in a ceiling, where there is no insulation in the wall beneath, to overlap the wall by not less than 50mm
(4) Roof, ceiling and wall materials	• Specification 36 outlines the thermal properties of roof, ceiling, wall and floor materials
(5) Thermal bridging	• Required Total R-Value and Total System U-Value must be: – calculated in accordance with AS 4859.2 for roof and floor – determined using Specification 37 for wall-glazing construction

J4D3 reference	Key requirements
	– determined using Specification 39 or Section 3.5 of the CIBSE (Chartered Institution of Building Services Engineers) Guide A for soil or sub-floor spaces

Roofs and ceilings construction

The minimum thermal requirements for roof and ceiling construction are specified in Clause J4D4. Clause J4D4 specifies the Total R-Value for the roof and ceiling insulation based on climate zones and the direction of heat flow. These are summarised in Table 3.3.

It includes internal elements between conditioned spaces and non-conditioned spaces (internal and external ceilings are not limited to the area immediately below the roof and include the ceiling between a conditioned space and a non-conditioned space such as a plant room).

Table 3.3 Key requirements for roof and ceilings

J4D4 reference	Roof and ceiling requirements
(1) Total R-Value	• Provides the minimum Total R-Value for the different climate zones: – R3.7, in the downward direction, for climate zones 1 to 5 – R3.2, in the downward direction, for climate zone 6 – R3.7, in the upward direction, for climate zone 7 – R4.8, in the upward direction, for climate zone 8
(2) Solar absorptance	• Specifies that in climate zones 1 to 7 the upper surface of a roof must have a solar absorptance less than 0.45

Reminder

Section F of NCC Volume One may require ventilation of roof space in climate zones 6, 7 and 8 to manage risks associated with condensation.

Roof lights

The requirements for roof lights (skylights) are specified in J4D5, as shown in Table 3.4.

Table 3.4 Key requirements for roof lights

J4D5 reference	Key requirements
(a) Maximum area	• Less than or equal to 5% of the floor area of the room or space the roof light serves
(b) Thermal performance	• Transparent and translucent elements of roof lights: – achieve Total System SHGC in Table J4D5 – maximum Total System U-Value of U3.9 – requires calculation of roof light shaft index (See Figure 3.3.5)

Roof lights are installed at an angle of between 0 and 70 degrees measured from the horizontal plane. Roof lights that fall outside this range are considered a wall-glazing construction and are addressed under Clause J4D6.

Walls and glazing

The building fabric provisions address external walls and glazing and internal walls and glazing that separate a conditioned space from a non-conditioned space. The requirements for walls and glazing are specified in J4D6, as shown in Table 3.5. This clause specifies the Total System U-Value of wall-glazing construction, based on climate zone.

Table 3.5 Key requirements for walls and glazing

J4D6 reference	Key requirements
(1) and (3) Total System U-Value	• Applies to wall-glazing construction, this includes wall-glazing construction which wholly or partly forms the envelope internally • Must not be greater than: – U1.1 in climate zone 1,3,4,6 or 7, or – U2.0 in climate zone 2 or 5, or – U0.9 in climate zone 8 • Must be calculated in accordance with Specification 37
(4) Wall components	• Applies to wall components of wall-glazing construction • Must achieve a minimum Total R-Value: – of R1.0 when the wall is less than 80% of the area of the wall-glazing construction, or – `specified in Table J4D6a when the wall is 80% or more of the area of the wall-glazing construction

J4D6 reference	Key requirements
(5) and (6) Solar admittance (SA)	– Applies to externally facing wall-glazing construction • Excludes wall-glazing construction that is wholly internal • SA must not be greater than the values specified in Table J4D6b or Table J4D6c based on building classification • Must be calculated in accordance with Specification 37
(2) and (7) Display glazing	• Applies to display glazing • Total System U-Value must not be greater than U5.8. • Total system SHGC must not be greater than 0.81 divided by the applicable shading factor specified in S37C7

Floors

Floor construction includes some internal floors between conditioned spaces and non-conditioned spaces. Clause J4D7 specifies the Total R-Value and insulation requirements for floors. A summary of the key requirements of these subclauses is in Table 3.6.

Table 3.6 Key requirements for floors

J4D7 reference	Key requirements
(1) Total R-Value	• Must achieve the Total R-Value specified in Table J4D7
(2) Total R-Value for a slab-on-ground	• A slab-on-ground that does not have an in-slab heating or cooling system is considered to achieve a Total R-Value of R2.0, except: – in climate zone 8 – Class 3, 9a and 9b buildings in climate zone 7 that has a floor area to floor perimeter ratio of less than or equal to 2
(3) Vertical edge insulation installation and properties	• A floor must be insulated around the vertical edge of its perimeter with insulation having an R-Value of at least 1.0 when the floor: – is a concrete slab-on-ground in climate zone 8, or – has an in-slab or in-screed heating or cooling system, except where used solely in a bathroom, amenity area or the like

J4D7 reference	Key requirements
(4) Water resistance and depth of insulation	• Insulation required by (3) for a concrete slab-on-ground must be water resistant and be continuous from the adjacent finished ground level: – to a depth of at least 300mm, or – for the full depth of the vertical edge of the concrete slab-on-ground

3.2.2.2 Part J5 – Building sealing

Part J5 Building sealing in Volume One contains the relevant DTS Provisions to adequately seal parts of a building. Relevant clauses on building sealing are outlined in Table 3.7.

Table 3.7 Building sealing clauses

Building element	Clause reference
Application	J5D2
Chimneys and flues	J5D3
Roof lights	J5D4
Windows and doors	J5D5
Exhaust fans	J5D6
Construction of ceilings, walls and floors	J5D7
Evaporative coolers	J5D8

The intent of the DTS Provisions to adequately seal parts of a building is to restrict air infiltration and air exfiltration.[3] Unintended leakage can lead to greater heat losses or gain and therefore, reduced thermal comfort of occupants and consequently, increase the use of artificial heating and/or cooling. Leakage of humid air into an air-conditioned building can increase energy use for dehumidification.

An issue that become increasingly important with high-rise buildings is air infiltration. The higher the floor above ground level, the greater the wind pressure and, as a result, the greater the potential for infiltration or leakage.

[3] See the terms ‘air infiltration and ‘air exfiltration’ in the Glossary at Appendix B for more information.

The introduction of the building envelope sealing Verification Method J1V4 in NCC 2022 (see Chapter 7) provides a method of demonstrating compliance with the building sealing requirements in J1P1(e) as an alternative compliance option to the DTS Provisions.

Application

Clause J5D2 specifies the DTS Provisions for building sealing applying to the elements forming the envelope of a building.

There are 3 exemptions:

(1) A building in climate zones 1, 2, 3 and 5 where the only means of air-conditioning is by using an evaporative cooler. This concession recognises that the evaporative cooler requires external air to be introduced to allow the cooler to work effectively.

(2) A permanent building opening, in a space where a gas appliance is located, that is necessary for the safe operation of a gas appliance. This may include wall vents and the like. However, the concession is limited to the areas required for the safe operation of that equipment. To determine the appropriate area, evidence should be received from the appliance manufacturer as part of the building approval process.

(3) A building or space where the mechanical ventilation required by Part F6 provides sufficient pressurisation to prevent infiltration, i.e. the ventilating air needs to be relieved.

Alert

Appropriate ventilation requirements for gas appliances can be obtained from relevant state and territory legislation, referenced standards and product installation manuals.

Alert

How do we know whether a building will be air-conditioned?

Building approval documents should clearly state what air-conditioning equipment will be used in the building. It is recommended that this should be listed as a distinct schedule, like a window schedule for ease of assessing compliance with Section J.

What happens if the building has no air-conditioning?

The NCC Volume One definition is quite broad in that a “conditioned space” includes any space “likely ... to have its temperature controlled by air-conditioning”. This requires a degree of discretion. The Appropriate Authority will be required to assess the future potential for air-conditioning.

It would be reasonable to assume that, for employee or customer comfort and product protection, most offices, shops and laboratories, for example, would be air-conditioned.

Chimneys and flues

Clause J5D3 requires a solid-fuel burning appliance (e.g. wood fireplace) to have a damper or flap on its chimney or flue so that it can be closed. The intent of this requirement is to prevent conditioned air being drawn up the chimney or flue when the appliance is not in use.

Roof lights

Clause J5D4 provides the minimum sealing requirements for roof lights (skylights). The skylight sealing requirements consist of 2 subclauses. The key requirements of these subclauses are summarised in Table 3.8.

Table 3.8 Key requirements to seal skylights

J5D4 reference	Key requirements
(1) Application	• Skylights must be sealed, or capable of being sealed in the following locations: – a conditioned space – a habitable room in climate zones 4, 5, 6, 7 and 8
(2) Sealing requirements	• Sealing can be achieved by any of the following: – an imperforate ceiling diffuser or the like (no holes) – a weatherproof seal – a manual, mechanical or electronic shutter system

Windows and doors

Clause J5D5 provides the minimum sealing requirements for windows and doors. The requirements consist of 2 subclauses. The key requirements to seal doors, windows and the like are summarised in Table 3.9.

Table 3.9 Key requirements to seal windows and doors

J5D5 reference	Key requirements
(1) Application	• Applies to the following doors, openable windows and similar openings: – when they form part of the envelope – are in climate zones 4, 5, 6, 7 or 8
(2) Sealing requirements	• Windows that comply with AS 2047 • Fire doors or smoke doors • Roller shutter doors, roller shutter grille or other security doors or devices
(3) Exemption	• A draft protection device must be used to seal the bottom edge of a door • A foam or rubber compressible strip, or fibrous seal, must be used to seal the other edge of doors and openable windows

Additionally, J5D5(4) requires an entrance of a building to have an airlock or similar if leading to a conditioned space. This is not applied where the conditioned space has a floor area of not more than 50 m^2 or where a café, restaurant, open front shop or similar has a 3m deep un-conditioned zone between the main entrance and all other entrances has self-closing doors.

If a loading dock entrance leading to a conditioned space, J5D5(5) requires it to be fitted with a rapid roller door or the like.

Exhaust fans

Clause J5D6 sets out the requirements for exhaust fans. Exhaust fans must be sealed with a self-closing damper or filter when located in one of the following:

- A conditioned space.
- A habitable room in climate zones 4, 5, 6, 7 or 8.

Construction of ceilings, walls and floors

Clause J5D7 provides the minimum requirements for sealing ceilings, walls and floors at junctions and around window and door penetrations. The requirements consist of 2 subclauses. A summary of the key requirements is outlined in Table 3.10.

Table 3.10 Key construction requirements to seal ceilings, walls and floors

J5D7 reference	Key requirements
(1) Application	• Applies to the following components of the envelope: – ceilings – walls – floors – window frames – door frames – skylight frames • Seals are needed for climate zones 4, 5, 6, 7 or 8
(2) Construction requirements	• Option 1: Construction in (1) must be enclosed by internal lining systems that are close-fitting for the following construction elements: – ceilings – wall and floor junctions • Option 2: Construction in (1) must be sealed at junctions and penetrations by either of the following: – close-fitting architraves, skirting or cornices – expanding foam, rubber compressive strip or caulking or the like
(3) Exemption	• Openings, grilles or the like required for smoke hazard management

Evaporative coolers

Clause J5D8 provides the minimum requirements for sealing evaporative coolers. Evaporative coolers must be sealed with a self-closing damper when supplying a heated space, or located in climate zone 4, 5, 6, 7 or 8.

3.2.2.3 Part J6 – Air-conditioning and ventilation

Part J6 sets out the provisions for the efficiency and control of air-conditioning and ventilation.

This includes air-conditioning, space heating and ventilation equipment, the efficiency, sealing and insulation requirements for ductwork systems containing fans, and for the efficiency and insulation of pipework and pump systems.

The relevant J6 clauses for different services are outlined in Table 3.11.

Table 3.11 Air-conditioning and ventilation clauses

Service	Clause reference
Application	J6D2
Air-conditioning system control	J6D3
Mechanical ventilation system control	J6D4
Fans and duct systems	J6D5
Ductwork insulation	J6D6
Ductwork sealings	J6D7
Pump systems	J6D8
Pipework insulation	J6D9
Space heating	J6D10
Refrigerant chillers	J6D11
Unitary air-conditioning equipment	J6D12
Heat rejection equipment	J6D13

The intent of Part J6 is to ensure that air-conditioning and ventilation systems have design features that allow the systems to be used in a manner that avoids excessive energy usage. The features themselves, however, do not ensure energy efficiency; as systems must be commissioned, operated and maintained in an effective manner to ensure energy consumption is reduced.

In most instances, the NCC Volume One requirements should prevent poor design, while encouraging considered selection of plant and equipment that could be expected to achieve a reasonable level of energy efficiency.

Design alert

Application of the requirements in Part J6 are likely to require specialist mechanical engineering input in conjunction with manufacturers' data validating the performance of the air-conditioning and ventilation plant to enable the Appropriate Authority to assess the proposal against the requirements of NCC Volume One.

Appropriately qualified engineers would ideally be specialists in air-conditioning. It may be necessary to validate their expertise before accepting their documentation.

Reminder

Part E2 of NCC Volume One contains requirements for smoke hazard management in the event of a fire incident.

Part E3 of NCC Volume One contains requirements for the cooling of lift shafts.

Part F6 of NCC Volume One contains requirements for certain rooms contained in buildings to be subjected to ventilation, whether it be via natural or mechanical means.

Application

Class 8 electricity network substations are exempt from Part J6. These substations commonly operate mechanical ventilation or air-conditioning 24 hours a day to serve high voltage equipment, so manual override or specific design features for energy efficiency could be hazardous.

Air-conditioning system control

The requirements for air-conditioning system control are provided in Clause J6D3. These are outlined in Table 3.12.

Table 3.12 Key requirements for air-conditioning system control

J6D3 reference	Key requirements
(1) An air-conditioning system	• Must be capable of being deactivated when the building or part of the building served by that system is not occupied • When serving more than one air-conditioning zone or area with different heating or cooling needs, must: – thermostatically control the temperature of each zone or area

J6D3 reference	Key requirements
	– not control the temperature by mixing actively heated/cooled air – limit reheating to not more than a 7.5K rise in temperature at a fixed supply air rate as well as at the nominal supply air rate for a variable supply air rate • Possess an outdoor air economy cycle function according to Table J6D3 • Capable of stopping the flow of water to those not operating • With an airflow of more than 1000 L/s, must have a variable speed fan when its supply air quantity is capable of being varied • When serving a sole-occupancy unit in a Class 3 building, must not operate when any external door of the sole-occupancy unit that opens to a balcony or the like, is open for more than one minute • Use direct signals to regulate the operation of central plant • A control dead band of not less than 2°C in general • Provided with balancing dampers and balancing valves to ensure achieving the maximum design air/fluid flow, but not exceeded by more than 15% for each component or group of components • Automatic variable temperature operation of heated water and chilled water circuits • Close any motorised outdoor air or return air damper that is not otherwise being actively controlled
(2) Two or more air-conditioning systems	• Control sequences must be used when two or more air-conditioning systems serve the same space that prevent systems from operating in opposing heating and cooling modes
(3) Time switches	• Time switches must be provided as follows: – when controlling an air-conditioning system of more than 2 kWr and a heater of more than 1 $kW_{heating}$ – be capable of switching electric power on and off at variable pre-programmed times and on variable pre-programmed days • The above requirements do not apply to:

J6D3 reference	Key requirements
	– an air-conditioning system that serves only one SOU in a Class 3 or 9c building – a conditioned space where air-conditioning is needed for 24 hour continuous use

Mechanical ventilation system control

Clause J6D4 specifies the requirements for mechanical ventilation system control. Table 3.13 outlines the key requirements for J6D4.

Table 3.13 Key requirements for mechanical ventilation systems

J6D4 reference	Key requirements
(1) General	• Specifies requirements for mechanical ventilation system control • Be capable of being deactivated when the building or part of the building it serves is unoccupied • When serving a conditioned space, except when an evaporative cooler is in use: – have energy reclaiming systems for systems specified in J6D4 – demand control ventilation as per AS 1668.2 for systems specified in J6D4 • Not exceed minimum outdoor air requirements of F6 except: – free cooling of the system is supplied by additional unconditioned outdoor air – the required exhaust or process exhaust needs additional mechanical ventilation – outdoor air is preconditioned by an energy reclaiming system. • Have a variable speed fan for systems with an airflow of 1000 L/s or more, except if downstream airflow is required by Part F6
(2) Exhaust systems	• An exhaust system with an air flow rate of more than 1000 L/s must be capable of stopping the motor when the system is not needed • The above requirement is to applicable to exhaust systems in an SOU of a Class 3 or 9c building
(3) Carpark exhaust systems	• Carpark exhaust systems must have a control system in accordance with clause 4.11.2 of AS 1668.2 or clause 4.11.3 of AS 1668.2

(4) Time switches	• Be provided to mechanical ventilation systems with an air flow for 100 L/s or more • Be capable of switching electric power on or off at variable pre-programmed times and on variable pre-programmed days • Exemptions: – mechanical ventilation system that serves a single SOU in a Class 3 or 9c building – where mechanical ventilation is needed for 24 hour occupation

Fans and duct systems

Clause J6D5 sets out requirements for fans, ductwork and duct components used as part of an air-conditioning system or mechanical ventilation system. The key requirements for J6D5 are in Table 3.14.

Table 3.14 Key requirements for fan and duct systems

J6D5 reference	Key requirements
(1) Application	• Fans, ductwork and ducts in an air-conditioning or mechanical ventilation system must: – Option 1 - separately comply with the requirements for fans, ductwork and ducts – Option 2 – achieve a fan motor input power per unit of flowrate lower than the fan motor input power per unit of flowrate of (2) – (5) combined
(2) Fans	• Fans must have a minimum efficiency at full load calculated as outlined in J6D5(2) • J6D5(2) has separate calculation methods for systems with static pressure of 200 Pa or less, and above 200 Pa

J6D5 reference	Key requirements
(3) Ductwork	• Pressure drop in the index run must not exceed 1 pa/m[4] • Flexible ductwork must not be more than 6m in any duct run • Bends, elbows and tees must have an equivalent diameter to the duct they are connected to • Turning vanes to be included in all rigid ductwork elbows of 90° or less except: – when their inclusion presents a fouling risk – a long radius bend in accordance with AS 4254.2 Ductwork for air-handling systems in buildings – Rigid duct, is used
(4) Ductwork components	• Set outs requirements for ductwork components in the index run and cover the following: – pressure drop across coils – high efficiency particulate arrestance (HEPA) air filters – other air filters – intake louvres – variable air volume boxes – rooftop cowls – attenuators – fire dampers – balancing and control damps – supply air diffusers – exhaust grilles – transfer ducts – door grilles – active chilled beams

[4] Averaged over the entire length of duct. The pressure drop of flexible ductwork sections may be calculated as if flexible ductwork is laid straight.

J6D5 reference	Key requirements
(5) Exemptions	• The requirements of (1) to (4) don't apply to: – fans in unducted air-conditioning systems with a capacity of less than 1000 L/s – smoke spill fans – the power for process-related components – kitchen exhausts

Ductwork insulation

J6D6 sets outs the requirements to reduce energy loss, ductwork and fittings in an air-conditioning system need to be insulated. The key requirements for J6D6 can be found in Table 3.15.

Table 3.15 Key requirements for ductwork insulation

J6D6 reference	Key requirement
(1) Application	• Specifies that insulation for ductwork and fittings for air-conditioning systems must: – comply with AS 4859.1 Thermal insulation materials for building – General criteria and technical provisions – have a minimum insulation R-Value of: ○ R1.0 for flexible ductwork, or ○ for cushion boxes equivalent to connecting ductwork, or ○ comply with Table J6D6
(2) Installation of ductwork insulation	• Insulation must: – be protected from the weather – abut adjacent insulation to form continuous layer – maintain its thickness other than at flanges or supports – be protected by a vapor barrier on the outside of the insulation when conveying cool air. The vapour barrier must be installed so that adjacent layers overlap by 50mm and are bonded or taped together
(3) Exemptions	• The requirements of (1) do not apply to: – ductwork and fittings located in the only or last room served by the system

J6D6 reference	Key requirement
	– fittings that form part of the interface with the conditioned space – return air ductwork which are in, or passing through a conditioned space – ductwork for outdoor air and exhaust air associated with an air-conditioning system – the floor of an in-situ air-handling unit – packaged air conditioners, split systems and variable refrigerant flow air-conditioning equipment complying with Minimum Energy Performance Standards (MEPS) – flexible fan connectors
(4) Fittings	• Include non-active components of a ductwork system such as cushion boxes • Exclude active components such as air-handling unit components

Ductwork sealing

J6D7 specifies the sealing of ductwork for large air-conditioning systems (capacity of 3000 L/S or greater). It specifies ductwork that is not located within the only or last room served by the system must be sealed from loss in accordance with AS 4254.1 and AS 4254.2.

Pump systems

J6D8 set outs the minimum requirements for pumps which form part of an air-conditioning system. Table 3.16 summarises the key requirements of J6D8.

Table 3.16 Summary of key requirements for pumps

J6D8 reference	Key requirements
(1) Application	• Pumps and pipework which form part of an air-conditioning system must: – separately comply with J6D8 (2) to (4) – achieve a pump motor power per unit of flow rate lower than the pump motor power per unit of flowrate achieved when applying the provisions of J6D8

J6D8 reference	Key requirements
(2) Circulator pumps	• Glandless impeller pump with a rated output of less than 2.5 kW and used in closed loop systems • Energy efficiency index (EEI) less than 0.27 • EEI must be calculated in accordance with European Union Commission Regulation No. 622/2012
(3) Other pumps	• Other pumps must be in accordance with European Union Commission No. 547/2012 articles No. 1 and 2 • Minimum efficiency index (MEI) of at least 0.4 • MEI must be calculated in accordance with European Union Commission Regulation No. 622/2012
(4) Pipework	• Applies to straight sections of pipework along the index run that form part of the air-conditioning system • For pipework systems that do not have any branches and have the same flow rate through the entire network, an average pressure drop less than the value specified in Table J6D8a or J6D8b • For any other pipework system, an average pressure drop less than the value specified in Table J6D8c or J6D8d
(5) Exemptions	• (4) does not apply to: – valves and fittings – pipework, where the smallest pipe size compliant with (4) results in a velocity of less than 0.7 m/s design flow

Pipework insulation

J6D9 specifies the DTS requirements for pipework insulation for piping, vessels and tanks which contain heating or cooling fluids. Table 3.17 provides a summary of the key requirements for J6D9.

Table 3.17 Summary of requirements for pipework insulation

J6D9 **reference**	Key requirements
(1) Application	• Requires insulation for piping, vessels, heat exchangers and tanks containing heating and cooling fluid held at a heated or cooled temperature • Insulation must:

J6D9 **reference**	Key requirements
	– comply with AS 4859.1 – for piping used heating and cooling, have an R-Value in accordance with Table J6D9a – for vessels, heat exchangers or tanks, have insulation in accordance with Table J6D9b – for refill or pressure relief piping, have insulation with an R-Value equal to the required insulation value of the connected pipe, vessel or tank within 500 mm of the connection
(2) Insulation installation	• Insulation must be: – protected against the effects of weather and sunlight – able to withstand the temperatures within the piping, vessel, heat exchanger or tank
(3) Vapour barrier protection	• Vapour barriers are required to be installed on the outside of insulation provided for piping, vessels, heat exchangers or tanks
(4) Exemptions	• The requirements of (1) and (2) do not apply to piping, vessels or heat exchangers: – located in the only or last room served by the system and downstream of the control device for the regulation of heating or cooling service to that room – encased within concrete slab or panel which is part of a heating or cooling system – supplied as an integral part of a chiller, boiler or unitary air-conditioner complying with the requirements of J6D10 to J6D12 – inside an air-handling unit, fan-coil unit or similar
(5) Definitions	• For the purposes of (1) to (4): – heating fluids include refrigerant, heated water, steam and condensate, and – cooling fluids include refrigerant, chilled water, brines and glycol mixtures but do not include condenser cooling water

Alert

AS 4859.1 specifies requirements and methods of testing of materials that are used in opaque envelopes of buildings and building services to provide thermal insulation. This includes ductwork and pipework. DTS Provisions are based on AS 4859.1 calculation methods.

Space heating

The minimum requirements for space heating can be found in J6D10. Table 3.18 summarises the key requirements for J6D10.

Table 3.18 Summary of requirements for space heating

J6D10 reference	Key requirements
(1) Heaters	• Specifies that heaters used for air-conditioning must be one of the following: – a solar heater – a gas heater – a heat pump heater – a heater which reclaims heat from another process – an electric heater – any combination of the above • An electric heater must have the following properties: – a heating capacity of 10 W/m^2 for climate zone, or – a heating capacity of 40 W/m^2 for climate zone 2, or – a heating capacity as specified in Table J6D10 where reticulated gas is not available to the allotment boundary, or – an annual energy consumption of 15 kWh/m^2, or less for climate zones 1 to 5 – an in-duct heater must comply with J6D3(1)(b)(iii)
(2) Bathroom heating	• Bathrooms in a Class 3, 9a or 9c building can be heated with an electric heater with a capacity of 1.2 kW or less
(3) Outdoor spaces	• Where a fixed heating or cooling appliance moderates the temperature of an outdoor space, it must be able to automatically shutdown when:

	– there are no occupants – it has been running for an hour – the space has reached the designed temperature
(4) Gas water heater	• Where a gas water heater is used as part of an air-conditioning system it must: – achieve a minimum gross thermal efficiency of 86%, if rated to consume 500 MJ/hour of gas or less – achieve a minimum gross thermal efficiency of 90% if rated to consume more than 500 MJ/hour of gas

Refrigerant chillers

J6D11 specifies the minimum requirements for refrigerant. Table 3.19 provides a summary of the key requirements of J6D11.

Table 3.19 Summary of requirements for refrigerant chillers

J6D11 reference	Key requirements
Refrigerant chillers	• Must comply with MEPS • Must comply with the full load operation energy efficiency ratio and integrated part load energy efficiency ratio expressed in $W_r/W_{input\ power}$ in Table J6D11a or Table J6D11b • The energy efficiency ratio and integrated part load energy efficiency ratio must be determined by testing in accordance with the American Air-Conditioning, Heating & Refrigeration Institute (AHRI) Standard AHRI 551/591

Unitary air-conditioning equipment

J6D12 specifies the minimum requirements for unitary air-conditioning equipment. Table 3.20 provides a summary of the key requirements of J6D12.

Table 3.20 Summary of unitary air-conditioning equipment

J6D12 reference	Key requirement
(a) Cooled water	• Air-conditioning equipment must have a minimum energy efficiency ratio of 4.0 $W_r/W_{inputpower}$ for cooling in accordance with AS/NZS 3823.1.2[5], at test condition T1
(b) Cooled air	• Air-conditioning equipment must have a minimum energy efficiency of 2.9 $W_r/W_{inputpower}$ cooling in accordance with Australian Standard/New Zealand Standard (AS/NZS) 3823.1.2 at test condition T1

Heat rejection equipment

J6D13 specifies the minimum requirements for fans that form part of a cooling tower, closed circuit cooler, an evaporative cooler or an air-cooled condensor that is part of an air-conditioning system.

Table 3.21 summarises the key requirements for J6D13.

[5] AS/NZS 3823.1.2 Performance of electrical appliances – Air conditioners and heat pumps – Ducted air conditioners and air-to-air heat pumps – Testing and rating for performance.

Table 3.21 Summary of heat rejection equipment

J6D13 reference	Key requirement
(1) Fan in a cooling tower, closed circuit cooler or evaporative condenser	• The maximum fan motor power allowed is dependent on whether the system is an induced or forced draft. • The fan motor rated power must not exceed the allowances in Table J6D13. • A closed circuit, forced draft cooling tower must not be used.
(2) Fan in an air-cooled condenser	• The fan motor rated power must not exceed 42 W for each kW of heat rejected from the refrigerant, when determined in accordance with AHRI 460. Exceptions: • a refrigerant chiller in an air-conditioning system that complies with the energy efficiency ratios in J6D11. • a packaged air-conditioner, split system, or variable refrigerant flow air-conditioning equipment that complies with the energy efficiency ratios in J6D12.

Types of air-conditioning systems

Examples and descriptions of air-conditioning systems are provided in Appendix E.

Alert

Many central air-conditioning systems incorporate a ventilation service to meet the NCC Volume One requirements in Part F6. However, for the purposes of Part J6, an air-conditioning system is a service installed in the building for heating or cooling. These services are not required by NCC Volume One, whereas minimum ventilation requirements are. The air-conditioning system may or may not incorporate the ventilation required for compliance with Part F6.

For example, the air-conditioning system may be a hot water radiator heating system or a passive chilled beam cooling system with no provisions for introducing outdoor air through the heating or cooling system. Therefore, a separate means of providing ventilation will be needed, be it a mechanical ventilation system or openings such as windows. On the other hand, the air-conditioning system may have provisions for introducing outdoor air as is the case with most of the larger central air-conditioning systems.

A required ventilation system is a system designed to provide mechanical ventilation in accordance with NCC Volume One Part F6 for the health of the building occupants. For Part J6, the mechanical ventilation air quantity should not exceed by more than 20%, the maximum that is required by Part F6, except in cases where outdoor air economy cycles or energy reclaiming systems are used, or where mechanical ventilation is needed to balance the required exhaust or process exhaust.

Alert

What are the requirements when the air-conditioning is achieved by a heated water system using heated water radiators to directly heat the room?

The requirements for a heated water system used to heat a building, such as a hydronic heat panel system are addressed by this Part through the requirements for pump energy, boiler efficiency and the energy source.

3.2.2.4 Part J7 – Artificial lighting and power

Part J7 aims to limit unreasonable energy use from artificial lighting and power.

Apart from clause numbering, the DTS Provisions for artificial lighting and power are unchanged for NCC 2022 when compared to NCC 2019.

A summary of the clauses on artificial lighting and power is outlined in Table 3.22.

Table 3.22 Artificial lighting and power clauses

Artificial lighting and power	Clause reference
Application	J7D2
Artificial lighting	J7D3
Interior artificial lighting and power control	J7D4
Interior decorative and display lighting	J7D5
Exterior artificial lighting	J7D6
Boiling water and chilled water storage units	J7D7
Lifts	J7D8
Escalators and moving walkways	J7D9

To assist in determining compliance, a Lighting Calculator is available from the Resource Library on the ABCB website.

To produce the same light output, different lighting systems use different amounts of energy. The NCC requirements recognise lighting systems that use technology such as timers or dimmers to reduce energy consumption.

Lighting inefficiencies have a compounding effect in warmer climates because the extra electrical load for lighting may translate to waste heat that increases the load on the air-conditioning system.

Additionally, power consumption of lifts and escalators can be excessive if inefficient systems are in place or if they are not configured to save energy when not in use.

Application

Part J7 sets out the requirements for artificial lighting and power. It applies to all building classifications, with the exception of Class 8 electricity network substation for which J7D3, J7D4 and J7D6(1)(b) do not apply. It defines the requirements for power usage for artificial lighting systems within buildings, as well as power requirements for boiling and chilled water units, lifts, escalators, and moving walkways.

Artificial lighting

J7D3 contains the requirements for artificial lighting. A summary of the key artificial lighting requirements is provided in Table 3.23.

Table 3.23 Key requirements for artificial lighting

J7D3 reference	Key requirements
(2) General	• The maximum illumination power density allowances are specified in Table J7D3a for various types of spaces and building class • The aggregate design illumination power load must be less than or equal to the maximum illumination power density allowance • The aggregate design illumination power load is the sum of the design illumination power load in each of the spaces served
(3) Exemptions	• The requirements of (1) and (2) do not apply to the following: – emergency lighting provided in accordance with Part E4 – signage, display lighting within cabinets and display cases that are fixed in place – lighting for accommodation within the residential part of a detention centre – a heater where the heater also emits light, such as in bathrooms – lighting of a specialist process nature such as in a surgical operating theatre, fume cupboard or clean workstation – lighting of performances such as theatrical or sporting – lighting for the permanent display and preservation of works of art or objects in a museum or gallery other than for retail sale, purchase or auction – lighting installed solely to provide photosynthetically active radiation for indoor plant growth on green walls and the like
(4) Additional requirements	• Table J7D3b, the following control devices must comply with Specification 40: – lighting timers – motion detectors – daylight sensors and dynamic lighting control devices

Interior artificial lighting and power control

J7D4 contains the requirements for interior artificial lighting and power control. J7D4 aims to enable occupants to save energy on lighting and power when the space is not occupied, or the service is not needed. A summary of the key artificial lighting requirements is provided in Table 3.24.

Table 3.24 Key requirements for interior artificial lighting and power control

J7D4 reference	Key requirement
(1) General	• Specifies that artificial lighting in a room or space must be individually controlled by a switch, other control device or combination of these two
(2) Occupant activated device	• Requires an occupant activated device to be provided in SOUs of a Class 3 building to cut power to artificial lighting, air-conditioner, local exhaust fans and bathroom hears when unoccupied • Does not apply to accommodation for people with a disability or the aged
(3) Switches	• Requires that artificial lighting switches or any other control device must be located in visible and easily accessed locations • Be located in the room or space being switched or in an adjacent room or space, where 90% of the lighting being controlled is visible • For other than a single function space such as an auditorium or the like, artificial lighting switches or control device cannot operate lighting for areas larger than the following: – $250m^2$ in a Class 5 building or Class 8 Laboratory – $250m^2$ in a space less than $2000m^2$ (Class 3, 6, 7, 8 (other than a laboratory) or 9 building) – $1000m^2$ in a space less than $2000m^2$ (Class 3, 6, 7, 8 (other than a laboratory) or 9 building)
(4) Light fittings	• Requires 95% of the light fittings in a building or storey of a building of more than $250m^2$ must be controlled by a time switch, or an occupant sensing device in accordance with Specification 40 • Does not apply to Class 3 buildings
(5) Natural lighting zone adjacent to windows	• In a Class 5, 6 or 8 building of more than 250 m^2, artificial lighting in a natural lighting zone adjacent to windows must be separately controlled from artificial lighting not in a natural lighting zone in the same storey except where one of the following apply: – the room containing the natural lighting zone is less than 20 m^2 – the room’s natural lighting zone contains less than 4 luminaires – 70% or more of the luminaires in the room are in the natural lighting zone

J7D4 reference	Key requirement
(6) Fire-isolated stairway, fire-isolated passageway or fire-isolated ramp	• Artificial lighting in a fire-isolated stairway, fire-isolated passageway or fire-isolated ramp, must be controlled by a motion detector in accordance with Specification 40
(7) Foyers	• Artificial lighting in foyers corridors and other circulation spaces must be controlled by a daylight sensor and dynamic lighting control device in accordance with Specification 40, if they are 250 W or more within a single zone and adjacent to windows
(8) Daytime travel	• Artificial lighting for daytime travel in the first 19 m of travel in a carpark entry zone must be controlled by a daylight sensor in accordance with Specification 40
(9) Exemptions	• The requirement of J7D1(1) to J7D4(8) do not apply to emergency lighting in accordance with Part E4 or where artificial lighting is needed for 24 hour occupancy
(10) Exemptions	• The requirement of J7D4(4) do not apply to where the sudden loss of artificial lighting would cause an unsafe situation or for a heater where the heater also emits light, such as in bathrooms

Interior decorative and display lighting

J7D5 contains the requirements for interior artificial lighting and power control. A summary of the key artificial lighting requirements is provided in Table 3.25.

Table 3.25 Key requirements for interior decorative and display lighting

J7D5 reference	Key requirement
(1) Interior decorative lighting	• Specifies interior decorative lighting, like foyer mural or art displays must be controlled: – separately from other artificial lighting, and – by a manual switch for each area other than when the operating times of the displays are the same in a number of areas in which case it can be combined, and – by a time switch, in accordance with Specification 40, if the display lighting exceeds 1 kW

J7D5 reference	Key requirement
(2) display lighting	• Window display lighting must be controlled separately from other display lighting

Exterior artificial lighting

Clause J7D6 requirements cover external lighting attached to or directed at the facade of a building. External lighting such as garden lighting, pathway lighting and the like are exempt from the NCC. A summary of the clauses in J7D6 is in Table 3.26.

Table 3.26 Summary of requirements for exterior artificial lighting

J7D6 reference	Key requirement
(1) Exterior lighting	• Provides controls for exterior lighting directed or attached the facade of the buildings • Must be controlled by day light sensors or time switches • Options for when total lighting load exceeds 100 W: – Use LED luminaires for 90% of the total lighting load – use motion detectors in accordance with Specification 40 – have a separate time switch in accordance with Specification 40 when used for decorative purposes
(2) Exemption	• The requirements for when the total lighting load exceeds 100 W does not apply to the following: – emergency lighting in accordance with Part E4 – Lighting around a detention centre

Boiling water and chilled water storage units

J7D7 provides the minimum power requirements for boiling water and chilled water storage units. It specifies that the power supply for boiling or chilled water systems must be fitted with a time switch. The time switch must be in accordance with Specification 40.

Lifts

The minimum power requirements for lifts are in J7D8. A summary of the key requirements in J7D8 is in Table 3.27.

Table 3.27 Summary of power requirements for lifts

J7D8 reference	Key requirement
(a) Artificial lighting and ventilation	• Artificial lighting and ventilation in a lift car must turn off when unused for 15 minutes
(b) Energy performance	• Lifts must achieve the idle and standby energy performance levels in Table J7D8a
(c) Energy efficiency	• Lifts must achieve the relevant energy efficiency class in Table J7D8b • A dedicated goods lift must achieve energy efficiency class D in accordance with ISO 25745-2 Energy performance of lifts, escalators and moving walks – Part 2: Energy calculation and classification for lifts (elevators)

Escalators and moving walkways

J7D9 specifies the minimum power requirements for escalators and moving walkways. It requires escalators and moving walkways to be capable of slowing down to between 0.2 m/s and 0.05 m/s if unused for 15 minutes.

3.2.2.5 Part J8 – Heated water supply and swimming pool and spa pool plant

Part J8 Heated water supply and swimming pool and spa pool plant contains requirements for ensuring water heaters, swimming pool and spa heaters and pump systems use energy efficiently. The 3 clauses in Part J8 are listed in Table 3.28.

Table 3.28 Heated water supply, swimming pool and spa pool plant clauses

Heated water supply and swimming pool and spa pool plant	Clause reference
Heated water supply	J8D2
Swimming pool heating and pumping	J8D3
Spa pool heating and pumping	J8D4

The intent of the DTS Provisions relevant to swimming pools and spas is to:

- limit the energy supply to a less GHG intensive source
- limit the amount of energy used
- limit the loss of heat by conduction and convection.

Application

The sanitary heated water supply to a building and any pool or spa heating and pumping is different to heated water used for space heating, which is covered by Part J6 of NCC Volume One and air-conditioning and ventilation sections of this Handbook.

Alert

State and territory plumbing legislation may already require compliance with certain plumbing and drainage standards irrespective of the NCC requirements.

Heated water supply

J8D2 states that heated water supply systems for food preparation and sanitary purposes must be designed and installed in accordance with Part B2 of NCC Volume Three - the Plumbing Code of Australia (PCA).

Swimming pool heating and pumping

J8D3 outlines the minimum requirements for swimming pool pumps and associated heating. Table 3.29 provides a summary of the requirements of J8D3.

Table 3.29 Key requirements for swimming pool heating and pumping

J8D3 reference	Key requirement
(1) Swimming pool heaters	• Requires that heating for swimming pools must come from: – a solar heater – a heater using reclaimed heat – geothermal heater – a gas heater – a heat pump – a combination of the above • The following applies to a gas heater: – achieve a minimum gross thermal efficiency of 86%, if rated to consume 500MJ/hour of gas or less – achieve a minimum gross thermal efficiency of 90% if rated to consume more than 500MJ/hour of gas
(2) Swimming pool gas heaters or heat pumps	• Applies to a gas heater or heat pump heater in (1). • A cover with a minimum R-Value of R0.05 is required • A time switch to control the operation of the heater is required
(3) and (4) Time switches	• Circulation pumps for swimming pools must be provided with a time switch to control its operation • When a required time switch is installed, it must be able to switch on and off electric power at variable pre-programmed times and days
(5) Pipework insulation	• Insulation, in accordance with J6D9, must be provided to pipework carrying heated or chilled water for a swimming pool
(6) Exemption	• A spa pool is not considered a swimming pool for the purposes of J8D3

Spa pool heating and pumping

J8D4 provides the DTS requirements for spa pool heating and pumping. The key requirements of J8D4 are summarised in Table 3.30.

Table 3.30 Key requirements for spa pool heating and pumping

J8D4 reference	Key requirement
(1) Spa pool heaters	• Requires that heating for swimming pools must come from: – a solar heater – a heater using reclaimed heat – a geothermal heater – a gas heater – a heat pump – a combination of the above • The following applies to a gas heater: – achieve a minimum gross thermal efficiency of 86%, if rated to consume 500 MJ/hour of gas or less – achieve a minimum gross thermal efficiency of 90% if rated to consume more than 500 MJ/hour of gas
(2) Spa pool gas heater or heat pump	• Applies to a gas heater or heat pump heater in (1) • A cover with a minimum R-Value of R0.05 is required • A time switch to control the operation of the heater is required
(3) and (4) Time switches	• Applies to a spa pool with a capacity of 680 L or more. • A circulation pump for a spa pool must be provided with a time switch to control its operation • When a required time switch is installed, it must be able to switch on and off electric power at variable pre-programmed times and days
(5) Pipework insulation	• Insulation, in accordance with J6D9, must be provided to pipework carrying heated or chilled water for a spa pool

3.2.2.6 Part J9 – Energy monitoring and on-site distributed energy resources

Part J9 contains requirements that enable the monitoring of energy use (other than for billing purposes) and facilitate easy retrofit of renewable energy and electric vehicle (EV) charging equipment.

The scope of the facilities required for energy monitoring varies from recording the total electricity and gas consumption of a relatively small building to individual monitoring of the major services in a larger building.

There are 4 main subclauses in Part J9 which are listed in Table 3.31.

Table 3.31 Energy monitoring and on-site distributed energy resources

Energy monitoring and on-site distributed energy resources	Clause reference
Application of Part	J9D2
Facilities for energy monitoring	J9D3
Facilities for electric vehicle charging equipment	J9D4
Facilities for solar photovoltaic and battery systems	J9D5

J9D4 and J9D5 are new for NCC 2022. These DTS Provisions were introduced as a deemed-to-comply option to comply with new Performance Requirement J1P4 Renewable energy and EV charging.

The intent of Part J9 is to ensure the building is designed to enable energy monitoring and future installation of EV charging equipment and renewable energy to be carried out easily. Building owners and designers should appreciate that effective design is concerned not only with the needs of the building occupants but also with the ongoing operation of the building infrastructure and future retrofits. The intent of requiring monitoring facilities is to enable information on the energy consumption of the building or its main services to be provided to identify and rectify any excessive use of energy.

Application

J9D2 specifies that the provisions in Part J9 do not apply to a Class 8 electricity network substation. This is because the power monitoring procedures for Class 8 electricity network substations have inherent and critical characteristics that either supersede or vary from the procedures adopted and applied to other buildings.

Facilities for monitoring energy

J9D3 outlines the DTS requirements for the monitoring of energy usage in buildings. Table 3.32 provides a summary of the J9D3 requirements.

Table 3.32 Summary of facilities for energy monitoring

J9D3 reference	Key requirement
(1) Energy metering (above 500 m^2)	• Applies to a building that has a floor area greater than 500 m^2 • Energy meters which are configured to record the time of use consumption of gas and electricity must be provided

J9D3 reference	Key requirement
(2) Energy metering (above 2500 m^2)	• Applies to a building that has a floor area greater than 2500 m^2 • Energy meters must be provided which record individual time-of use energy data for the following: – air-conditioning plant – artificial lighting – appliance power – central hot water supply – internal transport devices, such as lifts – on-site renewable energy equipment – on-site electric vehicle charging equipment – on-site battery systems – other plant
(3) Energy meters	• Where a meter is required by (2), it must be interlinked with a communication system that collates all time-of-use data for analysis and review
(4) Exemptions	• Energy meters serving individual sole occupancy units under 2,500 m^2 are exempted from (2)

Facilities for electric vehicle (EV) charging equipment

J9D4 contains the requirements to assist the future installation of EV charging equipment in the carparks of buildings. It does not require the installation of actual chargers in buildings.

Table 3.33 provides a summary of the key requirements for J9D4.

Table 3.33 Key requirements for facilities for EV charging equipment

J9D4 reference	Key requirements
(1) Electrical distribution boards	• Applies to Class 3, 5, 6, 7b, 8 or 9 buildings • Requires electric distribution boards dedicated to EVs to be installed • The number of electrical distribution boards required for EV charging is per storey and in accordance with Table J9D4 • Electrical distribution boards must be labelled to indicate use for future EV charging equipment

J9D4 reference	Key requirements
(2) Electrical distribution boards	• Applies to electrical distribution boards required by (1) • Fitted with a charging control system with the ability to manage and schedule charging of EVs in response to total building demand • Have the capacity for each circuit to support an EV charger able to deliver the following: – a minimum of 12 kWh from 9:00 am to 5:00 pm daily for a Class 5 to 9 building – a minimum of 48 kWh from 11:00 pm to 7:00 am daily for a Class 3 building • Be sized to support the future installation of a 7 kW (32A) type 2 EV charger in 10% of the car parking spaces in a Class 5 or 6 building and 20% of the car parking spaces in a Class 3, 7b, 8 or 9 building • Contain space of at least 36 mm width of DIN[6] rail per outgoing circuit for individual sub-circuit electricity metering to record electricity use of EV charging equipment • Be labelled to indicate the use of space required for the future installation of metering equipment
Limitations	• J9D4 does not apply to a stand-alone Class 7a building

Facilities for solar photovoltaic (PV) and battery systems

J9D5 contains requirements to assist the future installation of solar PV and battery systems in buildings. It does not require the installation of this equipment.

A summary of the key requirements for J9D5 can be found in Table 3.34.

Table 3.34 Summary of the key requirements for solar photovoltaic (PV) and battery systems

J9D5 reference	Key requirements
(1) Main electrical switch board	• Applies to the main electrical switch board • The following is required: – a minimum of 2 empty 3-phase circuit breaker slots

[6] Deutsches Institut für Normung (German Institute for Standardization)

J9D5 reference	Key requirements
	– a minimum of 4 DIN rail spaces that are labelled to indicate the use of each space for a solar PV system and a battery system – sized to accommodate the installation of solar PVs producing their maximum electrical output on at least 20% of the building roof area
(2) Roof area	• At least 20% of the roof area of a building must be left clear for installation of solar PVs • This requirement does not apply to the following: – when solar PVs are installed on at least 20% of the area or an equivalent generation capacity elsewhere on-site – when 100% of the roof area is shaded for more than 70% of daylight hours – a roof area of 55 m^2 or less – when more than 50% of the roof area is used as a terrace, carpark, roof garden, roof light or similar
Limitations	• (1)(a)(i) and (1)(b) do not apply to a building with solar PV panels installed on at least 20% of the roof • (1)(a)(ii) and (1)(b) do not apply to a building with a battery system installed

3.3 Useful Tips

3.3.1 Part J4 Building fabric

3.3.1.1 Building fabric thermal insulation

To ensure the performance of materials is correctly validated, test reports complying with AS/NZS 4859.1 should be provided in accordance with Part A5 of NCC Volume One and this documentation forms an integral part of the building approval.

Alert

The reference standard for insulation is AS/NZS 4859.1 - Materials for the thermal insulation of buildings: General criteria and technical provisions. This Standard specifies the testing criteria for insulation, including both reflective and bulk insulation. In broad terms, the Standard requires the manufacturer to test their products using a specified method and then provide a data sheet which explains the thermal performance properties and the installation requirements of the product.

The Standard notes that the thermal resistance of a material is fully representative of the element of construction, i.e. environmental factors can lower the long-term thermal resistance.

In addition to meeting the DTS Provisions for energy efficiency, the selection and installation of reflective and bulk insulation must meet other NCC requirements such as Part F8 Condensation management of NCC Volume One.

Thermal bridging

Consider the effect of thermal bridging by using the calculation method specified in AS/NZS 4859.2 (2018) when determining if the minimum R-Value of a roof has been achieved. In some cases, thermal breaks may be necessary to achieve compliance.

A thermal break may be provided by materials such as timber or expanded polystyrene strips, plywood or bulk insulation. Reflective insulation alone is not suitable for use as a thermal break because it requires an adjoining airspace to achieve the specified R-Value.

Some products or construction systems can meet the insulation and thermal break requirements simultaneously. For example, if a designer specifies continuous insulation between the lining and the frame, the lining is no longer fixed directly to the frame, so there is no need for an additional thermal break. If thermal bridging is instead addressed with extra insulation in the frames, a thermal break may still be needed as the extra insulation does not prevent local cold/hot patches.

Integrity of the insulation barrier

Subclause J4D3(1) requires any mandatory insulation, when installed in a building, to form a consistent and continuous barrier other than at supporting members. This means that insulation is to be fitted tightly to each side of framing members but need not be continuous over the framing member. This is important as any gaps in the barrier will allow heat to bypass the insulation and undermine the effectiveness of the overall energy efficiency requirements.

A key aspect of these requirements is the recognition that certain elements of the building contribute to achieving the required levels of thermal efficiency without any added insulation. For instance, wall insulation must closely fit within a wall frame to achieve the desired overall level of performance for the wall. The wall framing elements, in conjunction with the insulation, are deemed to achieve the required level of performance.

It is recognised however, that certain gaps are essential so that insulation does not affect the safety or performance of services and fittings. Examples of services and fittings may include heating flues, recessed light fittings, transformers for low voltage lighting, gas appliances and general plumbing and electrical components.

Appropriate clearance should therefore be provided, as detailed in relevant legislation and referenced standards such as for electrical, gas and fuel oil installations. Expert advice may be needed to determine these appropriate clearances, such as how much bulk insulation can be placed over electrical wiring.

Note that the addition of insulation to other building elements may alter the fire properties of those elements. Re-testing or re-appraisal of these elements may be required.

Manufacturers' data sheets should be utilised by both building designers and building surveyors as documentary evidence of the performance of the insulation and may be required to form part of the building approval documentation.

Reflective insulation installation

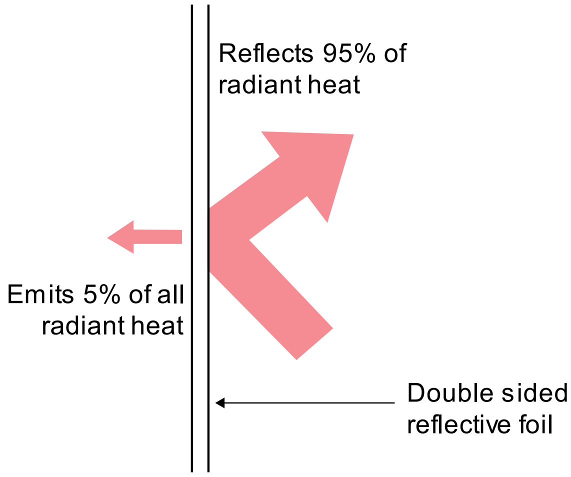
Subclause J4D3(2) provides a list of requirements for reflective insulation. To appreciate the requirements of this subclause, it is worthwhile understanding how reflective insulation works.

Reflectance is a measure of how much electromagnetic radiation a surface reflects compared to what it absorbs and transmits. Emissivity is a measure of the ability of a surface to radiate energy compared to a perfect emitter (known as blackbody).

Insulating performance is achieved by the ability of the reflective insulation to "reflect" heat (e.g. infra-red radiation) at one surface and not transmit it at another, combined with the insulating qualities of the thin air films adjacent to the reflective insulation. Some reflective insulation is also bonded to bulk, board or other insulation, providing enhanced performance of the composite system.

Accordingly, the reflectivity value and the presence of an airspace at the reflective surface are critical, as without this airspace, the reflection will not occur. Refer to Figure 3.3.1 for an illustration of reflective insulation. This figure shows reflectance and emittance from one side only, however each surface will reflect and emit heat to varying degrees from both sides. The illustration includes only the key reflectance and emittance for clarity.

Figure 3.3.1 Reflective insulation



The other issue to consider is that reflective insulation generally has a dull or anti-glare (painted) side and a shiny silver side. Both sides will achieve a degree of reflectivity, however, the shiny side is far more effective.

From an occupational health and safety (OH&S) perspective, the dull coloured side is installed facing outwards to prevent eye injury, which could occur if the high reflectivity from the silver side was on the outside.

Subclause J4D3(2)(a) specifies the reflective insulation must be installed with enough airspace to achieve the required R-Value. Where the width of airspace is to be achieved in a wall cavity or the like, care should be taken to ensure compliance with all other applicable NCC provisions. For example, the provisions relating to weatherproofing masonry may require a greater width of cavity.

Subclause J4D3(2)(d) specifies that overlapping of reflective insulation should be at least 50 mm, otherwise it must be taped together. This aligns with the requirements of AS/NZS 4200, the standard covering the installation of pliable building membranes.

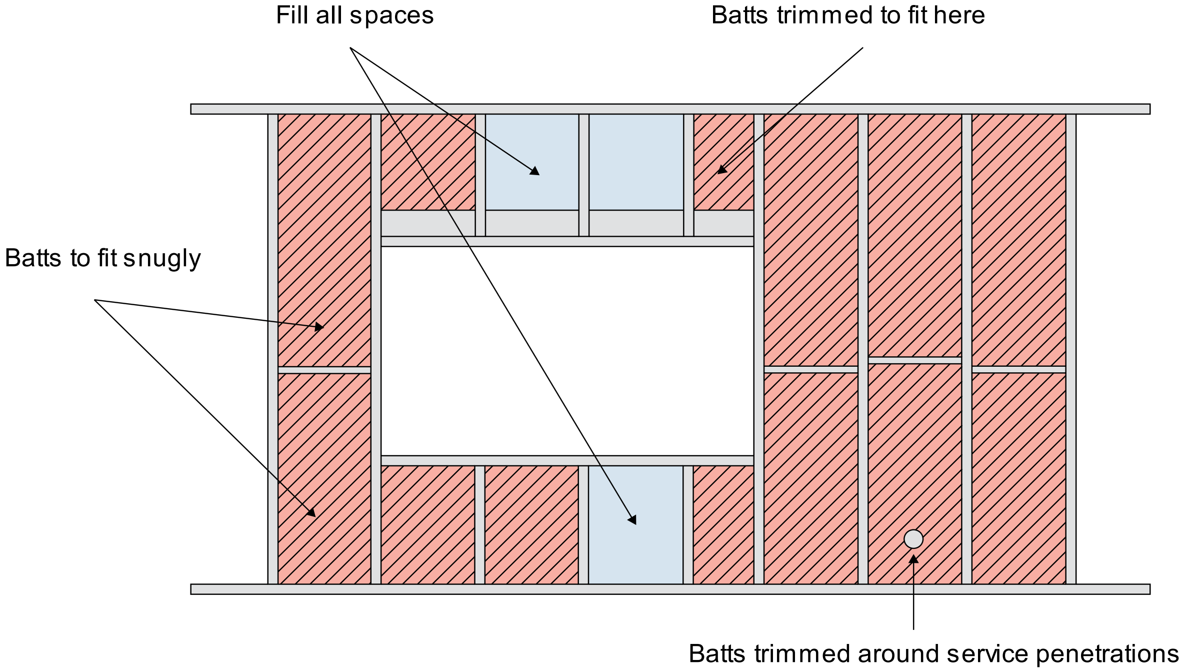
Bulk insulation installation

Subclause J4D3(3) provides a list of requirements for bulk insulation. The term “bulk insulation” includes glass fibre, wool, cellulose fibre, polyester and polystyrene foam. These materials tend to have a high percentage of air voids within the insulation that are fundamental to their ability to limit heat flow.

J4D3(3)(a) requires that bulk insulation must remain in position and not be compressed. The thermal performance of bulk insulation depends on the material retaining the depth specified by the manufacturer, in accordance with the required test results. The depth of the insulation is critical because of the need to retain the air pockets within the material. If the insulation is compressed, it will lose some of these air pockets as the fibre contact increases, which in turn will reduce its capacity to achieve the tested R-Value.

Walls and cathedral ceiling framing are examples where there may be limitations in the space required for bulk insulation. In some cases, either larger framing members or thinner insulation material, such as polystyrene boards, may be required to ensure that the insulation achieves its required R-Value once installed. Refer to Figure 3.3.2 for installation of bulk insulation in walls.

Figure 3.3.2 Installing bulk insulation in framed walls



The requirement recognises that the practical limitations of maintaining the position and thickness of bulk insulation where it is likely to be compressed between cladding, supporting members, water pipes and electrical cabling. In these instances, compression of the bulk insulation may occur but should be limited where possible.

Alert

Insulation materials used in a Class 3 to 9 building must also comply with the appropriate non-combustibility requirements and fire hazard properties. This may require the insulation used in these buildings to be of negligible fire hazard by complying with the non-combustibility, flammability, spread of flame and smoke development requirements of this clause. The performance of the insulation used should be validated by test reports and these reports should form part of the building approval documentation.

Thermal properties of materials

Subclause J4D3(4) refers to Specification 36 and provides the link between the DTS Provisions and the specification. The information contained within the specification can be used for assessing the contribution of construction components towards meeting the Total R-Value requirements contained in the DTS Provisions or for developing a Performance Solution.

Further details on Specification 36 are found later in this section.

Alert

Specification 36 relates only to compliance with Section J requirements, the condensation requirements of Part F8 must also be complied with concurrently, if applicable.

Calculating thermal performance

J4D3(5) specifies the general requirements for determining Total R-Values and Total System U-Values. J4D3(5) is a design clause, where compliance is shown in the design phase of the project and within design documentation. It is important that what is designed is also constructed.

The means of achieving the required Total R-Value for a roof or floor must be determined in accordance with AS/NZS 4859.2. This Standard contains a calculation method (New Zealand Standard (NZS) 4214 that takes into account the impact of thermal bridges on the thermal performances of a facade. If there are significant thermal bridges within a facade, additional steps may be required to achieve compliance, such as the use of extra insulation or thermal breaks.

Determining material properties

Specification 36 provides a list of common construction materials and their associated thermal performance. The values have been developed by industry experts and are based on the latest scientific test information. Other values for materials may be acceptable. However, these should be validated by supporting information as prescribed in Part A5 of NCC Volume One.

The thermal values in Specification 36 have been provided in NCC Volume One primarily to assist designers to calculate the Total R-Value of common construction systems for demonstrating compliance by either the DTS or for developing Performance Solutions. They also assist people wishing to understand the thermal performance of common construction types and are useful when changing the thickness of a particular material.

Thermal conductivity of typical wall, roof/ceiling and floor materials

NCC Volume One Specification 36 – Tables S36C2a to S36C2e contain the thermal conductivity values of typical wall, roof, ceiling and floor materials. These tables and the two qualities, material density and thermal conductivity are nominated as explained in Table 3.35 below.

Table 3.35 Extract from Specification 36 – Tables S36C2a to S36C2e Thermal Conductivity of typical wall, roof/ceiling and floor materials

Material description		Material density (kg/m³)	Thermal conductivity (W/m.K)
1.	**Framing**		
(a)	Steel	7850	47.5
(b)	Timber – kiln dried hardwood (across the grain)	677	0.16
(c)	Timber – Radiata pine (across the grain)	506	0.10
2.	**Roof Cladding**		
(a)	Aluminium sheeting	2680	210
(b)	Concrete or terra cotta tiles	1922	0.81
(c)	Steel sheeting	7850	47.5

Material density is the mass of a cubic metre of the material

Thermal conductivity is a measure of a material's ability to transmit heat (i.e. the rate at which heat is to be conducted through a 1 m² sample of the material which is 1 metre in thickness)

Typical R-Values for airspaces and air films

Tables S36C2f to S36C2j in Specification 36 (refer Table 3.36) provide typical R-Values of air films and airspaces. There is a general understanding that the thermal efficiency of the wall, floor or ceiling is achieved by simply installing insulation. However, the performance of the thin layers of air that adjoin building materials and the larger airspaces in areas such as roofs adjacent to the insulation have a noticeable impact on the thermal performance of the composite element. Tables S36C2f to S36C2j provides information on the levels of performance from airspaces and air-films for heat flowing up, down or horizontally.

The above tables also delineate between still and moving air for air films. This is important as air movement will have an impact on the thermal performance of the film. Typically, air movement will occur in exposed external environments around a building, while still air can be found inside the building, including within enclosed spaces such as the cavities of brick veneer walls.

Table 3.36 Extract from Specification 36 Tables S36C2f to S36C2j Typical R-values for airspaces and air films

Position of airspace	Direction of heat flow	*R-Value*
1. Airspaces non-reflective unventilated		
In a roof with a pitch of not more than 5°	Up	0.15
	Down	0.22
In a roof with a ceiling that is parallel with a roof with a pitch more than 5° and not more than 15°	Up	0.15
	Down	0.21
In a roof with a ceiling that is parallel with a roof with a pitch more than 22° and not more than 45°	Up	0.15
	Down	0.18
In any roof space with a horizontal ceiling, with a pitch more than 5°	Up	0.18
	Down	0.28
In a wall	Horizontal	0.17
2. Airspaces non-reflective ventilated		
In any roof with a pitch not more than 5° and 100 mm deep airspace	Up	Nil
	Down	0.19

Direction of heat flow refers to either heat flow into the building or heat loss out of the building. 'Down' indicates a summer heat (downwards heat flow into the building) is the major concern. 'Up' indicates that heat loss from the building during winter is the major concern. 'Up' indicates that heat loss from the building during winter is the major concern.

Note that the R-Values in Tables S36C2f to S36C2j are for a temperature of 10°C and a temperature difference of 15°K. If the temperature is to differ from this, R-Value calculations are to be shown and approved by the building certifier.

Performance of reflective insulation

Tables S36C2k, S36C2l and S36C2m of Specification 36 provide guidance on the performance of reflective surfaces installed in walls and roof spaces. These values are typical and can be used on the proviso that the emittance values, as listed in the clause, or the first column of Tables S36C2l and S36C2m of Specification 36, are achieved by the reflective insulation. If the emittance is different, then confirmation of the actual performance of the product should be obtained from the manufacturer's test data in accordance with AS/NZS 4859.1.

Tables S36C2i, S36C2l and S36C2m refer to the material emittance values. The definitions of reflectance and emittance are complex. However, the relationship between the two can be simply expressed as follows:

Emittance = 1 – Reflectance

Therefore, the more reflective the material, the lower its emittance value and the greater its insulative performance.

In simple terms, an unreflective material will tend to absorb heat and re-radiate it effectively. A shiny material absorbs less heat, as most of the heat is reflected, and re-radiates very little of it.

As discussed previously, airspaces are essential to the performance of reflective insulation. The size and configuration of roof spaces vary considerably, and this has an impact on the thermal properties of the roof when reflective insulation is installed. Tables S36C2k and S36C2l cover many scenarios, including whether the direction of heat flow is upwards or downwards, which also has a significant impact on the performance of the insulation. Refer to Table 3.37 of this document for further information.

Table 3.37 Extract from Specification 36 - S36C2m Typical R-Values for non-ventilated roof spaces with a reflective surface: Pitched roof with cathedral ceiling, roof space not more than 300 mm thick

Emittance of airspace bounding surfaces	Thickness of roof space	Direction of heat flow	R-Value of reflective airspace		
			15° to not more than 25° pitch	more than 25° to not more than 35° pitch	more than 35° to not more than 45° pitch
Surface 1 emittance 0.9, Surface 2 emittance 0.05	≤ 300 mm	Up	0.43	0.43	0.43
Surface 1 emittance 0.9, Surface 2 emittance 0.05	20 mm	Down	0.59	0.59	0.59
Surface 1 emittance 0.9, Surface 2 emittance 0.05	60 mm	Down	0.91	0.82	0.75
Surface 1 emittance 0.9, Surface 2 emittance 0.05	100 mm to ≤ 300 mm	Down	0.96	0.85	0.76

The angle of reflective insulation is the angle at which it is installed.

Ventilated roof space

Table notes in Specification 36 define a non-ventilated airspace in a roof as one with continuous cover, such as metal or sarked tiles, and no specific provision for ventilation.

Alert

Section F of NCC Volume One may require ventilation of roof space in climate zones 6, 7 and 8 to manage risks associated with condensation.

3.3.1.2 J4D4 Roof and ceiling construction

J4D4 covers roofs, including their ceilings, and any ceiling that is part of an intermediate floor forming part of the building's envelope, or where there is no ceiling.

Total R-Value requirement

J4D4(1) details the minimum Total R-Value required of a roof or ceiling. The Total R-Value may be provided by the roof construction itself and include any insulating properties of the roof and airspaces. If the Total R-Value provided by the roof is significant, the amount of insulation needed is reduced.

Reminder

The calculation method used to determine the Total R-Value must comply with AS/NZS 4859.2.

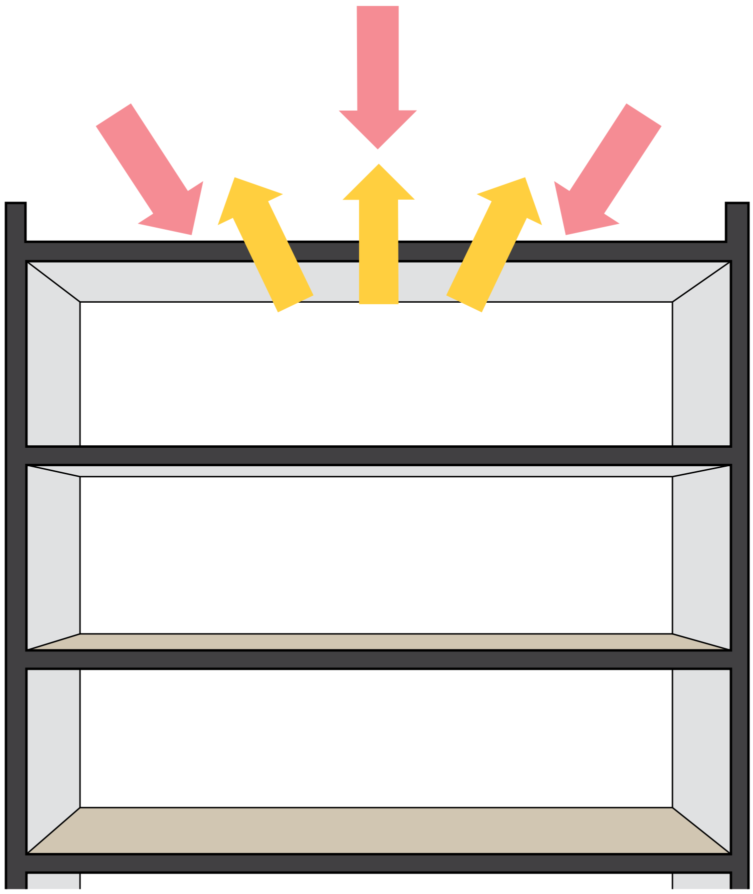
Depending on the design of the roof, it may be appropriate to consider the roof and ceiling together or separately. Factors to be considered include the size and ventilation rate of the air space, the ceiling construction material and thermal resistance, location and mounting arrangements for services, and whether or not the space is used as a plenum.

Insulation placed on the ceiling of some office and retail buildings may be interrupted by light fittings, air conditioning vents and the like, as well as possibility of disturbance in future fit outs. In this case, insulation would be better located at the roof level. If this is not the case (e.g. an aged care building or a building with suspended light fittings and air vents), then insulation on the ceiling may be more suitable and would be considered the envelope boundary.

If the ceiling space below the roof is used as the return air plenum, it is considered part of the conditioned space. In this instance, air from the conditioned spaces collects in the ceiling space and is drawn back into the heating, ventilation and air-conditioning (HVAC) equipment for more heating or cooling. Therefore, the envelope boundary for the roof and ceiling construction is located at the roof as conditioned air is within the ceiling space.

The direction of heat flow listed in J4D4(1) refers to either heat flow into the building or heat loss out of the building and is based on conditions in each climate zone. Where “downwards” is specified, this indicates that summer heat (a downwards heat flow into the building) is the major concern. An “upwards” flow indicates that heat loss from the building during winter is the major concern. This concept is explained further in Figure 3.3.3.

Figure 3.3.3 Upwards and downwards heat flow



The direction of heat flow stated in J4D4(1) should not be taken as the only direction in which any insulating properties operate. The direction is a statement of the prominent direction for that climate zone, i.e. the sun's radiant energy creates heat flow in a downwards direction into buildings in warmer climates, and warmth from conditioned air leaves a building in an upwards direction overnight in the cooler months in cooler climate zones. It is assumed that construction and insulating materials will also have insulating properties in the other direction.

For residential buildings, the direction of heat flow during night time is important as the buildings are most likely to be occupied at that time. During the night, the outside temperature likely to be the lowest of the day. Therefore, warm conditioned air may leave the building in an upwards direction overnight. A non-residential commercial building is likely to be air-conditioned and likely to have more day time use. The main heat flow direction for these buildings is therefore downwards for all climate zones except 7 and 8.

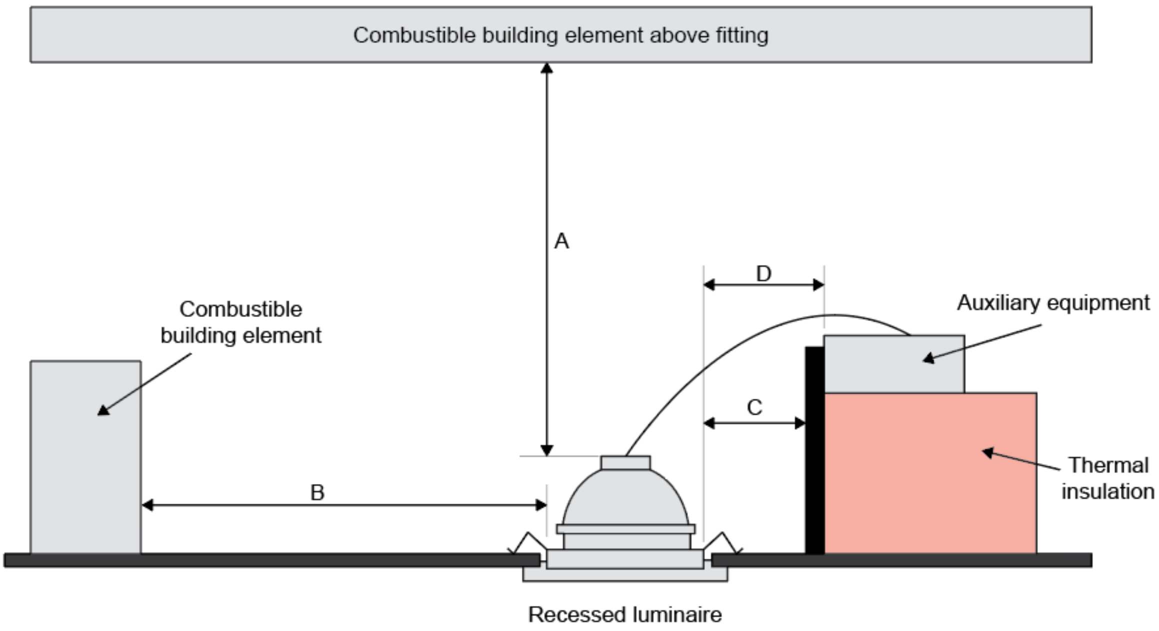
Alert

An important issue for roof design, especially where higher Total R-Values are required, will be to ensure that the roof structure has sufficient space to accommodate the insulation without compressing it. Any compression of the insulation will reduce its Total R-Value and consequently the effectiveness of the insulation.

•

There may be instances where downlights, fans or other ceiling penetrations limit the location of ceiling insulation. In these circumstances it is the responsibility of designers to determine how they will achieve the required Total R-Value given the construction of the roof and the penetrations. Although not referenced by NCC Volume One, AS/NZS 3000: 2018 – Electrical Installations (known as the Australian/New Zealand wiring rules) requires insulation to be kept away from downlights. A diagram to explain the requirements of the Standard is at Figure 3.3.4. Alternatively, there are IC-rated fixtures, covers for downlights or special downlight fittings that allow insulation to come closer to the downlight.

Figure 3.3.4 Downlight and fan insulation compensation



Notes to Figure 3.3.4:

A = 200 mm clearance above the recessed luminaire.

B = 200 mm clearance to the side of the recessed luminaire to combustible building element.

C = 50 mm clearance to the side of the recessed luminaire to bulk insulation.

D = 50 mm clearance to any auxiliary equipment (This would include the transformer for the luminaire).

Roof solar absorptance

The J4D4(2) requirements for roof solar absorptance values are calibrated to the climate zone (e.g. light roofs allow lower R-Values in cooling-dominated climates and darker roofs allow lower R-Values in heating-dominated climates). Solar absorptance refers to the proportion of solar radiation that is absorbed by the material. Colours with a greater solar absorptance will require Performance Solutions. Typical solar absorptance ranges from around 0.30 for light cream, to 0.90 for a dark grey slate. Galvanised steel for example has a typical solar absorptance of around 0.55.

3.3.1.3 J4D5 Roof lights

The NCC DTS Provisions for roof lights control the area and thermal performance of roof lights to limit heat transfer. From a thermal design perspective, a roof light can be considered as a large opening within the insulated roof space that allows energy to either enter or leave the building in an uncontrolled manner. Accordingly, that opening must be protected to reduce the energy transfer.

Remember that roof lights have a specific meaning within NCC Volume One as follows:

NCC Volume One Schedule 1 Definitions

Roof light, for the purposes of Section J and Part F6 in NCC Volume One means a skylight, *window* or the like installed in a roof—

(a) to permit natural light to enter the room below; and

(b) at an angle between 0 and 70° measured from the horizontal plane.

This means that a roof light may include elaborately manufactured units through to simple sheets of glass or polycarbonate roof cladding. The allowed area will depend upon the performance of the roof light and the geometry of any light shaft. To keep the clause simple, the impacts of climate zones and roof light orientation have not been included. Instead the provisions are based maximum areas of roof lights as a percentage of the floor area of the room or space the roof lights serve.

The thermal performance of roof lights is expressed in terms of Total System U-Value and Total System SHGC. Refer to Schedule 1 of NCC Volume One for further information on these terms.

Area

The provisions of J4D5(a) specify the maximum area of roof lights is limited to no more than 5% of the floor area of the space served to ensure that the thermal performance of a roof is not compromised to too great an extent. Larger roof lights will need to achieve compliance through a Verification Method or a Performance Solution.

The calculation floor area is based on the floor area of the space the roof lights serve. If the roof light is serving a single room, the floor area is simply the area of the room. In multi storey buildings, this would relate only to the top storey immediately below the roof lights. Accordingly, the area of other floors is not taken into consideration. In situations where there is an atrium, the floor area at the bottom of the atrium would be used to determine the total floor area served by the roof light.

Thermal performance

J4D5(b) has values for Total System SHGC and Total System U-Values, which are expressed in accordance with the AFRC Protocol.

The provisions of J4D5(b) require roof lights to have transparent and translucent elements with a maximum Total System U-Value of 3.9 and Total System SHCG in accordance with Table J4D5, including any ceiling diffusers.

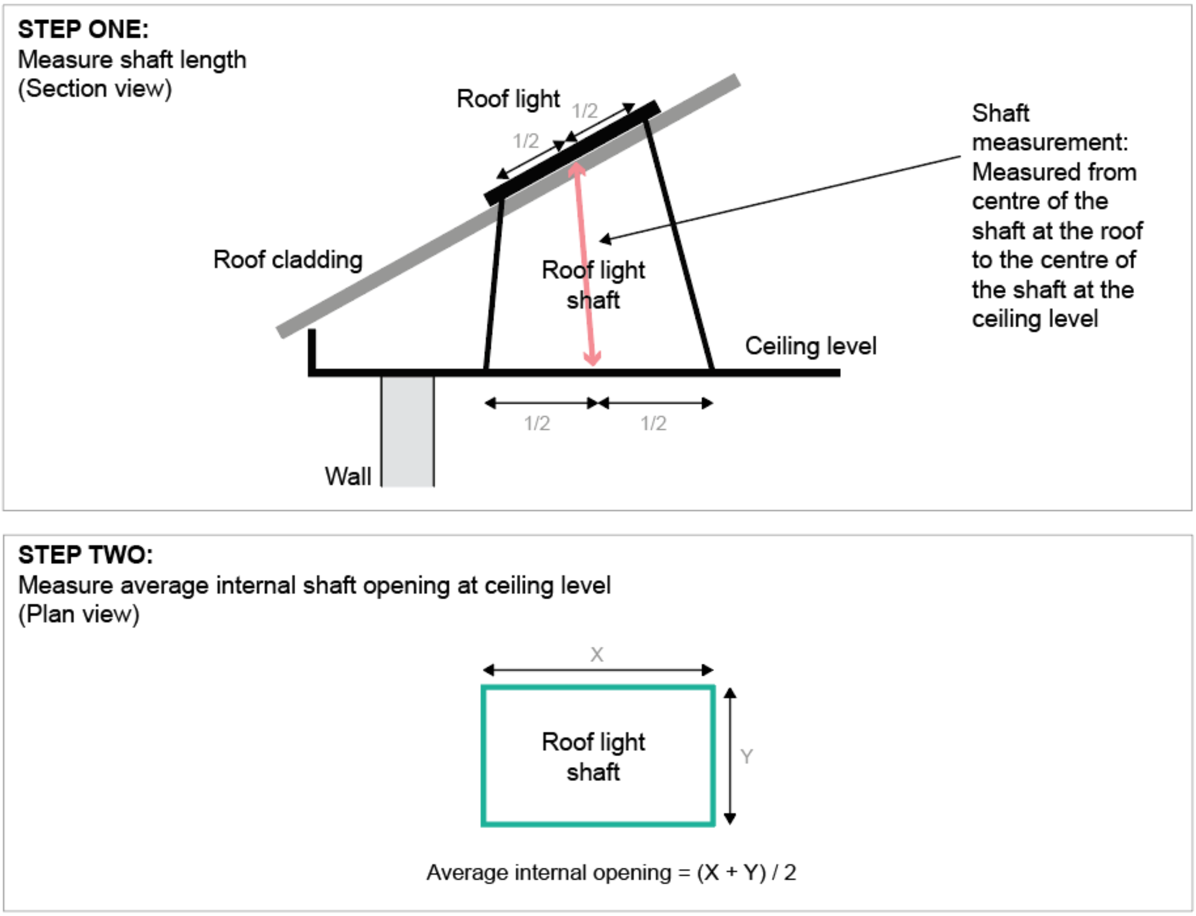
Notes to Table J4D5 provides an explanation on how to determine the roof light shaft index, specifies the area of roof light and total area of roof light.

Note 1 to Table J4D5 provides explanation on how to determine the roof light shaft index, a ratio of the vertical distance of the roof light to the ceiling level and the roof light opening at the ceiling level. Determining the roof light shaft index specified in Table J4D5 can be calculated using Figure 3.3.5 below.

Note 2 to Table J4D5 specifies that the area of a roof light is equal to the area of the opening in the roof that allows light into the building.

Note 3 specifies that combining the values of individual roof lights gives the total area of roof lights serving a room or space.

Figure 3.3.5 Determining roof light shaft index



STEP THREE:
Divide the centre shaft length (step one) by the average internal shaft opening (step two)

3.3.1.4 J4D6 Walls and glazing

The construction of walls and glazing are a major contributing factor in the overall thermal performance of the building. When considering the requirements in J4D6, it is important to appreciate that this provision applies to the walls and windows of the building envelope, which can include internal walls as well as external walls.

Reminder

Wall-glazing construction means the combination of wall and glazing components comprising the envelope of a building, excluding:

(a) display glazing

(b) opaque non-glazed openings such as doors, vents, penetrations and shutters.

This means that the elements in (a) and (b) are subtracted from the area of the facade during calculations.

Solar absorptance of window frames: Darker frames conduct more heat from solar radiation and effectively increase the impact of solar gains through glazing. Darker frames improve performance in winter and decrease it in summer.

Provisions for Total System U-Value and solar admittance for a wall-glazing construction are specified in J4D6. These provisions require the thermal performance (glass and frame) of the glazing elements in the wall-glazing construction. Window products and their thermal performance (Total System U-Value and Total System SHGC) are available from the Window Energy Rating Scheme (WERS).

Similarly, provisions for the Total R-Value of the wall component of a wall-glazing construction are provided.

Alert

When is a wall an internal wall?

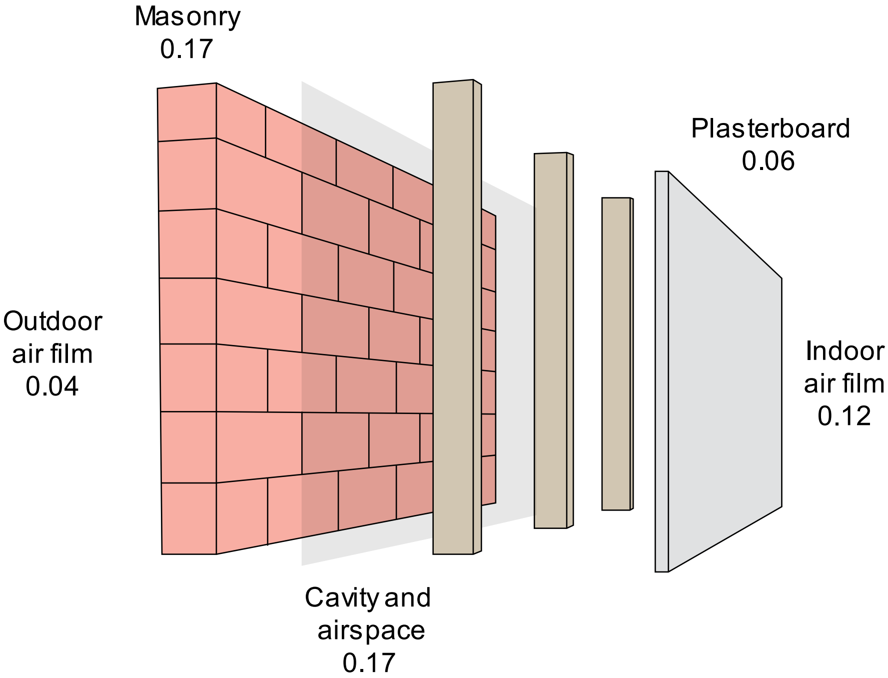
For the purposes of this subclause, an internal wall is a wall that is protected from the external elements by another wall, window or door. An external wall would be a wall open to the external environment, even though it may be within the roof line of the building. This is based on the idea that the wall is exposed to the external temperatures, sun and wind.

Walls adjoining an open courtyard area within the roof line would be considered external while a wall of a supervisor’s office overlooking a factory floor would be internal. Refer to the defined term external wall in the NCC for further guidance.

Typical constructions

The following figure describes the component R-Values for a typical wall construction.

Figure 3.3.6 Typical wall construction R-Values



The Total R-Value of the typical wall construction has been produced by adding together the material R-Values for outdoor air film, wall cladding, wall airspace, internal lining and internal air film. The Total R-Value required is achieved by adding the material R-Value of the basic wall and the material R-Value of any additional insulation incorporated with adjustment for any thermal bridging.

Note it should not be assumed that these figures are representative of all construction scenarios. For example, the spacing of framing members, the number of windows or the specific type of frame could all affect the actual Total R-Value by creating thermal bridging between elements or by compressing insulation. If developing a DTS Solution, Total R-Value must be calculated using the methods prescribed in AS/NZS 4859.2 to properly account for these effects.

The most common forms of construction for low-rise buildings are represented in the worked examples in Appendix D. It is beyond the scope of this Handbook to cover other forms of construction, particularly those used for high-rise construction. This is because of the wide range and the greater influence of winds, cyclones and earthquakes on the elements of the building. The Total R-Value of other forms of construction can be determined by adding the individual R-Values together.

Reflective insulation that has just one reflective surface is considered to achieve the R-Values when used in conjunction with the Total R-Value of the common wall construction stated in the figure below. The actual R-Value added by reflective insulation should be determined for each product in accordance with the standards prescribed in the NCC, which take into consideration factors such as the number of adjacent airspaces, dimensions of the adjacent airspace, whether the space is ventilated and the presence of an anti-glare coating.

The width for any reflective airspace adjacent to reflective insulation will not override other requirements such as minimum cavity requirements for masonry waterproofing.

Where a diagram shows reflective insulation or other insulation, these are indicative only. In some climates and using certain materials, neither may be necessary. In other cases, reflective insulation or insulation may be provided separately or in combination to give the required R-Value.

A minimum thickness of 70 mm is stated for framing. In some cases, the frame thickness may need to be increased to avoid compressing the bulk insulation and thus reducing its R-Value.

Walls with a large surface density can achieve higher levels of thermal performance in certain climate zones due to their ability to store heat and therefore slow the heat transfer through the building fabric. This can be demonstrated through a Performance Solution.

Alert

Examples of typical constructions for low rise construction can be found in the Guide to Volume One.

Total System U-Value for wall-glazing construction

J4D6(1) contains the basic Total System U-Values that need to be achieved by wall-glazing construction forming the envelope of a building. Importantly, this applies to both external and internal wall-glazing construction that form part of the building envelope.

Reminder

The calculation method used to determine the Total System U-Value must comply with Specification 37.

J4D6(1)(a) applies to Class 5, 6, 7, 8 or 9b buildings or Class 9a buildings other than a ward area. For these building types, the Total System U-Value must be less than or equal to U2.0.

J4D6(1)(b) applies to Class 3 or 9c buildings or Class 9a ward areas. In climate zones 1, 3, 4, 6 or 7, the Total System U-Value must be less than or equal to U1.1, in climate zones 2 or 5, the Total System U-Value must be less than or equal to U2.0, and in climate zone 8, the Total System U-Value must be less than or equal to U0.9.

Total R-Value for wall components

J4D6(4) outlines requirements for wall components of wall-glazing constructions based on the percentage of area the wall component makes up of the total construction. If the wall component is less than 80% of the total area of the wall-glazing construction, the required Total R-Value is at least R1.0. If the wall component is greater than 80% of the total area the Total R-Value is specified in Table J4D6a. Table J4D6a specifies Total R-Values based on climate zones and building class types.

Reminder

The calculation method used to determine the Total R-Value must comply with Specification 37.

The Total R-Values for wall-glazing constructions where the wall component makes up less than 80% of the construction are less than the Total R-Values for constructions where the wall component makes up more than 80% of the wall-glazing construction. It is considered that once the glazing component is greater than 20% of the construction the glazing becomes the primary driver of energy use. Therefore, Total R-Values for the wall components can be less when the glazing component is relatively large.

Reminder

The definition of a wall-glazing construction comprises of wall and glazing components that make up the envelope of the building. If a basement qualifies as a conditioned space, basement walls would be required to comply with this clause.

Solar admittance

J4D6(5) contains the basic solar admittance values that must not be exceeded by externally facing wall-glazing construction. Importantly, this subclause only applies to external wall-glazing construction forming part of the building envelope. Tables J4D6b and J4D6c specify maximum solar admittance values based on building class and direction.

The lower solar admittance values in Table J4D6c reflect the stricter Total System U-Value requirements of the identified building types. This is because of the likely 24/7 operation of these buildings. 24/7 operation means that the buildings do not cool down overnight and therefore have greater cooling requirements.

J4D6(3) requires that for wall-glazing constructions, the solar admittance must be calculated in accordance with Specification 37.

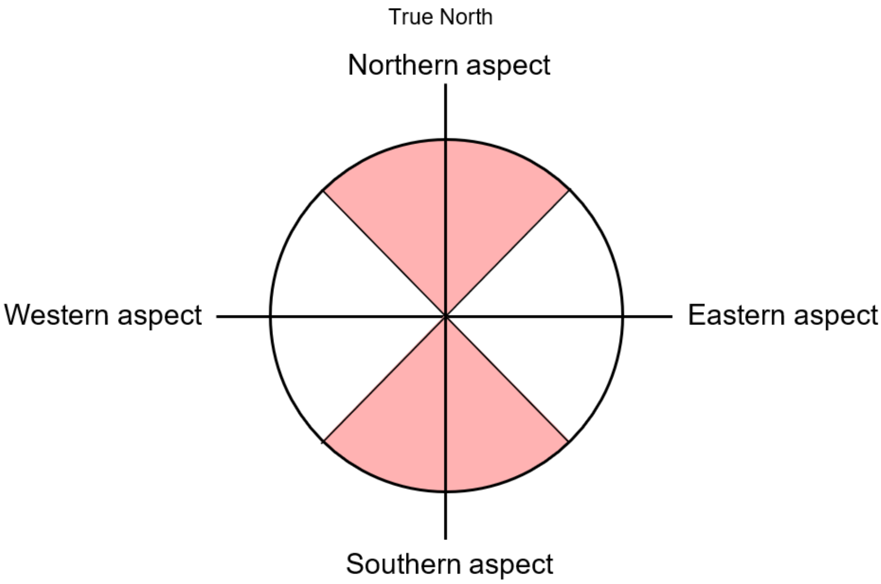
U-Value and solar admittance calculation

Specification 37 describes the two calculation methods for determining if wall-glazing construction complies with the U-Value and solar admittance requirements in J4D6. The methods are dependent on whether the wall-glazing construction includes walls and glazing facing a single aspect or multiple aspects.

Determining the aspect of the wall-glazing construction is as follows:

- true north or within 45° of true north = northern aspect
- true south or within 45° of true south = southern aspect
- true east or within 45° of true east = eastern aspect
- true west or within 45° of true west = western aspect.

Figure 3.3.7 Northern, eastern, southern and western aspects



When applying the methods described below, the Total System U-Value and Total System SHGC of glazing must account for the combined effect of the glass and frame. The measurement of the Total System U-Value and Total System SHGC is specified in the Technical Protocols and Procedures Manual for Energy Rating of Fenestration Products of the AFRC.

Various assessors using AFRC procedures might refer to their published performance values by slightly different terms (including "U-factor" or "Uw" for Total System U-Value or "SHGC" for Total System SHGC). These values can be used under Specification 37 providing they measure combined glass and frame performance according to AFRC requirements.

For the compliance pathways within Specification 37, Method 1 includes calculations for wall-glazing constructions facing a single aspect. Method 2 includes calculations for wall-glazing constructions facing multiple aspects.

U-Value - Method 1 (single aspect)

For Method 1, each aspect of wall-glazing construction is required to meet the applicable Total System U-Value for the building classification and climate zone.

Clause S37C3(2) specifies that the Total System U-Value of the wall component is calculated as the inverse of the Total R-Value, with allowances made for thermal bridging. The thermal conductivity of typical materials provided in Specification 36 can aid in calculating material R-Values. All calculations are to be made in accordance with AS/NSZ 4859.2 or Specification 38 for spandrel panels.

Alert

AS/NZS 4859.2 is the design standard for thermal insulation materials for buildings. The standard provides prescriptive system R-Value calculations.

Subclause S37C3(3) specifies the Total System U-Value of the wall-glazing construction is calculated as an area-weighted average of the Total System U-Value of each component of the construction. This value must be less than or equal to the applicable value in J4D6(1) as per subclause S37C3(4).

For complicated wall-glazing constructions, the ABCB Facade Calculator can provide an alternative means of undertaking the required calculations.

U-Value - Method 2 (multiple aspects)

Wall-glazing constructions facing multiple aspects can be assessed together to determine if they collectively achieve the applicable Total System U-Value and solar admittance. Method 2 effectively allows for trading of thermal performance values between different aspects and is intended to make it easier for a building to have the same glazing system in all directions.

Please note, orientations may also be considered separately using Method 1.

Solar admittance - Method 1 (single aspect)

Subclause S37C5(1) in Specification 37 provides a formula to determine the solar admittance of a wall-glazing construction facing a single aspect. The calculated solar admittance of the construction must be less than or equal to the applicable value in Specification 38.

Solar admittance - Method 2 (multiple aspects)

Method 2 specifies the solar admittance for a wall-glazing construction facing multiple aspects. Please note aspects may also be considered separately using Method 1.

Method 2 requires a representative air-conditioning energy value less than that achieved by a reference case.

The calculation requires the area of each wall-glazing construction, the solar admittance weighting coefficient of each aspect and the wall-glazing construction solar admittance of each aspect.

For glazing on an aspect with an area of less than 20% of the wall-glazing construction the solar admittance is 0. This is to not gain unreasonable allowances for glazing on other aspects. Where glazing is less than 20%, it is recommended that Method 1 is used.

Where there are large numbers of different wall-glazing construction elements, the ABCB Facade Calculator can provide a quicker way to undertake the calculations.

Shading

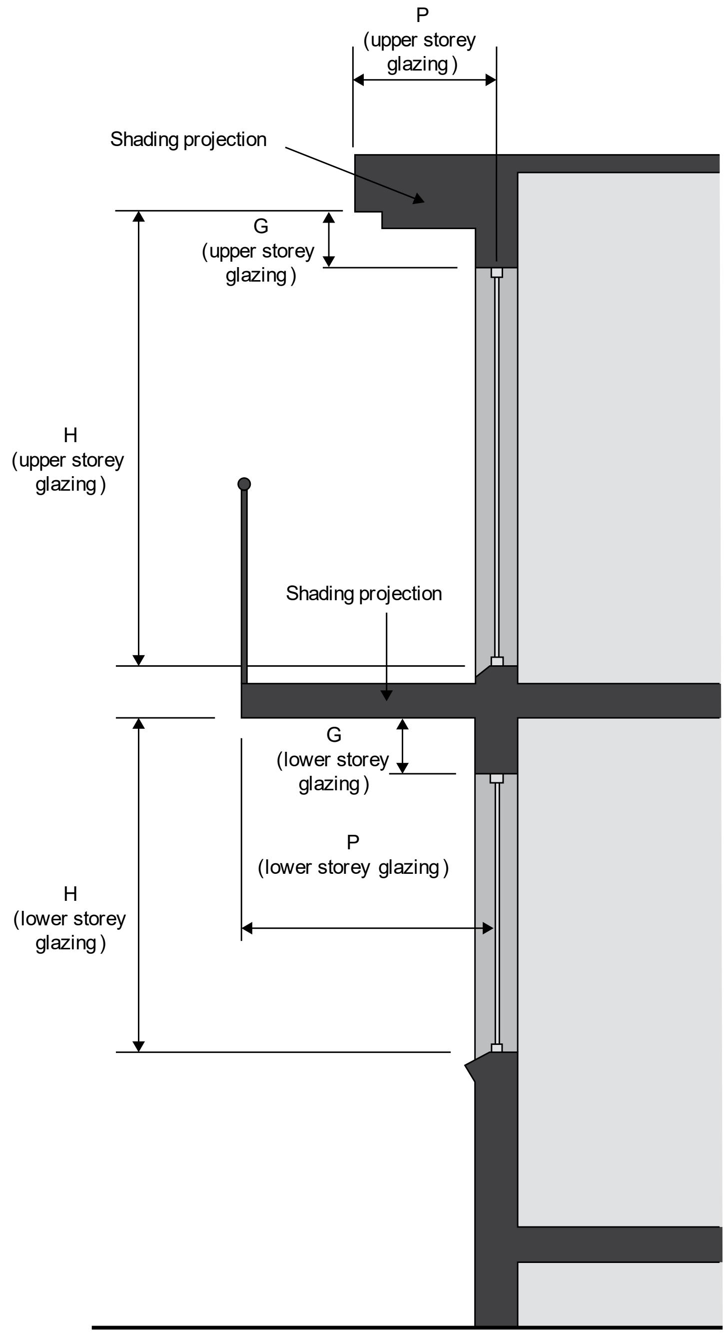
Clause S37C7 in Specification 37 specifies the shading multiplier for calculating solar admittance.

The presence of shading projections and devices reduces the level of thermal performance required for glazing. However, to be effective, shading projections and devices must restrict a significant proportion of solar radiation.

Subclause S37C7(a) specifies the shading multiplier for northern, eastern or western aspects in Table S37C7a and for southern aspects in Table S37C7b, for shading provided by permanent external projections. The projection must extend horizontally on both sides of the glazing for the same distance, as shown in Figure 3.3.8 as distance P. Examples of this may include balconies.

Where the ratio of P/H or G/H are between the values stated, interpolation may be used to determine the shading multiplier.

Figure 3.3.8 Shading projection coefficients



Subclause S37C7(b) specifies a shading multiplier equal to 0.35 for external shading devices such as shutters, blinds, vertical or horizontal building screens with blades, battens or slats. The external shading devices are required to restrict the amount of summer solar radiation that reaches the glazing by 80% or more. Additionally, the device must operate automatically in response to the level of solar radiation if adjustable, as devices operated manually are considered less likely to be used efficiently. Vertical shading is commonly used, however often does not meet the DTS requirements and therefore does not receive the available shading multipliers. Vertical shading provides great benefits, particularly on East and West facing facades as the sun angles are low. Given this, vertical shading could form the basis of a Performance Solution if they are unable to restrict the amount of summer solar radiation that reaches the glazing by 80% or more.

The restriction of summer solar radiation is the sum of the amount of hour-by-hour summer (December, January, February) solar radiation that does not reach the glazing as a percentage of what would have reached the glazing if the shading device was not fitted. If the device adjusts automatically in response to the sun, the worst-case scenario during the period of December to February can be used.

The 80% figure acknowledges that while a device may be capable of providing 100% shade during summer, some leakage of solar radiation may occur at the sides of the device.

A degree of judgement is required to determine whether the amount of summer solar radiation that reaches the glazing at the sides of a device exceeds that permitted. Generally, close fitting blinds or horizontal screens that extend either side of the glazing by the same projection distance (P) should sufficiently restrict the amount of summer solar radiation that reaches the glazing at the sides of the device.

Note that the shading projection for walls is measured from the wall face whereas for glazing the projection is measured from the glass face.

Display glazing

The NCC definition of display glazing is as follows:

NCC Volume One Schedule 3 Definitions

Display *glazing* means *glazing* used to display retail goods in a shop or showroom directly adjacent to a walkway or footpath, but not including that used in a café or restaurant.

Total System U-Value

J4D6(2) specifies that the Total System U-Value of display glazing must be less than or equal to U5.8.

Total System SHGC

J4D6(7) specifies that for display glazing, the Total System SHGC must be less than or equal to 0.81 divided by the applicable shading factor specified in Clause S37C7 of Specification 37.

Spandrel panel thermal performance

Specification 38 describes the methods of determining the thermal performance of spandrel panels using one of two calculation methods.

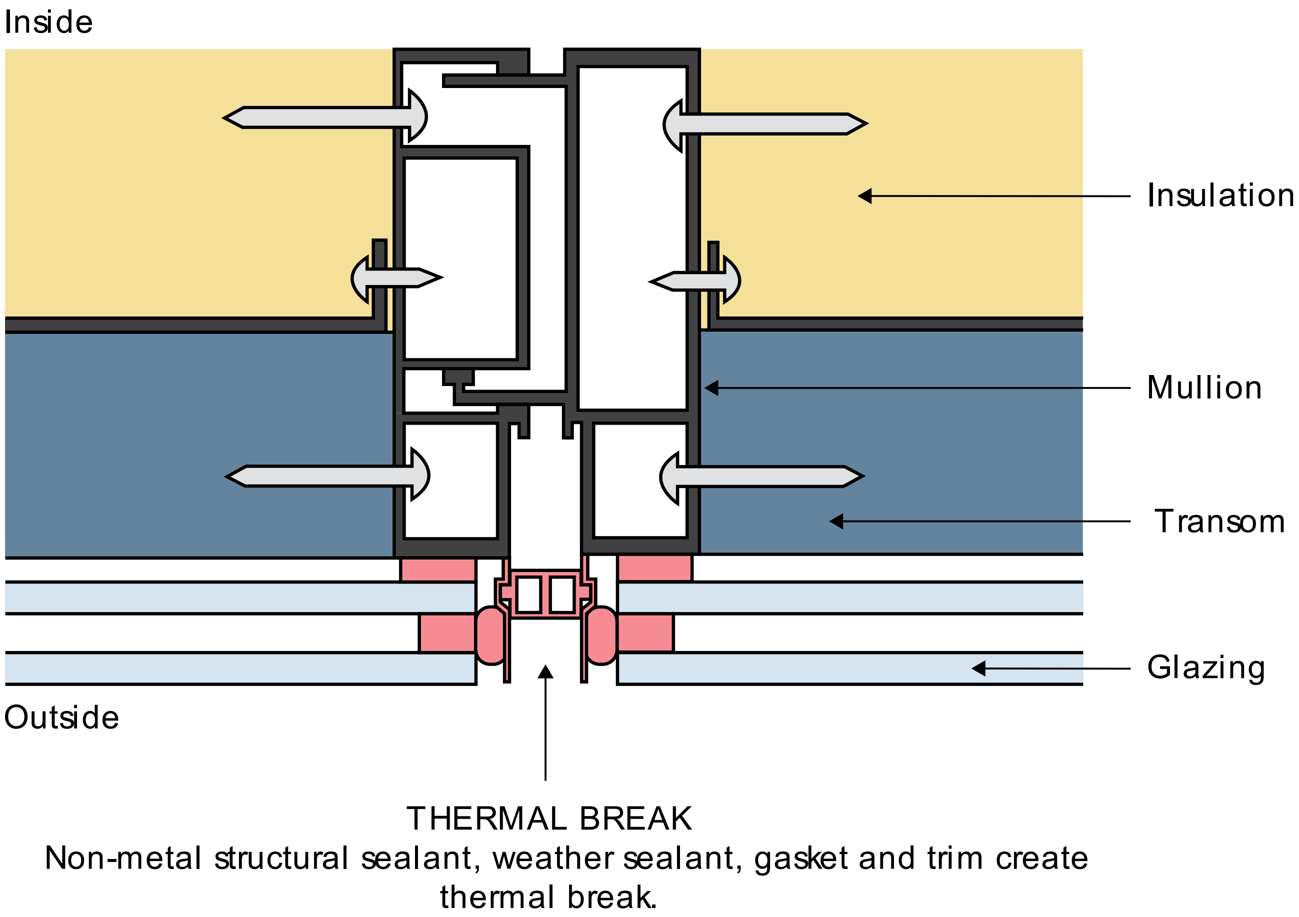
Reminder

Spandrel panels refer to the opaque part of a facade in curtain wall constructions which is commonly adjacent to, and integrated with, glazing.

As per glazing, the thermal performance of a spandrel panel relates to the whole assembly, including the frame, the edge of the spandrel panel that has reduced thermal properties due to the frame, and the centre of the spandrel panel. When insulation is added in a spandrel panel, it is often added along the backside of the panel between the structural parts of the frame.

Spandrel panels are typically poor for thermal bridging as the frames are generally made from highly conductive materials that allow heat to transfer from the outside into the building. Often insulation is installed on the backside of the panel, however, this does not limit the thermal bridging through the frame. Figure 3.3.9 provides an example of a spandrel panel that uses non-metal elements to create a thermal break.

Figure 3.3.9 Example of a spandrel panel with thermal break



Calculation method 1

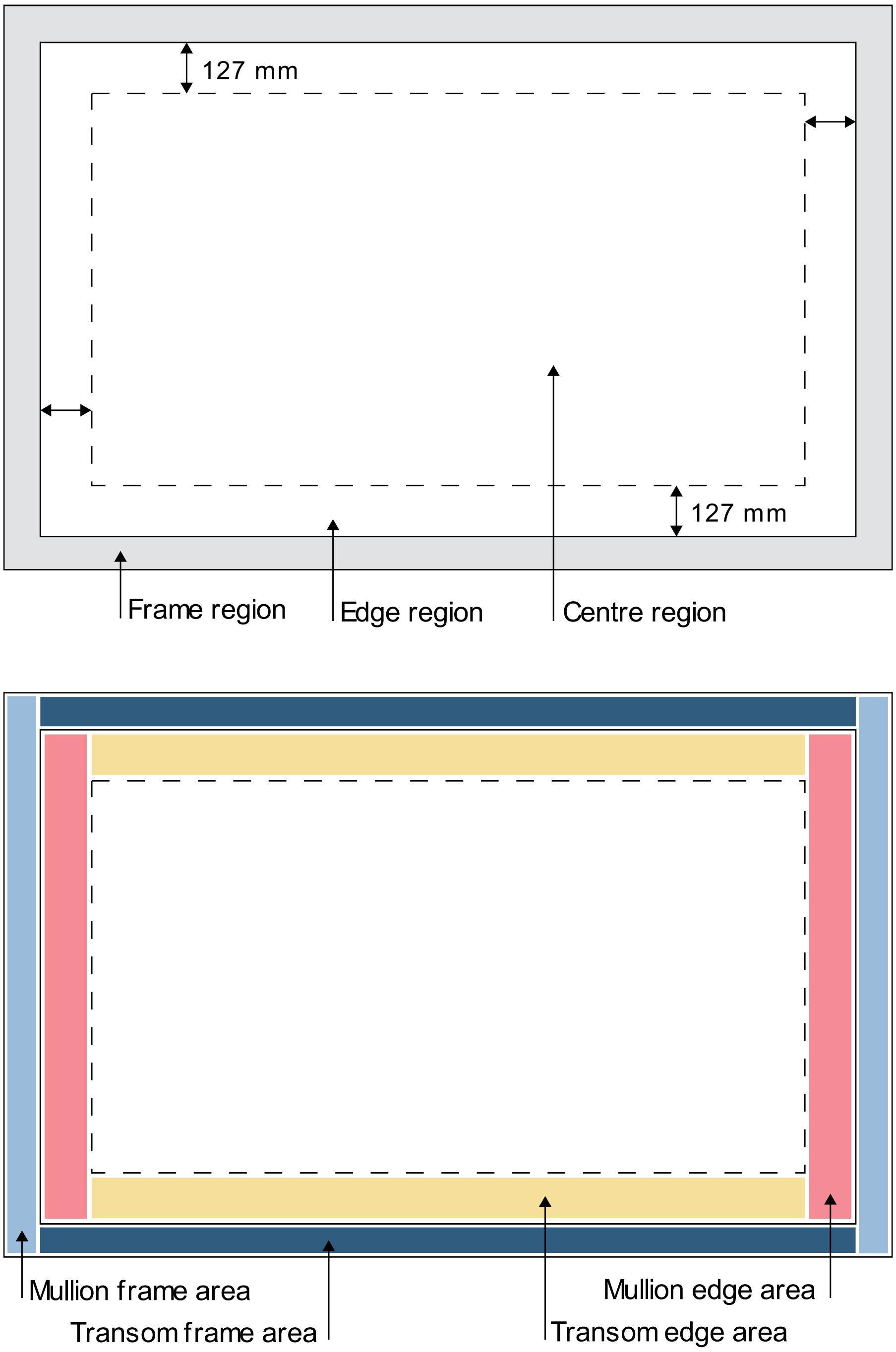
Calculation method 1 is used to detail the R-Values to be achieved by common forms of spandrel panels. Four common forms are provided with their thermal properties listed in Table S38C2 of Specification 38. Values listed Table S38C2 include R-values obtained from air films in the calculation, but any materials not listed in S38C2 for each configuration, i.e. plasterboard, are not included.

Calculation method 2

Calculation method 2 is used for the calculation of the Total System R-Values of less common forms of spandrel panels. An equation, like that used for glazing, is provided to determine the Total System R-Value.

Please note that when calculating the area of the frame and edge regions, to avoid double counting, the area of the mullion is to be used with the full height and the area of the transom is to be used with the middle dimension. See Figure 3.3.10 for details.

Figure 3.3.10 Spandrel panel frame, edge and centre regions



Facade calculator

The ABCB has developed a Facade Calculator for NCC users to assist with demonstrating compliance with the NCC wall and glazing provisions. The calculator is available on the ABCB website.

Glazing strategies

The importance of glazing in a building's envelope

All elements of a building's envelope present opportunities for energy savings. However, in high-rise buildings, there is not the same scope for reducing energy flow through roofs and floors as for low-rise buildings as there is less roof and floor area exposed to the external environment when compared to external walls/glazing.

The energy efficiency requirements emphasise the importance of maintaining the thermal performance of the envelope. Engineering systems may be replaced many times over a building's life, but fundamental fabric requirements such as wall insulation, glazing size and performance, shading, orientation and air tightness generally remain for the life of the building.

For energy flow through the envelope, glazing is often the greatest path of heat transfer and, possibly, of infiltration, making it a critical element in achieving energy efficiency.

The importance of glazing generally

Some glazing systems commonly used in Australia have thermal insulation qualities that are poor compared to other parts of the building fabric. Some elements of the building envelope are heavily insulated (such as walls, floors and roofs), against heat loss or gain. However much of the heat can pass through the glazing unless orientation, shading devices and glazing performance (glass + frame) are managed appropriately.

In summer, sunlight radiates through the glazing, bringing unwanted heat into the interior. However, in winter, solar heat gains through the glazing can contribute effectively to the energy efficiency of a building where heating is desired. This is less important in non-residential commercial buildings where internal heat loads from lighting, appliances, equipment and people can be high enough to require little or no additional heating in most climates.

The provisions contain requirements for the thermal performance of glazing (glass + frame) depending on the glazing area, its orientation and the extent of any shading. This attempts to limit unwanted heat gain into the building in hot weather without unduly restricting the potential for solar heat gains in winter.

Glazing – the main opportunity to improve energy efficiency

Poorly designed glazing can become the main thoroughfare for unwanted heat gain or heat loss. However, with the correct design, glazed windows and doors may provide an opportunity to achieve greater energy efficiencies within the building by:

- maximising solar heat gains in cooler seasons, lessening the need for heating;
- minimising unwanted heat gains in hotter seasons, lessening the need for cooling; and
- providing natural light which can reduce the use of heat-producing artificial lighting in the building during daylight hours.

Design alert

One of the main considerations in the design of mechanical equipment for a building is the heating or cooling load resulting from the glazing. Correctly designed and installed glazing may reduce the size and operating load of the mechanical equipment needed to air-condition a building.

It is recognised that for most commercial buildings in most climate zones, the predominant mode is cooling. Therefore, there is a greater emphasis on Total System SHGC over Total System U-Value in the provisions.

If used carelessly glazing elements risk becoming a major weakness in the insulated building envelope. The requirements in NCC Volume One are intended to keep unwanted energy flows through the glazing within limits that are considered reasonable for each climate zone. In some building types in some locations, greater energy efficiency can be achieved by also making use of desirable solar heat gains in colder periods.

The effect of sun angles on glazing energy efficiency

The winter sun appears lower on the horizon at any time of day than the summer sun at the same time. Between the lowest winter position and the highest summer position, there is a difference of about 47°. For unshaded glazing, the angle of the sun's rays onto the glass will affect the amount of solar heat gain transmitted through the glass. The sharper the angle (closer to 90° from the horizontal), the greater the reflectance from the surface of the glass, which results in less solar heat gain. This is most effective in summer as the sun is higher in the sky and thus the angle is sharper, whilst the winter sun is lower in the sky and the angle is more direct.

Another important benefit of the changing sun angles is that it is possible to provide shading devices that protect glazing from unwanted summer sun while allowing the lower winter sun to shine directly into the windows providing heat gains when they may be welcome.

The importance of orientation to glazing energy efficiency

The orientation of glazing can help to receive beneficial winter sun but not unwanted summer sun.

Generally, during the summer months, glazing facing the East and West receives the largest amount of solar gain, while glazing facing the North or South receives the least solar gain. This is in relation to the higher sun position on the horizon during the summer months, limiting the amount of solar heat transmitted through the North and South facing glazing.

Generally, during the winter months, glazing facing the North is the largest source of solar gain. Glazing facing the East and West still provide gains, however they are less than that of those available from the North due to the lower sun position during winter months. The South facing orientation provides negligible heat gains during the winter months when they are most desirable.

Combining the summer and winter outcomes shows that glazing facing the East and West provides the highest level of unwanted summertime heat gains but less during winter when solar gains might be beneficial. The South sector provides the lowest summertime heat gains but virtually no useful heat gains in winter.

By contrast, the North sector has the same advantage during summer as the South sector but is the best source of heat gains during the winter months. This combination identifies the North orientation sector as uniquely favourable for avoiding heat gains when they are not wanted and being able to make use of them when they can be most beneficial.

Orientation however is not directly important for conductance. Whether glazing faces North, South, East or West, the same amount of heat loss is calculated to occur because the loss depends on the air temperature inside the building compared to the air temperature outside, which is assumed to be similar in all directions. Good orientation however, can compensate for heat lost through conduction by providing offsetting solar gains.

3.3.1.5 Floors

The requirements for floors apply to all floors that are part of the building envelope. These include the floor above or below a plant room, a carpark or the like if it is part of the envelope. However, the requirements do not apply to the intermediate floors between conditioned spaces.

Unlike the roof and wall requirements, the requirements for floors address heat flow for two directions:

(1) Vertical direction – an overall minimum Total R-Value is required and in some instances under-slab insulation with a specific R-Value.

(2) Horizontal direction – perimeter insulation required with a specific R-Value.

Total R-Value

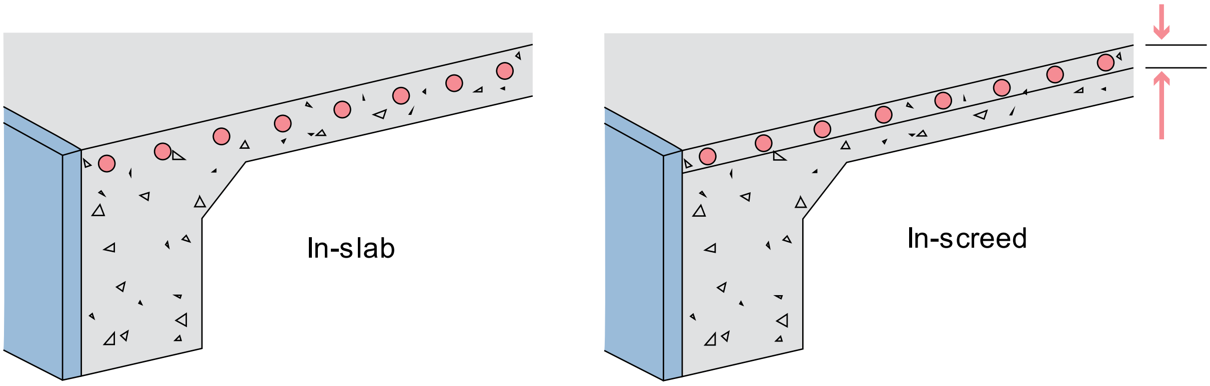
Clause J4D7(1) establishes the requirements for floors that are part of the envelope. Table J4D7 specifies minimum Total R-Values based on climate zone and whether the floor has an in-slab heating or cooling system.

Reminder

The calculation method used to determine the Total R-Value must comply with AS/NZS 4859.2, or Specification 39 or Section 3.5 of CIBSE Guide A for soil or sub-floor spaces.

An in-slab or in-screed heating or cooling system is a system where pipes or cables are encased within the concrete slab or screed for the purposes of providing artificial heating and/or cooling. An example of an in-slab and in-screed heating or cooling system is shown in Figure 3.3.11.

Figure 3.3.11 Diagram of an in-slab and in-screed heating or cooling system



The note to Table S39C2a details requirements for sub-floor R-Values. Sub floor R-Values are to be calculated in accordance with Specification 39 or Section 3.5 of CIBSE Guide A.

Alert

CIBSE Guide A is a guide for Environmental Design. Section 3.5 - Thermal properties of building structures covers the determination of heat transmission properties of building elements including walls, floors, roofs, windows. It provides methods of calculation and associated data on the thermal conductivity of materials.

Vertical edge insulation

Clause J4D7(3) requires that a concrete slab-on-ground in climate zone 8 or a floor with an in-slab or in-screed heating or cooling system must be insulated around the vertical edge of its perimeter to a minimum R-Value of 1.0. Floors used solely in a bathroom, amenity area or the like are excluded from floors with an in-slab or in-screed heating or cooling system, as these are typically small areas.

The energy from a heated slab is distributed to all faces of the slab and not just to the surface within the building envelope. In a sense, the slab itself acts like a radiator. This means energy is lost from the underside of the slab and at the external edges. To control this heat loss, the slab must be insulated at the vertical edges.

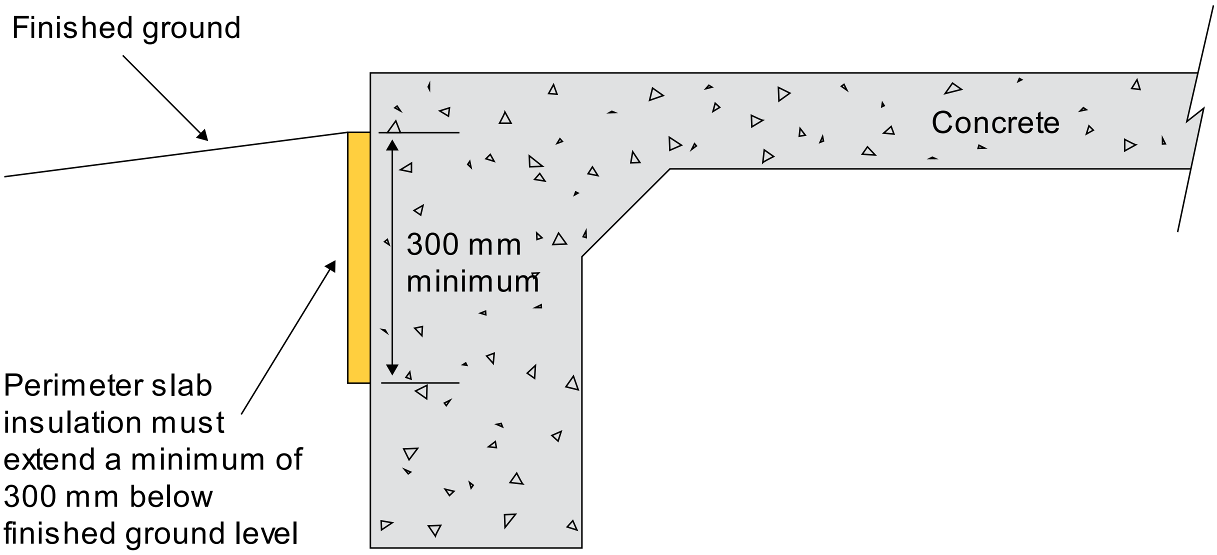
Slab-on-ground insulation

J4D7(4) specified the insulation for a slab-on-ground required by J4D7(4). The insulation must be suitable for an external environment. In particular, it must be water resistant and still achieve the required R-Value. This can be validated by manufacturer’s literature on test results.

Clause J4D7(4) also addresses the installation of perimeter slab insulation. The most problematic area is where the slab is in direct contact with the portion of the ground that is subject to significant seasonal or daily temperature variations. Conduction between slab and ground would increase the energy needed to keep the slab at the desired temperature.

To reduce the extent of this problem, the insulation must extend from the adjacent finished ground level to a depth of 300 mm, or for the full depth of the vertical edge of the slab-on- ground if the slab edge is less than 300 mm. Refer to Figure 3.3.12 for further explanation.

Figure 3.3.12 Depth of insulation



Typical constructions

For the thermal performance of floor construction, the material R-Value may be determined by dividing the thickness of the item in metres by the thermal conductivity in W/m.K (typical values are described in Specification 36).

For the purposes of calculating the Total R-Value of a floor, the R-Value attributable to an in-slab or in-screed heating or cooling system is not included.

The spacing of stumps, or the specific type of frame could all affect the actual Total R-Value by creating thermal bridging between elements or by compressing insulation. If following a DTS compliance pathway, Total R-Value must be calculated using the methods prescribed in AS/NZS 4859.2 to properly account for these effects.

Alert

Examples of typical constructions for low rise construction can be found in the Guide to Volume One.

Sub-floor thermal performance

Specification 39 provides detail on the thermal performance achieved by sub-floor spaces and soil in direct contact with a floor.

The R-Values provided are intended to assist in determining whether and how much additional insulation is required to achieve the minimum Total R-Values in Table J4D7. This is provided as an alternative to carrying out a more detailed calculation using Section 3.5 of CIBSE Guide A.

Sub-floor thermal performance

Clause S39C2 of Specification 39 details the R-Values considered to be achieved by enclosed sub-floor spaces that are mechanically ventilated by 1.5 air changes per hour at most or are provided with a maximum of 150% of the aggregate sub-floor ventilation required by Part F1 and are not mechanically ventilated.

The R-Values are listed in Table S39C2a of Specification 39 and are determined based on the ratio of floor area to floor perimeter in metres. Where the ratio of floor area to floor perimeter is between the values stated, interpolation may be used to determine the sub-floor space R-Value.

R-Values

Table S39C2b of Specification 39 details the R-Values of the soil for floors that are in direct contact with the ground.

The R-Values are listed in Table S39C2b of Specification 39 and are determined based on the ratio of floor area to floor perimeter in metres, as well as the wall thickness.

Where a wall thickness or ratio of floor area to floor perimeter is between the values stated, interpolation may be used to determine the soil R-Value.

3.3.2 Part J5 Building sealing

Part J5 Building sealing in Volume One contains the relevant DTS Provisions to adequately seal parts of a building. The intent is to restrict air infiltration and air exfiltration.[7] Unintended leakage can lead to greater heat losses or gain and therefore reduced thermal comfort of occupants and consequently, increase the use of artificial heating and/or cooling.

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[7] See the terms ‘air infiltration and ‘air exfiltration’ in the Glossary at **Error! Reference source not found.** for more information.

Relevant clauses on building sealing are outlined in Table 3.7 and discussed in the following sections. Air leakage most commonly occurs at the:

- roof/ceiling to wall junction
- floor to wall junction
- wall to door frame junction
- wall to window frame junction
- all services penetrations.

3.3.2.1 Chimneys and flues

J5D3 sets out that a chimney or flue serving an open solid fuel burning appliance is required to have a damper or flap fitted. The damper or flap must be designed so that it can be operated easily by the occupants to close off the flue to prevent conditioned air being drawn up the chimney or flue when the appliance is not in use, especially in summer months. It is important to note that only appliances with an open face, which burn a solid-fuel such as timber, are required to have a damper.

In addition to the sealing requirements for chimneys and flues, Part G2 of NCC Volume One contains requirements that also need to be met.

3.3.2.2 Roof lights

What roof lights need to be sealed?

Clause J5D4(1) provides general requirements for sealing of roof lights and covers two distinct situations where roof lights must be sealed, or capable of being sealed. The first is when they serve a conditioned space. The second situation is when they are in a habitable room in climate zones 4, 5, 6, 7 and 8.

For example, a roof light will need to be sealed if it serves a laundry that is air-conditioned. Conversely, it would not require sealing if the laundry was not air-conditioned, because the room is not considered to be a habitable room for the purposes of the NCC.

How are roof lights sealed?

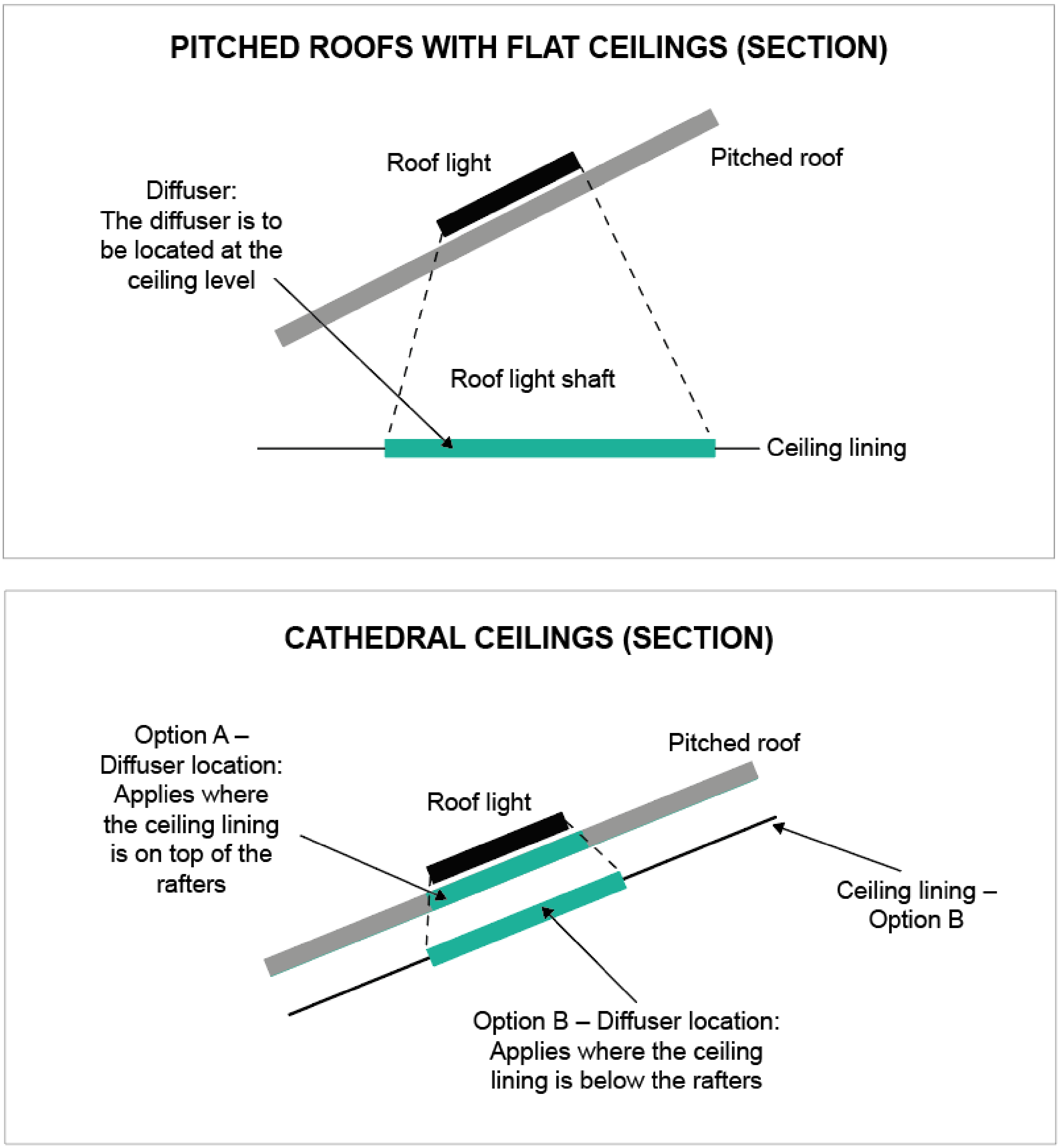
There are three options for achieving an effective seal:

(1) An imperforate (secondary) diffuser installed at the ceiling level or the internal lining level. In cathedral ceilings, the diffuser can be installed at the lower edge of the roof light shaft opening. The diffuser is typically an opaque sheet of plastic used to reduce the glare from the roof light. Refer to Figure 3.3.13 for suitable ceiling diffuser locations.

(2) A weatherproof seal can be installed, and although not mentioned in the clause, the seal could be a foam or rubber compression strip or the like as described in J5D5(3)(b) for sealing external doors and windows.

(3) A shutter system can be installed that is operated either manually, electronically or mechanically. It is also a requirement to ensure the operating mechanisms are easily accessible to the occupant, so they can be readily used.

Figure 3.3.13 Suitable location of ceiling diffusers



Reminder

It is important to note that a window becomes a roof light only when it is installed at an angle between 0 and 70 degrees, measured from the horizontal plane. Glazed openings that are installed in roofs with a greater angle are considered to be windows and are addressed by clause J5D5 for sealing purposes.

3.3.2.3 External windows and doors

External windows and doors must be sealed when they form part of the envelope or are in climate zones 4, 5, 6, 7 and 8. Reasonable judgement is required when applying sealing to windows and doors, i.e. the seal must be durable with no gaps between a conditioned and non-conditioned space.

The application parameters for a habitable room or conditioned space are the same as discussed previously in this Chapter for roof light sealing.

Clause J5D5 details three exemptions:

(1) Windows that comply with AS 2047 (Windows in buildings – selection and installation) are exempt as the Standard contains acceptable provisions for window sealing.

(2) Fire or smoke doors, as any seal might compromise the integrity of the door.

(3) A roller shutter door, roller shutter grille or other security door or device installed only for out-of-hours security.

Clause J5D5(4) relates to external entry doors leading to a conditioned space. An external door opening into a conditioned space with a floor area greater than 50 m^2 must be self-closing, have an airlock or be a revolving door to minimise loss of conditioned air. This provision applies to all climate zones (refer to Figure 3.3.14 for further explanation).

Clause J5D5(5) relates to entrances to loading docks. Should a loading dock lead to a conditioned space, it must be fitted with a rapid roller door.

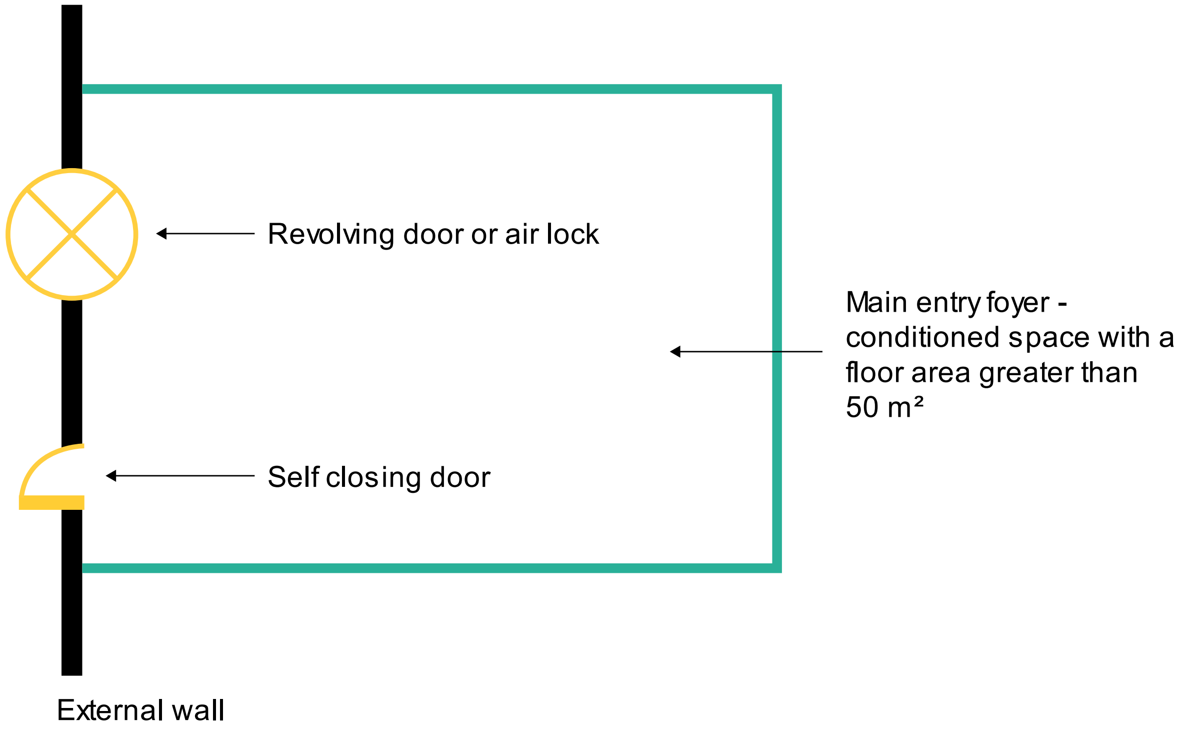
Design alert

What is the difference between sealing a door and minimising air loss?

Clause J5D5(1) requires most external doors to be provided with a seal, so that closed air is prevented from passing through the gap between the door and door frame.

Clause J5D5(4) requires most entry doors to be designed so that when the door is in use the loss of conditioned air is minimised. This can be achieved by a revolving door, air lock or a self-closer.

Figure 3.3.14 Entry doors to a conditioned building (plan view)



3.3.2.4 Exhaust fans

This requirement in J5D6 applies to exhaust fans located in the envelope of a conditioned space in any climate zone or in the external fabric of a habitable room in climate zones 4, 5, 6, 7 and 8.

The exhaust fans are essentially openings in the insulated envelope, through which conditioned air will escape when they are not operating. Accordingly, the requirement is to restrict the extent of air leakage from intermittently operating fans. A simple flap damper system can fulfil the minimum requirements. These are readily available for most fan types. Alternatively, a mesh filter system, like those used in kitchen range hoods, is acceptable. This is because these systems significantly restrict the flow of air when the fan is not operating.

Alert

What if the exhaust fan is part of a conditioning system?

If the fan was operating as part of the air-conditioning system, such as a control return air fan, an additional damper would not be required but, if one is already there for other purposes, it must close on shut down under a provision in Part J6.

3.3.2.5 Construction of ceilings, walls and floors

Clause J5D7 is intended to limit air leakage through gaps at the junctions of each element and around openings, such as between a window or door frame and a wall lining. It applies to the external fabric elements of the building such as ceilings, walls and floors and any opening in those elements when they form part of the envelope in any climate zone or in climate zones 4, 5, 6, 7 and 8.

In most instances, conventional internal fixing and finishing procedures will be sufficient to comply with the required seal, provided the linings are close fitting and trimmed by skirtings, architraves, cornices and the like.

Alert

What does close fitting mean?

If we consider that doors and windows require a compression seal, it is easy to see that the gap around a window or door when closed is not considered acceptable. Therefore, a reasonable interpretation of 'close fitting' could be a gap less than that between the compressible seal of a closed window or door and the associated frame.

It is noted that some lining systems, such as plasterboard, require gaps to allow for movement of sheeting. In such instances, skirtings will be required to seal the wall and floor junctions where a fitted floor is installed and there are gaps between the subfloor and internal space. However, if the floor was a concrete slab or platform particleboard flooring then no gap would exist between the internal and external spaces and sealing is not necessary. Where it is not possible to have close fitting junctions or penetrations, expanding foam, caulking, rubber compressible strip etc. may be used to seal the gap.

As mentioned earlier, in most instances this requirement will be addressed by conventional construction practices i.e. no additional requirements will be required to seal the internal space from the external space. Where gaps occur, and architraves, skirtings or cornices are not being used, it is necessary to seal any opening with caulking or other flexible sealant if the gaps are considered to be excessive.

3.3.2.6 Evaporative coolers

Clause J5D8 requires evaporative coolers to have self-closing dampers to prevent loss of heated air in those climates where heating may be needed in the winter. Typically, this would occur in climate zones 4, 5, 6, 7 and 8. However, dampers are also required in any climate zone if the space served by the evaporative cooler has a heating system, even if the space is non-habitable. This is because heated air would otherwise leak through the unsealed cooler or its ductwork.

3.3.3 Part J6 Air-conditioning and ventilation

3.3.3.1 Air-conditioning system control

J6D3 relates to a system that provides air-conditioning.

It should be noted that the NCC cannot mandate operational or administrative matters such as the set point for temperature control devices, nor would it be practical to do so. It can only require that temperature control devices be installed.

Note that J6D3 relates to air-conditioning units and systems so the floor area measured would only be that for the space served by that air-conditioning unit or system and not include non-conditioned corridors, toilets, plant rooms and the like.

Control

Clause J6D3(1) relates to the control requirements for air-conditioning systems so that the consumption of energy is limited.

Subclause J6D3(1)(a) requires controls to deactivate the air-conditioning system when a building or part of a building is unoccupied. The system is intended to deactivate only where the building or part of the building served by the air-conditioning system is not occupied. For example, if an air-conditioning system serves a whole building, it is only required to be capable of being deactivated when the whole building is unoccupied. Similarly, if an air-conditioning system only serves a single floor of a building, the system must be capable of being deactivated when that floor of the building is unoccupied. It is likely this clause will require the operational arrangements of the air-conditioning system to be designed based on logical building layouts.

Subclause J6D3(1)(b)(i) outlines that when one space has different thermal characteristics to another space, and both are conditioned by the same air-conditioner, it is necessary to provide separate temperature control of each space so as not to increase energy usage due to over heating or cooling.

For example, consider the differing thermal characteristics between a south and east facing room due to the differing solar gains received. If the temperature sensor is in the east facing room, it may activate a higher level of cooling than the south facing room may require. This may result in the south facing room being cooler than desired. An additional temperature control device will allow separate control of the space, facilitating reduced energy use.

Subclause J6D3(1)(b)(ii) requires the temperature control of the air-conditioning system to not depend on mixing heated and cooled air streams that have been actively conditioned by the plant. This requirement allows the air-conditioning system to use no more energy than is necessary.

Subclause J6D3(1)(b)(iii) contains restrictions on reheating the supply air. These requirements are intended to encourage the grouping of areas with similar loads (heating and cooling demand), rather than sub-cooling all the supply air and reheating excessively to achieve the desired temperature. Subclause J6D3(1)(b)(iii)(A) outlines that where a separate reheat device is provided; the supply air temperature must not increase by more than 7.5 K at the full supply air rate. The 7.5 K limit on temperature rise allows for some trim heating of cold air supply but within reasonable limits.

Reminder

The kelvin is the primary unit of temperature measurement in the physical sciences and is often used in conjunction with the degree Celsius which has the same magnitude (i.e. an increase of 7.5 K is the same as an increase of 7.5°C).

Subclause J6D3(1)(b)(iii)(B) outlines that the allowable temperature rise can be determined by using an inverse relationship between allowable temperature rise and supply air rate. If, during the reheating, the supply air rate is also reduced then the temperature rise can be proportionally increased above 7.5K at the same rate that the supply air rate has been reduced. For example, the reheat temperature could be increased to 10K when the supply air rate is reduced by 25% or increased to 15K if the supply air rate is reduced by 50%.

Subclause J6D3(1)(c) requires outdoor air economy cycles to be provided, however, buildings in climate zone 1 or an area needing humidity control for process applications are exempt. If the air flow rate of an air-conditioning system is greater than or equal to the figures in Table J6D3, then this subclause applies. For example, if an air-conditioning system in climate zone 2 has a total air flow rate equal to or larger than 9000 L/s then an outdoor air economy cycle must be provided. The outdoor air economy cycle is designed to bring in larger quantities of outdoor air for conditioning when the ambient enthalpy conditions are suitable. This typically means that in the summer cooling season during times when the ambient temperature/humidity conditions are lower than the return air condition then outdoor air economy cycle can be used to minimise energy usage to cool the air.

In this case, the air-conditioning unit capacity means the capacity of each air-conditioner serving a space, not the combination of all units serving a space, because an outdoor air economy cycle is cost effective only in a unit larger than the stated capacities.

Outdoor air economy cycles can be cost effective in partially occupied Class 6 restaurants or cafes and some Class 9b buildings. However, when the occupancy of a building is less than one person per square metre, the amount of outdoor air required by Part F6 could be so great that an outdoor air economy cycle would admit only a small additional amount of air. Should this be the case, the added cost of the dampers and controls, as well as the added pressure drops, may not be justified for the energy saving returned and a performance-based solution verifying that an outdoor air economy cycle is not required may be appropriate.

An exemption is granted to applications that require humidity control for a specific process related application within the building or a building that is in climate zone 1. It is considered the additional cost and energy use of humidification or activation of a dehumidification plant offsets any benefit of free cooling from outdoor air economy cycle. Additionally, the amount of time throughout the year where an outdoor air economy cycle for buildings within climate zone 1 would be practical is minimal, due to high temperatures and humidity.

Subclause J6D3(1)(d) requires the water flow through items such as water heaters, chillers and coils to be stopped when the item is not operating. This is usually achieved by an automatic valve. This requirement applies only when there is more than one water heater, chiller or coil in the air-conditioning system. This will reduce the pump energy consumption by preventing water being circulated unnecessarily and reducing energy associated with losses from pumping water through equipment that is not operational. In addition, thermal losses through pipework and components will be reduced.

Subclause J6D3(1)(e) outlines that a variable speed fan must be used when the supply air quantity is capable of being varied. This is because a variable speed fan is a more energy efficient method of reducing energy consumption when compared to throttling the air supply with dampers. An air-conditioning system with an airflow less than 1000 L/s is exempt.

Subclause J6D3(1)(f) requires the air-conditioning unit or system to stop when a door to a balcony, patio, or courtyard of a SOU of a Class 3 building is open for more than one minute. This can be achieved by an electric power micro-switch/ reed switch on the door. The one minute timing allows for people to open and close the door without the air-conditioning stopping and starting each time. However, if the door is left open for more than one minute, it ensures that the air-conditioning does not continue to operate and leak conditioned air.

Subclause J6D3(1)(g) requires air-conditioning systems to have coordinated control from central plant through to zone and room controls. The term “direct signals” means that the information comes directly from the components within the building such as temperature sensors or control valves. Direct signals help to regulate the operation and set-points of central plant in coordination with the needs of the building, rather than operating central services as a continuous provision that can be used when required.

Subclause J6D3(1)(h) requires that the air-conditioning system has a control dead band greater than or equal to 2°C. A dead band is the temperature band between the set points for heating and cooling that automatically control the system. Within the dead band the system is not operating, and therefore using no energy. An air-conditioning system where a smaller range is required for specialised applications is exempt.

Subclause J6D3(1)(i) outlines that the maximum design air or fluid flow is achieved but not exceeded by more than 15% above design at each component. If a common control system contains multiple components as required to meet the needs of the system at its maximum operating condition, the maximum design air or fluid flow is achieved but not exceeded by more than 15% above design at each group of components. To meet the requirements of the subclause, balancing dampers and balancing values must be provided. Balancing dampers and valves are designed to regulate airflow within ducts and air-handling equipment. This clause requires designers to consider the inclusion of components that are allow for appropriate commissioning of building HVAC systems.

Subclause J6D3(1)(j) requires that airflow can be stopped in independent operating spaces of more than 1000 m^2 and each separate floor of the building without interrupting the remaining areas of the air-conditioning system. The system must be capable of allowing for different operating times when terminating airflow in independent areas. For example, if an air-conditioning system serves a Class 5 office building with different work zones or business on the same floor, the airflow to each business or work zone must be capable of stopping without interrupting the air-conditioning of the remaining work zones or businesses. This is typically done with dampers and variable speed drives on plant to reduce air flow.

Subclause J6D3(1)(k) outlines that an air-conditioning system's heated water and chilled water circuits must have automatic variable temperature operation. When operated at variable temperature, chillers and boilers have the potential for improved efficiency operation. This can be implemented via a temperature reset control strategy.

Subclause J6D3(1)(l) requires any motorised outdoor air or return air dampers to close when the system is deactivated if it is not being actively closed through the BMS. It does not require that the dampers be motorised, only that if motorised dampers are installed, they close. This requirement is to reduce the uncontrolled infiltration of outside air into the building during periods when air-conditioning systems are not in operation.

Same space control

Subclause J6D3(2) requires that air-conditioning systems must use control sequences to prevent the systems from operating in opposing heating and cooling modes when two or more systems serve the same space. This is commonly the case when supplementary systems to suit a fit out are added to base building systems. For example, if two FCUs are serving the same teaching room in an education building, controls should be in place to prevent them from operating in opposing modes.

Time switches

J6D4(4) specifies the requirements for time switch control of power supply to air-conditioning systems. The intent is to reduce unnecessary energy consumption attributable to the system when it is not being used.

Air-conditioning systems greater than 2 kW and heaters greater than 1 kW used for air-conditioning must be provided with time switches that can activate and de-activate the respective system. Controls are readily available with minimal associated cost to suit the requirements of this clause. Many units can be supplied with in-built controllers. At variable pre-programmed times and on variable pre-programmed days, the time switch must be capable of switching electric power on and off. Examples where pre-programmed days and times need to be changed may include changes with daylight savings or buildings where the occupancy is variable throughout the year such as for education facilities.

J6D3(3)(c) grants exemptions for time switches for an air-conditioning system serving a single SOU in a Class 3 or 9c building. This exemption recognises that where a space is served by a small system, the system is likely to be under the control of the occupants who would determine when the system should operate and therefore could effectively control the system manually. There is also an exemption for a building where air-conditioning is needed for 24 hour continued use, such as a hospital emergency room.

3.3.3.2 Mechanical ventilation system control

J6D4 relates to a system that provides mechanical ventilation.

It should be noted that the NCC cannot mandate operational or administrative matters such as the pre-programmed times for time switches, nor would it be practical to do so. It can only require that time switches be installed.

General

J6D4(1) relates to the control requirements for mechanical ventilation systems so that the consumption of energy is limited. The mechanical ventilation system may be part of an air-conditioning system described in J6D3 or may be a separate mechanical ventilation system such as a carpark mechanical ventilation system.

J6D4(1)(a) is intended to only apply when the building or part of a building served by the mechanical ventilation system is unoccupied. For example, if a mechanical ventilation system serves a whole building, it is only required to be capable of being deactivated when the whole building is unoccupied. Similarly, if a mechanical ventilation system only serves a single floor of a building, the system must be capable of being deactivated when that part of the building is unoccupied.

J6D4(1)(b) contains specific requirements for when a mechanical ventilation system serves a conditioned space. Periods where evaporative cooling is being used are excluded as there are potential issues with increased humidity.

J6D4(1)(b)(i) requires that the mechanical ventilation system have either an energy reclaiming system that preconditions outdoor air at a minimum sensible heat transfer effectiveness of 60% or demand control ventilation in accordance with AS 1668.2.

The required measures for J6D4(1)(b)(i) are specified in Table J6D4. As an example, if a mechanical ventilation system in climate zone 3 has an outdoor air flow greater than 1000 L/s, a modulating control device is required.

J6D4(1)(b)(ii) requires that the outdoor air requirement of Part F6 not be exceeded by more than 20% when serving a conditioned space. This value is to provide the designers some flexibility when supplying a series of spaces from one system. Where there is a need for more outdoor air for one space, it may be appropriate that a dedicated system be installed for that space. There are many exemptions for requirement J6D4(1)(b)(ii) including:

- situations where additional unconditioned outdoor air is supplied for free cooling as part of an outdoor air economy cycle
- situations where e is needed to balance the required exhaust or process exhaust. This may occur in areas such as toilets or bathrooms which have high exhaust rates to remove contaminated air or to balance process exhausts such as those used in a health care building or laboratory
- situations where an energy reclaiming system preconditions all outdoor air are exempt..
-

Reminder

Part F6 of NCC Volume One contains requirements for certain rooms contained in buildings to be subjected to ventilation, whether it be via natural or mechanical means.

J6D4(1)(c) requires a larger mechanical ventilation system with a high airflow rate of more than 1000 L/s to have a variable speed fan when the supply air quantity is capable of being varied. Varying the fan speed to suit demand will minimise energy consumption. Fans whose airflow is required to be constant by Part F6 are exempt.

Exhaust systems

J6D4(2) contains requirements for exhaust systems.

An exhaust system with an air-flow rate of more than 1000 L/s must be capable of stopping the motor when the system is not needed to reduce energy consumption.

The requirements do not apply to a miscellaneous exhaust system serving an SOU in a Class 3 or Class 9c building.

Consideration should be given to situations where safety is an issue, such as the exhaust from a chemical storage cabinet. Likewise, it may be more appropriate that fume hoods in some situations operate on a reduced flow, while in other situations operate at full flow. A Performance Solution may be considered more appropriate in such situations.

The required minimum ventilation rates take precedence over energy efficiency measures. Therefore, exhaust systems that must balance the intake of outdoor air required for ventilation are exempt. This is because there are no opportunities to stop the motor in these systems.

Carpark exhaust systems

J6D4(3) requires that carpark exhaust systems have an atmospheric contaminant monitoring system and control in accordance with AS 1668.2. Monitoring of atmospheric contaminants, typically carbon monoxide, is required to allow for variable speed operation of carpark supply and exhaust fans to provide energy efficient operation of the systems.

Carpark exhaust systems can be controlled in accordance with 4.11.2 or 4.11.3 of AS 1668.2 under J6D4(3). The former requires ventilation rates to be varied in a prescribed manner based on the concentration of atmospheric contaminants in the carpark. The latter provides a simpler method for use with small carparks with 40 or fewer spaces. This ventilation rate variation should be done using a variable speed fan in conjunction with the requirement of J6D4(1)(c).

Time switches

J6D4(4) specifies the requirements for time switch control of power supply to mechanical ventilation systems. The intent is to reduce unnecessary energy consumption attributable to the system when it is not being used.

Mechanical ventilation systems with an air flow rate of more than 1000 L/s are required to be provided with a time switch. The time switch is to be capable of activating and deactivating the respective system at variable pre-programmed times and days.

J6D4(4)(c) grants exemptions for time switches for a mechanical ventilation system serving a single SOU in a Class 3 or Class 9c building. This exemption recognises that the system is likely to be under the control of the occupants who would determine when the system should operate and therefore could effectively control the system manually.

There is also an exemption in J6D4(4)(c)(ii) for a building where mechanical ventilation is needed for 24-hour occupancy such as a hospital emergency room or factory. In such cases a time switch would serve no purpose.

3.3.3.3 Fan and duct systems

J6D5 sets out requirements for fans, ductwork and duct components used as part of an air-conditioning system or mechanical ventilation system.

Methods of compliance

There are two options to demonstrate that a fan system that forms part of an air-conditioning or mechanical ventilation system is compliant with J6D5.

J6D5(1) outlines the first option. Fans, ductwork, and duct components must separately comply with subclauses (2), (3), (4) and (5). In other words, each of the individual components of a fan system must be individually more efficient than the values specified in J6D5.

J6D5(1)(b) specifies the second option for a whole-of-fan-system compliance. The fan motor input power per unit of flowrate (e.g. W/L/s) must be lower than the fan motor input power per unit of flowrate achieved if the system was designed in accordance with subclauses (2), (3), (4) and (5) together. In other words, the fan system as a whole must be more efficient than a system that is designed to meet the individual component requirements.

Whole-of-system compliance allows for increased flexibility when design constraints prevent individual component level DTS metrics from being met, without the need for a Performance Solution.

Fans

J6D5(2) outlines the efficiency requirements for a system's fan. Separate options are provided for fans with static pressure above and below 200 Pa to encourage designers to minimise static pressure where suitable, as this contributes to energy savings.

J6D5(2)(a) requires that the overall static efficiency at Best Efficiency Point (BEP) must be more than $0.13 \times \ln(p) - 0.3$ for fans in systems that have a static pressure of less than 200 Pa. This equation refers to the natural logarithm and the fan's static pressure requirement in pascals. Static pressure is the overall resistance to airflow that the fan is required to overcome. The static efficiency at BEP is the ratio of the fan power output to the power supplied to the fan.

For fans with a static pressure above 200 Pa, J6D5(2)(c) nominates the required efficiency of a fan at the full load operating point. The clause uses a regression formula, based on the fan input power, minimum fan performance grade and two regression coefficients to specify a suitably efficient fan. Table J6D5a, Table J6D5b and Table J6D5c provide the minimum fan performance grade and regression coefficients based on fan type, fan installation arrangement and fan power. Calculation requires an iterative approach since the motor power is dependent on the efficiency and is also an input to the efficiency calculation. This allows the most appropriate fan to be selected for the application when total system design, configuration and pressure are considered.

Axial fans use blades rotating around an axis to draw air in parallel to that axis and force air out in the same direction. Axial fans are often used in ductwork as components of return air, exhaust air or supply air systems.

Mixed flow fans incorporate elements of axial fans and centrifugal fans so that the air flows in both axial and radial direction relative to the shaft. These are commonly used in smaller ventilation systems.

Centrifugal fans are a mechanical device that increases the volume of an airstream by impellers, a series of blades mounted on a circular hub, which in turn accelerates air radially and alters the direction of the outward flowing air, typically by 90 degrees. These are commonly used in scenarios where a higher static pressure is required, such as air-handling units (AHUs).

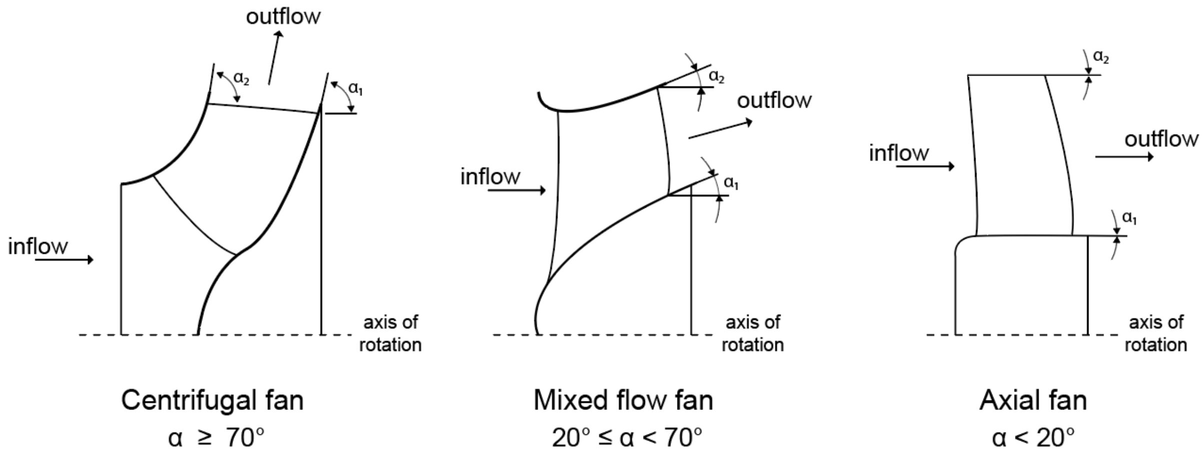
Centrifugal forward-curved fans have impellers with forward blades that are curved in the direction of wheel rotation.

Centrifugal radial bladed fans have impellers with multiple equally spaced flat blades that extend in a perpendicular direction to wheel rotation.

Centrifugal backward-curved fans have impellers with blades that are curved in the direction opposite to wheel rotation. Plug in fans are typically backward curved centrifugal fans.

FPREN 17166 2019 (a Standard for Fans – Procedures and methods to determine the energy efficiency for the electrical input power range of 125 W up to 500 kW) provides further clarification on the differentiation of fan types described in Figure 3.3.15 below.

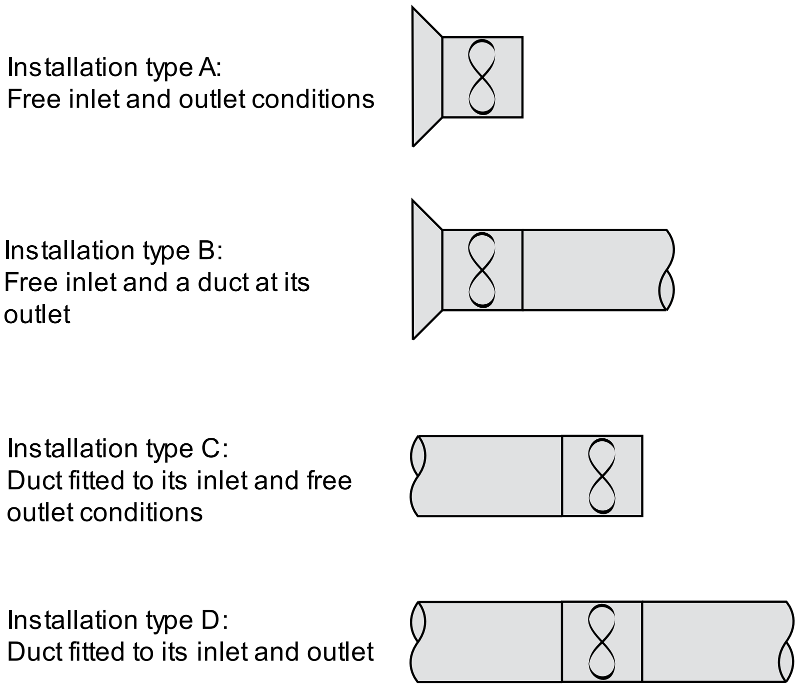
Figure 3.3.15 Fan type differentiation by angles



There are 4 installation types in J6D5(2) that affect the calculation of the minimum efficiency: A, B, C and D.

- Installation type A refers to an arrangement where the fan is installed with free inlet and outlet conditions.
- Installation type B refers to an arrangement where the fan is installed with a free inlet and a duct at its outlet.
- Installation type C refers to an arrangement where the fan is installed with a duct fitted to its inlet and with free outlet conditions respectively.
- Installation type D refers to an arrangement where the fan is installed with a duct fitted to its inlet and outlet.

Figure 3.3.16 Installation types A, B, C and D



Installation types A and C require a minimum required system static efficiency, while installation types B and D require a minimum required system total efficiency.

J6D5(2)(e) exempts fans that are required to be explosion proof from the requirements of J6D5(2). Examples of fans that are required to be explosion proof may include fans located in dangerous goods areas. In these cases, safety overrides energy efficiency requirements.

Ductwork

J6D5(3)(a) nominates that the average pressure drop for flexible ductwork and straight segments of rigid ductwork in the index run of a fan system must not exceed 1 Pa/m. The index run is the path within the air duct system with the greatest pressure drop. As the requirement is for the average pressure drop, localised sections may exceed 1 Pa/m if these gains are traded off with lower losses elsewhere in the system. For this calculation, the pressure drop of flexible ductwork sections may be calculated as if the flexible ductwork is in a straight configuration, i.e. 6m of flexible ductwork with bends is equal to 6m of flexible ductwork laid straight.

J6D5(3)(b) limits flexible ductwork to a maximum of 6 m in length in any duct run. The excessive use of flexible ductwork can introduce the risk of a heightened pressure drop.

J6D5(3)(c) disallows ductwork bends, elbows and tees in the index run that have a smaller effective diameter than the upstream duct section they are connected to. Such fittings have substantial pressure drops. Reducing bends are permissible.

J6D5(3)(d) requires rigid ductwork elbows of 90° or less (e.g. a sharp 45° bend) include turning vanes, except where turning vanes would present a fouling risk (i.e. potential for particulates to build up affecting the characteristics of the duct) or where it is a long radius bend in accordance with AS 4254.2. Turning vanes assist the airflow in making a smoother and more gradual change in direction, reducing energy lost due to abrupt changes in direction.

Ductwork components in the index run

J6D5(4), Table J6D5d and Table J6D5e specify the maximum allowable pressure losses of components in a ductwork system. For ease of clarification, these have been simplified into Table 3.38 below.

Table 3.38 Maximum allowable pressure losses of components in a ductwork system

Subclause	Location	Maximum pressure drop (Pa)	Clarifications
J6D5(4)(a)	Across a coil	Specified in Table J6D5d	Specified in Table J6D5d
J6D5(4)(a)	(1 row)	30	
J6D5(4)(a)	(2 rows)	50	
J6D5(4)(a)	(4 rows)	90	
J6D5(4)(a)	(6 rows)	130	
J6D5(4)(a)	(8 rows)	175	
J6D5(4)(a)	(10 rows)	220	
J6D5(4)(b)(i)	HEPA air filters	200	When clean
J6D5(4)(b)(ii)	HEPA air filters at an air velocity of 1.5 m/s	Filter design pressure drop	When clean
J6D5(4)(c)(i)	Filters other than a HEPA filter	Specified in Table J6D5e	Specified in Table J6D5e
J6D5(4)(c)(i)	MERV = 9	55	When clean
J6D5(4)(c)(i)	MERV = 11	65	When clean
J6D5(4)(c)(i)	MERV = 13	95	When clean
J6D5(4)(c)(i)	MERV = 14	110	When clean

Subclause	Location	Maximum pressure drop (Pa)	Clarifications
J6D5(4)(c)(i)	Filters other than a HEPA filter at an air velocity of 2.5 m/s	Filter design pressure drop	When clean
J6D5(4)(d)(i)	Single stage intake louvres	30	
J6D5(4)(d)(ii)	Two stage intake louvres	60	
J6D5(4)(d)(iii)	Acoustic intake louvres	50	
J6D5(4)(d)(iv)	Non-weatherproof intake louvres	30	
J6D5(4)(e)(i)	VAV boxes for units with electric reheat	100	
J6D5(4)(e)(ii)	VAV boxes for other units	25	Not including coil pressure losses
J6D5(4)(f)	Rooftop cowls	30	
J6D5(4)(g)	Attenuators	40	Use of multiple attenuators in series is not permitted
J6D5(4)(h)	Fire dampers	15	When open
J6D5(4)(i)	Balancing and control dampers in the index run	25	When in a fully open position
J6D5(4)(j)	Supply air diffusers and grilles	40	
J6D5(4)(k)	Exhaust grilles	30	
J6D5(4)(l)	Transfer ducts	12	
J6D5(4)(m)	Door grilles	12	
J6D5(4)(n)	Active chilled beams	150	

Where the pressure loss of a component exceeds the allowance provided in J6D5(4), compliance using J6D5(1)(b) may be demonstrated through another section's pressure drop being below its allowance by an equivalent amount. For example, throw diffusers are likely to have a higher pressure drop than specified in J6D5(4), and can therefore be offset by savings elsewhere. AS 1324 and AS 1668.2 provide pressure drop values that may be used as the basis of a Performance Solution or subclause J6D5(1)(b).

Note that the allowances for grilles do not include any balancing dampers that may be included within the grille.

Exemptions

J6D5(5) includes some exemptions to subclauses (1), (2), (3) and (4), as the requirements are not appropriate for all fan systems. These exemptions include fans in an air-conditioning system that is unducted and has a supply air capacity smaller than 1000 L/s, kitchen exhaust systems and the power for process-related components. Smoke spill fans are also exempt, except in cases where they are used for air-conditioning or ventilation. In these cases, other requirements take precedence over energy efficiency.

Fan System Calculator

The ABCB has developed a Fan System Calculator for NCC users to assist with demonstrating compliance with the NCC fan system provisions. The calculator is available on the ABCB website.

3.3.3.4 Ductwork insulation

To reduce energy loss, ductwork and fittings in an air-conditioning system need to be insulated. The insulating requirements do not apply to ventilation ductwork where the air is not heated or cooled (such as the return air), as the temperature of this air does not need to be maintained.

Ductwork and fittings

J6D6(1) outlines the basic requirements for insulation. Under J6D6(1)(a), insulation must comply with the requirements of AS/NZS 4859.1 which covers the technical requirements for insulation.

Alert

AS 4859.1 is the Australian Standard for, “General criteria and technical requirements of materials for the thermal insulation of buildings” and covers testing, installation, and calculations. The Standard specifies requirements and methods of test for materials that are added to, or incorporated in, opaque envelopes of buildings and building services, including ductwork and pipework, to provide thermal insulation by moderating the flow of heat through these envelopes and building services. DTS Provisions are based on AS 4859.1 calculation methods.

J6D6(1)(b) specifies the minimum material R-Values of flexible ductwork, cushion boxes and other ductwork and fittings. A lower R-Value is allowed for flexible ductwork to account for the greater practicality of insulating solid ductwork. As the amount of flexible ductwork in a system is limited by J6D5(3)(b), it will only have a small impact upon the system as a whole. Cushion boxes and other ductwork requires the insulation levels listed in Table J6D6. These vary depending on the conditions that the ductwork is exposed to, indicating that there are greater energy losses in more severe conditions (i.e. when exposed to sunlight).

Note that the insulation levels in Table J6D6 are minimum material R-Values of the added insulation only. The R-Values are based on the location and climate zone of the installed ductwork and fittings.

Integrity of the insulation barrier

J6D6(2) outlines the specific requirements of the ductwork insulation.

J6D6(2)(a) specifies that the insulation must be protected against the effects of weather and sunlight. A typical design life of insulation is between 5 to 10 years. Lack of protection to the effects of weather and sunlight will drastically reduce the design life, and in turn its insulating properties. This protection may be achieved by ensuring that the insulation is enclosed in protective sheathing such as formed metal sheeting, external grade plastics or other similar material.

J6D6(2)(b) requires insulation to be installed so that it forms a continuous barrier by abutting adjoining insulation. This limits heat loss or gain through any gaps in the insulation. The insulation should also maintain its position and thickness other than at flanges and supports. Any compression of insulation can reduce its effectiveness.

J6D6(2)(c)(i) requires a vapour barrier (such as duct tape or other impervious seals) to be installed around the insulation on ductwork that carries cold air. This vapour barrier controls the level of condensation resulting from the cold surface. Condensing moisture can saturate the insulation, which reduces its effectiveness and causes it to deteriorate.

J6D6(2)(c)(ii) states that where the vapour barrier is used as a membrane, it must overlap by 50 mm and be bonded or taped together to ensure the vapour barrier membrane can function as intended.

Exemptions

J6D6(3) exempts situations where ductwork and fittings do not need to be in accordance with the requirements of J6D6(1) as there are cases where it may be impractical or pointless to do so.

Alert

Combustibility of duct materials

NCC Volume One - Specification 7, Clause 5 requires flexible ductwork to comply with the fire hazard properties set out in AS 4254.1 and AS 4254.2. Compliance with these Standards should be validated by appropriate test reports in accordance with Clause A2.2 of the NCC.

J6D6(3)(a) exempts the insulation requirements from ductwork and fittings located within the only room or last room served. It is implied that the heating or cooling effect is intended for that room anyway and therefore insulation in unnecessary. However, if a room where the ductwork is not insulated is sub-divided, the insulation will then need to be added to the ductwork that passes through the first sub-divided room to serve the second sub-divided room. Examples where this should be considered are parts of a building or storey likely to be sub-divided as part of a fit-out such as an office.

J6D6(3)(b) exempts fittings that form the interface with the conditioned space as there would be minimal heat transfer occurring from these fittings. Examples include air registers, diffusers, outlets, and grilles. This, however, does not exempt cushion boxes, which are specifically included by J6D6(1)(b)(ii).

J6D6(3)(c) exempts the minimum insulation requirements from return air ductwork in, or passing through, a conditioned space. There would be no heat transfer across the ductwork in these areas as the air temperature would be the same in both the duct and the conditioned space.

J6D6(3)(d) exempts ductwork containing unconditioned outdoor air or exhaust air ductwork where the air is to be discarded. There would be no benefit gained, in terms of reducing energy consumption, by requiring insulation to be installed on this ductwork as the air is to be discarded and not reused. In some cases, designers may choose to insulate this ductwork to reduce condensation, but this is at their discretion and outside the scope of the energy efficiency requirements.

J6D6(3)(e) exempts the floor of an in-situ AHU from the insulation requirements of J6D6(1) on the basis that the heating or cooling effect is intended for that location anyway.

J6D6(3)(f) exempts air-conditioning equipment that complies with MEPS.

Reminder

MEPS means the Minimum Energy Performance Standards.

J6D6(3)(g) exempts flexible fan connections.

Alert

Note that air-handling ductwork must also comply with Clause S7C5 of Specification 7 in NCC Volume One, which requires the fire hazard properties of ductwork to comply with AS 4254.1 and AS 4254.2.

The application of the ductwork insulation requirements is shown in the worked example in Appendix D.

Fittings

For the purposes of J6D6(1), (2) and (3), ‘fittings’ includes passive or static components of a ductwork system and excludes active components of a ductwork system such as those used in an AHU.

Passive or static components of a ductwork system include items such as plenums, bends, branches, transitions, reducers, offsets, spigots, cushion heads, attenuators and fixed air balance dampers. These passive or static components of a ductwork system must therefore meet the insulation requirements of section J6D6.

Active components may include VAV boxes, electric duct heaters, actuated volume control dampers, access panels and doors, fire and smoke dampers, fans or humidifiers. These components often move or require regular access which would make insulation on the components impractical. Therefore, active components of a ductwork system are exempt from the insulation requirements of section J6D6.

3.3.3.5 Ductwork sealing

Unsealed joints in air-conditioning ductwork allows heated or cooled air to leak. J6D7 requires that ductwork must be sealed in accordance with AS 4254.1 and AS 4254.2 for the static pressure in the system. Sealing methods include adhesives, mastics, sealants, gaskets or the like. These requirements do not apply to ventilation ductwork where the air is not heated or cooled.

Alert

AS 4254 is the Australian Standard for, “Ductwork for air-handling systems in buildings”. Part One of the standard includes requirements for materials, construction and installation, including some aspects of performance, for flexible duct for air-handling systems in buildings and facilities.

The requirements only apply to duct systems with a capacity of 3000 L/s or greater.

The duct leakage tests of clause 2.2.4 of AS 4254.2 are included in this requirement. The key purpose of this is to ensure that there are no major leaks, such as uncapped spigots or similar, in the system. Construction errors of this nature can cause extreme leakage rates in some systems, severely compromising system performance.

3.3.3.6 Pump systems

J6D8 specifies two options for demonstrating compliance for pump systems that form part of an air-conditioning system.

One option is to demonstrate that each individual component within the pump system is individually more efficient than the values specified in J6D8. This allows for a relatively simple comparison against a DTS efficiency value for each component of the pump system.

Alternatively, demonstrating that the pump system (as a whole) is more efficient than a comparative pump system (also as a whole) designed to meet all individual DTS requirements. This allows for increased flexibility when design constraints prevent the individual component level metrics from being met, without the need for a J1V3 calculation or other Performance Solution.

General

The two options for demonstrating compliance are specified in J6D8(1).

J6D8(1)(a) specifies the option for component-level compliance and requires compliance with each of J6D8(2), (3) and (4).

J6D8(1)(b) outlines the option for whole-of-system compliance. The designed pump motor power per unit of flowrate (e.g. W/L/s) of the pump in the system must be lower than that as if the system was designed in accordance with J6D8(2), (3) and (4). In other words, the pump system (as a whole) must be more efficient than a system designed to meet the individual component requirements. If a pump system is compliant with J6D8(1)(b), it does not need to comply with J6D8(2), (3) or (4). For situations where certain reticulation configurations do not meet the requirements of J6D8(1)(a), this method would be appropriate.

Calculation requires an iterative approach since the motor power is dependent on the efficiency and is also an input to the efficiency calculation. This allows the most appropriate pump to be selected for the application when total system design, configuration and pressure are considered.

Circulator pumps

J6D8(2) specifies the efficiency requirements for circulator pumps that form part of an air-conditioning system. J6D8(3) is a requirement if the component-level compliance option of J6D8(1)(a) is used.

J6D8(2) applies to glandless impeller pumps used in a closed loop system with a rated hydraulic power output below 2.5 kW. The clause specifies that the glandless impeller pump must have an energy efficiency index (EEI) of less than or equal to 0.27. The EEI must be calculated in accordance with European Union Commission Regulation No. 622/2012.

The EEI compares the weighted average power with a calculated reference. This reference is calibrated such that only 20% of circulators or a certain type have an EEI less than or equal to 0.20. The lower the EEI, the less energy the circulator uses. The EEI is a characteristic of the pump, and so should be included in the data provided by pump manufacturers.

A Pump System Calculator has been developed by the ABCB to aid in the EEI calculations. The calculator is available on the ABCB website.

Alert

The European Union Commission Regulation No. 622/2012 is the regulation for eco-design requirements for glandless standalone circulators and glandless circulators integrated in products. It provides the calculation methods to determine the EEI for circulator pumps.

Other pumps

J6D8(3) nominates the efficiency requirements of other pumps that form part of an air-conditioning system. J6D8(3) is a requirement if the component-level compliance option of J6D8(1)(a) is used.

The clause applies to pumps not covered by J6D8(2). The clause specifies that the pump must have a Minimum Efficiency Index of at least 0.4. The Minimum Efficiency Index must be calculated in accordance with European Union Commission Regulation No. 547/2012.

The Minimum Efficiency Index (MEI) is a dimensionless comparator which indicates the minimum efficiency required for a pump. The MEI does not directly correlate to an efficiency value, but to the value of a constant within an equation in European Commission Regulation No. 547/2012 which then determines the minimum efficiency. Unlike the EEI for circulator pumps, a greater MEI indicates a greater efficiency and thus less energy use.

A Pump System Calculator has been developed by the ABCB to aid in the MEI calculations. The calculator is available on the ABCB website.

It is intended that almost all pumps are covered by either European Union Commission Regulation No. 622/2012 or No. 547/2012. If a pump is not covered, a Performance Solution may be appropriate. The methodology of J6D8(1)(b) could serve as a starting point for such a Performance Solution.

Pipework

J6D8(4) specifies the maximum allowable pressure losses for straight segments of pipework that form part of an air-conditioning system. J6D8(4) is a requirement if the component-level compliance option of J6D8(1)(a) is used.

J6D8(4)(a) specifies the allowable pressure losses attributable to straight segments of pipework, that do not have branches and have a constant flowrate through the entire pipe network (i.e. a non-distributive pipework system). Pressure losses for constant speed systems are listed in Table J6D8a and pressure losses for variable speed systems are listed in Table J6D8b.

J6D8(4)(b) specifies the allowable pressure losses attributable to straight segments of pipework in other pipework systems (i.e. distributive pipework systems). Pressure losses for constant speed systems are listed in Table J6D8c and pressure losses for variable speed systems are listed in Table J6D8d.

The variance of requirements for pressure drops across different types of systems indicate the differences in energy use from these systems. Systems which operate for a shorter period have a smaller aggregate energy use, and so have loosened requirements. Incorporating variable speed control into a system will also reduce the aggregate energy use and allow for a similar loosening of requirements.

References such as CIBSE Guide C (Section 4.4 Water flow in pipes) and AIRAH (Australian Institute of Refrigeration Air-conditioning and Heating) Design Application Manual DA01 Centrifugal Pumps provide details of pump system design that could be used in preparing a Performance Solution.

Exemptions

J6D8(5)(a) exempts the requirements of J6D8(4) from valves and fittings. This is because the average pressure drop in these are largely determined by the functional requirements of the system.

J6D8(5)(b) exempts the requirements of J6D8(4) from the smallest compliant pipework with a velocity of 0.7 m/s or less. This does not refer to the smallest pipework within the proposed design, the exemption refers to the smallest pipework allowable in proposed the design. See the worked example in Appendix D for further clarification.

Pump System Calculator

The ABCB has developed a Pump System Calculator to assist with demonstrating compliance with the NCC pump system provisions. Note that the calculator automatically calculates whether segments of pipe will meet the requirements of J6D8(5). The calculator is available on the ABCB website. Additional advice can be found in the Help Screen of the Calculator.

3.3.3.7 Pipework insulation

J6D9 requires piping, vessels, heat exchangers and tanks that contain heating and cooling fluids that are part of an air-conditioning system to be insulated. Heating fluids include heated water, steam and condensate. Cooling fluids include refrigerant, chilled water, brines and glycol mixtures; but do not include condenser cooling water. Piping, vessels, heat exchangers and tanks that are covered by MEPS are exempt from these requirements.

J6D9(1)(a) specifies that insulation must comply with the requirements of AS/NZS 4859.1.

Alert

AS 4859.1 is the Australian Standard for, “General criteria and technical requirements of materials for the thermal insulation of buildings”. The Standard specifies requirements and methods of test for materials that are added to, or incorporated in, opaque envelopes of buildings and building services, including ductwork and pipework, to provide thermal insulation by moderating the flow of heat through these envelopes and building services. DTS Provisions are based on AS 4859.1 calculation methods.

J6D9(1)(b) specifies the insulation requirements for piping of heating and cooling fluids. Table J6D9a outlines minimum total insulation R-Values based on fluid temperature and a nominal diameter of the water piping. The single required R-Value for each pipe diameter is intended to allow for straightforward installation on-site and compliance to be achieved.

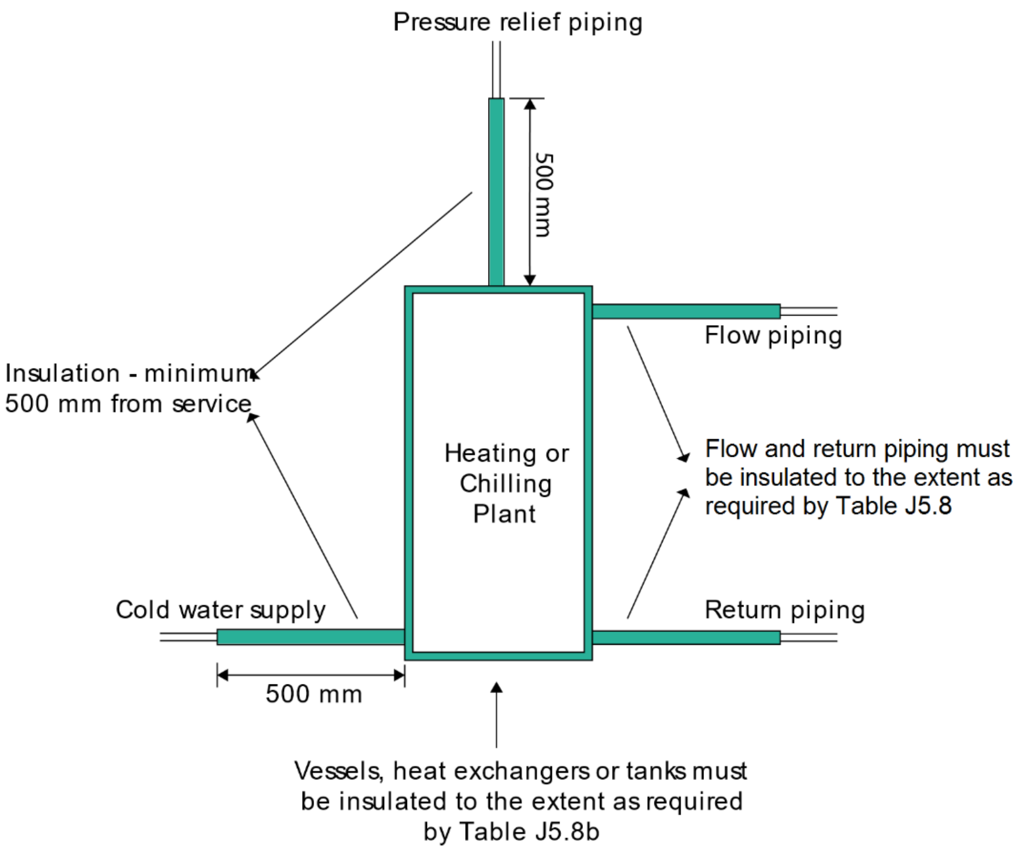
For example, a pipe with a diameter of less than 40 mm carrying a chilled fluid of a temperature above 2°C requires a minimum R-Value for pipework insulation of 1.0, as specified in Table J6D9a.

The note to Table J6D9a outlines scenarios where the required insulation R-Value may be halved. The concession recognises the practical and physical limitations of installing thick insulation to small diameter piping where the pipework penetrates a structural member. Where the pipework penetrates a structural member, piping is only required to have insulation installed that is half of the added R-Value required by S36C2(1).

J6D9(1)(c) outlines that insulation requirements for vessels, heat exchangers and tanks are in Table J6D9b. This table specifies minimum insulation R-Values based on the fluid temperature range.

J6D9(1)(d) specifies that insulation requirements apply to refill and pressure relief piping within 500 mm of the connection to the air-conditioning system. The piping must have an R-Value equal to the required R-Value of the pipe, vessel or tank connected to the piping.

Figure 3.3.17 Insulation of piping serving a heating or cooling system



As an example, pressure relief piping is connected to a 40 mm diameter pipe carrying low temperature chilled water ≤ 2°C. The pipe requires a minimum insulation R-Value of 1.3 and therefore the pressure relief piping, to 500 mm from the connection also requires insulation with R-Value of 1.3.

Note the R-Value is the material R-Value of the insulation and not the Total R-Value of the pipe, air film and insulation. However, where piping has a significant inherent R-Value, it may be subtracted from the material R-Value required. The inherent R-Value of most piping materials, such as copper and steel, is however not sufficient to satisfy the requirements in Table J6D9a.

The insulation types in the following table are typical examples of materials that can be used to insulate piping. The R-Values provided are to be used for guidance only. The R-Values are calculated in accordance with AS/NZS 4859.1 as per the requirement in J6D9(1)(a).

Table 3.39 Typical pipe insulation and corresponding R-values

Insulation	R-Value
13 mm of closed cell polymer	0.6
19 mm of closed cell polymer	0.9
25 mm of closed cell polymer	1.3
25 mm of glass wool	1.3

Weather and temperature protection

J6D9(2)(a) requires insulation to be protected from the effects of weather and sunlight, as these may reduce the insulating properties. A typical design life of insulation is between 5 to 10 years. Lack of protection from the effects of weather and sunlight will drastically reduce the design life, and in turn its insulating properties. This protection may be achieved by ensuring that the insulation is enclosed in protective sheathing such as formed metal sheeting, external grade plastics or other similar material.

J6D9(2)(b) requires insulation to be able to withstand the temperatures within the piping, vessel, heat exchanger or tank, otherwise degradation of the insulation's thermal performance may occur.

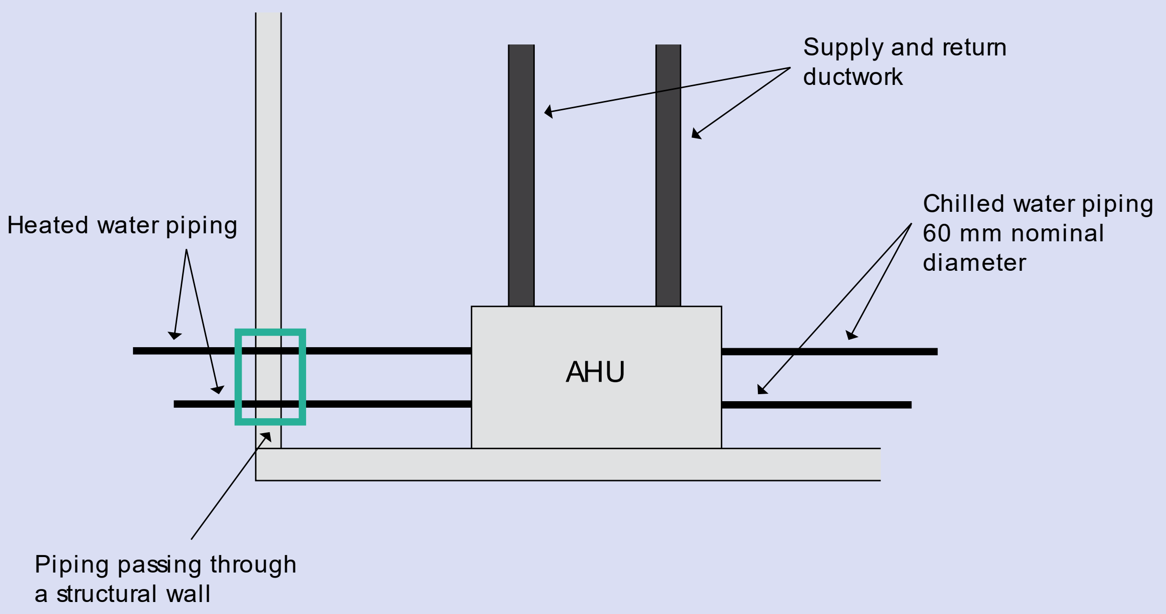
Integrity of the insulation barrier

J6D9(3) requires insulation to be protected by a vapour barrier if the piping, heat exchanger or tank contains a cooling fluid. A vapour barrier helps to reduce the likelihood of condensation problems. Condensation problems can occur when the internal temperature of the piping, heat exchanger or tank is below the dew point of the external air.

Exemptions

- J6D9(4) outlines circumstances when piping, vessels and heat exchangers are exempt from meeting the requirements of J6D9(1) and (2). Exemptions include:
- piping, vessels and heat exchangers located within the last space being heated or cooled as the heating or cooling effect is intended for that space anyway
- piping, vessels and heat exchangers in a slab or panel that is specifically designed as a heating or cooling system, such as an in-slab or in-screed heating or cooling system. This is because the insulation would contradict the aim of the heating or cooling from the piping.
- piping, vessels and heat exchangers that are supplied as part of an item of plant such as a chiller or boiler
- piping, vessels and heat exchangers inside an item of plant such as an AHU, fan coil unit (FCU) or the like.

Figure 3.3.18 Piping insulation requirements



The piping insulation requirements would be as follows.

For heated water piping, insulation with a material R-Value of 1.7 would be required to be installed. However, for the heated water piping section that passes through a structural wall, a concession is available as described in the note to Table J6D9a. This results in a minimum required insulation R-Value of 0.85 for the section of supply and return piping.

The chilled water supply and return piping has a 60 mm nominal diameter. This means an added R-Value of 1.5 is required to be installed on this piping as per Table J6D9a.

Heating and cooling fluid definitions

J6D9(5) provides clarification on heating and cooling fluids for the purposed of J6D9(1), (2), (3) and (4). Heating fluids include refrigerant, heated water, steam and condensate, while cooling fluids include refrigerant, chilled water, brines and glycol mixtures. Cooling fluids do not include condenser cooling water.

Condenser cooling water is exempt from the minimum insulation requirements of this clause due to the limited temperature difference between the piping contents and the surrounding space. This means there would likely be small energy savings achieved compared to the costs of insulation in these circumstances. However, insulation may be installed for reasons other than energy efficiency such as for acoustics, or to minimise the risk of condensation forming.

3.3.3.8 Space heating

Energy sources

Energy sources that may be used for heating a space directly are listed in J6D10(1). All forms of heating described in J6D10(1)(a) to (1)(e) can be used in combination so as not to restrict heating to only one type. This recognises that a combination of heating options may be the most appropriate and cost-effective heating solution and may include a limited amount of electric resistance heating.

J6D10(1)(a) to (c) permit solar heaters, gas heaters or heat pump heaters to be used for air-conditioning or as a part of an air-conditioning system.

J6D10(1)(d) allows reclaimed heat from another process such as from a refrigeration plant and bio-fuels to be used. This reclaimed energy can be used in conjunction with one or more heaters allowed under J6D10.

Electric heating can be used in specific circumstances only as outlined in J6D10(1)(e)(i). A small amount of electric resistance heating is allowed for the floor area of the conditioned space of up to 10 W/m^2 for climate zone 1 and 40 W/m^2 for climate zone 2. The small allowances for climate zones 1 and 2 recognise the likely limited heating required for these mild climates.

J6D10(1)(e)(i)(C) allows larger electric heating allowances in situations where reticulated gas is not available at the allotment boundary. This recognises the likely limited heating options in areas where natural gas is not readily available. The maximum values are specified in Table J6D10 and are again climate zone based. This recognises the limited heating required in temperate climates, compared to cool climates.

J6D10(1)(e)(ii) allows a further exemption for relatively small electric heaters in climate zones 1 to 5 if the annual energy consumption for this heating is not more than 15 kWh/m^2 of the floor area of the conditioned space.

J6D10(1)(e)(iii) places limits on the amount of reheat allowed for an in-duct heater in line with J6D3(1)(b)(iii).

Reminder

Subclause J6D3(1)(b)(iii) contains restrictions on reheating the supply air. These requirements are intended to encourage the grouping of areas with similar loads (heating and cooling demand), rather than sub-cooling all the supply air and reheating excessively to achieve the desired temperature.

J6D3(1)(b)(iii)(A) outlines that where a separate reheat device is provided; the supply air temperature must not increase by more than 7.5 K at the full supply air rate. The 7.5 K limit on temperature rise allows for some trim heating of cold air supply but within reasonable limits.

Subclause J6D3(1)(b)(iii)(B) outlines that the allowable temperature rise can be determined by using an inverse relationship between allowable temperature rise and supply air rate. If, during the reheating, the supply air rate is also reduced then the temperature rise can be proportionally increased above 7.5 K at the same rate that the supply air rate has been reduced. For example, the reheat temperature could be increased to 10 K when the supply air rate is reduced by 25% or increased to 15 K if the supply air rate is reduced by 50%.

Bathroom electric heaters

J6D10(2) permits a small electric heater in a bathroom of a Class 3, Class 9a, or Class 9c aged care building. The system must have a heating capacity of 1.2 kW or less. Typically, this would include small electric heaters such as a 3-in-1 heater, exhaust fan and light system. The heater must be fitted with a means to ensure it will not run excessively when the bathroom is not in use, such as a timer.

Outdoor fixed heating or cooling

J6D10(3) is specifically for fixed outdoor heating and cooling appliances. The clause requires that the appliance must be capable of automatic shutdown when:

- nobody is occupying the space
- a period of one hour has elapsed since the heater was last activated, or
- the space has reached the required temperature.

This may be achieved by an outdoor temperature sensor, timer, motion detector or the like. The requirement aims to limit energy consumption when the service is not needed.

Gas water heaters

J6D10(4) specifies the efficiencies required for a gas fired heater that heats a space via water. Examples of these include units such as a boiler.

The minimum thermal efficiencies are based on the rated gas consumption of the boiler in MJ/hour. There are many testing standards that can be used to demonstrate a unit’s gross thermal efficiency, including BS 7190, ANSI/AHRI 1500 and AS/NZS 5263.1.2. Larger boilers are required to have a greater gross thermal efficiency as they have both greater energy consumption and economies of scale able to reduce the relative cost of achieving higher efficiencies.

It is important that test conditions mirror the expected, typical operating conditions for every test used to determine the unit's thermal efficiency. This is especially important for condensing boilers, where the inlet/outlet temperature of water will greatly impact the overall efficiency.

Alert

BS7190 is the British Standard for the “Method for assessing thermal performance of low temperature hot water boilers using a test rig”. The Standard specifies a procedure for assessing the thermal performance of low temperature hot water boilers which are intended for central heating or indirect hot water supply, and which are fired with solid, liquid or gaseous fuels.

See NCC Volume Three for more information on the requirements for water heaters in a heated water supply system.

3.3.3.9 Refrigerant chillers

J6D11 covers the requirements for refrigerant chillers. The clause specifies that a refrigerant chiller, that is part of an air-conditioning system, must have an EER complying with Table J6D11a or Table J6D11b Refrigerant chillers must also comply with the MEPS efficiency requirements.

The tables are similar to tables in ASHRAE 90.1 2016. Table J6D11a (Option 1) contains higher full-load performance values. These performance values are applicable to chillers which are more likely to operate at full load. Table J6D11b (Option 2) contains higher part-load performance values. These performance values are applicable to chillers which are more likely to operate at part load.

A designer may choose whether to comply with Table J6D11a (Option 1) or Table J6D11b (Option 2). The choice of tables gives designers scope to use the most appropriate chiller depending on building operation (i.e. full load or part load).

Generally, full load can be simplified to operating at greater than 90% of the rated capacity for most of its run time, and part load can be simplified to operating at less than 90% of the rated capacity for most of its run time.

The EER must be determined by testing in accordance with the American Air-Conditioning, Heating & Refrigeration Institute (AHRI) Standard, AHRI 551/591. This standard requires chillers to be tested at full load and at a series of part loads, which are then integrated into a single number part-load efficiency.

Alert

AHRI 551/591 is the American Air-Conditioning, Heating & Refrigeration Institute standard for the "Performance rating of water-chilling and heat pump water-heating packages using the vapour compression cycle". The standard specifies the requirements for water-chilling and water-heating packages using the vapour compression cycle including test requirements, rating requirements, minimum data requirements, marking and nameplate data and conformance conditions.

Note that the use of flow and return temperatures applied during the testing of chillers to AHRI 551/591 (a 6°C flow and 12°C return) may not be appropriate to allow for a pumping system compliant with J6D8.

Comparison with the European Union MEPs (EUROVENT)

The European Union (EU) has developed a minimum energy performance requirement for chillers used within its borders: EU Eco-design Lot 21. Systems certified under this scheme may be used as the basis of a Performance Solution with the approval of the Appropriate Authority.

Reminder

MEPS means the Minimum Energy Performance Standards.

3.3.3.10 Unitary air-conditioning equipment

A unitary air-conditioner is a modular factory assembled air-conditioning unit. These units are self-contained and include within the unit all the components for heating and/or cooling; such as fans, controls, a refrigeration system, heating coil and sometimes the heater. Split systems, packaged air-conditioners, variable refrigerant flow and variable refrigerant volume air-conditioners are all types of unitary air-conditioners.

Capacity less than 65 kWr

Unitary air-conditioning equipment with a capacity of less than 65 kWr must comply with MEPS. For these small systems, no further improvements above this level are required.

Capacity of 65 kWr or more

J6D12(a) and (b) specify the efficiency required for water- and air-cooled packaged air-conditioning systems when tested in accordance with AS/NZS 3823.1.2 at test condition T1.

AS/NZS 3823.1.2 has various test conditions, so this clause requires the equipment to be tested at condition T1, which provides standard cooling capacity rating conditions for moderate climates. The standard covers the performance of electrical appliances, air-conditioners and heat pumps. Part 1.2 covers ducted air-conditioners and air-to-air heat pumps – testing and rating for performance.

Alert

AS/NZS 3823.1.2 is the Australian and New Zealand Standard for the "Performance of electrical appliances – air-conditioners and heat pumps", specifically "Ducted air-conditioners and air-to-air heat pumps – testing and rating for performance". The Standard specifies the standard conditions for capacity and efficiency ratings of ducted, air-cooled air-conditioners and ducted air-to-air heat pumps

J6D12(a) specifies the efficiency required for water-cooled packaged air-conditioning equipment. The air-conditioning equipment must have a minimum EER of 4.0 W_r / $W_{input\ power}$.

J6D12(b) specifies the efficiency required for air-cooled packaged air-conditioning equipment. The air-conditioning equipment must have a minimum EER of 2.9 W_r / $W_{input\ power}$.

These systems must also comply with MEPS.

Alert

The input power includes both compressor and fan input power.

3.3.3.11 Heat rejection equipment

Cooling towers, closed circuit coolers and evaporative condensers

J6D13(1) outlines that the requirements for a fan that forms part of a cooling tower, closed circuit cooler or an evaporative cooler that is part of an air-conditioning system, are in Table J6D13. The maximum fan motor power allowed is dependent on whether the system is an induced or forced draft. Induced draft is more efficient than forced draft, using a draw-through arrangement as opposed to blowing air from the bottom of the cooling system.

The Note to Table J6D13 specifies that a closed circuit, forced draft cooling tower must not be used as a DTS Solution as these systems are extremely inefficient. However, if a closed circuit forced draft cooling tower is required within the design, a Performance Solution may be used to demonstrate compliance.

The performance of cooling tower fans, closed circuit cooler fans and evaporative condenser fans can be determined using any nationally or internationally accepted standard. For example, Cooling Technology Institute's (CTI) Standard CTI STD-201RS(13) and Acceptance Testing Code (ATC) ATC-105(00) can be used to determine the performance of cooling tower fans. CTI STD-201RS(13) and ATC-105S(11) can be used for closed circuit cooler fans and ATC-106(11) can be used to determine the performance of evaporative condenser fans.

Air-cooled condenser

J6D13(2) specifies the requirements for a self-contained, air-cooled condenser fan motor that is part of an air-conditioning system. An air-cooled condenser fan is used as part of the refrigeration cycle to cool refrigerant from its vapour phase to its liquid phase. The fan motor must not use more than 42 watts of fan motor power for each kW of heat removed from the refrigerant.

Air-cooled condensers not part of a package air-conditioner or split unit are exempt from the requirements of J6D13(2). These air-cooled condensers are typically associated with larger plant installations. The requirements of J6D13(2) are also not intended to capture a condenser covered by MEPS.

3.3.4 Part J7 Artificial lighting and power

3.3.4.1 Artificial lighting

Subclause J7D3(2) applies to lighting in Class 3 and Class 5 to9 buildings. This clause sets a lighting power allowance in terms of the illumination power density. This includes for power losses in ballasts and control devices.

Only illumination power density can be used to measure compliance. LED lighting is becoming increasing popular for non-residential and the updated illumination power density values reflect this shift to LED technology.

J7D3(2)(a) explains that the individual load allowance for a space is calculated by multiplying the area of that space by the appropriate maximum illumination power density value from Table J7D3a.

The maximum illumination power density values in Table J7D3a have been based on a lighting design complying with the acceptable lighting level recommendations of AS 1680 Interior and workplace lighting – Part 1 General principles and recommendations, for the nature of the task, including an allowance for a safety margin in design and the physical limitations in placing a discrete number of fittings in a uniform array.

J7D3(2)(b) specifies that the aggregate design illumination power load is the sum of the design illumination power loads in each of the spaces served. The aggregate design illumination must not exceed the individual load allowance calculated in J7D3(2)(a).

J7D3(2)(c) provides a solution to calculating the design illumination power load in (a) where there are multiple lighting systems serving the same space. The design illumination power load is based on the highest illumination power load where the highest illumination power load is multiplied by the area of the space served; or is determined by the following formula:

$$[H \times T \div 2 + P \times (100 - T \div 2)] \div 100$$

Where:

- H = the highest illumination power load
- T = the time for which the maximum illumination power load will occur, expressed as a percentage of time in which the lights operate within nominated hours
- P = the predominant illumination power load.

Exemptions

The energy efficiency provisions in J7D3(1) and J7D3(2) are not always appropriate depending upon the use of a space; and there are situations when life safety must take precedence. J7D6(3) lists exemptions which take account of such situations. The following paragraphs describe these exemptions.

Emergency lighting as required by NCC Volume One Part E4 is exempt, as life safety takes precedence over energy efficiency.

Lighting associated with signage, lighting within display cabinets, and lighting for cases that are fixed in place are all exempt. This concession applies to both external and internal signage and, includes lighting that highlights signs. Regarding display cases, the lighting must be within the fixed cabinet or display case to be exempted, but this cabinet does not necessarily need to be enclosed.

Lighting installed in the accommodation areas of detention centres such as jails and remand centres are also exempt as lighting requirements may differ due to safety reasons. Accommodation should be interpreted as the area specifically set aside for the detainees. Ancillary areas, such as staff common rooms and administrative areas do not receive this concession.

Lighting used for heating, such as a bathroom using heat radiated from special purpose lamps to warm room occupants are exempt. In simple terms, a higher number of watts means more heat is radiated. The use of such a system should be nominated on the building approval documents.

Lighting used for a specialised process such as lighting used for specific medical procedures, lighting in a fume cupboard or clean workstation are usually separate from the general overhead lighting and are often built into specialised equipment. Therefore, they are exempt.

Lighting used for performances such as theatrical or sporting events, which are often separately switched from any general overhead lighting, are also exempt.

Lighting used for the permanent display and preservation of works of art or objects in a museum or gallery other than those for retail sale, purchase or auction are exempt, as these lights are used to facilitate and enhance the viewing of the works of art.

Lighting installed solely to provide photosynthetically active radiation for indoor plant growth on green walls and the like often requires specific light intensities and colours to support different plant growth. Therefore, they are exempt.

Control devices

Subclause J7D3(4) identifies control devices in Table J7D3b that must comply with Specification 40. The control devices include lighting timers, motion detectors, daylight sensors and dynamic lighting control devices. See Specification 40 for an explanation on the technical requirements for lighting and power control devices.

In total, 5 adjustment factors can be applied to the maximum illumination power density. These include:

- Room Aspect Ratio
- a maximum of two control devices from Table J7D3b
- Colour Rendering Index (CRI) adjustment factor from Table J7D3c
- Correlated colour temperature (CCT) adjustment factor from Table J7D3c.

Maximum illumination power density

The base (pre-adjustment) illumination power density values in Table J7D3a have been set at a level that can be achieved with reasonable surface reflectance, high efficacy light sources, low loss control devices and high efficiency luminaires.

AS 1680.1 includes scenarios where it may be appropriate for higher illumination levels. Where higher illumination levels are required, a Performance Solution based on the notes to Table J7D3a could be developed.

There are two levels for offices. General open areas that are lit to more than 200 lx may use 4.5 W/m^2. For offices lit to less than 200 lx, where task lighting is intended to supplement the general lighting, the maximum for the general lighting is only 2.5 W/m^2.

Note 1 of Table J7D3a provides values for applications not specifically listed in the table.

Note 2 of Table J7D3a is a concession for small, enclosed spaces. This is because walls absorb light energy which means that less illumination would be available at the working surface level unless some compensation is permitted. A formula is given for calculating the allowable increase to the maximum illumination power density permitted and is based on a Room Aspect Ratio. Defined in Note 3, the Room Aspect Ratio is a ratio of the area of the enclosed space to the height and perimeter of the enclosed space. See the worked example for a laboratory, in Appendix D to show how this is calculated.

Note 4 of Table J7D3a allows an increase to the maximum illumination power density if a suitable control device is used for Table J7D3b and Table J7D3c. These adjustment factors are explained below.

Table 3.40 details the relationship of the maximum illumination power density values in Table J7D3a to AS 1680 illuminance levels.

Table 3.40 Recommended illuminance levels and corresponding illumination power densities for space types

Space	AS 1680 recommended illuminance (Lux)	Illumination power density (W/m^2)
Auditorium, church and public hall	160	8
Board room and conference room	240	5
Carpark – general	40	2
Carpark – entry zone (first 15 m of travel) during the daytime	800	11.5
Carpark – entry zone (next 4 m of travel) during the day	160	2.5
Carpark – entry zone (first 20 m of travel) during night time	160	2.5
Control room, switch room and the like – intermittent monitoring	160	3
Control room, switch room and the like – constant monitoring	240	4.5
Corridors	240	5
Courtroom	320	4.5
Entry lobby from outside the building	160	9
Health-care – infants' and children's wards and emergency department	240	4
Health-care – examination room	400	4.5
Health-care – examination room in intensive care and high dependency ward	400	6
Health-care – all other patient care areas including wards and corridors	240	2.5
Kitchen and food preparation area	240	4

Space	AS 1680 recommended illuminance (Lux)	Illumination power density (W/m^2)
Laboratory – artificially lit to an ambient level of 400 lx or more	400	6
Library – stack and shelving area	240	2.5
Library – reading room and general areas	320	4.5
Lounge area for communal use in a Class 3 or 9c building	240	4
Museum and gallery – circulation, cleaning and service lighting	240	2.5
Office – artificially lit to an ambient level of 200 lx or more (maintained average)	320	4.5
Office – artificially lit to an ambient level of less than 200 lx (maintained average)	160	2.5
Plant room where an average of 160 lx vertical illuminance is required on a vertical panel such as in switch rooms	160	4
Plant rooms with a horizontal illuminance target of 80 lx	80	2
Restaurant, café, bar, hotel lounge and a space for the serving and consumption of food or drinks	80	14
Retail space including a museum and gallery whose purpose is the sale of objects	160	14
School – general purpose learning areas and tutorial rooms	320	4.5
SOU in a Class 3 or 9c building	160	5
Storage	80	1.5
Service area, cleaner’s room and the like	80	1.5
Toilet, locker room, staff room, rest room and the like	80	3
Wholesale storage area with a vertical illuminance target of 160 lx	160	4

Space	AS 1680 recommended illuminance (Lux)	Illumination power density (W/m^2)
Stairways, including fire-isolated stairways	80	2
Lift cars	160	3

Control device illumination power density adjustment factor

It is recognised that there are variables in lighting that limit the ability to achieve the maximum illumination power density limits specified in Table J7D3a. To provide flexibility in meeting the requirements, a series of adjustment factors have been included in Table J7D3b that provide credit for using additional energy limiting devices.

The adjustment factors are applied to the illumination power density allowance in Table J7D3a for the space. This means that, if a designer selects a less efficient light source or luminaire, compliance can still be achieved by including a supplementary control device such as an occupancy sensor or photoelectric device.

Occupancy sensors represent an efficient way of tailoring the lighting to the functional needs of the space. The fewer lights that are controlled by an individual sensor, the greater the potential energy saved, however there is less cost saving on the energy to offset the cost of each sensor. Therefore, there is a graduated scale of adjustment factors for the area of lights controlled.

A designer can look at the relative cost/benefit ratio of each option for the project. The cost/benefit may not be a simple balance of the cost of the control device versus the potential energy saving. For example, the preference may be to provide surplus illumination power density allowances to offset another area.

Motion detectors turn on lighting in response to movement and are therefore applicable in areas that are not constantly occupied such as toilets and change rooms.

Programmable dimming systems are where pre-selected scenes or levels are automatically selected by the time of day, photoelectric cell or occupancy sensor. Examples of buildings or spaces where this may be beneficial are university buildings and classrooms. Timetables enable occupancy to be pre-determined and for lighting to be switched on in these times.

Fixed dimming is where lights are controlled to a level and that level cannot be adjusted by the user. For example, where drivers are factory set to a dimmed output to limit the light output.

Lumen depreciation dimming occurs over the lifespan of the light source. Put simply, lighting gets dimmer over time. LED or fluorescent lighting fixtures have much longer lifespans than other lighting fixtures. Therefore, this factor does not apply to tungsten, halogen or other incandescent sources to encourage the use of more efficient lighting sources.

Two stage sensor: The illumination power density adjustment factor for two stage sensor equipped lights with minimum power of 30% of peak power refers to both sensors integrated into the lighting system and standalone sensors as part of the lighting control system.

Daylight sensors turn off lighting when sufficient natural light from a window or roof light is present. Sensors for artificial lights located adjacent to roof lights are to be located at the discretion of the electrical engineer/lighting designer.

Dynamic dimming systems are where the lighting level is varied automatically by a photoelectric cell to either proportionally compensate for the availability of daylight or the lumen depreciation of the lamps.

Note 1 of Table J7D3b specifies that two adjustment factors for a control device can be applied to the maximum illumination power density for an area. Where more than one adjustment factor is applied, they are to be combined using the formula below.

$$A \times (B + [(1 - B) \div 2])$$

Where:

A is the lowest applicable adjustment factor

B is the second lowest applicable adjustment factor.

Note 3 specifies that the adjustment factors do not apply to tungsten halogen or other incandescent sources for programmable dimming systems, fixed dimming systems, lumen depreciation dimming, and daylight sensors and dynamic lighting control devices.

Note 4 specifies that the adjustment factors apply to luminaires with a pre-programmed function which provides one-stage dimming (dimming from ON to OFF) for fixed dimming controls.

Note 5 specifies that adjustment factors for daylight sensors are only applicable to lighting that is on during the day. In other words, daylight sensors for lighting on during the night would not be applicable.

Light colour illumination power density adjustment factor

Table J7D3c provides allowances based on light colour. The maximum illumination power density may be increased by dividing it by the illumination power density adjustment factor. There are two possible adjustments for light colour, one regarding CRI and one regarding CCT.

CRI is the measurement of how colours look under a light source when compared with sunlight and is measured from 0-100. A CRI of 100 means that the colours appear the same as they would under sunlight. For lighting with a CRI greater than or equal to 90, the maximum illumination power density will increase once divided by the adjustment factor of 0.9.

CCT defines the colour appearance and is defined in degrees Kelvin. A warm light is about 3500 K and below, moving to brighter, whiter and ‘cooler’ as the degrees increase. A warmer light is favoured in the DTS requirements. For example, for lighting with a CCT ≤ 3500 K the maximum illumination power density will increase once divided by the adjustment factor of 0.8. Contrastingly, for lighting with a CCT ≥ 4,500 K, the maximum illumination power density will decrease once divided by the adjustment factor of 1.1.

Colour tuneable luminaires provide the ability to deliver varying light colours and may meet multiple categories in Table J7D3d. If tuneable luminaires achieve both ≤ 3,500 K and ≥ 4,500 K, the ≤ 3,000 K adjustment factor would be appropriate. The intent of this clause is to prevent designers using cool/blue-tinge daylight luminaires to achieve energy efficiencies. Tuneable luminaires are top of the range and most preferable because they adapt to user requirements and are optimal for circadian rhythms. Therefore, tuneable luminaires should be rewarded for the capacity achieving ≤ 3,500 K and not penalised for the capacity being ≥ 4,500 K.

Lighting Calculator

The ABCB has produced a Lighting Calculator to assist users in assessing compliance with J7D3. It can be used to assist in reviewing lighting power usage and can be used to quickly check the effects of changes to a lighting to system when updating, amending or optimising. The calculator is available on the ABCB website.

3.3.4.2 Interior artificial lighting and power control

These requirements cover the switching and control of lighting in various building classes and for automatic control of lighting and power in a SOU of a Class 3 building. The intention is to ensure that rooms are not unnecessarily using artificial lighting or power when unoccupied.

Individual lighting controls for each space

Subclause J7D4(1) requires lighting in each room or space within a building to be operated separately from other rooms or spaces. In simple terms, lighting in each space must be switched by its own light switch or group of switches, a control device, or a combination of a switch and a control device. The requirement prevents the use of a master light switch to operate all lights in several rooms or spaces.

Design alert

The term ‘space’ may apply to a separate activity area within a larger room and is not necessarily defined by walls. An example would be a TV area within a larger recreational room. These spaces should be defined on the architectural/electrical plans.

Occupant activated light and power switch

Subclause J7D4(2) requires each SOU within a Class 3 building, except one accommodating the aged or people with a disability, to have a device to cut off power to artificial lighting, air-conditioning, local exhaust fans and bathroom heating when unoccupied.

The device must be activated by the presence of occupants. It can, for example, be operated by a motion detector or a security card reader which turns power off when the card is removed.

Lighting switch location and area of operation

Subclause J7D4(3) requires that a lighting switch be in a visible position in the room where the lighting is being switched or in an adjacent room where 90 percent of the lighting being switched is visible. It also limits the area of lighting that a single switch can control. The area permitted varies according to the class of the building and the size of the space being artificially lit.

Lighting controls

Subclause J7D4(4) requires that 95 percent of the light fittings in a building or storey of a Class 5 to 9 building which is larger than 250 m^2 be controlled by a device which can turn lighting off when unoccupied. The device can include a time switch or an occupant sensing device such as a motion detector complying with Specification 40, or a security card reader that registers a person entering and leaving the building.

Separation of switching

Subclause J7D4(5) requires that, a Class 5, 6 or 8 building with a floor area greater than 250 m^2 must have separate controls for artificial lighting in the natural lighting zone adjacent to windows, and for general lighting not in the natural lighting zone. There are exemptions for small spaces (20 m^2 or less), natural lighting zones with less than four light fittings, or where most (70 percent) of the light fittings in the room are in the natural lighting zone adjacent to windows.

Fire-isolated stairway, passageway or ramp lighting controls

Subclause J7D4(6) requires that artificial lighting in a fire-isolated stairway, passageway or ramp must be controlled by a motion detector in accordance with Specification 40.

Foyer, corridor and circulation space lighting controls

Subclause J7D4(7) requires that lighting of more than 250 W within a single zone and located adjacent to windows must be controlled by a daylight sensor and dynamic lighting control device in accordance with Specification 40 for foyers, corridors and other circulation spaces.

Carpark lighting controls

Subclause J7D4(8) requires that the first 19 m of travel in a carpark entry zone lighting must be controlled by a daylight sensor in accordance with Specification 40. 19 m is consistent with AS 1680.1 and applied for safety reasons to allow eyes to adjust when travelling from bright to dark spaces.

Exemptions

Like Part J7D3 there is an exemption in subclause J7D4(9) for emergency lighting required by Part E4. There are also exemptions for spaces where artificial lighting is needed for 24-hour occupancy such as for a manufacturing process, parts of a hospital, an airport control tower or within a detention centre.

Subclause J7D4(10) exempts from J7D4(4) any lighting whose sudden loss would create a safety risk. Areas where lighting loss would cause a safety risk include, among others, lighting installations in the patient care areas of a Class 9a or a Class 9c building, a plant room or lift motor room; or a workshop where power tools are used. Heaters where the heater also emits light, such as in bathrooms, are also exempt under this clause.

3.3.4.3 Interior decorative and display lighting

The provisions of this clause cover decorative and display lighting inside a building and window display lighting. The interior lighting, such as for a foyer mural or art display, must:

- be separately controlled from other artificial lighting
- have separate manual switching for each area that operates during different periods, except where operating times coincide such as in a museum or art gallery
- have a separate time switch, in accordance with Specification 40, for display lighting uses more than 1 kW.

Subclause J7D5(2) requires window display lighting (usually on the internal perimeter of the building) to be controlled separately from other display lighting.

3.3.4.4 Exterior artificial lighting

J7D6 requirements cover external lighting attached to or directed at the facade of a building. Therefore, external lighting such as garden lighting, pathway lighting and the like are exempt from the NCC, however they should comply with Australian Standards and any applicable local laws. External lighting, attached or directed at the facade, must be controlled by a daylight sensor or a programmable time switch control.

If the total lighting load exceeds 100 W, LED lighting must be used for 90 percent of the total load, be controlled by a motion detector in accordance with Specification 40 or have a separate time switch in accordance with Specification 40 when used for decorative purposes.

Subclause J7D6(2) exempts emergency lighting required by Part E4 and lighting around a detention centre from the requirements of (1)(b) but not from (1)(a). This means that artificial lighting attached to or directed at the facade of a building in these circumstances must be controlled by a daylight sensor or a time switch.

3.3.4.5 Boiling water and chilled water storage units

A time switch is required for boiling water and chilled water storage units that continually maintain water at temperature; as energy can be wasted when not used for long periods of time, such as overnight. The time switch used must be in accordance with Specification 40. The requirement does not apply to instantaneous units that heat or chill water as it is being drawn off.

3.3.4.6 Lifts

Clause J7D8 prescribes both operational and standby/idle lift operation energy efficiency measures. A lower energy rating has been allowed for dedicated goods lifts, this is in recognition that these lifts have different requirements to passenger lifts. Dedicated goods lifts are lifts used for carrying goods or materials and in which only the attendant and the persons required to load and unload are intended (or permitted) to travel. Lifts that are intended as passenger lifts, that occasionally carry goods or materials do not fall under this category.

Subclause J7D8(a) specifies that any lifts forming part of a project must have lighting and ventilation systems that are able to be turned off if the lift is not used for more than 15 minutes.

Subclause J7D8(b) requires that any lift must achieve the idle and standby energy performance levels in Table J7D8a. For example, if the rated load is less than or equal to 800 kg, the maximum idle standby energy performance level is 2. Note that Table J7D8a applies to the standby power used after 30 minutes.

Subclause J7D8(c) specifies that any lift must achieve the energy efficiency class in Table J7D8b. The intent of this provision is that lifts that are travelling further have a higher frequency and are more efficient, and that low traffic lifts have a lower target. Dedicated goods lifts are exempt and are to achieve the energy efficiency class D in accordance with ISO 25745-2.

Alert

ISO 25745 is the Standard for the Energy performance of lifts, escalators and moving walks – Part 2: Energy calculation and classification for lifts. The Standard provides methods to estimate energy consumptions for lifts and methods for energy classification of new, existing or modernised lifts.

3.3.4.7 Escalators and moving walkways

If escalators and/or moving walkways are provided as part of a development, they must be capable of either stopping completely or slowing to at least 0.2 m/s when not used for more than 15 minutes. Note that this clause does not preclude escalators/ and or moving walkways stopping completely out of hours.

3.3.4.8 Lighting and power control devices

Specification 40 contains the technical requirements for any lighting and power control devices that are required by Part J7.

Compliance with the requirements of this specification should be verified and substantiated by manufacturer's data sheets during the building approval process. Verification would be like current approval processes for emergency lighting where details of the intended systems form an integral part of the approval process and approved documentation.

Specification 40 provides specific requirements for the operation and capability of the following electrical equipment:

- lighting timers
- time switches
- motion detectors
- daylight sensors and dynamic lighting control devices.

Lighting timers

A lighting timer is installed so that artificial lighting needed only for transiting between occupied parts of a building will operate on demand before turning off automatically after a reasonable time has passed. The provisions within clause S40C2 in Specification 40 are intended to provide a reliable and safe switching and lighting arrangement, without running unnecessarily.

The provisions specify that a timer switch needs to be available within 2m of every entry door and visible when the space is not artificially lit. The area controlled by a single push button timer is limited to 100 m^2 to avoid wasteful energy use. Even so, at least 5 percent of lights in areas larger than 25 m^2 must operate separately from the timer to allow a constant low level of lighting for people to enter the space safely. The 5 percent of lighting that can remain active can usually be achieved by an exit sign or similar fitting. The percentage applies to numbers of lights and not to the energy used or illumination produced by the lighting.

The lighting timer must be capable of maintaining artificial lighting for more than 5 minutes and less than 12 hours if the timer is reset. The lighting timer must be capable of maintaining artificial lighting while the timer is reset.

Alert

Where the corridor or space is part of an exit or other space defined under Part F6D5, the artificial lighting levels should comply with F6D5.

Time switches

Time switches are intended to turn off the power automatically. Subclause (1) in Clause S40C3 of Specification 40 specifies time switches to be programmed to accommodate the needs of the specific occupancy. However, the program must be capable of turning off the system after normal occupation has finished.

S40C3(2) requires a manual switch or occupant sensing device that overrides time switches for internal lighting by turning the lights on. The override period is to be up to 2 hours. If there is no further presence detected after 2 hours, the time switch must resume control. An alternative solution is to have occupant sensing devices such as security card readers or remote controls that override the time switch upon entry and returns control to the time switch upon exiting.

S40C3(3) specifies a time switch for external lighting to be configured to limit the systems on hours from 30 minutes before sunrise to 30 minutes after sunset, including any pre-programmed periods between these times, and be capable of being overridden for up to 8 hours by a manual switch, remote control or a security access system.

S40C3(4) requires a time switch for boiling water and chilled water storage units to be capable of being overridden by a manual switch or a security access system that detects a person's presence. If there is no further presence detected after 2 hours the time switch must resume control.

Design alert

The term 'normal occupation' would, for example, also include suitable allowance for after-hours cleaning and other building functions outside the traditional 9 am to 5 pm operation of business premises.

Motion detectors

Motion detectors have many advantages over other control devices. For example, a person entering a space does not need to find the button to switch on the lights. The motion detector requirements for lighting include movement sensing means, detection thresholds, maximum areas that an individual detector can control, maximum number of lights that can be controlled by a detector, how long they can operate the lights after activation, and override facilities. Clause S40C4 in Specification 40 separates these requirements into four applications, for:

- a Class 3 or Class 9c building, other than within a SOU
- a Class 5, 6, 7, 8, 9a and 9b non-residential building
- outside a building
- fire-isolated stairways, fire-isolated passageways or fire-isolated ramps.

Subclause S40C4(1) applies to Class 3 or 9c buildings other than within a SOU. Within these buildings motion detectors must detect a person before they are 1m into the space through infra-red, ultrasonic or microwave detection. Other than within a SOU of a Class 3 building, the motion detectors must not control more than 100 m^2 to avoid wasteful energy use. Even so, at least 5 percent of lights in areas larger than 25 m^2 must operate separately from the timer to allow a constant low level of lighting for people to enter the space safely.

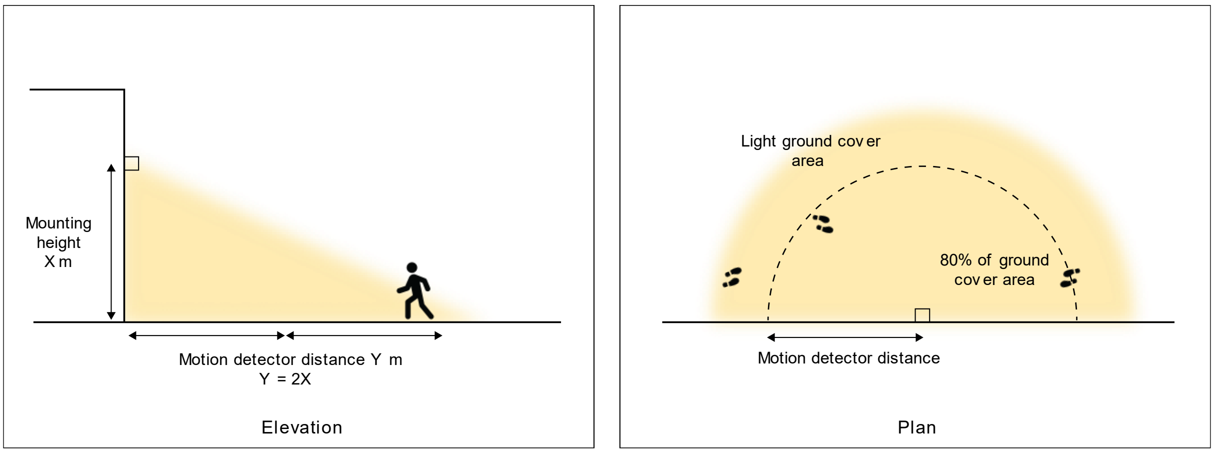
The motion detector must also be configured so that the lights turn on after 15 minutes of the space being unoccupied and be capable of being overridden by a manual switch. A manual switch is required as a backup so the power can be cutoff to replace a globe or if the space is only occupied for less than the run-on time of the occupancy sensor.

Subclause S40C4(2) applies to Class 5, 6, 7, 8, 9a or 9b buildings. Within these buildings a motion detector must detect a person before they are 1 m into the space and any movement within the space of 500 mm through infra-red, ultrasonic or microwave detection. The motion detector must:

- not control more than 500 m^2 or more than 75 percent of the lights using high intensity discharge (Metal halides, high pressure sodiums, mercury vapour lamps) to avoid wasteful energy use
- be configured so that the lights turn off after 15 minutes of the space being unoccupied and be capable of being overridden by a manual switch. A manual switch is required as a backup so the power can be cutoff to replace a globe or if the space is only occupied for less than the run-on time of the occupancy sensor.

Subclause S40C4(3) applies to areas outside of a building. Motion detectors must be capable of detecting a person from at least twice the distance of the mounting height or within 80 percent of the ground area covered by the light through pressure, infra-red, ultrasonic or microwave detection. The distances are explained in the diagrams below.

Figure 3.3.19 Motion detector spatial requirements of Specification 40 subclause S40C4(3)



When outside a building, the motion detector must control less than or equal to 5 lights to avoid wasteful energy. The motion detector must use time switches to ensure the lighting does not operate during the day. Additionally, the motion detector must be configured so that the lights turn off after 15 minutes of the space being unoccupied and be capable of being overridden by a manual switch which is reset after a period of less than 4 hours.

Subclause S40C4(4) applies to fire-isolated stairways, fire-isolated passageways and fire isolated ramps. Motion detectors must detect a person before they are 1 m into the space and movement of 500 mm through infra-red, ultrasonic or microwave detection. For safety reasons these lights must be configured so that the lights dim to a 30 percent peak power or less (they can go to zero) if the space has been unoccupied for 15 minutes.

Daylight sensor and dynamic lighting control devices

The daylight and dynamic lighting sensors are designed to respond to changes in the illumination levels within a designated area. The provisions define essential operational parameters for the sensors. These details can be verified from manufacturer's data.

The provisions in Clause S40C5 of Specification 40 require the sensor or control device to be designed to operate only the artificial lighting.

Subclause S40C5(1) requires daylight sensors and dynamic control devices to be capable of adjusting the switching level set point between 50 and 1000 lux for switching on and off. Additionally, the devices must have a delay of more than 2 minutes and a differential of more than 100 lux for a sensor controlling high pressure discharge lighting, and 50 lux for a sensor controlling other than high pressure discharge lighting.

Dimmed or stepped switching is acceptable, provided the process complies with the arrangements in subclause S40C5(1)(b), so that the system is capable of reducing the power consumed to continuously less than 50 percent of full power or at least 4 steps down to a power consumption that is less than 50 percent of full power and the technical requirements of this clause can be verified by manufacturer's data.

Subclause S40C5(2) places limits on any manual override switch for sensors or dynamic control devices. It cannot bypass the controls or switch the lights permanently on, independently of the dimming arrangements. The limitation reduces the amount of time the override can be in place.

3.3.5 Part J8 Heated water supply and swimming pool and spa pool plant

3.3.5.1 Heated water supply

The requirements of subclause J8D2 Heated water supply, are located in NCC Volume Three. The current text directs the user to the requirements in NCC Volume Three.

NCC Volume One J8D2 Heated water supply

A heated water supply system for food preparation and sanitary purposes must be designed and installed in accordance with Part B2 of NCC Volume Three – Plumbing Code of Australia.

NCC Volume Three – Part B2 Heated water services

The requirements of B2 in NCC Volume Three contain the heated water requirements previously located in NCC Volume One. B2 sets out the requirements for the design, construction, installation, replacement, repair, alteration and maintenance of any part of heated water service of a property that is connected to the drinking water supply. It covers from the point of connection to the points of discharge.

NCC Volume Three B2D9 General Requirements

The insulation of heated water service pipes for all Classes of building are covered by B2D9, General requirements which states, ‘A heated water service must be in accordance with AS/NZS 3500.4.’

AS/NZS 3500.4 specifies insulation requirements for heated water installations. The requirements in the Standard are intended to reduce heat loss from heated water supply system piping. In most instances, this is achieved by insulation and heat traps, which involve specific pipe configurations.

The heat trap controls energy loss by utilising gravity and the density of the heated water to limit the movement of heated water, thereby greatly reducing convection in the piping. In other words, the heated water is prevented from rising in the piping where its heat would be lost.

It should be noted that some heated water systems have internal heat traps concealed within the unit cabinet. Confirmation of such a heat trap arrangement can be obtained from the manufacturer.

The AS 3500 series characterises climates more broadly than the NCC climate zones. This results in the Standard having three climate regions where the NCC has eight climate zones. The climate regions within the Standard are larger than the NCC climate zones because the insulation levels that are economically justifiable are similar over a larger range of conditions. This reduces the need for more complex climate zoning and more graduation in the requirements.

3.3.5.2 Swimming pool heating and pumping

The first subclause J8D3(1) requires the heating for a swimming pool to be from any one of five energy sources or from a combination of them. These requirements effectively exclude oil heating and electric resistance heating, either as the only heating method or to boost a solar heater system.

Minimum efficiencies have been introduced for gas heating systems; so that larger systems require greater efficiency. This is particularly important for condensing boilers, as the inlet/outlet temperature of water will greatly impact the overall efficiency.

When a gas heater or a heat pump provides the heating, subclause J8D3(2) requires a pool cover regardless of the pool location with a minimum R-value of 0.05; and a time switch to control the operation of the heater. Requirements for a time switch are described in Specification 40 which is discussed in detail in Section 3.3.4.8.

Subclause (3) requires the time switch to operate the pump to reduce the amount of time and associated energy consumed when the pump is operating when not needed.

A time switch required by either subclause (2) or (3), must be capable of switching electric power on and off to a pre-programmed schedule (subclause (4)); which must allow both different times to be scheduled as well as different days. E.g. the swimming pool is used during the week from 7 am to 7 pm and on weekends from 9am to 5pm. Programming this schedule into the time switch must be possible.

Insulation requirements, covered in Section 3.3.3.7 apply to pipework carrying heated or chilled water for a swimming pool.

The sixth subclause J8D3(6) clarifies that this clause is about swimming pools and not about spa pools. Spa pools are covered by Clause J8D3.

3.3.5.3 Spa pool heating and pumping

Subclause J8D3(1) restricts the heating sources for a spa pool to the same ones permitted for a swimming pool where it shares a water reticulation system with a swimming pool.

The second subclause J8D3(2) requires a spa pool cover, regardless of the spa location, with a minimum R-value of 0.05; plus, a push button switch and a time switch to control the heater where either a gas heater or a heat pump, is used.

Subclause (3) requires a time switch to be provided in accordance with Specification 40 to control the operation of a circulation pump for a spa pool having a capacity of 680 litres or more. 680 litres is generally accepted as the capacity of when a spa bath becomes a spa pool.

As for swimming pools, a time switch required by either subclause (2) or (3), must be capable of switching electric power on and off to a pre-programmed schedule (subclause (4)); which must allow both different times to be scheduled as well as different days (e.g. the swimming pool is used during the week from 7am to 7pm and on weekends from 9am to 5pm). Programming this schedule into the time switch must be possible.

Insulation requirements outlined in Section 3.3.3 apply to pipework carrying heated water for a spa pool.

3.3.6 Part J9 Energy monitoring and on-site distributed energy resources

3.3.6.1 Energy monitoring

All buildings with a floor area greater than 500 m^2 must have a means of recording the consumption of gas and electricity. This includes all SOUs as these can include either residential buildings or suites of rooms, such as doctors' suites, which may have floor areas greater than

500 m^2. This does not mean recording of the electricity and gas consumption is required by the NCC, but rather that the ability to record is available. For buildings with a floor area no larger than 2,500 m^2, this need only be whole-of-building metering such as an electricity supply meter and/or a gas supply meter (whichever service is provided).

Most smaller buildings would have such meters supplied by the utilities company but, in the case of a campus style complex, such as a hospital, school or university, the utility company might provide only a single meter for the site.

Once a building exceeds 2,500 m^2, additional provisions apply in subclause J9D3(2). Buildings with a floor area greater than 2,500 m^2 must also have the means to record individually the energy consumption of nominated main services. The services include:

- air-conditioning plant including, where appropriate, heating plant, cooling plant and air handling fans
- artificial lighting
- appliance power
- central heated water supply
- internal transport devices including lifts, escalators, and moving walkways where there is more than one system serving the building
- on-site renewable energy equipment
- on-site electric vehicle charging equipment
- on-site battery systems
- other ancillary plant.

Note, it is not the intent of this provision to require the sub-metering of services within any SOUs within a building, or those related to the separate metering of a tenancy from a common area, only those that operate building wide.

The sub-meters monitoring the main services do not require the ability to record the data individually, however the ability to record, analyse and review the time-of-use energy consumption of these services is required in a single interface monitoring system (i.e. in 15, 30 or 60 minute intervals). This should form part of the building solution documentation. The intent of requiring time-of-use data is to easily and freely allow the building manager and maintenance personnel to see an energy use profile that shows energy over the course of a day or at a specific time to ensure the building operates efficiently. Therefore, excess energy (for example after hours, on hot days) can be identified and remedied. This monitoring system may take the form of a Building Management System which is likely to be used, in any case, for effective management of the building services. However, other suitable facilities to perform this function are available.

3.3.6.2 EV charging equipment

J9D4 does not require the installation of EV charging equipment, but does require had features that make for their easy retrofit in the future. For useful tips on the safe installation of EV charging equipment refer to the ABCB's Advisory Notice on Electrical Vehicles in Buildings, which is available from the ABCB website.

3.3.6.3 Solar PV and battery systems

J9D5 does not require the installation of any solar PV or battery systems, just sufficient space on electrical switchboards and physical roof space dedicated to it. This is to make for easy retrofit for their installation in the future.

3.4 Demonstrating compliance

3.4.1 Assessment Methods for DTS Solutions

An overview of how to comply and demonstrate compliance with the NCC is in Appendix C of this document, with further guidance available from the ABCB website.

A2G3(2) sets out the following Assessment Methods as being suitable for demonstrating compliance for DTS Solutions:

- Evidence of suitability (NCC clauses A2G2, A2G3, A5G1 to A5G4).
- Expert Judgement (NCC clauses A2G2 and A2G3 of the NCC).

The following provides further information on these Assessment Methods.

3.4.2 Evidence of suitability

Evidence of suitability, also known as 'documentary evidence', can generally be used to support that a material, product, form of construction or design satisfies a DTS Provision. Subject to certain NCC provisions, the form of evidence that may be used consists of one, or a combination, of the following:

- A report from an Accredited Testing Laboratory (ATL)
- A Certificate of Conformity or a Certificate of Accreditation
- A certificate from a professional engineer or appropriately qualified person
- A current certificate issued by a product certification body that has been accredited by JAS-ANZ
- Any other form of documentary evidence that adequately demonstrates suitability such as a Product Technical Statement.

More information on this Assessment Method is available in the ABCB Evidence of Suitability Handbook (2021).

In relation to housing energy efficiency, individual jurisdictions may have issued directions or notices specifying what documentary evidence is considered acceptable to demonstrate compliance.

3.4.3 Expert Judgement

Where physical criteria is unable to be tested, or modelled by calculation, the opinion of an expert may be accepted. Expert Judgment is the judgement of a person who has the qualifications and experience necessary to determine whether a Performance Solution or DTS Solution complies with the Performance Requirements.

It is the role of the appropriate authority to determine whether a person providing an Expert Judgement is considered an expert. More information on the use of Expert Judgement including guidance on who may be considered an expert is in the resource Understanding the NCC – Assessment Methods, which is available from the ABCB website.

3.4.4 Examples

To assist with complying with the DTS Provisions, several worked examples are in Appendix D:

- Building fabric – Appendix D.1
- Fan and duct systems – Appendix D.2
- Water pump – Appendix D.3
- Artificial lighting – Appendix D.4

4 Compliance Option 2: J1V1 NABERS Energy

4.1 Introduction

J1V1 NABERS Energy is a Verification Method (VM) that can be used as part of a Performance Solution to assess if a proposed solution complies with the Performance Requirement J1P1. NABERS Energy is the National Australian Built Environment Rating System for energy efficiency.

J1V1 can be used for a Class 3, 5 and 6 building. Prior to NCC 2022, this method was limited to Class 5 (office) buildings only.

4.2 Method

J1V1 allows the use of building commitment agreement modelling protocols and schedules from NABERS Energy to demonstrate compliance with J1P1 for Class 3, 5 and 6 buildings.

A NABERS Energy Commitment Agreement is obtained when the property owner/developer receives a countersigned Commitment Agreement from the NABERS National Administrator. Obtaining a commitment agreement helps ensure the necessary rating will be verified through the NABERS Energy process; and the design will be followed through to construction completion and into the building's operation. Current commitment agreements are listed on the NABERS website.

J1V1(1), J1V1(3) and J1V1(4) outlines the process for the Class 5, 3 and 6 buildings respectively. This is shown in Figure 4.2.1.

Figure 4.2.1 J1V1 for Class 3, 5 and 6 buildings

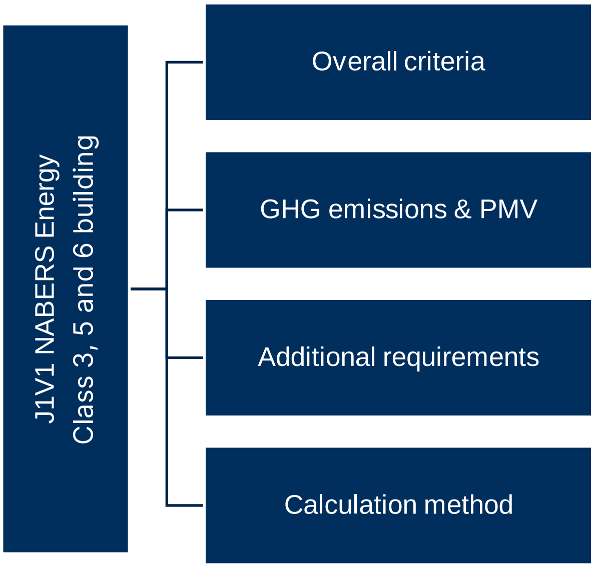


Table 4.1 Key requirements for J1V1

Clause J1V1 reference	Key requirements
(1)(a) General criteria	• For Class 5 building, a minimum 5.5-star NABERS Energy base building Commitment Agreement is obtained.
(1)(b) Energy model	• The energy model required for (1)(a) must demonstrate the following: – the greenhouse gas (GHG) emissions of the services are less than 67% of the 5.5-star level when excluding tenant supplementary heating and cooling systems, external lighting and carpark services – a thermal comfort level of between a Predicted Mean Vote (PMV) of –1 to +1 across not less than 95% of the floor area of all occupied zones – the thermal comfort level must be demonstrated for not less than 98% of the annual hours of operation of the building.
(3)(a) and (3)(b) General criteria	• For Class 3 building, a minimum 4-star NABERS Energy for Hotel Commitment Agreement is obtained. • The minimum air-conditioning hours is 12 hours per day in bedrooms, dining rooms, and conference facilities, 24 hours

Clause J1V1 reference	Key requirements
	per day in corridors and foyers and 18 hours per day in back-of-house areas.
(3)(c) Energy model	• The energy model required for (3)(a) must demonstrate the following: – the greenhouse gas (GHG) emissions of the services are less than 70% of the 5-star level – a thermal comfort level of between a Predicted Mean Vote (PMV) of –1 to +1 across not less than 95% of the floor area of all occupied zones – the thermal comfort level must be demonstrated for not less than 98% of the annual hours of operation of the building – the space temperature in any indoor swimming pool chamber is maintained at 2°C above the pool temperature during occupied hours (not less than 12 hours per day).
(4)(a) and (4)(b) General criteria	• For Class 6 building, a minimum 4.5-star NABERS Energy for Shopping Centres Commitment Agreement is obtained. • The building has an air-conditioned common area of not less than 20% of the gross lettable area and a gross lettable area greater than 15000 m^2.
(4)(c) Energy model	• The energy model required for (1)(a) must demonstrate the following: – the greenhouse gas (GHG) emissions of the services are less than 80% of the 4.5-star level – a thermal comfort level of between a Predicted Mean Vote (PMV) of –1 to +1 across not less than 95% of the floor area of all occupied zones – the thermal comfort level must be demonstrated for not less than 98% of the annual hours of operation of the building.
(1)(c), (3)(d) and (4)(d) Additional requirements	• The building must comply with the additional requirements in Specification 33. Refer Table 4.2 below.

Clause J1V1 reference	Key requirements
(5) Calculation method	• The calculation method for the energy model must comply with ANSI/ASHRAE Standard 140.

Alert

ANSI/ASHRAE Standard 140 2007 is the Standard Method of test for the Evaluation of Building Energy Analysis Computer Programs. ANSI/ASHRAE Standard 140 specifies test procedures for evaluating the technical capabilities of software used to calculate the thermal performance of buildings and their HVAC systems.

4.2.1 Additional requirements for Verification Methods J1V1

Specification 33 specifies additional requirements that must be completed in addition to the modelling requirements of J1V1.

In addition to the necessary modelling, Clause S33C2 of Specification 33 lists requirements from the DTS Provisions and reference documents. This ensures all buildings designed under J1V1 J1V2 and J1V3 cover the same range of energy efficiency aspects. The additional requirements are either outside the scope of the energy model, or items that the energy model assumes are executed and relies on them to be accurate. Therefore, it must be properly demonstrated that the requirements have been met when constructing the building.

As an example, the standard of installing insulation is covered in S33C2(a) of Specification 33 because it is not specifically addressed through modelling alone. Table 4.2 outlines the additional requirements below.

Table 4.2 Additional requirements from Specification 33

S33C2 reference	NCC reference/requirement
(a) General thermal construction	• J4D3
(b) Floor edge insulation	• J4D7(2) and J4D7(3)
(c) Building sealing	• J1V4 or Part J5
(d) Air-conditioning and mechanical ventilation systems	• Covers deactivation, control and insulation: – J6D3(1)(a), J6D3(1)(b)(i) – J6D3(1)(d), J6D3(1)(f)

S33C2 reference	NCC reference/requirement
	– J6D3(2) and (3) – J6D4(2) and (4) – J6D5, J6D6 and J6D9
(e) Packaged air-conditioning equipment	• Applies to equipment not less than 65 kWr • AS/NZS 3823.1.2 at test condition T1
(f) Refrigeration chiller	• Applies to testing a refrigeration chiller • AHRI 551/591
(g) Interior artificial lighting and power control	• J7D4
(h) Interior decorative and display lighting	• J7D5
(i) Artificial lighting around the exterior of a building	• J7D6
(j) Boiling water and chilled water storage units	• J7D7
(k) Deactivation of swimming pool heating and pumping	• J8D3(2)(b) and J8D3(3)
(l) Deactivation of spa pool heating and pumping	• J8D4(2)(b) and J8D4(3)
(m) Facilities for energy monitoring	• Part J9
(n) Deactivation of fixed outdoor space heating appliances	• J6D10(3)

4.2.2 Methodology

Only one energy model is required for both the NABERS Energy Commitment Agreement and to demonstrate compliance with J1P1. While NABERS Energy Commitment Agreement and the DTS Provisions differ in scope slightly, both NABERS Energy Commitment Agreements and NCC Volume One Section J have the same objective of energy efficiency and reduced GHG consumption.

NABERS Energy Commitment Agreements have a well-established energy modelling framework, which is used primarily to benchmark a building's energy use against a 6-star scale and will be verified operationally based on its actual energy consumption over a 12-month period.

4.2.2.1 Class 5 buildings

J1V1(1) for a Class 5 building compliance with J1V1 is shown when the predicted GHG emissions of an energy model of the proposed building design is less than 67 percent of 5.5 stars on the NABERS Energy for Offices base-building scale, modelled using the Handbook for Estimating NABERS ratings available from the NABERS website.

4.2.2.2 Class 3 buildings

J1V1(3) for a Class 3 building compliance with J1V1 is shown when the predicted GHG emissions of an energy model of the proposed building design is a minimum of 4 stars on the NABERS Energy for Hotels scale, modelled using the Handbook for Estimating NABERS ratings available from the NABERS website.

4.2.2.3 Class 6 buildings

J1V1(4) for a Class 6 building compliance with J1V1 is shown when the predicted GHG emissions of an energy model of the proposed building design is a minimum of 4.5 stars on the NABERS Energy for Shopping Centres scale, modelled using the Handbook for Estimating NABERS ratings available from the NABERS website.

4.3 Useful tips

4.3.1 General

Verification Method J1V1 is limited to assessing compliance with Performance Requirement J1P1 only. Performance Requirement J1P4 needs to be satisfied through another compliance option.

The intent of Verification Method J1V1 is to enable J1P1 to be met using NABERS Energy for a building without the need to separately show compliance using another NCC compliance option. This saves time and money.

Alert

In some cases, project teams choose to apply risk management margins to the simulation results to safeguard against post construction performance risks. No such margin is required in relation to compliance with the NCC, however, it is not discouraged for the purpose of providing additional assurance.

4.3.2 NABERS tools

NABERS provides a rating from one to six stars for building efficiency across: energy, water, waste and indoor environment.

NABERS ratings are valid for twelve months. This annual model helps ensure a rating represents a building or workplace's current operational performance.

NABERS ratings must be performed by a NABERS Accredited Assessor and comply with the quality standard set in the principles and rules for gathering, interpreting and using data.

More information on the NABERS Energy Commitment Agreements, the predicted GHG emissions for the energy model and the star levels required in J1V1, is available in the Handbook for Estimating NABERS ratings available from the NABERS website.

4.3.3 Exclusions in NABERS Commitment Agreements

Note that items such as tenant supplementary heating and cooling systems, external lighting and carpark services may be included in the model as they can have an impact on other equipment energy consumption. However, the items are not to be taken into consideration when calculating the GHG emission estimate for the base building rating.

Alert

For a definition of tenant supplementary heating and cooling systems refer to the NABERS rules.

4.3.4 PMV metric

An assessment of the Predicted Mean Vote (PMV) as part of J1V1 ensures that occupant comfort is not compromised in the pursuit of energy efficiency. The PMV index predicts the mean response of a large group of people on a 7-point thermal sensation scale, from +3 (hot) to –3 (cold) where 0 is neutral.

A PMV of –1 to +1 means that 75% of people are satisfied and comfortable. Note, this is likely to be appropriate for buildings that meet the applicability criterion in Section 5.4.1 of ASHRAE 55-2013.

The PMV metric is designed for fully mechanically ventilated buildings. If a building is either mixed-mode or naturally ventilated, the Adaptive Thermal Comfort metric may be more appropriate. The Adaptive Thermal Comfort metric relates indoor design temperatures to outdoor temperatures (i.e. higher room temperatures during warmer weather) based on the understanding that occupants can adapt to, or even prefer a wider range of conditions. This can be used as a Performance Solution subject to the approval of the Appropriate Authority. Adaptive

Thermal Comfort can also be used in combination with PMV in buildings that have both fully mechanical and partially naturally ventilated spaces.

4.3.5 On site generation

For situations with onsite generation, the building may be modelled with all loads included to calculate total emissions and export percentages.

GHG emissions calculated in accordance with J1V1(1)(b)(i) can incorporate savings from renewable energy. However, renewable energy must be consumed on site if it is to be counted.

4.4 Demonstrating compliance

4.4.1 Background

A Performance Solution can be used in an individual situation where the desired solution meets the Performance Requirements of the NCC, but not the relevant DTS Provisions. These solutions are often flexible in achieving the outcomes required and encourage innovative design and technology use.

A building owner may not have all the information they need to complete a NABERS energy model when they complete a development application, meaning it is not used often to show compliance. If the owner is committed to using NABERS as a compliance pathway, it is suggested that they discuss the timing of the delivery of information with the relevant authority (e.g. a building surveyor) in order to facilitate the use of J1V1 as a compliance pathway.

An overview of how to demonstrate compliance with the NCC is in Appendix C of this document, with further guidance available from the ABCB website.

J1V1 NABERS Energy is a Verification Method; therefore, where a Performance Solution utilises J1V1, Verification Method is the relevant Assessment Method. More information on Assessment Methods is in the resource Understanding the NCC – Assessment Methods, which is available from the ABCB website.

Reminder

'Verification Method' is an NCC defined term and means a test, inspection, calculation or other method that determines whether a Performance Solution complies with the relevant Performance Requirements.

4.4.2 Performance Solution process

To help ensure a Performance Solution provides the level of intended performance, Clause A2G2(4) of the NCC mandates a process for developing Performance Solutions. This process must be followed regardless of whether the Performance Solution is simple or complex in nature.

In simple terms, the 4 steps of the Performance Solution process are:

(1) prepare a brief

(2) carry out analysis

(3) evaluate results

(4) prepare a final report.

More information on this process is in the Performance Solution Process Guidance Document and the ABCB Performance Solution Process Handbook, which are available from the ABCB website.

4.4.3 Professional practice and ethics

Some state and territory legislation empowers certain practitioners to develop and/or approve Performance Solutions. Irrespective of controls about who can undertake this work, the practitioners involved have a professional responsibility for ensuring that appropriately skilled and experienced persons are engaged to develop and approve Performance Solutions.

When preparing a Performance Solution, practitioners should exercise their duties in an appropriate manner. Key principles include:

- Acting in the public interest – In undertaking their duties, a practitioner should exercise their discretionary powers in ways that safeguard the public interest. A practitioner’s consideration of the interests of their clients and employers must not be contrary to the public interest.
- Independence – In performing their professional duties, a building surveyor/certifier should be objective, impartial and conduct themselves in accordance with the relevant requirements of state and territory legislation. Other practitioners should ensure any conflicts of interest are disclosed to all relevant parties.
- Competence – A practitioner should not undertake professional work that they are not competent to perform.

5 Compliance Option 3: J1V2 Green Star

5.1 Introduction

J1V2 Green Star is a Verification Method (VM) that can be used as part of a Performance Solution to assess if a proposed solution complies with the Performance Requirement J1P1.

Green Star – Design & As-Built and Green Star Buildings rates buildings across a range of sustainability categories, including energy efficiency, and uses a similar methodology to the DTS Provisions.

5.2 Method

5.2.1 Scope and application

J1V2 is applicable to all Class 3, 5, 6, 7, 8 or 9 building.

Green Star – Design & As-Built, Green Star Buildings, and the DTS Provisions differ in scope slightly, however both Green Star and NCC Volume One Section J have the same objective of energy efficiency and reduced GHG consumption. The Green Building Council of Australia (GBCA) have rigorous governing frameworks that drive Green Star rated buildings to energy efficient outcomes.

In simple terms, the method requires the annual GHG emissions of the proposed building to be less than 90% of the annual GHG emissions of a reference building. This is detailed in Figure 5.2.1.

The project is required to be registered for a Green Star – Design & As-Built or Green Star Buildings rating to confirm its compliance with the modelling requirements. Registering the project ensures that the most recent Green Star rating tool is being used, reinforces the commitment to following through with the energy requirements, and adds a layer of oversight from the GBCA.

Figure 5.2.2 outlines the process for J1V2.

Figure 5.2.2 J1V2 for a Class 3, 5, 6, 7, 8 or 9 building and the common areas of Class 2 building

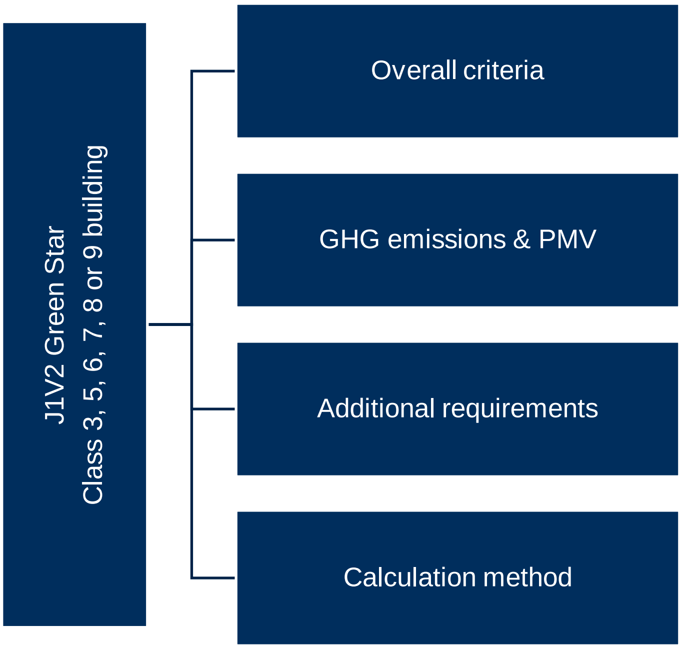


Figure 5.2.1 J1V2 – Comparison of GHG emissions

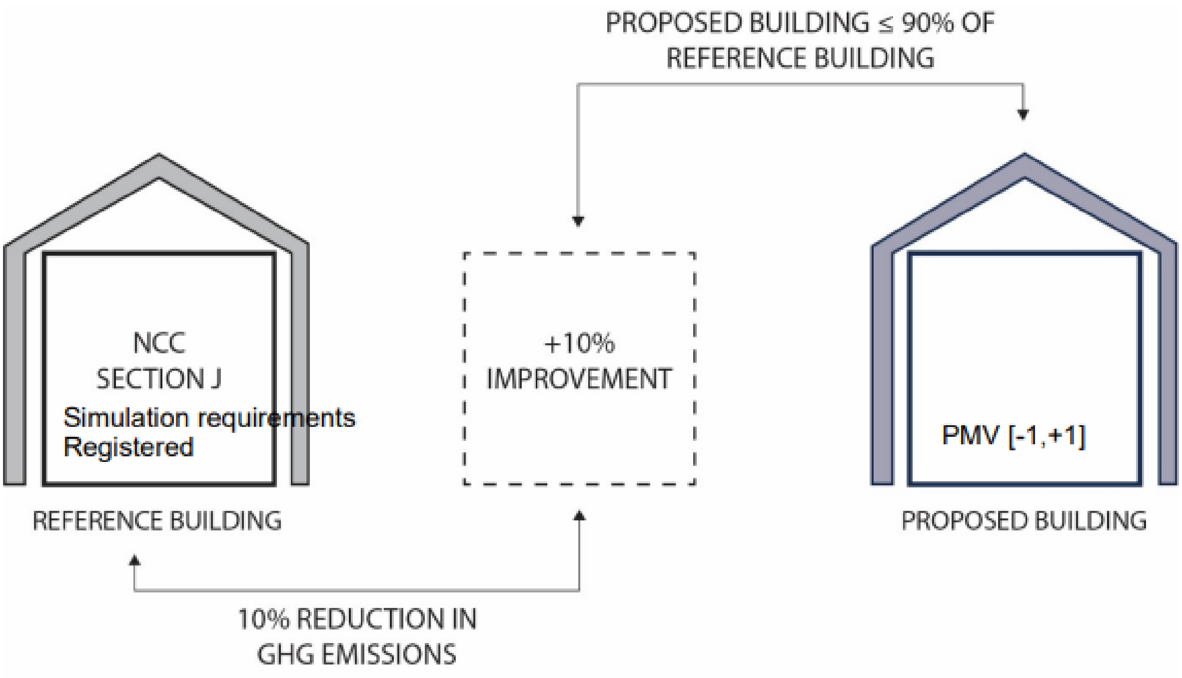


Figure 5.2.2 J1V2 for a Class 3, 5, 6, 7, 8 or 9 building and the common areas of Class 2 building

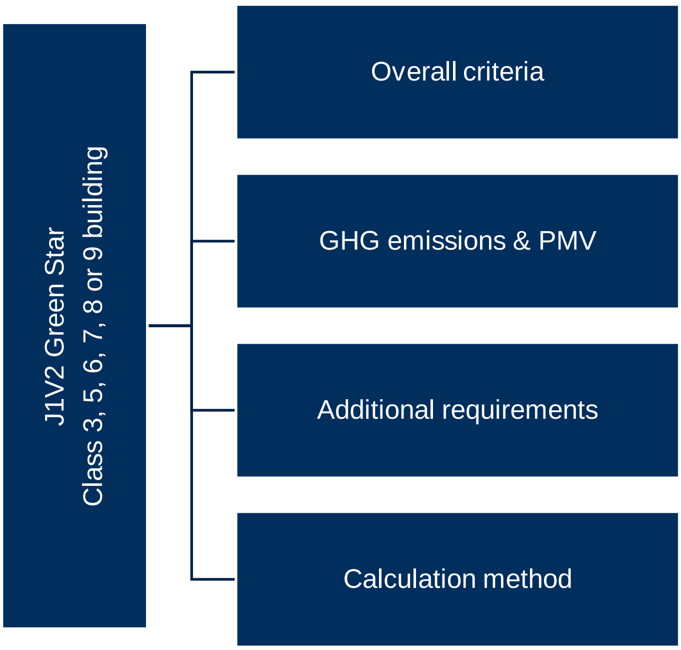


Table 5.1 Key requirements for J1V2

Clause J1V2 reference	Key requirements
(1)(a) Overall criteria	• Registration and compliance with one of the following: – Green Star – Design & As-Built – Green Star Buildings Rating
(1)(b) and (c) GHG emissions and PMV	• The annual GHG emissions the proposed building must be less than 90% of the annual GHG emissions of a reference building. • The proposed building must provide a thermal comfort level of between a PMV of –1 to +1 across not less than 95% of the floor area of all occupied zones • The thermal comfort level must be demonstrated for not less than 98% of the annual hours of operation of the building
(1)(d) Additional requirements	• The building must comply with the additional requirements in Specification 33 (refer to Table 5.2 below)
(2) Calculation method	• The calculation method must comply with ANSI/ASHRAE Standard 140

Alert

ANSI/ASHRAE Standard 140 2007 is the Standard Method of test for the Evaluation of Building Energy Analysis Computer Programs. ANSI/ASHRAE Standard 140 specifies test procedures for evaluating the technical capabilities of software used to calculate the thermal performance of buildings and their HVAC systems.

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Alert

The Green Building Council of Australia (GBCA) is responsible for maintaining and updating the Green Star rating system. Refer to the Green Building Council of Australia website for information relating to the use of Green Star as a compliance option for buildings to meet the relevant energy efficiency Performance Requirement in NCC 2022.

5.2.2 Additional requirements for Verification Method J1V2

Specification 33 specifies additional requirements that must be completed in addition to the modelling requirements of J1V2.

In addition to the necessary modelling, Clause S33C2 of Specification 33 lists requirements from the DTS Provisions and reference documents. This ensures all buildings designed under J1V1 J1V2 and J1V3 cover the same range of energy efficiency aspects. The additional requirements are items that are either outside the scope of the energy model, or the energy model assumes are executed and relies on them to be accurate. Therefore, it must be properly demonstrated that the requirements have been met when constructing the building.

As an example, the standard of installing insulation is covered in S33C2(a) of Specification 33 because it is not specifically addressed through modelling alone. Table 5.2 outlines the additional requirements below.

Table 5.2 Additional requirements from Specification 33

S33C2 reference	NCC reference/requirement
(a) General thermal construction	• J4D3
(b) Floor edge insulation	• J4D7(2) and J4D7(3)
(c) Building sealing	• J1V4 or Part J5
(d) Air-conditioning and mechanical ventilation systems	• Covers deactivation, control and insulation: – J6D3(1)(a), J6D3(1)(b)(i) – J6D3(1)(d), J6D3(1)(f) – J6D3(2) and (3) – J6D4(2) and (4) – J6D5, J6D6 and J6D9
(e) Packaged air-conditioning equipment	• Applies to equipment not less than 65 kWr • AS/NZS 3823.1.2 at test condition T1
(f) Refrigeration chiller	• Applies to testing a refrigeration chiller • AHRI 551/591
(g) Interior artificial lighting and power control	• J7D4
(h) Interior decorative and display lighting	• J7D5
(i) Artificial lighting around the exterior of a building	• J7D6
(j) Boiling water and chilled water storage units	• J7D7

S33C2 reference	NCC reference/requirement
(k) Deactivation of swimming pool heating and pumping	• J8D3(2)(b) and J8D3(3)
(l) Deactivation of spa pool heating and pumping	• J8D4(2)(b) and J8D4(3)
(m) Facilities for energy monitoring	• Part J9
(n) Deactivation of fixed outdoor space heating appliances	• J6D10(3)

In addition, in S33C3, where not included in the building energy simulation to satisfy J1V2(1), compliance must be achieved:

- for heating, cooling and ventilation equipment outside the scope of the Green Star model, Part J6
- for artificial lighting outside the scope of the Green Star model, Part J7.

5.3 Useful tips

Projects using the Green Star – Design & As-Built and Green Star Buildings rating tool must achieve an As Built Certification. This certifies completed buildings (up to 2 years after practical completion) and confirms that the finished product delivers sustainable outcomes, and that everything is in place to ensure the building can be operated as sustainably as possible.

Only one set of energy models is required to meet the requirements of both the Green Star rating tool and to demonstrate compliance with J1P1.

Registrations for Green Star – Design & As Built v1.3 closed in December 2021. This rating tool has been superseded by Green Star Buildings, which is a rating tool for new buildings and major refurbishments.

In fulfilling the conditional requirement of the Green Star – Design & As-Built credit for 'Greenhouse Gas Emissions Reduction – Reference Building Pathway' or Green Star Buildings Minimum Expectation of the Energy Use Credit, a building exceeds the energy efficiency requirements of J1P1. However, the intent of the Verification Method is to allow buildings designed to achieve a Green Star rating to meet compliance without the need of separately showing compliance using the Verification Method J1V3, saving both time and money.

Another way of saying this is the proposed building has 10% less emissions than the reference building. A comparison of GHG emissions reconciles the different emission intensities of gas and electricity and allows credit for on-site renewable energy.

The project is required to be registered for a Green Star – Design & As-Built or Green Star Buildings rating to confirm its compliance with the Green Star modelling requirements. Registering the project ensures that the most recent Green Star rating tool is being used, reinforces the commitment to follow through with the energy requirements, and adds a layer of oversight from the GBCA.

An assessment of the PMV is also a requirement of Verification Method J1V2. This ensures that occupant comfort is not compromised in the pursuit of energy efficiency. The PMV index predicts the mean response of a large group of people on a 7-point thermal sensation scale, from +3 (hot) to –3 (cold) where 0 is neutral.

As with J1V1 and J1V3, the J1V2 Verification Method requires the thermal comfort level in the proposed building to be between a PMV of –1 to +1 across at least 95 percent of the floor area of all occupied zones for at least 98 percent of the hours of operation. A PMV of –1 to +1 means that 75% of people are satisfied and comfortable. Note, this is likely to be appropriate for buildings that meet the applicability criterion in Section 5.4.1 of ASHRAE 55-2013. This is also a requirement of J1V1 and J1V2.

The PMV metric is designed for fully mechanically ventilated buildings. If a building is either mixed-mode or naturally ventilated, the Adaptive Thermal Comfort metric may be more appropriate. The Adaptive Thermal Comfort metric relates indoor design temperatures to outdoor temperatures (i.e. higher room temperatures during warmer weather) based on the understanding that occupants can adapt to, or even prefer a wider range of conditions. This can be used as a Performance Solution subject to the approval of the Appropriate Authority. Adaptive Thermal Comfort can also be used in combination with PMV in buildings that have both fully mechanical and partially naturally ventilated spaces as a Performance Solution.

Table 5.3 below provides additional compliance requirements for areas not included in the building energy simulation to satisfy J1V2(1).

Table 5.3 Additional requirements – Green Star

Building component	Compliance method
Heating, cooling and ventilation equipment outside the scope of the Green Star model	Part J6
Artificial lighting outside the scope of the Green Star model	Part J7

Examples of heating, cooling, ventilation equipment and lighting not covered by Green Star – Design & As-Built or Green Star Buildings may include tenancy specific systems.

5.4 Demonstrating compliance

5.4.1 Background

A Performance Solution can be used in an individual situation where the desired solution meets the Performance Requirements of the NCC, but not the relevant DTS Provisions. These solutions are often flexible in achieving the outcomes required and encourage innovative design and technology use. An overview of how to demonstrate compliance with the NCC is in Appendix C of this document, with further guidance available from the ABCB website.

J1V2 Green Star is a Verification Method; therefore, where a Performance Solution utilises J1V2, Verification Method is the relevant Assessment Method. More information on Assessment Methods is in the resource Understanding the NCC – Assessment Methods, which is available from the ABCB website.

A building owner may not have all the information they need to complete a Green Star model when they complete a development application, meaning it is not used often to show compliance. If the owner is committed to using Green Star as a compliance pathway, it is suggested that they discuss the timing of the delivery of information with the relevant authority (e.g. a building surveyor) in order to facilitate the use of J1V2 as a compliance pathway.

Reminder

'Verification Method' is an NCC defined term and means a test, inspection, calculation or other method that determines whether a Performance Solution complies with the relevant Performance Requirements.

5.4.2 Performance Solutions process

To help ensure a Performance Solution provides the level of intended performance, Clause A2G2(4) of the NCC mandates a process for developing Performance Solutions. This process must be followed regardless of whether the Performance Solution is simple or complex in nature.

In simple terms, the 4 steps of the Performance Solution process are:

(1) prepare a brief
(2) carry out analysis
(3) collate and evaluate results
(4) prepare a final report.

More information on this process is in the Performance Solution Process Guidance Document and the ABCB Performance Solution Process Handbook, which are available from the ABCB website.

5.4.3 Professional practice and ethics

Some state and territory legislation empowers certain practitioners to develop and/or approve Performance Solutions. Irrespective of controls about who can undertake this work, the practitioners involved have a professional responsibility for ensuring that appropriately skilled and experienced persons are engaged to develop and approve Performance Solutions.

When preparing a Performance Solution, practitioners should exercise their duties in an appropriate manner. Key principles include:

- Acting in the public interest – In undertaking their duties, a practitioner should exercise their discretionary powers in ways that safeguard the public interest. A practitioner's consideration of the interests of their clients and employers must not be contrary to the public interest.
- Independence – In performing their professional duties, a building surveyor/certifier should be objective, impartial and conduct themselves in accordance with the relevant requirements of state and territory legislation. Other practitioners should ensure any conflicts of interest are disclosed to all relevant parties.
- Competence – A practitioner should not undertake professional work that they are not competent to perform.

6 Compliance Option 4: J1V3 Verification using a reference building

6.1 Introduction

J1V3 Verification using a reference building (VURB) is a Verification Method (VM) that can be used as part of a Performance Solution to demonstrate compliance with the Performance Requirement J1P1. It can be used instead of the DTS Provisions of Parts J1 to J8.

Figure 6.1.1 summarises the relevant requirements that form J1V3. These requirements are discussed in further detail in this chapter.

Figure 6.1.1 J1V3 VURB

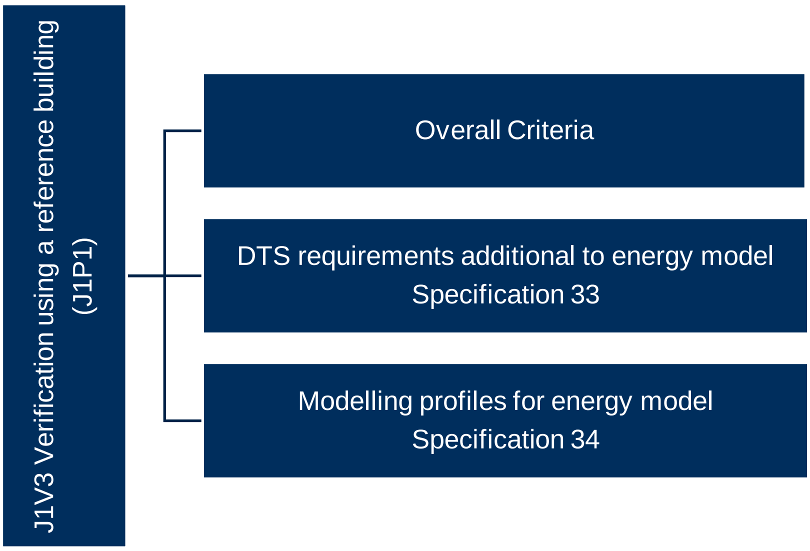
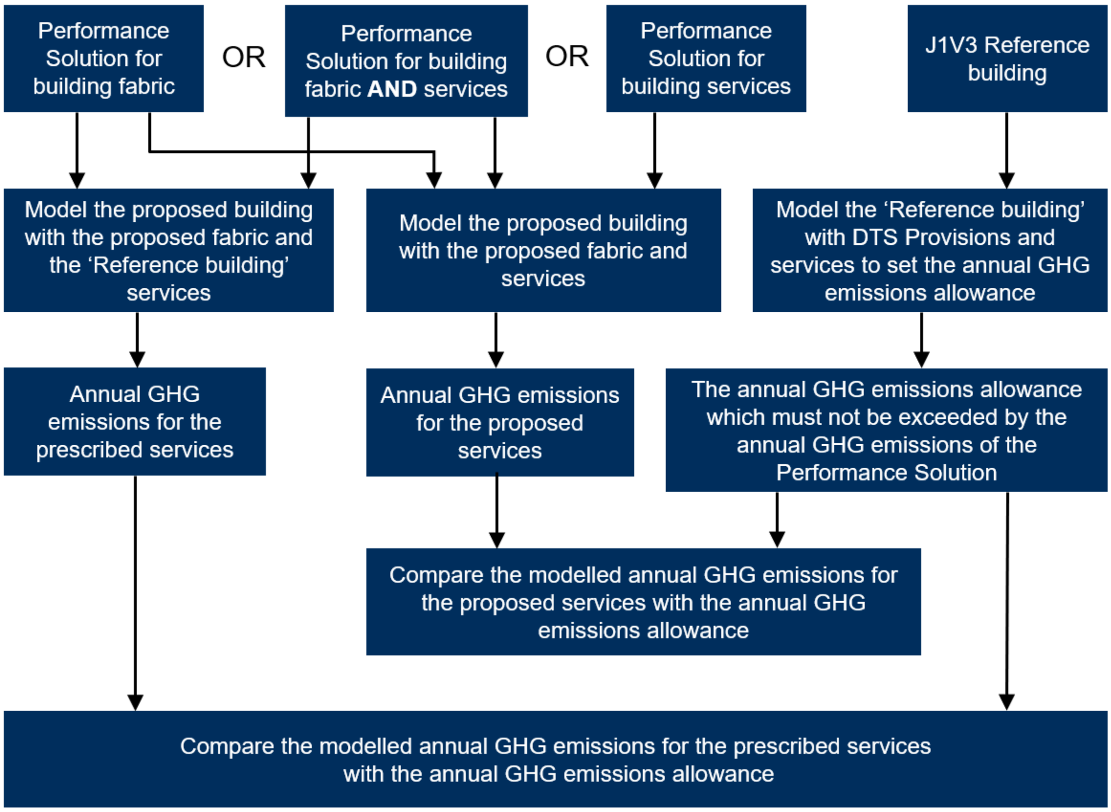


Figure 6.1.2 illustrates how J1V3 can be used as part of different Performance Solutions.

It should be emphasised that it is not mandatory to use a prescribed NCC VM as the Assessment Method.

Figure 6.1.2 Using Verification Method J1V3



6.2 Method

6.2.1 Scope and application

J1V3 VURB is applicable to all Class 3, 5, 6, 7, 8, and 9 buildings or common area of Class 2 buildings.

This VM is a comparative assessment. The basic approach is that the annual GHG emissions of the proposed building must not be more than the annual GHG emissions of a complying reference building which is based on the DTS Provisions.

In J1V3(a), the following two scenarios must be met:

- J1V3(1)(a)(i) with the proposed services in the proposed building and services complying with the DTS Provisions for the reference building; and
- J1V3(1)(a)(ii) with the same services in both cases that comply with the DTS Provisions.

These two theoretical scenarios are necessary because, if only subclause J1V3(1)(a)(i) was required, the thermal performance of the building's envelope could be "traded-off" for more energy efficient building services. Whilst energy efficient building services are always desirable, the energy efficiency of a building's envelope is of greater importance. Services may change over time or a lack of maintenance may cause the services to under-perform.

On the other hand, once the passive energy efficiency requirements for the envelope are in place, they generally maintain their performance for the life of the building, which will exceed the life of the services. Services are also typically easier and more cost-effective to upgrade in comparison to the building fabric.

Table 6.1 outlines the key requirements for J1V3.

Table 6.1 Key requirements for J1V3

Clause J1V3 reference	Key requirements
(1)(a) and (b) GHG emissions and PMV	• The annual GHG emissions of the proposed building are not more than the annual GHG emissions of a reference building when: – the proposed building is modelled with the proposed services – the proposed building is modelled with the same services as the reference building. • The Proposed building must provide a thermal comfort level of between a Predicted Mean Vote (PMV) of -1 to +1 across not less than 95% of the floor area of all occupied zones. • The thermal comfort level must be demonstrated for not less than 98% of the annual hours of operation of the building.
(1) Additional requirements	• The building must comply with the additional requirements in Specification 33 (refer to Table 6.2 below).
(2) Renewable and reclaimed energy	• The annual greenhouse gas emissions of the proposed building may be offset by: – renewable energy generated and used on site – another process such as reclaimed energy, used on site.
(3) Calculation method	• The calculation method used for (1) and (2) must comply with: – ANSI/ASHRAE Standard 140 – Specification 34.

6.2.2 Methodology

J1V3 does, however, permit the trade-off to go the other way. Increasing the energy efficiency of the building's envelope can allow the performance of the building services to be beneath the standard required by the DTS Provisions.

This means that there are multiple steps to using this Verification Method.

(1) Software run 1 - determine the annual GHG emissions allowance by modelling a reference building, which is a DTS Provisions compliant building based on the criteria in J1V3(3).

(2) Software run 2 - calculate the theoretical annual GHG emissions of the proposed Performance Solution using the parameters set in Specification 34.

(3) Software run 3 - calculate the theoretical annual GHG emissions of the proposed Performance Solution, with the services modelled as if they were the same as that of the reference building.

(4) Compare the theoretical annual GHG emissions calculated in steps 2 and 3, to the annual GHG emissions allowance calculated in step 1, to ensure that in both cases, the annual GHG emissions are not more than the allowance, software run 1.

6.2.3 Additional requirements

In addition to the modelling requirements specified in J1V3, a building must comply with the requirements specified in S33C2. This ensures all buildings designed under J1V1 J1V2 and J1V3 cover the same range of energy efficiency aspects. A summary of the additional requirements is shown in Table 6.2.

Table 6.2 Additional requirements from Specification 33

S33C2 reference	NCC reference/requirement
(a) General thermal construction	• J4D3
(b) Floor edge insulation	• J4D7(2) and J4D7(3)
(c) Building sealing	• J1V4 or Part J5
(d) Air-conditioning and mechanical ventilation systems	• Covers deactivation, control and insulation: – J6D3(1)(a), J6D3(1)(b)(i) – J6D3(1)(d), J6D3(1)(f) – J6D3(2) and (3) – J6D4(2) and (4)

S33C2 reference	NCC reference/requirement
	– J6D5, J6D6 and J6D9
(e) Packaged air-conditioning equipment	• Applies to equipment not less than 65 kWr • AS/NZS 3823.1.2 at test condition T1
(f) Refrigeration chiller	• Applies to testing a refrigeration chiller • AHRI 551/591
(g) Interior artificial lighting and power control	• J7D4
(h) Interior decorative and display lighting	• J7D5
(i) Artificial lighting around the exterior of a building	• J7D6
(j) Boiling water and chilled water storage units	• J7D7
(k) Deactivation of swimming pool heating and pumping	• J8D3(2)(b) and J8D3(3)
(l) Deactivation of spa pool heating and pumping	• J8D4(2)(b) and J8D4(3)
(m) Facilities for energy monitoring	• Part J9
(n) Deactivation of fixed outdoor space heating appliances	• J6D10(3)

6.2.4 Calculation method

The calculation method used for J1V3(1) and (2) must comply with ANSI/ASHRAE Standard 140. ANSI/ASHRAE Standard 140 provides a consistent test method for the evaluation of building analysis computer programs.

The calculation method must also comply with Specification 34, which outlines the modelling parameters for J1V3.

Alert

ANSI/ASHRAE Standard 140 2007 is the Standard Method of test for the Evaluation of Building Energy Analysis Computer Programs. ANSI/ASHRAE Standard 140 specifies test procedures for evaluating the technical capabilities of software used to calculate the thermal performance of buildings and their HVAC systems.

6.2.5 Modelling parameters and profiles

Clause 3 of Specification 34 specifies the parameters used for modelling the proposed building and reference building, to ensure a fair and equal comparison of parameters between the two building models. In general, the annual GHG emissions value for J1V3(1) and (2) must be calculated using the same parameters as outlined in S34C3(1)(a) to (i) for the proposed building and reference building.

The key requirements that must be the same in both modelling runs, and the associated clause reference is in Table 6.3.

Table 6.3 Key modelling parameter requirements for both models using J1V3 VURB

Parameters that must be used to calculate annual GHG emissions for both models	NCC reference(s)
Annual GHG emissions calculation method	S34C3(1)(a)
GHG emissions factors	S34C3(1)(b) and (2) Table S34C3
Location	S34C3(1)(c) and (3)
Adjacent structures and features	S34C3(1)(d)
Orientation	S34C3(1)(e)
Building form including: – roof geometry – floor plan – number of storeys – location – extent and configuration of ground floors and basements – the size and location of glazing	S34C3(1)(f) and (4)

Parameters that must be used to calculate annual GHG emissions for both models	NCC reference(s)
– external doors.	
Fabric and glazing including insulation, thermal resistance of air films, internal shading devices, and external, internal and separating walls	S34C3(5)
Services (and profiles), including air-conditioning control and services, floor coverings, furniture, fittings, internal heat gains (i.e. people, lighting, appliances, meals and other appliances), energy sources[8]	S34C3(6) Specification 35 Table S34C3
Services – system demand and response	S34C4(a)
Services – energy usage	S34C4(b) to (i)

Profiles for occupancy, air-conditioning, lighting and internal heat gains (i.e. from people, hot meals, appliances, equipment and heated water supply systems) need to be modelled as part of the calculation of the annual GHG emissions. Options for generating these profiles are outlined at S34C3(6)(g).

One of these options includes Specification 35 Modelling profiles for J1V3. This specification contains modelling profiles that can be used as part of the calculation for modelling the proposed and reference building. Table 6.4 outlines the modelling profiles in Specification 35.

Table 6.4 Key modelling requirements for both models (reference and proposed) using J1V3 VURB

Model profile required	NCC reference(s)
Air-conditioning – Daily occupancy and operation profiles	S35C2(1)(a), Table S35C2a
Air-conditioning – Internal heat gains in a building	S35C2(b), Tables S35C2n and S35C2l
Artificial lighting	S35C2(2), Table S35C2a
Heated water supply	S35C2(3), Table S35C2m

8 Not including renewable energy generated on-site.

6.2.6 Renewable energy

- J1V3 allows on-site renewable energy resources and re-claimed energy from another process to be deducted from the annual GHG emissions of the proposed building. This means that the annual GHG emissions represent the sum of the GHG emissions drawn annually from the electrical grid, the gas network or fuel brought in by road transport and not the total of the energy consumed by the services that use energy.
- To obtain this concession, the renewable energy must be used and generated on-site. This means that electricity purchased as GreenPower for example does not comply with the concession as it is grid distributed. Energy that is exported to the grid cannot be used as part of this concession.
- In determining the amount of renewable energy, a designer needs to consider the likely availability of energy from the resources, including any down time the plant equipment may experience for maintenance.
- Examples of reclaimed energy could be the waste heat captured to heat water from a refrigeration chiller (rather than being rejected to a cooling tower); or energy from a process unrelated to building services, such as steam condensate from a laundry process. Note that co-generation and tri-generation systems are excluded from providing any credit; as they are considered a service in their entirety, rather than a subsequent energy gain from a system already in place.

6.3 Useful tips

As with J1V1 and J1V2, J1V3 requires the thermal comfort level in the proposed building to be between a PMV of – 1 to +1 across at least 95 percent of the floor area of all occupied zones for at least 98 percent of the hours of operation. A PMV of –1 to +1 means that 75% of people are satisfied and comfortable. Note, this is likely to be appropriate for buildings that meet the applicability criterion in Section 5.4.1 of ASHRAE 55-2013.

The PMV metric is designed for fully mechanically ventilated buildings. If a building is either mixed-mode or naturally ventilated, the Adaptive Thermal Comfort metric may be more appropriate. The Adaptive Thermal Comfort metric relates indoor design temperatures to outdoor temperatures (i.e. higher room temperatures during warmer weather) based on the understanding that occupants can adapt to, or even prefer a wider range of conditions. This can be used as a Performance Solution subject to the approval of the Appropriate Authority.

J1V2 and J1V3 require that the reference building be modelled with parameters which are considered typical for a range of buildings over their life. If these parameters were not fixed, the calculations could be manipulated by using less energy efficiency parameters when setting the allowance with the reference building.

Parameters are to be set for the reference building and the same must also be used for the proposed building unless there is innovative technology used, in which case another Verification Method could be developed and used.

Although the parameters may not be how the subject building is to operate, a building may change its use over its life; and may even change its building classification. Different owners and different tenants will have different internal loads, different operating times and other criteria. Even though the values stated may not be those of the proposed building, they are considered reasonable averages for how some buildings operate over their life.

The reference building is that which would have been built had the Performance Solution not been proposed. For example, decorative lighting may be installed in a building for aesthetic purposes. DTS requirements specify maximum illumination power densities for different space types may be smaller than the illumination power density of the decorative lighting. The reference building would have DTS lighting requirements and the Performance Solution would have the installed decorative lighting (and the associated GHG emission penalty required to be made up elsewhere). Please note, while there are no DTS requirements for the maximum illumination power density for decorative lighting, there are specific control requirements.

The requirements for the reference building would be the minimum or the maximum as appropriate, required by the DTS Provisions of Parts J4 to J8. They would include only the minimum amount of mechanical ventilation required by Part F2 as it would be unreasonable to present an argument for a higher outdoor air rate for the reference building for improved health but not the proposed building.

If the proposed building requires temperature ranges outside that specified in S34C2(c) for air-conditioning to condition the space, for example an indoor aquatic centre, a Performance Solution may be required.

Artificial lighting in the reference building must achieve the maximum illumination power density in Part J7 without applying any control device or light colour adjustment factors. Adjustment factors for light colours applied to the proposed building are not required in the reference building. This provides an advantage to the proposed building where better than average colour rendering is used in lighting. It would be unreasonable to claim that the reference building has motion detectors to increase the illumination power density allowance, when not the case. However, it would be reasonable to make allowances for Room Aspect Ratios based on the room arrangement of building layout.

Calculating heat losses or gains through floors that are ground coupled and establishing ground temperatures under buildings is extremely difficult. Therefore, heat transfer through ground coupled floors (an uninsulated slab-on-ground) could be ignored, provided it is ignored in the modelling of both the reference building and the proposed building.

The conditions under which products are rated are only used for determining the performance rating and not the actual conditions in the proposed building or where the proposed building is to be located.

Thermal resistance of air films includes any adjustment factors, moisture content of materials and the like. Generally, there is no reason why these values should change from one run to the next, other than in an innovative solution where specific provisions are made such as reveals or other such protrusions or devices used to reduce the air velocity across the external surfaces.

The profiles for occupancy, air-conditioning, lighting and internal heat gains are to be based on either Specification 35, NABERS Energy Commitment Agreement simulation requirements or Green Star simulation requirements. However, if the actual building's operating hours are greater than or equal to 2,500 hours per year, or if the daily operating profiles are not listed in Specification 35, the proposed building's profiles may be used.

The infiltration values must be the same unless there are specific additional sealing requirements, an intended building leakage of less than 10 $m^3/hr.m^2$ at 50 Pa, or pressure testing to be undertaken with the proposed building. In these instances, the intended building leakage at 50 Pa may be converted into a whole building infiltration value for the proposed building using Tables 4.16 to 4.24 of CIBSE Guide A.

Clause S34C4 of Specification 34 prescribes the detailed modelling requirements for the services of both the proposed and reference building. See the Development of Performance Solutions documents for additional guidance available on the ABCB website. The documents provide details on preparing a PBDB, analysis, modelling and testing, evaluating results and preparing a final report.

AHRI 551/591 specifies requirements on consistent testing and conformance conditions and may provide guidance on allowances for the energy use of all cooling plant items.

Alert

AHRI 551/591 is the American Air-Conditioning & Refrigeration Institute (AHRI) Standard for the "Performance rating of water-chilling and heat pump water-heating packages using the vapour compression cycle". The standard specifies the requirements for water-chilling and water-heating packages using the vapour compression cycle including test requirements, rating requirements, minimum data requirements, marking and nameplate data and conformance conditions.

Energy efficiency requirements for vertical transport (lifts or escalators) include standby performance levels, energy efficiency classes and controls for when not in use. Vertical transport and heated water supply for food preparation and sanitary purposes may be omitted from the annual GHG emissions calculations if they are the same in both the proposed building and reference building.

Alternatively, the performance of a basic but realistic system can be selected for the reference building and a higher performance system selected for the proposed building. In this way, a high performance heated water system or high-performance lift can provide “credit” and can contribute towards off-setting the under-performance of other services. The proposed solution is required to be approved by the Appropriate Authority.

Where a lift is included in the calculations and the lift serves more than one building classification, the energy consumption of the lift may be proportioned according to the number of storeys. This means that if four storeys of a building are retail (a Class 6 building) and 6 storeys are hotel accommodation (Class 3 building) then 40% of the annual GHG emissions produced by the lifts is attributed to the Class 6 building and 60% to the Class 3 building.

6.4 Demonstrating compliance

6.4.1 Background

A Performance Solution can be used in an individual situation where the desired solution meets the Performance Requirements of the NCC, but not the relevant DTS Provisions. These solutions are often flexible in achieving the outcomes required and encourage innovative design and technology use.

Demonstrating compliance with the Performance Requirements may utilise one of more of the NCC Assessment Methods. These are evidence of suitability, Expert Judgement; Verification Methods and Comparison to DTS. An overview of how to demonstrate compliance with the NCC is in Appendix C of this document, with further guidance available from the ABCB website.

J1V3 is an NCC Verification Method and therefore can form part of a Performance Solution. More information on NCC Assessment Methods is provided by the resource, Understanding the NCC – Assessment Methods, which is available from the ABCB website.

Reminder

‘Verification Method’ is an NCC defined term. It means a test, inspection, calculation, or other method that determines whether a Performance Solution complies with the relevant Performance Requirements.

6.4.2 Performance Solution process

To help ensure a Performance Solution provides the level of intended performance, Clause A2G2(4) of the NCC mandates a process for developing Performance Solutions. This process must be followed regardless of whether the Performance Solution is simple or complex in nature. The 4 steps of the Performance Solution process include:

(1) preparing a brief
(2) carrying out analysis
(3) evaluating results
(4) preparing a final report.

More information is provided in the Performance Solution Process Guidance Document and the ABCB Performance Solution Process Handbook, which are available from the ABCB website.

6.4.3 Professional practice and ethics

Some state and territory legislation empowers certain practitioners to develop and/or approve Performance Solutions. Irrespective of controls about who can undertake this process, the practitioners involved have a professional responsibility for ensuring that appropriately skilled and experienced persons are engaged and participate as stakeholders in the process.

When preparing a Performance Solution, practitioners should exercise their duties in an appropriate manner. Key principles include:

- Acting in the public interest – In undertaking their duties, a practitioner should exercise their discretionary powers in ways that safeguard the public interest. A practitioner's consideration of the interests of their clients and employers must not be contrary to the public interest.
- Independence – In performing their professional duties, a building surveyor/certifier should be objective, impartial and conduct themselves in accordance with the relevant requirements of state and territory legislation. Other practitioners should ensure any conflicts of interest are disclosed to all relevant parties.
- Competence – A practitioner should not undertake professional work that they are not competent to perform.

6.4.4 Examples

An example of using J1V3 VURB is provided in Appendix D.5.

7 Compliance Option 5: J1V4 Verification of building envelope sealing

7.1 Introduction

J1V4 Verification of building envelope sealing is a Verification Method that can be used as part of a Performance Solution to assess if a proposed solution for a building complies with the Performance Requirement J1P1(e) for building envelope sealing.

It should be emphasised that it is not mandatory to use a prescribed NCC Verification Method as the Assessment Method.

7.2 Method

7.2.1 Scope and application

J1V4 is applicable to Class 3, 5, 6, 8 and 9 buildings.

The intent of J1V4 is to provide a means of verifying compliance with the thermal Performance Requirements of J1P1(e) for building envelope sealing through practical testing.

Alert

AS/NZS ISO 9972 is the Australian/New Zealand standard, “Thermal performance of buildings – Determination of air permeability of buildings – Fan pressurization method”.

This standard contains requirements for testing the air permeability of buildings using the fan pressurisation method, including the apparatus, measurement procedures, expression of results and the standardised format of testing reports.

There are 3 different methods contained within the standard. However, Method 1 must be used for the purposes of Verification Method J1V4.

7.2.1.1 Methodology

J1V4 specifies that the envelope be sealed at an air permeability rate, tested in accordance with Method 1 of AS/NZS ISO 9972. The clause outlines different permeability rates for different building classes. To demonstrate compliance, the results of the verified blower door test should be provided in accordance with Part A5 of NCC Volume One.

Alert

AS/NZS ISO 9972 is the standard for thermal performance of buildings – determination of air permeability of buildings – fan pressurization method. Method 1 is a test of the building in use where the natural ventilation openings are closed, and the mechanical ventilation or air-conditioning openings are sealed.

7.2.1.2 Air permeability rates

J1V4 sets out the test method and criteria for the air permeability rates for different building classifications and climate zones. Some climate zones are not included in these provisions as in some cases air tightness has been found to increase energy consumption. Table 7.1 summarises these requirements.

Table 7.1 Air permeability requirements for building envelope sealing tested in accordance with Method 1 of AS/NZS ISO 9972 (Source: NCC 2022 Volume One)

Building classification	J1V4 reference	Climate zone	Maximum air permeability rate ($m^3/hr.m^2$) at 50Pa reference pressure
Class 3	J1V4(1)(c)	1, 3, 4, 6, 7, 8	5
Class 5	J1V4(1)(b)	1, 7, 8	5
Class 6	J1V4(1)(b)	1, 7, 8	5
Class 7	n.a.	n.a.	n.a.
Class 8	J1V4(1)(b)	1, 7, 8	5
Class 9a (other than a ward area)	J1V4(1)(b)	1, 7, 8	5
Class 9a (ward areas)	J1V4(1)(c)	1, 3, 4, 6, 7, 8	5
Class 9b	J1V4(1)(b)	1, 7, 8	5
Class 9c	J1V4(1)(c)	1, 3, 4, 6, 7, 8	5

Notes to Table 7.1: n.a. means J1V4 is not applicable

7.3 Useful tips

Verification Method J1V4 is limited to Performance Requirement J1P1(e) for building envelope sealing and cannot verify compliance with any other components of J1P1.

The DTS Provisions for building sealing in Part J5, can be used as guidance prior to testing commencing.

The intent of this method is to restrict unintended in/exfiltration in buildings (i.e. unwanted outdoor air into the building and the loss of conditioned air from the building). J1V4 provides an alternative method to the building sealing requirements in Part J5 for demonstrating compliance with the building sealing requirements in J1P1(e).

In addition to unnoticed air leakage, drafts caused by poorly sealed external openings and construction gaps can affect the building occupants' sense of comfort, causing them to increase the use of artificial heating and cooling. Leakage of humid air into an air-conditioned building can increase energy needed for dehumidification.

Air leakage most commonly occurs at the:

- roof to wall junction
- floor to wall junction
- wall to door frame junction
- wall to window frame junction
- all services penetrations.

Envelope sealing in some climates can have a reduced overall energy benefit. With reduced air infiltration, buildings in some climates are less likely to cool naturally overnight, particularly buildings in mild climates that do not operate overnight. However, if buildings in these climate zones operate their cooling system to expel warm air and draw cool air in overnight (typically known as night purging), then a lower air permeability rate could still be beneficial.

A blower door test can only be completed at the end of the construction process, not prior to receiving a buildings design approval.

Temporary envelope sealing (except for that within the testing procedure) is not appropriate, as the tested scenario must represent the final building.

This verification testing should be planned in the program of a build, to ensure that the requirement can be demonstrated, and improvements made after testing if required.

Air infiltration rates are determined for all windows tested to AS 2047 and are published on the WERS website. The selection of windows with a low air infiltration rate should be considered to assist complying with the criteria in Verification Method J1V4.

Method 1 within AS/NZS ISO 9972 precisely defines the testing requirements, so refer to the standard to confirm the requirements for your specific project.

When designing a building, both Performance Solutions and DTS Solutions can be used to achieve compliance with the Performance Requirements. A combination of both Performance and DTS Solutions may also be used to satisfy a single Performance Requirement. This may include occasions where a specific Performance Requirement covers several elements of a building. See Part A2 of NCC Volume One for more information.

7.4 Demonstrating compliance

7.4.1 Background

A Performance Solution can be used in an individual situation where the desired solution meets the Performance Requirements of the NCC, but not the relevant DTS Provisions. These solutions are often flexible in achieving the outcomes required and encourage innovative design and technology use.

Demonstrating compliance with the Performance Requirements may utilise one of more of the NCC Assessment Methods. These are evidence of suitability, Expert Judgement; Verification Methods and Comparison to DTS. An overview of how to demonstrate compliance with the NCC is in Appendix C of this document, with further guidance available from the ABCB website.

Verification of building envelope sealing is an NCC Verification Method and therefore part of a Performance Solution. More information on NCC Assessment Methods provided in the resource, Understanding the NCC – Assessment Methods, which is available from the ABCB website.

Reminder

'Verification Method' is an NCC defined term and means a test, inspection, calculation or other method that determines whether a Performance Solution complies with the relevant Performance Requirements.

7.4.2 Performance Solution process

To help ensure a Performance Solution provides the level of intended performance, Clause A2G2(4) of the NCC mandates a process for developing Performance Solutions. This process must be followed regardless of whether the Performance Solution is simple or complex in nature.

The 4 steps of the Performance Solution process include:

(1) preparing a brief

(2) carrying out analysis

(3) evaluating results

(4) preparing a final report.

More information on this process is in the Performance Solution Process Guidance Document and the ABCB Performance Solution Process Handbook, which are available from the ABCB website.

7.4.3 Professional practice and ethics

Some state and territory legislation empowers certain practitioners to develop and/or approve Performance Solutions. Irrespective of controls about who can undertake this process, the practitioners involved have a professional responsibility for ensuring that appropriately skilled and experienced persons are engaged and participate as stakeholders in the process.

When preparing a Performance Solution, practitioners should exercise their duties in an appropriate manner. Key principles include:

- Acting in the public interest – In undertaking their duties, a practitioner should exercise their discretionary powers in ways that safeguard the public interest. A practitioner's consideration of the interests of their clients and employers must not be contrary to the public interest.
- Independence – In performing their professional duties, a building surveyor/certifier should be objective, impartial and conduct themselves in accordance with the relevant requirements of state and territory legislation. Other practitioners should ensure any conflicts of interest are disclosed to all relevant parties.
- Competence – A practitioner should not undertake professional work that they are not competent to perform.

7.4.4 Example

To assist with the use of J1V4 Verification of building envelope sealing, an example is in Appendix D.6.

8 Compliance Option 6: Other Performance Solutions

8.1 Introduction

As outlined in Chapter 2, there are 3 options available to demonstrate compliance with the Performance Requirements:

- a Performance Solution
- a DTS Solution, or
- a combination of a Performance Solution and a DTS Solution.

An overview of how to comply with the NCC is in Appendix C of this document, with further guidance available from the ABCB website.

A Performance Solution can be used in an individual situation where the desired solution meets the Performance Requirements of the NCC, but not the relevant DTS Provisions. These solutions are often flexible in achieving the outcomes required and encourage innovative design and technology use.

Compliance with the energy efficiency Performance Requirements for a building - J1P1 Energy use and J1P4 Renewable energy and electric vehicle charging - need to be achieved. Any proposed Performance Solution needs to demonstrate that this has been achieved.

This section outlines some potential options for Performance Solutions that do not use an NCC Verification Method as the Assessment Method.

Reminder

A key principle underpinning the NCC 2022 energy efficiency requirements is that all compliance options aim to offer an equivalent level of performance. This principle helps ensure the policy objectives set out in Objective J1O1 (see section 2.2) are achieved.

8.2 Assessment Methods

Assessment Methods are used when determining if a Performance Solution complies with the relevant Performance Requirements.

The following Assessment Methods are listed in the NCC (see A2G2 and A2G3) and each, or any combination, can be used to demonstrate compliance for a Performance Solution where appropriate:

- Evidence of suitability
- Expert Judgement
- Comparison with the DTS Provisions
- Verification Methods.

These Assessment Methods are discussed in the following sections.

8.2.1 Evidence of suitability

Evidence of suitability, also known as 'documentary evidence', can generally be used to support that a material, product, form of construction or design satisfies a Performance Requirement. Subject to certain NCC provisions, the form of evidence that may be used consists of one, or a combination, of the following:

- a report from an Accredited Testing Laboratory
- a Certificate of Conformity or a Certificate of Accreditation
- a certificate from a professional engineer or appropriately qualified person
- a current certificate issued by a product certification body that has been accredited by the Joint Accreditation System of Australia and New Zealand (JASANZ)
- any other form of documentary evidence that adequately demonstrates suitability such as a Product Technical Statement.

More information on this Assessment Method is available in the ABCB Website.

In relation to the commercial energy efficiency provisions in the NCC, individual jurisdictions may have issued specific directions or notices specifying what documentary evidence is considered acceptable to demonstrate compliance.

8.2.2 Expert Judgement

Where physical criteria is unable to be tested, or modelled by calculation, the opinion of an expert may be accepted. Expert Judgment is the judgement of a person who has the qualifications and experience necessary to determine whether a Performance Solution complies with the Performance Requirements.

It is the role of the appropriate authority to determine whether a person providing an Expert Judgement is considered an expert.

More information on the use of Expert Judgement, including guidance on who may be considered an expert, is in the resource Understanding the NCC – Assessment Methods, which is available from the ABCB website.

8.2.3 Comparison with the DTS Provisions

This Assessment Method involves a comparative analysis demonstrating that a Performance Solution is better than, or at least equivalent to, a solution that complies with the relevant DTS Provision(s).

To carry out this comparison, the applicable DTS Solution and Performance Solution both need to be subject to the same level of analysis using the same methodology. This provides the building designer and appropriate authority with a defined benchmark or level for the DTS Solution and the Performance Solution.

The intent of J1V3 Verification using a reference building is to provide a pathway that utilises the principle underpinning the Comparison with the DTS Provisions Assessment Method, in that the outcome must be better than, or at least equivalent to, a DTS Solution. This is achieved using a reference building and a proposed building. The method provides a set of reasonable assumptions, parameters and exclusions to help ensure a Performance Solution produced using this Verification Method provides the intended level of performance.

Therefore, it is expected that a Performance Solution that uses a Comparison with the DTS Provisions Assessment Method would use a similar set of reasonable assumptions, parameters and exclusions to those specified in J1V3. The parameters, assumptions, exclusions, calculation methodology and acceptance criteria would also need to be agreed by relevant stakeholders as required by the Performance Solution Process.

8.2.4 Verification Methods

Verification Methods are tests or calculations that prescribe a way to assess compliance with relevant NCC Performance Requirements. They include a test, inspection, calculation, or a combination of these.

Verification Methods not contained in the NCC may be used if deemed suitable by the appropriate authority.

8.3 Performance Solution Process

To help ensure a Performance Solution provides the level of intended performance, clause A2G2(4) of the NCC mandates a process for developing Performance Solutions. This process must be followed regardless of whether the Performance Solution is simple or complex in nature.

The 4 steps of the Performance Solution process include:

(1) preparing a brief

(2) carrying out analysis

(3) evaluating results

(4) preparing a final report.

More information on this process is in the Performance Solution Process Guidance Document and the ABCB Performance Solution Process Handbook, which are available from the ABCB website.

8.3.1 Quantified Performance Requirements

The incorporation of energy targets into J1P1 (Energy use) provides a quantified compliance pathway for a building that is air-conditioned to meet this Performance Requirement. J1P1 incorporates targets for the energy use of a building in units of kilojoules per square metre of conditioned space per hour ($kJ/m^2.hr$) of building operation, averaged over the course of a year. The quantified energy targets are only applicable to conditioned spaces.

J1P1 provides an absolute performance target for the energy use of air-conditioned buildings. This approach is intended to ensure that designers have a pure performance target and are thereby free to innovate across all aspects of design. Clause J1P1(f) has three energy targets for three different groups of building classifications. These metrics have been set at a level of stringency to ensure they are generally at least as stringent as the DTS Provisions.

Unconditioned spaces such as carparks (Class 7a) attached to another class of building will not be able to fully use a direct Performance Solution for J1P1 as they are limited to Performance Solutions based on the unquantified elements of J1P1.

Performance Solutions that use either the quantified or unquantified elements of J1P1 both need to use the Performance Solution process described in section 8.3.

For step 1 of the Performance Solution process, a Performance-based Design Brief (PBDB) needs to be developed. The purpose of the brief is to record the fundamental activities and outcomes of the Performance Solution development, as agreed by stakeholders. The PBDB must include the acceptance criteria for the proposed Performance Solution, which often requires accounting for the location and characteristics of the building.

8.3.2 J1P1 Performance Solution using energy modelling

The following sections look at what is needed when using energy modelling as a direct J1P1 Performance Solution (i.e. a Performance Solution not using the Verification Methods J1V1, J1V2 or J1V3).

8.3.2.1 Software requirements

Where used to demonstrate compliance with J1P1, energy modelling software should:

- provide a detailed representation of the building design, including the building fabric, services and occupancy

- calculate the operation of the building on a dynamic basis, allowing for effects of thermal mass in the building fabric, thermal properties of materials, the efficiency of plant items under varying operating conditions, and the control of services
- use a time-step of not more than one hour throughout an entire year from which to assess building performance, using representative local weather data as an input to calculations.
- Modelling tools used for assessing J1P1 compliance should meet the requirements of ANSI/ASHRAE Standard 140 (2007), i.e. the same Standard as the modelling tools used to comply with the Verification Methods. ANSI/ASHRAE Standard 140 uses a combination of analytical, comparative and empirical tests to confirm that the model:
- complies with the laws of physics
- produces results that are comparable to other simulation packages
- can provide an acceptable representation of measured performance data for key tests.

Modelling of lift energy consumption, which is not covered in ANSI/ASHRAE Standard 140, should follow a well-defined procedure, such as that laid out in ISO 25745-2:2014.

8.3.2.2 Evaluation of results

The primary parameter for evaluating the performance of the proposed building is regulated energy consumption per square metre of conditioned floor area, divided by the total hours of operation of the building per year.

The regulated energy use is defined as the energy consumed by the building services, less any renewable energy generated and used on site. Renewable energy that is either not generated on site or is not used on site may not be subtracted from the regulated energy use total.

In practice, the regulated energy consumption includes all energy use other than for:

- emergency systems
- cooking facilities
- portable devices (computing equipment and other plug loads)
- process loads (equipment for the creation or processing of materials or data that is sited within the building, but is not associated with the provision of air-conditioning, mechanical ventilation, heated water supply, artificial lighting or any other services associated with the operation of the building in providing a habitable environment)
- electric vehicle charging stations.

Specifically, the regulated energy consumption includes all energy use associated with all components covered in Parts J1 to J8 of Section J.

Regulated energy includes energy from lifts. Where a lift serves multiple building classifications, the energy use from the lift may be apportioned based on the percentage of floor area of each classification that it serves.

8.3.2.3 Inputs

Climate

The climate at the building location should be represented using a weather file that provides data using actual data for a full year (e.g. Test Reference Year (TRY) or Typical Meteorological Year (TMY)) that is typical for the location. It should be selected based on a nearby climate station that experiences comparable climatic conditions to the building location. To be considered typical, the climate station should be within 50 km of the building location and within 100 m of the building altitude.

TMY weather files drawn from the years 1990 to 2015 published by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) should be used for climatic data, which were used to develop J1P2. This dataset contains 83 text files in EnergyPlus Weather File (EPW) format. The files contain hourly weather data for a typical meteorological year in 83 Australian locations. Refer to CSIRO AgData Shop (free access) for more information.

Where no such weather station exists, select two weather stations which can reasonably be expected to have similar climates. One weather station should be expected to have a slightly larger heating energy consumption, and the other a slightly larger cooling energy consumption. The building energy model should then be based on the climate zone which results in a higher energy consumption.

The model should incorporate ground temperatures that are realistic for the location.

Building form

The model should represent the building's shape, location, orientation, architecture and thermal properties with emphasis on representation of:

- the overall building envelope dimensions, including floor plate, height, building shape and self-shading components of the building
- the orientation of the building relative to the path of the sun
- the building glazing, including window locations both with respect to individual thermal zones of the building and with respect to the location of any elements that may cause shading of the window
- the building location, including allowance for adjacent permanent buildings and landscape
- shading from vegetation, which may be represented only if it is within the footprint of the legal title within which the building is located. Growth of vegetation may be allowed for in the model

for a maximum of 5 years into the future. Ground reflectance should be modelled in a manner representative of the local environment.

8.3.2.4 Thermal properties of the building

Opaque external building elements should be represented accurately with respect to:

- overall thermal resistance, allowing for thermal bridging
- solar absorptivity
- materials, including their thermal mass and order in the building element construction.

Transparent external building elements should be represented correctly with respect to:

- transmittance, absorptance and reflectance properties at varying solar angles and in short wave and long wave spectrums
- thermal conductance allowing for frames, edge-of-window and centre of window effects
- visual transmittance, if any form of daylight sensitive control is used based on internal light level in the building.

The values for transparent external building elements should be based on the technical protocols and procedures of the Australian Fenestration Rating Council (AFRC).

Building infiltration should be modelled at the appropriate rate for the building. The infiltration provisions of Specification 34 may be used for guidance.

Internal building element characteristics in the model should include:

- thermal mass
- thermal resistance (where the building element separates different thermal zones)
- reflectance, if daylight sensitive control based on internal light level is used.

Internal partitions do not need to be represented where they do not form part of the plans being submitted for approval.

8.3.2.5 Building services

The building services should be represented in detail, including:

- the capacity and efficiency of the individual plant items as their load varies across their operating range
- thermal losses from circulating systems
- standing loads from jacket heaters, sump heaters and similar parasitic power requirements for individual plant items
- lift energy
- on-site renewable energy

- domestic hot water energy.

The control of services should be modelled as they are intended to be used in the proposed building, including but not limited to:

- physical layout of control zones, allowing for some aggregation of thermally similar zones in the model relative to the building
- zone temperature control, including set point, dead band and overall control band, local heating/cooling control and local airflow control
- supply air temperature control
- dehumidification/humidification control
- economy cycle control
- optimum start control
- night purge/night ventilation control
- fan control
- chilled water pump control
- hot water pump control
- condenser water pump control
- steam system control, where steam use falls within the definition of regulated energy
- chiller staging control
- boiler staging control.

For further modelling detail, the provisions of Specification 34 Clause S34C4 may be used as a guide.

8.3.2.6 Occupancy

The representation of occupancy should follow a similar approach to Specification 34 S34C3 (6)(g), i.e. based on either:

- Specification 35, or
- NABERS Energy for Offices simulation requirements, or
- Green Star simulation requirements, or
- the proposed building operation if the operating hours are not less than 2500 hours per annum or the daily operating profiles are not listed in Specification 35.

Occupant density and internal load density shall be modelled to represent expected normal operation, rather than design load operation.

For the purposes of thermal comfort calculations, the clothing and metabolic rates of the building occupants should be selected reflecting justifiable assumptions of the actual likely clothing and activity levels of the occupants, referenced to an external standard such as ANSI/ASHRAE Standard 55.

8.3.2.7 Outputs

For each separate iteration or scenario of the model presented in the reporting, the model outputs should include:

- the energy use by month and annually for subcategories including, but not limited to:
  - chillers
  - cooling provided by systems other than chillers
  - boilers
  - heating provided by systems other than boilers
  - humidifiers
  - air handling unit (AHU) fans
  - ventilation fans
  - chilled water system pumps
  - hot water system pumps
  - other pumps
  - lifts
  - lighting
  - internal/equipment/process loads
  - on-site renewable energy
  - for cogeneration and trigeneration systems:
    - electricity generated
    - cooling generated
    - waste heat transferred to building services
    - waste heat rejected
    - auxiliary energy.
- the hours of air-conditioning operation for each zone and the associated area of each zone
- the total regulated energy usage of the conditioned spaces
- the achievement of comfort conditions as appropriate to the building type and occupancy schedule based on a reputable methodology, such as ANSI/ASHRAE Standard 55. Note that unless specifically demonstrated as part of the design, the air speed should be modelled at 0.05 m/s. Results may be presented:

- for each zone, the percentage of operating hours when the building is occupied, and the thermal comfort is acceptable
- for the building as a whole, an area-weighted average of the percentage of operating hours for each zone when the zone is occupied, and the thermal comfort is acceptable.

8.3.2.8 Acceptance criteria

The model satisfies the requirements of J1P1 if the following has been demonstrated to the satisfaction of the Appropriate Authority:

- To meet J1P1(a), the design outcome supports the intended function and use of the building and its services.
- To meet J1P1(b), the design outcome delivers the required level of human comfort for the building use.
- To meet J1P1(c), solar radiation is utilised for heating and controlled to minimise energy for cooling.
- To meet J1P1(d), the building does not use an energy source which emits an excessively high amount of GHG.
- To meet J1P1(e), the building envelope is sufficiently sealed against air leakage.
- To meet J1P1(f), the total regulated energy usage of the conditioned spaces is less than or equal to the overall allowance, where the overall allowance is calculated by:
  - multiplying the allowance for each classification by the area-weighted hours of building operation for that space and the floor area of the conditioned space for that classification
  - summing the results for all conditioned spaces to obtain the overall allowance.
- For the purposes of J1P1(f), the allowance for regulated energy consumption for each classification is:
  - for a Class 6 conditioned space, 80 kJ/m^2.hr
  - for a Class 5, 7b, 8 or 9a building other than a ward area, or a Class 9b school, 43 kJ/m^2.hr
  - for all other building classifications, 15 kJ/m^2.hr.

8.3.2.9 Documentation

The following documentation may be produced to demonstrate compliance with J1P1.

Building form

- Three dimensional renderings of the building as represented in the model showing orientation, building form, glazing location, facade shading and shading from adjacent structures.
- A list of construction types (materials, their order and material properties) used in the model for opaque exterior walls, floors and roofs including modelled R-Values, solar absorptance and thermal mass.
- A list of window types used in the model including specifications of individual panes and gaps, frame type, and calculated AFRC U-Value and Solar Heat Gain Coefficient (SHGC), correct for window size, for each window.
- A list of construction types for internal walls between thermal zones, listing modelled R-Value and thermal mass.
- Plans showing the division of floorplates into thermal zones.
- Documentation justifying non-default infiltration figures.

Building services (as applicable)

- Coefficient of Performance (COP), Integrated Part Load Value (IPLV)/ Non-standard Part Load Value (NPLV) and nominal capacity of each chiller.
- COP or Energy Efficiency Ratio (EER) of each unitary air conditioning system.
- Absorbed power, motor power, design flow and design pressure of each fan and pump.
- Gross calorific efficiency and capacity of each boiler/water heater.
- COP and capacity of each hot water heat pump.
- Input power of each direct electric heating element.
- Modelled thermal losses for chilled water, hot water and steam systems.
- The relationship between field demand and percentage thermal energy requirement for fan and pump systems.
- Efficiency of on-site generation equipment.
- Control algorithms and settings for each control item under this section.
- Energy inputs used for lift energy calculation as per ISO 25745-2.
- Schedule of lighting power calculations for each zone.

Building occupancy

- Occupancy schedules and densities.
- Lighting schedules.

- Internal/process loads schedules and densities.

Model outputs

- Model outputs as per 8.3.2.7.

Sensitivity studies

The following sensitivity analyses are recommended:

- building performance in the absence of shade from vegetation
- building performance at design occupancy and internal/process load densities
- building performance with fewer hours of operation
- if a non-default infiltration rate has been used, building performance at default infiltration rates.

8.3.2.10 Maintenance and management assumptions

The report should list any assumptions made in relation to the operation of the building that are critical to any of the following:

- the achievement and maintenance of shading from vegetation
- the operation of moveable facade elements
- the achievement and maintenance of the efficiency of plant items
- achievement of modelled internal load/process or lighting schedules
- achievement of thermal comfort.

8.4 Professional Practice and Ethics

Some state and territory legislation empowers certain practitioners to develop and/or approve Performance Solutions. Irrespective of controls about who can undertake this work, the practitioners involved have a professional responsibility for ensuring that appropriately skilled and experienced persons are engaged to develop and approve Performance Solutions.

When preparing a Performance Solution, practitioners should exercise their duties in an appropriate manner. Key principles include:

- Acting in the public interest – In undertaking their duties, a practitioner should exercise their discretionary powers in ways that safeguard the public interest. A practitioner’s consideration of the interests of their clients and employers must not be contrary to the public interest.
- Independence – In performing their professional duties, a building surveyor/certifier should be objective, impartial and conduct themselves in accordance with the relevant requirements of

state and territory legislation. Other practitioners should ensure any conflicts of interest are disclosed to all relevant parties.

- Competence – A practitioner should not undertake professional work that they are not competent to perform.

Appendices

Appendix A Abbreviations

The following table, Table A.1 contains abbreviations used in this document.

Table A.1 Abbreviations

Acronym/Symbol	Meaning
ABCB	Australian Building Codes Board
AFRC	Australian Fenestration Rating Council
AHRI	American Air-Conditioning, Heating & Refrigeration Institute
AHU	Air-handling unit
AIRAH	Australian Institute of Refrigeration Air-conditioning and Heating
ANSI	American National Standards Institute
AS	Australian Standard
ASHRAE	The American Society for Heating, Refrigeration and Air-Conditioning Engineers
BCA	Building Code of Australia
BEP	Best Efficiency Point
BPIC	Building Products Innovation Council
CCT	Correlated colour temperature
CDB	Degree(s) Celsius Dry Bulb
CIBSE	Chartered Institution of Building Services Engineers
COP	Coefficient of Performance
CRI	Colour rendering index
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEE	Department of Climate Change and Energy Efficiency (Australian Government)
DTS	Deemed-to-Satisfy
EEI	Energy efficiency index
EER	Energy Efficiency Ratio

Acronym/Symbol	Meaning
FCU	Fan coil unit
FMAANZ	Fan Manufacturing Association of Australia and New Zealand
GBCA	Green Building Council of Australia
GHG	Greenhouse gas
HEPA	High efficiency particulate arrestance
HVAC	Heating, Ventilation and Air-Conditioning
IGA	Inter-government agreement
JASANZ	Joint Accreditation System of Australia and New Zealand
MEI	Minimum efficiency index
MEPS	Minimum Energy Performance Standards
NABERS	National Australian Built Environment Rating System
NEPP	National Energy Productivity Plan
NCC	National Construction Code
NZS	New Zealand Standard
PBDB	Performance-based Design Brief
PCA	Plumbing Code of Australia
PMV	Predicted Mean Vote
SHGC	Solar Heat Gain Coefficient
SOU	Sole-occupancy unit
TMY	Typical Meteorological Year
TRY	Test Reference Year
VAV	Variable-air volume
VM	Verification Method
VURB	Verification using a reference building
WHS	Workplace Health and Safety

Appendix B Glossary

This appendix contains a glossary of key terms used in this document with links to further information where relevant.

The glossary includes NCC extracts of defined terms. These are identified by the following document style below.

NCC extracts[9]

Air barrier: A layer used to restrict the movement of air under the normal pressure differences found across building elements[10].

More information is available from the ABCB Condensation in buildings Handbook which is available from the ABCB website.

Air-conditioning: For the purposes of Section J of Volume One, a service that actively cools or heats the air within a space, but does not include a service that directly—

a) cools or heats cold or hot rooms; or
b) maintains specialised conditions for equipment or processes, where this is the main purpose of the service.

Air infiltration: The unintended movement of outside air into a building through gaps, cracks and penetrations in the building structure.

The DTS Provisions for building sealing in Part J5 Building sealing of Volume One aim to minimise air infiltration.

Air exfiltration: The unintended movement of indoor air out of a house building through gaps, cracks and penetrations in the building structure.

The DTS Provisions for building sealing in Part J5 Building sealing of Volume One aim to minimise air exfiltration. See section 3.3.2 and section 7 for more information.

Air Handling Unit (AHU): An item of plant that moves air by mechanical means using fans. It also often contains filtration devices and coils for heating and cooling. It is often located in a plant room or on the roof.

Air movement: The movement of air for the purpose of cooling that is created either through natural forces (i.e. openings, vents) or mechanical power (i.e. fans).

[9] NCC extracts italicise defined terms as per the NCC. See Schedule 1 of the NCC for further information.

[10] ABCB (2023) Condensation in buildings handbook, ABCB, accessed Jan 2023.

Air permeability: The tested rate of air infiltration and air exfiltration in $m^3/hr.m^2$ for a house measured using a blower door test at a 50 Pa reference pressure.

See J1V4 Verification building envelope sealing (section 3.3 and section 7).

Amenity: An attribute which contributes to the health, physical independence, comfort and well-being of people.

Annual greenhouse gas emissions: The theoretical amount of greenhouse gas emissions attributable to the energy used annually by a building's *services*, excluding kitchen exhaust and the like.

Artificial cooling: The cooling of an indoor air space using air-conditioning, not including passive cooling[11].

More information is available from YourHome.

Artificial heating: The heating of an indoor air space using air-conditioning, not including passive heating[12].

Assessment Method: A method that can be used for determining that a *Performance Solution* or *Deemed-to-Satisfy Solution* complies with the *Performance Requirements*.

More information on Assessment Methods is in the resource Understanding the NCC – Assessment Methods, which is available from the ABCB website.

Building element: The major functional parts of the building envelope such as roof, walls and floors.

Building sealing: To limit air infiltration and exfiltration through the building envelope by caulking, sealing, weather-stripping, or using dampers. The tighter the building is sealed; the less air infiltration and exfiltration occurs. This can help with lowering the heating and cooling load of a house and reduce the use of artificial heating or cooling.

Bulk insulation: Bulk insulation includes glass fibre, wool, cellulose fibre, polyester, wood fibre and polystyrene foam. These materials have a high percentage of air voids that provide thermal resistance to heat flow[13], i.e. limits conduction. In some cases, the material itself may provide significant thermal resistance, e.g. cellulose.

More information is available from YourHome.

[11] YourHome, Passive cooling, accessed September 2023.

[12] YourHome, Passive heating, accessed September 2023.

[13] YourHome, Insulation, accessed September 2023.

Cavity: A void between 2 leaves of masonry, or in masonry veneer construction, a void between a leaf of masonry and the supporting frame.

Typically, a cavity is a minimum void of 35 mm between 2 leaves of masonry, or in masonry veneer construction, the void between a leaf of masonry and the supporting frame.

Climate zone: Climate zone means an area defined in Figure 2 and in Table 3 of the NCC Glossary for specific locations, having energy efficiency provisions based on a range of similar climatic characteristics.

The NCC specifies 8 climate zones for thermal design.

Commitment Agreement: A Commitment Agreement is a contract signed by a developer or owner to commit to design, build and commission a building to achieve a specific NABERS energy rating[14].

Condensation: The formation of moisture on the surface of a building element or material as a result of moist air coming into contact with a surface which is at a lower temperature.

More information on condensation management in the NCC is available in the ABCB's handbook, Condensation in Buildings (2023), which is available from the ABCB website.

Conditioned space: For the purposes of—Volume One, a space within a building, including a ceiling or under-floor supply air plenum or return air plenum, where the environment is likely, by the intended use of the space, to have its temperature controlled by *air-conditioning.*

(b) …

Conduction: The process of heat transfer from one material to another by direct contact of the materials. A simple example of conduction is the transfer of heat from a stovetop to a metal pot.

Cross-ventilation: A natural method of cooling by allowing cool air in and hot air out through openings such as windows[15]. Cross-ventilation is a technique used in passive cooling. Window open-ability can be varied to account for the benefits of cross-ventilation.

Deemed-to-Satisfy Provisions: Provisions which are deemed to satisfy the *Performance Requirements.*

The DTS Provisions are prescriptive (i.e. like a recipe book, they tell you how, what and in which location things must be done). They include materials, components, design factors, and construction methods that, if used, are deemed to meet the Performance Requirements, hence the term 'Deemed-to-Satisfy'.

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14 www.nabers.gov.au

15 YourHome, Glossary (2020), YourHome, accessed Oct 2022.

Deemed-to-Satisfy Solution: A method of satisfying the *Deemed-to-Satisfy Provisions*.

A DTS Solution is achieved by following all appropriate DTS Provisions in the NCC.

Distributed energy resources: Distributed energy resources (DER) refers to smaller energy generation units that are located on the consumer's side of the meter. Examples of DER that can be installed are roof top solar PV panels, battery storage and batteries in electric cars used to export power back to the grid. It also includes combined heat and power units that use waste heat to provide cooling[16].

Domestic services: The basic engineering systems that use energy or control the use of energy; and—includes—

(i) heating, *air-conditioning*, mechanical ventilation and artificial lighting; and

(ii) pumps and heaters for *swimming pools* and spa pools; and

(iii) heated water systems; and

(iv) on-site *renewable energy* equipment; but

excludes cooking facilities and portable appliances.

The definition of domestic services excludes portable appliances. This means the definition of domestic services excludes plug-in appliances such as like fridges, dishwashers, clothes washers and microwaves.

Elemental provisions: DTS Provisions that require each element or part of a proposed building to meet a minimum level of thermal performance or efficiency. For example, the floors, walls, glazing and roof.

Energy value: The net cost to society including, but not limited to, costs to the building user, the environment and energy networks.

Energy value is the economic or societal cost (or cost savings) associated with on-site energy usage or generation. It is primarily based on:

- energy prices
- impacts of pollution and GHG emissions[17]
- impacts on energy networks.[18]

[16] www.aemc.gov.au.

[17] The costs to the environment were determined per tonne of GHG emissions.

[18] The costs to the energy network were determined using a time of use tariff.

Energy efficiency: To minimise the use of energy for heating, cooling, heated water, lighting, pool pumps and heating services by improving the efficiency of appliances or minimising heat flow through building fabric.

Energy efficiency index (EEI): EEI is a characteristic of a pump. The lower the EEI, the less energy the pump uses. EEI is calculated in accordance with European Union Commission Regulation No. 622/2012.

Energy peak demand: The time of day where a building's energy consumption is at its highest. It can also mean the period(s) during a year where a building's energy consumption is at its highest.

Energy source: The type of energy used for domestic services, such as electricity, gas, wood or solar power[19].

Envelope: For the purposes of—

(a) Section J in NCC Volume One, the parts of a building's fabric that separate a conditioned space or (a) habitable room from—
   (i) the exterior of the building; or
   (ii) a non-conditioned space including—
      1. floor of a rooftop plant room, lift-machine room or the like; and
      2. the floor above a carpark or warehouse; and
      3. the common wall with a carpark, warehouse or the like; or

(b) …

Expert Judgement: The judgement of an expert who has the qualifications and experience to determine whether a *Performance Solution* or *Deemed-to-Satisfy Solution* complies with the *Performance Requirements*.

Contemporary and relevant qualifications and/or experience are necessary to determine whether a Performance Solution complies with the Performance Requirements. The level of qualification and/or experience may differ depending on the complexity of the proposal and the requirements of the regulatory authority.

Practitioners should seek advice from the authority having jurisdiction or appropriate authority for clarification as to what will be accepted.

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19 YourHome, Energy (2020), YourHome, accessed 2022.

External wall: For the purposes of—

(a) Volume One, an outer wall of a building which is not a *common wall*; or

(b) ….

Evaporative cooling: Evaporative cooling is a type of passive cooling that uses evaporated water to cool hot air.

Facilitate: used in Performance Requirement JP1 to highlight that the installation of energy efficiency features gives the building the ability to reduce energy consumption. However, reduced energy consumption may only be achieved if the building is operated, managed and maintained correctly.

Fabric: The basic building structural elements and components of a building including the roof, ceilings, walls, glazing and floors.

Fan Coil Units (FCU): can be considered a small AHU and contains a circulation fan, one or more coils for heating/cooling and possibly, an air filter. An FCU may be used alone or in conjunction with an AHU. For example, an AHU may handle the fresh make-up air for many FCUs which are then located either in or adjacent to the conditioned spaces. FCUs are often located in ceiling spaces above the areas served.

Floor area: For the purposes of—

(1) Volume One—

(a) in relation to a building — the total area of all storeys; and

(b) in relation to a storey — the area of all floors of that storey measured over the enclosing walls, and includes—

1. the area of a mezzanine within the storey, measured within the finished surfaces of any external walls; and
2. the area occupied by any internal wall or partitions, any cupboard, or other built-in furniture, fixture or fitting; and
3. if there is no enclosing wall, an area which has a use that contributes to the *fire load* or impacts on the safety, health or amenity of the occupants in relation to the provisions of the BCA; and

(c) in relation to a room — the area of the room measured within the internal finished surfaces of the walls, and includes the area occupied by any cupboard or other built-in furniture, fixture or fitting; and

(d) in relation to a fire compartment — the total area of all floors within the fire compartment measured within the finished internal surfaces of the bounding construction, and if there is no bounding construction, includes an area which has a use which contributes to the fire load; and

(e) in relation to an atrium — the total area of all floors within the atrium measured within the finished surfaces of the bounding construction and no bounding construction, within the external walls.

Functional statement: A non-mandatory statement providing guidance on how buildings and building elements achieve the Objectives. The Functional Statement for non-residential building energy efficiency is in the introduction of NCC Volume One Part J1F1 and discussed in Chapter 2.

Glazing: For the purposes of—

(a) Section J of Volume One, except for a *sole-occupancy unit* of a Class 2 building or a Class 4 part of a building—

(i) a transparent or translucent element and its supporting frame located in the *envelope*; and

(ii) includes a *window* other than a *roof light*; or

(b) ….

Governing Requirements: These are the mandatory rules and instructions for using and complying with the NCC. They are in Section A of NCC Volumes One, Two and Three.

The Governing Requirements explain important concepts on how the NCC must be interpreted and applied. There are certain conventions and approaches that need to be taken into account when using the NCC, such as interpreting specific language and terms. This is critical to understanding the intended technical and legal meaning of the NCC.

The Governing Requirements also explain the difference between the mandatory parts of the NCC and the parts that are only explanatory or guidance in nature.

Heated water: Water that has been intentionally heated; normally referred to as hot water or warm water.

Greenhouse gas: The atmospheric gases responsible for causing climate change[20]. More information is available from YourHome.

Green Star: The building sustainability rating scheme managed by the Green Building Council Australia[21].

Gross thermal efficiency: The total amount of heat produced through the burning of gas (or oil).

[20] YourHome, Glossary (2020), YourHome, accessed Oct 2022

[21] Green Building Council Australia

Heat flow: The movement of heat (energy). Heat flows from hot objects to cool objects through the processes of conduction, convection and radiation.

For example, in cold climates heat flows from indoors to outdoors.

Hours of operation: The number of hours when the occupancy of the building is greater than 20% of the peak occupancy.

HVAC (Heating, Ventilation and Air-Conditioning): HVAC describes all systems in a building which condition air by heating or cooling or which move it through the building. A simple split air-conditioning unit is part of an HVAC system as much as is a more complex centralised air-conditioning system involving chillers, boilers and air handling plant.

Illumination power density: The total of the power that will be consumed by the lights in a space, including any lamps, ballasts, current regulators and control devices other than those that are plugged into socket outlets for intermittent use such as floor standing lamps, desk lamps or work station lamps, divided by the area of the space, and expressed in W/m2.

The DTS Provisions for artificial lighting in J7D3 Volume One specify the lighting allowances permitted and these depend on the space the lights serve. The allowances can be increased by using an illumination power density adjustment factor. See section 3.1.2 and section 4.1.2 of this document for more information.

Indoor air quality: A measure of the condition of air in a room with respect to the health and comfort of its occupants. It includes the physical, chemical and microbiological makeup of the air. Note the term means different things to different people and there is no single accepted definition.

More information is available in the ABCB Indoor Air Quality Verification Methods Handbook (2023) that is available from the ABCB website.

Insulation: A material, assembly of materials, or building product which provides resistance to conductive or radiative heat flow. Examples include bulk insulation and reflective insulation.

kW_r: Kilowatts of refrigeration. A metric or SI unit (International System of Units) with the additional abbreviation ‘r’ referring to the cooling capacity of refrigeration plant.

$kW_{heating}$: Means kilowatts of heating. An SI unit with the additional word ‘heating’ referring to the capacity of heating plant.

Lamp power density: The total of the maximum power rating of the lamps in a space, other than those that are plugged into socket outlets for intermittent use such as floor standing lamps, desk lamps or work station lamps, divided by the area of the space, and expressed in W/m^2.

The DTS Provisions for artificial lighting in J7D3(1) Volume One specify the lighting allowances permitted (i.e. lamp power density) and these depend on the space the lights serve. See section 3.2.2 and section 3.3.5 of this document for more information.

Mechanical ventilation: Applies to the provision of ventilation using mechanical fans, typically exhaust and/or supply air fans. The ventilation requirement may be integrated into an air-conditioning system or be a standalone system. It includes the mechanical ventilation required by Part F4.

Mechanical ventilation system: A powered means of using fans to distribute outside air within a building for either heating, cooling or fresh air purposes. A typical mechanical ventilation system is usually comprised of an external air handling unit that is connected to internal ductwork that delivers and extracts air from the building.

Membrane: A barrier impervious to moisture.

NABERS Energy: The National Australian Built Environment Rating Systems for energy efficiency, which is managed by the NSW Government.

Objective: A statement providing guidance on the public's expectation of requirements in the NCC. The objective for non-residential building energy efficiency is located in NCC Volume One J1O1. See Chapter 2 for more information.

Opaque: A non-transparent building material i.e. one that does not allow light to pass through. This includes masonry, timber, stone, fibre cement lining board, etc. A typical transparent or translucent material would be glass or polycarbonate sheeting. The term is important to the application of the building fabric and glazing provisions.

Both opaque building materials such as walls, and transparent or translucent elements considered as glazing are under Part J4 – Building Fabric.

Orientation: The position of a building based on climate, solar exposure and wind direction[22]. More information is available from YourHome.

Outdoor air: Air outside the building.

On-site energy production: Energy produced on-site through sources such as solar panels.

On-site energy production is considered in Performance Requirements J1P1 and J1P4.

Passive cooling: Using the design of the building and selection of materials to manage the temperature during hot weather[23]. More information is available from YourHome.

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22 YourHome, Orientation (2020), YourHome, accessed 2022.

23 YourHome, Passive cooling (2020), YourHome, accessed 2022.

Passive heating: Using the design of the building and selection of materials to utilises the sun to increase and trap that warmth[24]. The glazing calculations allow for the heating of a home from solar gains through glazing. More information is available from YourHome.

Performance Requirement: A requirement which states the level of performance which a *Performance Solution* or *Deemed-to-Satisfy Solution* must meet.

Performance Solution: A method of complying with the *Performance Requirements* other than by a *Deemed-to-Satisfy Solution.*

Piping: For the purposes of Section J in Volume One or Part H6 in Volume Two, and Section 13 of the Housing Provisions, means an assembly of pipes, with or without valves or other fittings, connected together for the conveyance of liquids and gases.

Pliable building membrane: A water barrier as classified by AS/NZS 4200.1.

Predicted Mean Vote (PMV): The Predicted Mean Vote of the thermal perception of building occupants determined in accordance with ANSI/AHSRAE Standard 55.

Primary insulation layer: The most interior insulation layer of a wall or roof construction.

Projection: The depth of a horizontal overhang as defined by NCC 2022 Figure S37C7. Provides shading which extends horizontally on both sides of the glazing, generally located externally. This could be in a form of a verandah, balcony, fixed canopy, eaves, shading hood or a carport[25]. More information is available from YourHome.

R-Value: The thermal resistance of a component calculated by dividing its thickness by its thermal conductivity, expressed in m^2.K/W.

For bulk insulation products, this is simply the R-Value shown on the packaging. For reflective products, the R-Value they add to a building component is more complicated. Reflective insulation only works when installed in conjunction with an air space. The R-Value that a reflective product adds to a component is the R-Value of the reflective air space(s), less the R-Value of any non-reflective air spaces that the reflective air space(s) replaces.

Reclaimed energy: NCC Volume One Clause J6D10 (d) allows reclaimed heat from another process such as from a refrigeration plant and bio-fuels to be used. This reclaimed energy can be used in conjunction with one or more heaters allowed under J6D10. Examples of reclaimed energy could be the waste heat captured to heat water from a refrigeration chiller (rather than

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24 YourHome, Passive heating (2020), YourHome, accessed 2022.

25 YourHome, Shading (2020), YourHome, accessed 2022.

being rejected to a cooling tower); or energy from a process unrelated to building services, such as steam condensate from a laundry process.

Reference building: For the purposes of—Volume One, a hypothetical building that is used to calculate the maximum allowable—

(i) *annual greenhouse gas emissions* for the common area of a Class 2 building or a Class 3 to 9 building; or

(ii) *heating load*, *cooling load* and *energy value* for a *sole-occupancy unit* of a Class 2 building or a Class 4 part of a building; or

(b) ….

Reflective insulation: A building membrane with a reflective surface such as a reflective foil laminate, reflective barrier, foil batt or the like capable of reducing radiant heat flow.

Renewable energy: Energy that is not depleted when used. Renewable energy includes solar, wind and geothermal power.

Required: Required to satisfy a *Performance Requirement* or a *Deemed-to-Satisfy Provision* of the NCC as appropriate.

Roof light: For the purposes of Section J and Part F6 in NCC Volume One, Part H6 in NCC Volume Two, and Part 10.5 and Section 13 of the ABCB Housing Provisions, a skylight, window or the like installed in a roof—

(a) to permit natural light to enter the room below; and

(b) at an angle between 0 and 70 degrees measured from the horizontal plane.

Roof light shaft index: is determined by measuring the distance from the centre of the shaft at the roof to the centre of the shaft at the ceiling level and dividing it by the average internal dimension of the shaft opening at the ceiling level. See Table J4D5 NCC Volume One, Note 1.

Sarking-type material: A material such as a *reflective insulation* or other flexible membrane of a type normally used for a purpose such as waterproofing, vapour management or thermal reflectance.

Service: For the purposes of Section J in Volume One, means a mechanical or electrical system that uses energy to provide *air-conditioning*, mechanical ventilation, *heated water* supply, artificial lighting, vertical transport and the like within a building, but which does not include—

(a) systems used solely for emergency purposes; and

(b) cooking facilities; and

(c) portable appliances.

Shading device: A device used to block direct rays from the sun, generally these devices are fixed or operable. Some examples of these are awnings, blinds and eaves[26]. More information is available from YourHome.

Skylight: A type of window located on a roof to permit light to enter a room below. The NCC defines this as a roof light.

Solar absorptance: A measure of the solar radiation which an object can absorb. The higher the solar absorptance, the more heat it can absorb. Lighter coloured materials are commonly more reflective and absorb less heat. More information is available from the Building Sustainability Index (BASIX) website[27].

Solar gain: Heat gained through solar radiation entering a building through windows or skylights[28]. More information on solar gain and how to use solar gain for passive heating can be found at YourHome.

Specification: A specification provides technical data in the NCC which is relied upon as a component of one or more DTS Provisions. A specification may be referenced by multiple DTS Provisions, wherever the same data needs to be referred to by different parts of the NCC. Including this common information in a single specification avoids the need to repeat the same information across multiple parts of the NCC.

Storey: A space within a building which is situated between one floor level and the floor level next above, or if there is no floor above, the ceiling or roof above, but not—

(a) a space that contains only—
  (i) a lift *shaft*, stairway or meter room; or
  (ii) a bathroom, shower room, laundry, water closet, or other *sanitary compartment*; or
  (iii) accommodation intended for not more than 3 vehicles; or
  (iv) a combination of the above; or
(b) a *mezzanine*.

Swimming pool: Any excavation or structure containing water and principally used, or that is designed, manufactured or adapted to be principally used for swimming, wading, paddling, or the like, including a bathing or wading pool, or spa.

Thermal break: A material of low conductivity which is used between materials with high conductivity to reduce its heat transfer.

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26 YourHome, Shading (2020), YourHome, accessed 2022.

27 BASIX, Roof colour and solar absorptance, BASIX, accessed 2022.

28 YourHome, (2020), YourHome, accessed 2022.

Thermal bridging: Thermal bridging, in practical terms for the NCC, is an unintended path of heat flow between the outside and inside of the building envelope. Thermal bridges may occur where there is an interruption in the insulation or where highly conductive materials (e.g. metal) are used.

As an example, if a steel truss roof directly supports an insulated corrugated iron roof, the heat flows through the truss more readily than the surrounding insulation, negating the effect of the insulation (i.e. the truss acts as a thermal bridge).

Thermal bridges can significantly reduce the effectiveness of the insulation (thermal resistance) of the building envelope (i.e. walls, floors and roof) by essentially bypassing the insulation in favour of a more conductive material (e.g. metal). This results in either losing heat from inside the building to the outside on a cold day or adding warmth to the inside the building on a hot day.

This may cause unwanted comfort issues in a building, and a likely increase in energy use by a building's heating and cooling systems. Additionally, unaddressed thermal bridges may lead to condensation where warm, moist air contacts a colder surface and condenses into water droplets. Condensation can result in mould growth, causing indoor air quality issues, negative health impacts for occupants, and potentially affects the durability of the structure.

Thermal comfort level: The level of thermal comfort in a building expressed as a PMV sensation scale.

Thermal energy load: The sum of the *heating load* and the *cooling load*.

Thermal conductivity: Thermal conductivity is defined as the rate of thermal conduction through a material per unit area per unit thickness per unit temperature differential.

Reminder

The heating load, cooling load and total thermal energy load limits specified by J1P2 and associated compliance options, are not the same as the actual amount of energy used for heating and cooling.

The amount of energy used for heating and cooling depends on the source of the energy used (i.e. fuel type) and the efficiency of the heating and cooling equipment.

The amount of energy used for heating and cooling is regulated by J1P3.

Thermal performance: The effectiveness of a building envelope to maintain acceptable levels of human comfort inside a building relative to the outside weather conditions, while minimising the need for artificial heating or cooling.

Total R-Value: The sum of the *R-Values* of the individual component layers in a composite element including any building material, insulating material, airspace, thermal bridging and associated surface resistances, expressed in m^2.K/W.

Total System Solar Heat Gain Coefficient: For the purposes of—

(a) Volume One, the fraction of incident irradiance on a *wall-glazing construction* or a *roof light* that adds heat to a building's space; or

(b) ….

Total System U-Value: The sum of the *R-Values* of the individual component layers in a composite element including any building material, insulating material, airspace, thermal bridging and associated surface resistances, expressed in m^2.K/W.

Unconditioned space: A space that is not usually heated or cooled by the building's air conditioning services. Examples include storerooms and bathrooms.

Ventilation opening: An opening in the *external wall*, floor or roof of a building designed to allow air movement into or out of the building by natural means including a permanent opening, an openable part of a *window*, a door or other device which can be held open.

Vapour barrier: A layer or material used to restrict the transmission of vapour, generally water vapour into a building or from inside into the cavity of the building fabric[29].

More information is available in the ABCB Condensation in Buildings Handbook (2023) which is available from the ABCB website.

Vapour permeance: The degree that water vapour is able to diffuse through a material, measured in µg/N.s and tested in accordance with the ASTM-E96 Procedure B – Water Method at 23°C 50% relative humidity.

Verification Method: A test, inspection, calculation or other method that determines whether a *Performance Solution* complies with the relevant *Performance Requirements*.

Wall-glazing construction: For the purposes of Section J in Volume One, the combination of wall and glazing components comprising the *envelope* of a building, excluding—

(a) *display glazing*; and

(b) opaque non-glazed openings such as doors, vents, penetrations and shutters.

Watt (W): The determined metric or SI (international system of measuring units) value for power and is used to rate electrical motors, appliances, lights etc. and in expressing both energy loads and energy consumption.

Watt/(W/L/s): A measure of the amount of energy used in moving a litre of air (by fans) or of water (by pumps) in one second for purposes of providing building services. The higher the

29 ABCB (2023) Condensation in buildings handbook, accessed Oct 2023.

wattage, the more power the fan or pump uses to move the air or water and the lower its energy efficiency.

Appendix C Compliance with the NCC

C.1 Responsibilities for regulation of building and plumbing in Australia

State and territory governments are responsible for regulation of building, plumbing and development/planning in their respective state or territory.

The NCC is a joint initiative of the Commonwealth and State and Territory Governments in Australia and is produced and maintained by the ABCB on behalf of the Australian Government and each state and territory government. The NCC provides a uniform set of technical provisions for the design and construction of buildings and other structures and plumbing and drainage systems throughout Australia. It allows for variations in climate and geological or geographic conditions.

The NCC is given legal effect by building and plumbing regulatory legislation in each state and territory. This legislation consists of an Act of Parliament and subordinate legislation (e.g. Building Regulations) which empowers the regulation of certain aspects of buildings and structures and contains the administrative provisions necessary to give effect to the legislation.

Each state's and territory's legislation adopts the NCC subject to the variation or deletion of some of its provisions, or the addition of extra provisions. These variations, deletions and additions are generally signposted within the relevant section of the NCC and located within appendices to the NCC. Notwithstanding this, any provision of the NCC may be overridden by, or subject to, state or territory legislation. The NCC must therefore be read in conjunction with that legislation.

C.2 Demonstrating compliance with the NCC

Compliance with the NCC is achieved by complying with the NCC Governing Requirements and relevant Performance Requirements.

The Governing Requirements are a set of governing rules outlining how the NCC must be used and the process that must be followed.

The Performance Requirements prescribe the minimum necessary requirements for buildings, building elements, and plumbing and drainage systems. They must be met to demonstrate compliance with the NCC.

There are 3 options available to demonstrate compliance with the Performance Requirements. These are:

- a Performance Solution

- a Deemed-to-Satisfy Solution, or
- a combination of a Performance Solution and a Deemed-to-Satisfy Solution.

All compliance options must be assessed using one or a combination of Assessment Methods, as appropriate. These include:

- Evidence of Suitability
- Expert Judgement
- Verification Methods
- Comparison with DTS Provisions.

A figure showing hierarchy of the NCC and its compliance options is provided in Figure C.1. It should be read in conjunction with the NCC.

To access the NCC or for further general information regarding demonstrating compliance with the NCC visit the ABCB website.

C.3 Other Applicable Acts, Regulations and design responsibilities

There is other legislation (both Commonwealth, and State and Territory) which may impact on building approval and design.

For instance, the NCC does not regulate matters such as the roles and responsibilities of building and plumbing practitioners. These fall under the jurisdiction of the States and Territories.

State and Territory building and plumbing legislation is not nationally consistent in relation to these matters with significant variations with respect to:

- registration of practitioners
- mandatory requirements for inspections during construction.

The design and approval of building and plumbing and drainage solutions will need to consider these variations.

In addition to the relevant legislation, Workplace Health and Safety (WHS) legislation is also applicable which requires safe design principles to be applied.

A Code of Practice on the safe design of structures has been published by Safe Work Australia (2012) which provides guidance to persons conducting a business or undertaking work in regard to structures that will be used, or could reasonably be expected to be used, as a workplace. It is prudent to apply these requirements generally to most building classes since they represent a workplace for people undertaking building work, maintenance, inspections at various times during the building life.

The Code of Practice defines safe design as:

- “the integration of control measures early in the design process to eliminate or, if this is not reasonably practicable, minimise risks to health and safety throughout the life of the structure being designed”.

It indicates that safe design begins at the start of the design process when making decisions about:

- the design and its intended purpose
- materials to be used
- possible methods of construction, maintenance, operation, demolition or dismantling and disposal
- what legislation, codes of practice and standards need to be considered and complied with.

The Code of Practice also provides clear guidance on who has health and safety duties in relation to the design of structures and lists the following practitioners:

- architects, building designers, engineers, building surveyors, interior designers, landscape architects, town planners and all other design practitioners contributing to, or having overall responsibility for, any part of the design
- building service designers, engineering firms or others designing services that are part of the structure such as ventilation, electrical systems and permanent fire extinguisher installations
- contractors carrying out design work as part of their contribution to a project (for example, an engineering contractor providing design, procurement and construction management services)
- temporary works engineers, including those designing formwork, falsework, scaffolding and sheet piling
- persons who specify how structural alteration, demolition or dismantling work is to be carried out.

In addition, WHS legislation places the primary responsibility for safety during the construction phase on the builder.

From the above it is clear that the design team in conjunction with owners/operators and the builder have a responsibility to document designs, specify and implement procedures that will minimise risks to health and safety throughout the life of the structure being designed.

A key element of safe design is consultation to identify risks, develop practical mitigation measures and to assign responsibilities to individuals/organisations for ensuring the mitigation measures are satisfactorily implemented.

This approach should be undertaken whichever NCC compliance pathway is adopted.

Additional matters specific to health and safety are summarised below, but this list is not comprehensive.

- The NCC and associated referenced documents represent nationally recognised minimum standards for health and safety for new building works.
- The NCC's treatment of safety precautions during construction is very limited. Additional precautions are required to address WHS requirements during construction.
- Detailed design of features to optimise reliability and facilitate safe installation, maintenance and inspection where practicable.
- Document procedures and allocate responsibilities for determining evidence of suitability for all health and safety measures.
- Provide details of health and safety measures within the building, evidence of suitability, commissioning results and requirements for maintenance and inspection to the owner as part of the building manual. (Note: Some State and Territory legislation contains minimum requirements for inspection of fire safety measures).
- The building manual should also provide information on how to avoid compromising fire safety through the life of a building (e.g. preventing disconnection of smoke detectors or damage to fire resistant construction).

Some health and safety measures will be impacted by other legislation that may be synergistic with the NCC requirements or potentially in conflict particularly in relation to natural hazards. These include:

- planning/development
- conservation
- state emergency risk management policies.

Figure C. 1 Demonstrating compliance with the NCC

Appendix D Worked Examples

This appendix contains examples to assist with understanding and applying the energy efficiency DTS Provisions and Verifications Methods in the NCC relevant to a commercial building.

The examples and their location in this appendix are listed and hyperlinked in Table D.1 Examples and their location.

They should be read in conjunction with a copy of NCC Volume One.

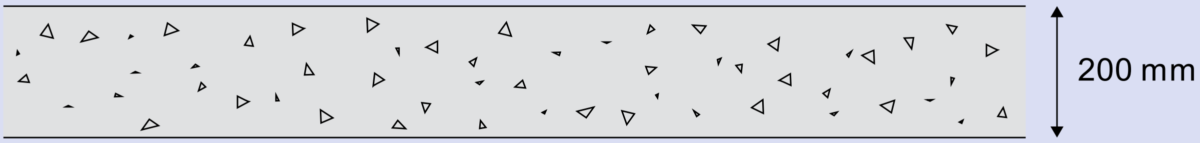
Table D.1 Examples and their location

Appendix Examples	Page reference
D.1 Building fabric	207 – 224
D.2 Fan and duct systems	224 – 235
D.3 Water pump	236 – 238
D.4 Artificial lighting	239 – 242
D.5 J1V3 Verification using a reference building	243 – 244
D.6 J1V4 Verification of building envelope sealing	245 – 247

D.1 Building fabric

D.1.1 R-Value

Figure D.2 R-Value of concrete slab



A solid concrete slab is 200 mm thick.

Table S36C2c in Specification 36 specifies that the thermal conductivity for solid concrete is equal to 1.44.

The R-Value is equal to the thickness of the concrete divided by the thermal conductivity.

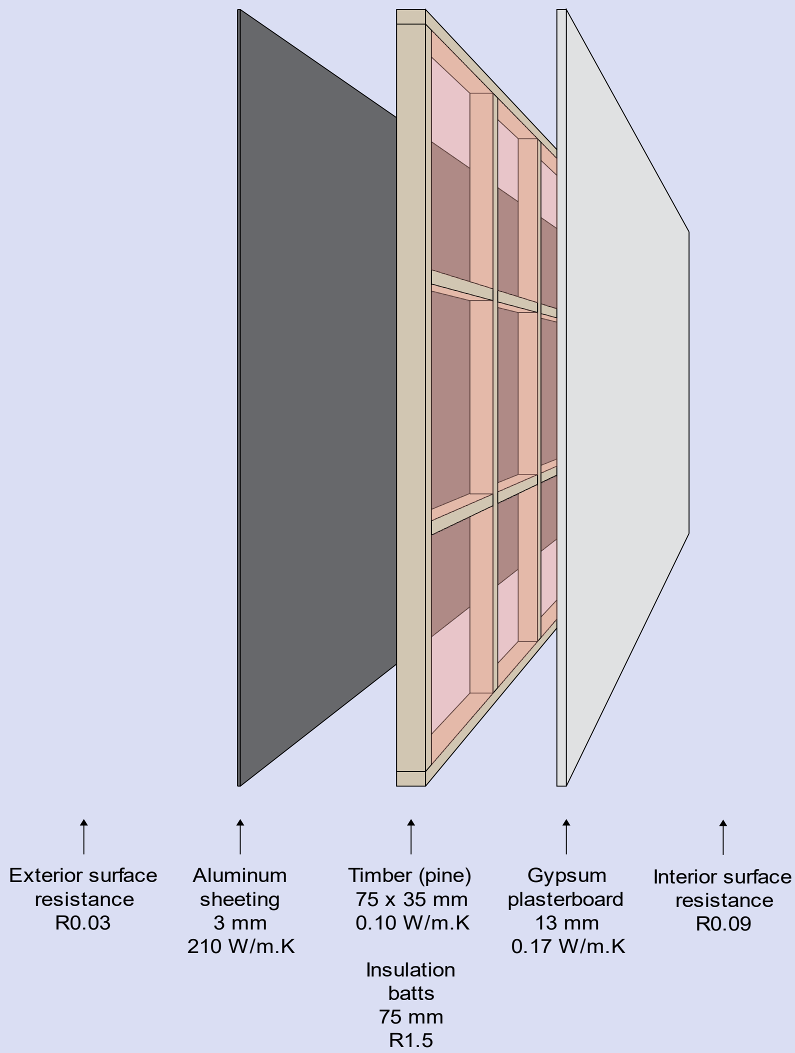
R-Value = 0.20 m ÷ 1.44 W/m.K

R-Value = 0.14

D.1.2 Total R-Value Calculation (showing bridging calculation as per NZ 4214)

A stud wall consists of 3 mm thick aluminium sheeting, 75 mm thick bulk insulation with an R-Value of 1.5 mm, and 13 mm thick gypsum plasterboard. The insulation layer is bridged by 75 mm × 35 mm framing studs at 600 mm centres, noggings at 800 mm centres, and 35 mm height top and bottom plates. The wall is 2.4 m tall.

Figure D.2 Stud wall section



The Total R-Value is calculated by determining the thermal resistance of each layer, surface layer, and any bridged layers in the wall. Note that the thermal conductivity values in this example reference NCC Volume One Specification 36.

Exterior surface resistance

See NZS 4214 Section 5.2.

$R = 0.03\ m^2.K/W$

Layer 1: 3 mm aluminium sheeting

$$R = \frac{0.003\ \mathrm{m}}{210\ \mathrm{W/m.k}}$$

$$R = 0.00001\ m^2.K/W$$

Layer 2: Insulation with timber thermal bridge

See NZS 4214 Section 5.7.

First the R-values of each material in the layer is determined.

$$R_1\ (75\ \text{mm thick R1.5 insulation batts}) = 1.5\ m^2.K/W$$

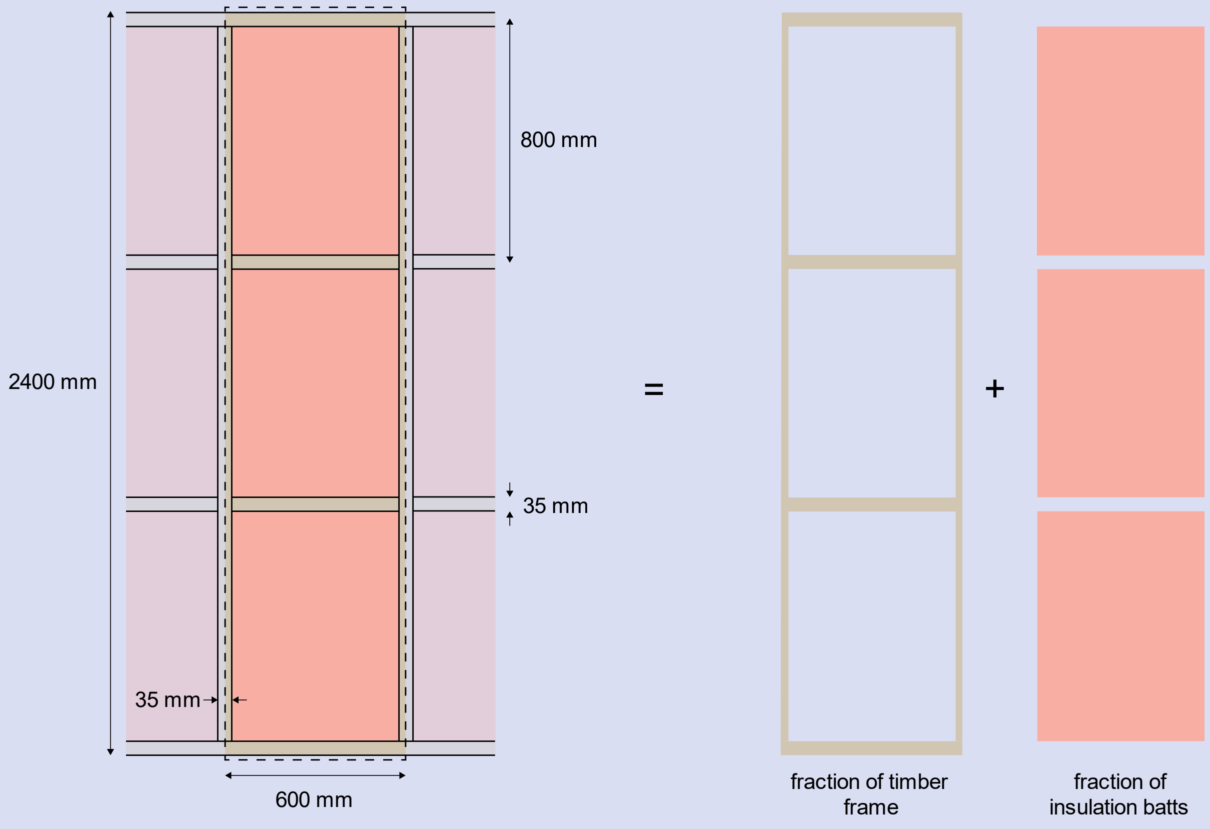
$$R_2\ (75\ \text{mm deep timber framing}) = \frac{0.075\ \mathrm{m}}{0.10\ \mathrm{W/m.k}}$$

$$R_2\ (70\ \text{mm deep timber framing}) = 0.75\ m^2.K/W$$

Next, the fraction of the cross-section at right angles to the direction of heat flow occupied by each region in the layer is determined.

One repeated section of the wall can be examined to determine the fraction of each region in the layer as per Figure D.3.

Figure D.3 Insulation with framing acting as a thermal bridge



$$f_1(\text{fraction of insulation batts}) = \frac{\text{area of insulation}}{\text{total area}}$$

$$f_1(\text{fraction of insulation batts}) = \frac{(600 \times 2400) - ((2400 \times 35) + ((600 - 35) \times 35 \times 4))}{600 \ \times 2400}$$

$$\text{f1 (fraction of insulation batts)} = 0.8867$$

$$f_2(\text{fraction of timber framing}) = \frac{\text{area of timber framing}}{\text{total area}}$$

$$f_2(\text{fraction of timber framing}) = \frac{((2400 \times 35) + ((600 - 35) \times 35 \times 4))}{600 \ \times 2400}$$

$\text{f2 (fraction of timber framing)} = 0.1133$

Next the total resistance of the layer is calculated.

See equation 5 and 6 of NZS 4214.

$$\frac{1}{R} = \frac{f_1}{R_1} + \frac{f_2}{R_2} = \frac{0.8867}{1.5} + \frac{0.1133}{0.75} = 0.742$$

$$R = \frac{1}{0.742}$$

R = 1.347 m^2.K/W

Layer 3: 13 mm gypsum plaster board

$$\text{R} = \frac{0.013\ \text{m}}{0.17\ \text{W/m.k}}$$

$$\text{R} = 0.076\ \text{m2.K/W}$$

Interior surface resistance

See NZS 4214 Section 5.2.

R = 0.09 m^2.K/W

Total thermal resistance (Total R-Value)

The total thermal resistance is the sum of all the layers, the surface layers and any bridge layers (i.e. layer 2).

Total R-Value = 0.03 + 0.00001 + 1.347 + 0.076 + 0.09

Total R-Value = 1.544

Please note this calculated Total R-Value is representative of the wall where the timber frame and insulation batts are consistent with the area used in this example. The areas on the edge of the wall, for example, would therefore have a different Total R-Value as the fraction of timber would be larger due to the edge stud components.

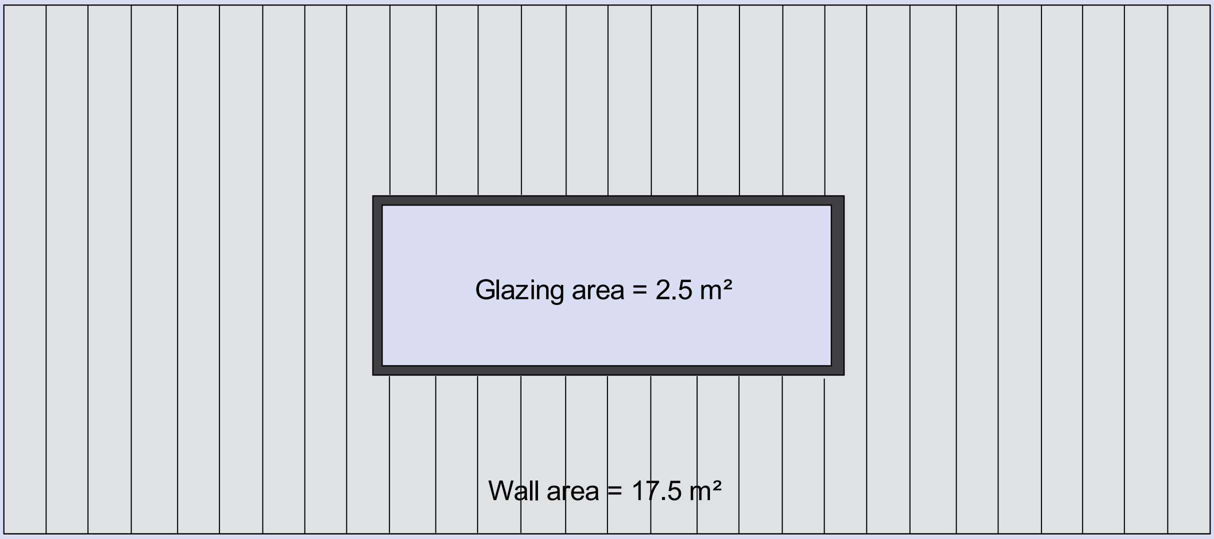
D.1.3 Wall-glazing construction Total System U-Value calculation

Wall-glazing constructions refer to the combination of wall and glazing components that make up the envelope of a building. They exclude display glazing and opaque non-glazed openings such as doors, vents, penetrations and shutters.

The following wall-glazing construction is facing north. As the wall glazing-construction is facing only the northern aspect, the single aspect calculation method (Method 1) can be used.

The wall-glazing construction is part of a Class 6 building and is in climate zone 7.

Figure D.4 Window to Wall ratio



The U-Value of the glazing is equal to U3.5.

The wall component is a stud wall that is made up of 3 mm thick aluminium sheeting, bulk insulation with an R-Value of 1.5 , and 13 mm thick plasterboard and the Total R-Value is equal to 1.54.

Wall construction R-Value

The Total R-Value of 1.54 is calculated in accordance with AS/NZS 4859.2, with allowances for thermal bridging.

Please note the ABCB Facade Calculator provides a Total System R-Value Calculator that enables the input of material layers and determines the Total R-Value with allowances for thermal bridging in accordance with AS/NZS 4859.2.

The percentage area of the wall component can be calculated as the area of the wall component divided by the total area.

17.5 ÷ 20 = 0.875 or 87.5%

As the percentage of wall area is greater than 80% of the wall-glazing construction, the minimum R-Value is specified in Table J4D6a.

Per Table J4D6a, the minimum requirement for a Class 6 building in climate zone 7 is R1.4.

As 1.54 is greater than R1.4 the wall component meets the requirements of J4D6(4).

Wall construction U-Value

The Total System U-Value of the wall component can be calculated as the inverse of the Total R-Value.

Total System U-Value = 1 ÷ 1.54 = 0.65

Total System U-Value

The Total System U-Value of the wall-glazing construction is calculated as the area weighted average of the Total System U-Value of each component.

The percentage area of the wall component is equal to 87.5% as calculated above.

The percentage area of the glazing component can be calculated as the area of the glazing component divided by the total area.

2.5 ÷ 20 = 0.125 or 12.5%

The area weighted average is then calculated by multiplying the percentage area by the U-Value of each component and adding them together.

Percentage wall × wall U-Value + Percentage glazing × glazing U-Value =

$0.875 \times 0.65 + 0.125 \times 3.5 = 1.00$

Result

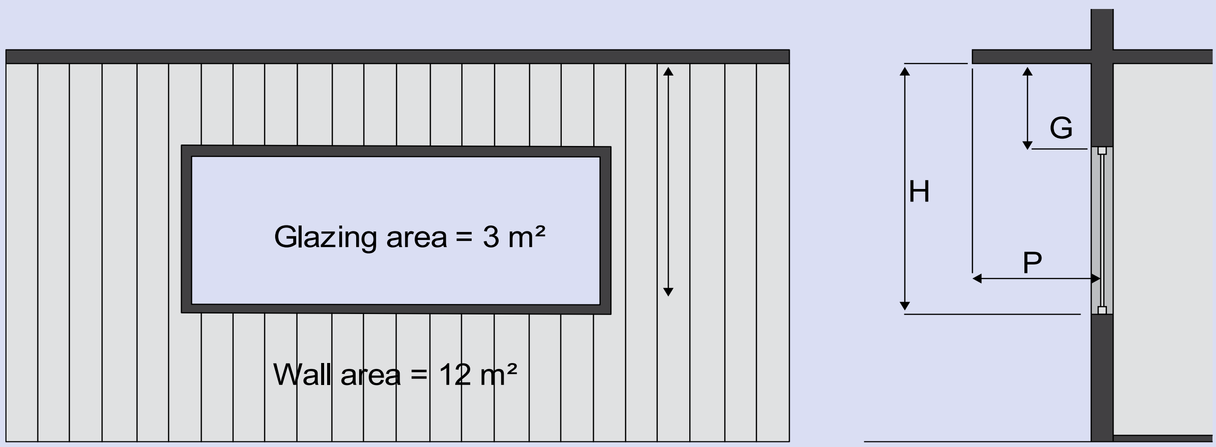
As the Total System U-Value (1.00) does not exceed the requirements of J4D6(1)(a) Total System U-Value no greater than U2.0 for a Class 6 building), the wall-glazing construction meets J4D6 and Specification 37 requirements.

D.1.4 Solar admittance (Single Aspect)

The following example is a north facing wall of a Class 3 building in climate zone 2. The SHGC of the proposed glazing is 0.45.

In the example G = 0.6 m, P = 0.8 m, and H = 2 m.

Figure D.5 Window to wall ratio and shading



Area of each glazing element (A_W)

As there is only one glazing element, $A_{w1} = 3.0\ m^2$

Shading multiplier of each glazing element (S_W)

To determine the shading multiplier, G ÷ H and P ÷ H must first be calculated.

G ÷ H = 0.6 ÷ 2 = 0.3

P ÷ H = 0.8 ÷ 2 = 0.4

The shading multiplier can be found in Table S37C7a of Specification 37 and is therefore, 0.89.

$S_{W1} = 0.89$

SHGC of each glazing element ($SHGC_W$)

$SHGC_{W1} = 0.45$

Area of the wall-glazing construction (A_{Wall})

$A_{Wall} = 15\ m^2$

Calculation of solar admittance

The values determined can now be used in the solar admittance equation provided in Specification 37 Clause S37C5.

$$SA = \frac{A_{W1} \times S_{W1} \times SHGC_{W1}}{A_{Wall}}$$

$$SA = \frac{3.0 \times 0.89 \times 0.45}{15}$$

SA = 0.080

The calculated solar admittance must be less than or equal to the values specified in J4D6(5).

For a Class 3 building, the maximum solar admittance factor is found in Table J4D6c and is determined to be 0.10.

Result

As the calculated solar admittance of 0.080 does not exceed the applicable value in J4D6(5)(0.10), the proposed design meets the requirements.

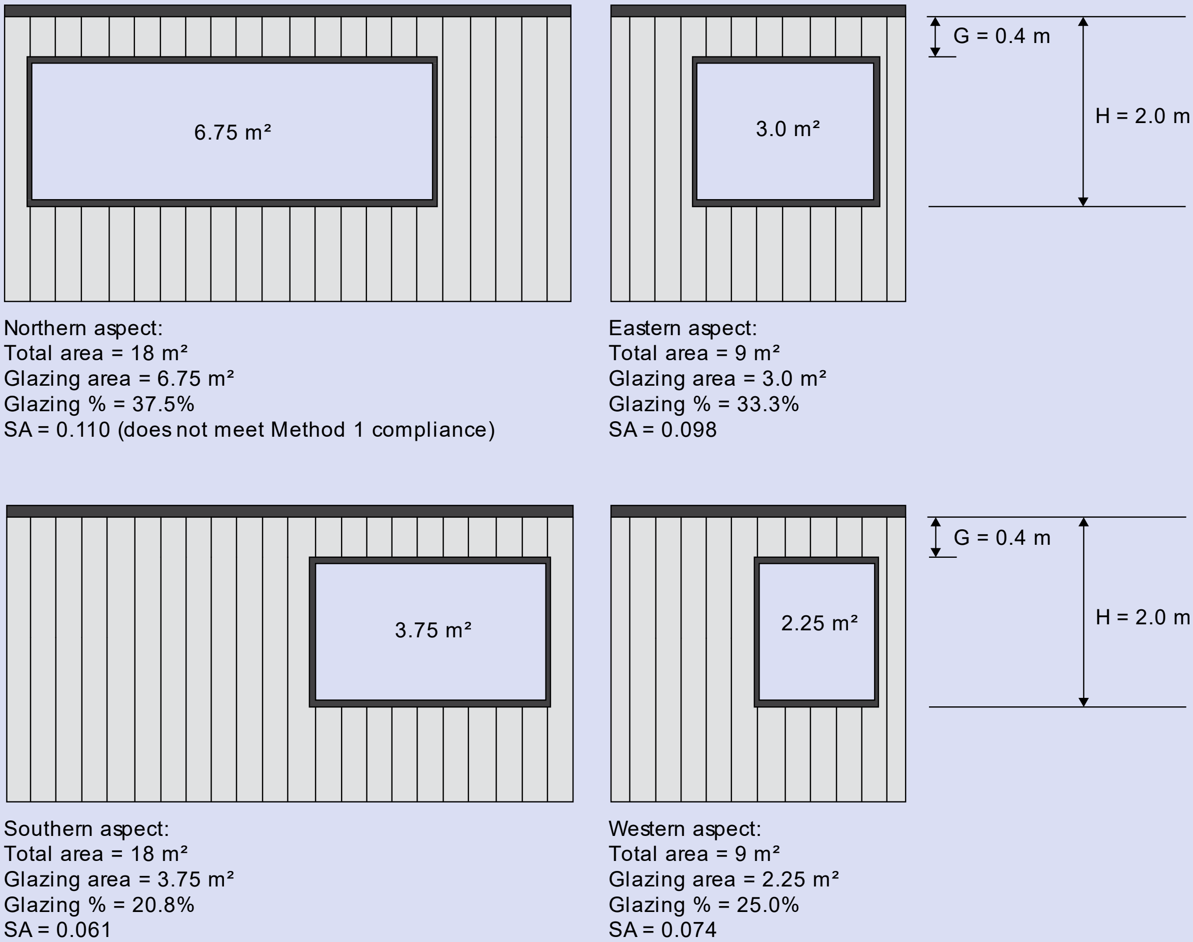
D.1.5 Solar admittance (multiple aspects)

The following example is for a Class 3 building located in climate zone 5.

The solar admittance for each aspect has been pre-determined for the proposed building in accordance with Clause S37C5 of Specification 37 (Method 1). The solar admittance is based on a SHGC of 0.30 for all glazing. There is an external shading projection of 0.2 m.

The solar admittance does not meet the requirements for Method 1 on the northern aspect. Therefore, Method 2 is to be used to see if overall compliance can be met for the whole building.

Figure D.6 Window to wall ratio



Solar admittance weighting coefficient ($\alpha_{N, E, S, W}$)

The solar admittance weighting coefficient of each aspect is based on the percentage of glazing area per each aspect. If the glazing area is greater than or equal to 20%, the weighting coefficients are listed in Table S37C6a and S37C6b in Specification 37.

As the percentage of glazing is greater than 20% on each aspect, the solar admittance weighting coefficients can be found in Table S37C6a and S37C6b. For this example, the solar admittance weighting coefficients are found in Table S37C6b for a Class 3 building.

For a Class 3 building in climate zone 5:

The northern aspect solar admittance weighting coefficient = 1.88

The eastern aspect solar admittance weighting coefficient = 1.48

The southern aspect solar admittance weighting coefficient = 1.00

The western aspect solar admittance weighting coefficient = 1.52

To summarise:

$\alpha_N = 1.88$

$\alpha_E = 1.48$

$\alpha_S = 1.00$

$\alpha_W = 1.52$

Wall-glazing construction solar admittance ($SA_{N, E, S, W}$)

Reference case:

Values for the wall-glazing construction solar admittance for the reference case are found in J4D6(5).

$SA_N = 0.10$

$SA_E = 0.10$

$SA_S = 0.10$

$SA_W = 0.10$

Proposed case:

The values for wall-glazing construction solar admittance for the proposed case are calculated in accordance with Clause S37C5(1) and in this example, are pre-determined. See examples of this method in the example above.

$SA_N = 0.011$

$SA_E = 0.098$

$SA_S = 0.061$

$SA_W = 0.074$

Representative air-conditioning energy value (E_R)

Reference case:

$$E_R = A_N \alpha_N SA_N + A_E \alpha_E SA_E + A_S \alpha_S SA_S + A_W \alpha_W SA_W$$

$$E_R = (18 \times 1.88 \times 0.10) + (9 \times 1.48 \times 0.10) + (18 \times 1.00 \times 0.10) + (9 \times 1.52 \times 0.10)$$

$$E_R = 7.884$$

Proposed case:

$$E_R = (18 \times 1.88 \times 0.110) + (9 \times 1.48 \times 0.098) + (18 \times 1.00 \times 0.061) + (9 \times 1.52 \times 0.074)$$

$$E_R = 7.144$$

Result

As the proposed case representative air-conditioning energy value (7.144) is less than that of the reference case (7.884), the wall-glazing construction meets the requirements for Method 2.

D.1.6 Display glazing Total System SHGC

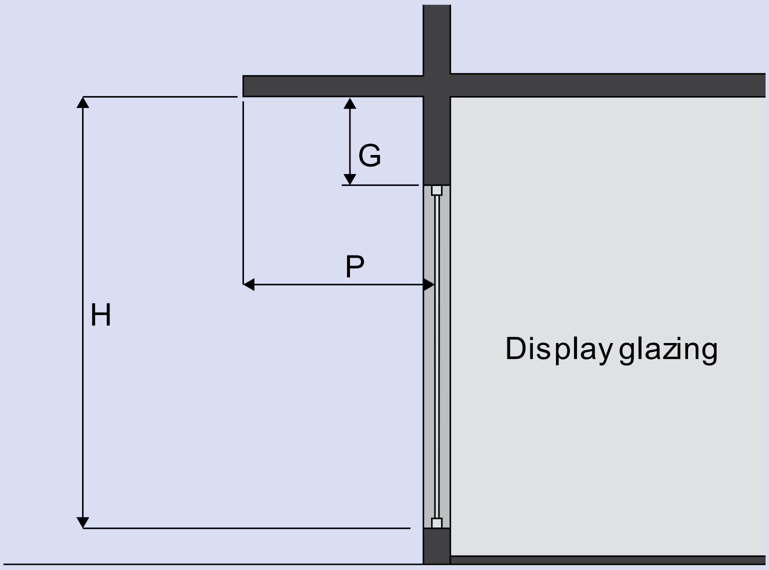
The following wall-glazing construction is east facing with a permanent projection shading the window. The suggestion Total System SHGC for the glazing is 0.4.

H = 2.5 m

P = 1 m

G = 0.5 m

Figure D.8 Shading



To determine the shading multiplier, G ÷ H and P ÷ H must first be calculated.

G ÷ H = 0.5 ÷ 2.5 = 0.2

P ÷ H = 1 ÷ 2.5 = 0.40

The shading multiplier can be found in Table S37C7a of Specification 37 and is therefore, 0.82.

Total System SHGC

The Total System SHGC must a maximum of 0.81 divided by the calculated shading multiplier.

0.81 ÷ 0.82 = 0.99

Therefore, as 0.4 is less than 0.99 the system meets the requirements of J4D6(7).

D.1.7 Method 2 Spandrel panel R-Value

Example

A spandrel panel is 1.5 m wide and 1.2 m high. The spandrel panel has the following U-Values.

Frame region:

- Area 1: U = 10
- Area 2: U = 11.8
- Area 3: U = 10
- Area 4: U = 4.6

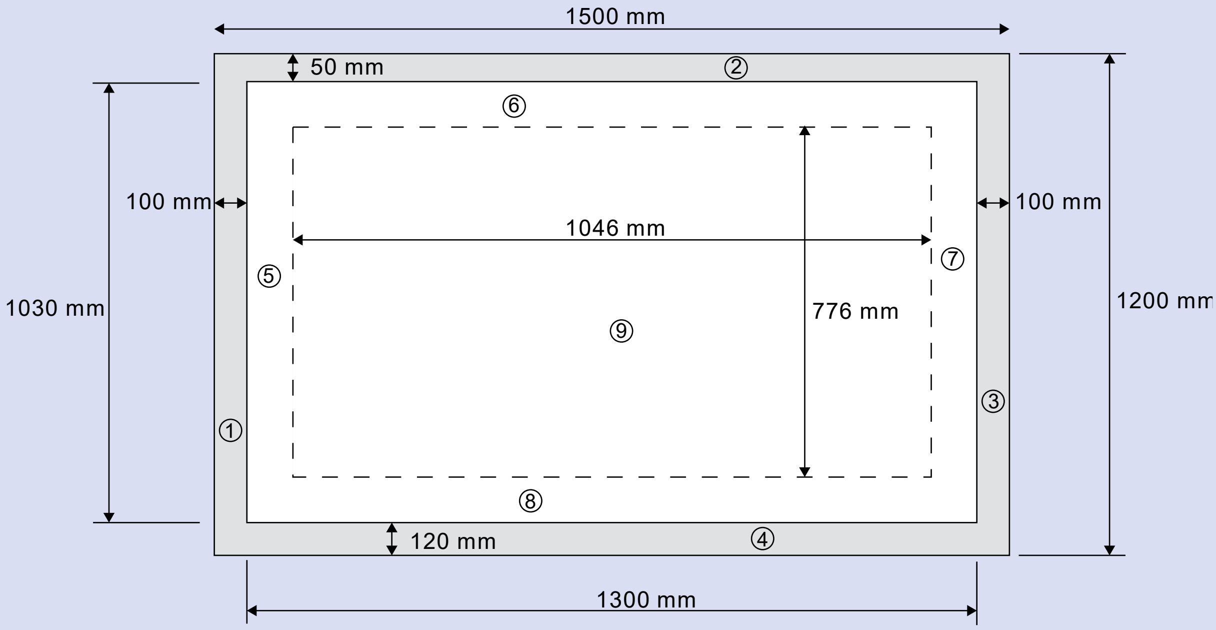
Edge region (width of 127 mm):

- Area 5: U = 1.9
- Area 6: U = 1.9
- Area 7: U = 1.9
- Area 8: U = 1.6

Centre region:

- Area 9: U = 0.355

Figure D.9 Spandrel dimensions



Step 1: Area calculations

Based on the image above, the spandrel panel has the following dimensions

Frame region:

Area 1 = 1200 × 100 = 120000 mm^2 = 0.12 m^2

Area 2 = 1300 × 50 = 65000 mm^2 = 0.065 m^2

Area 3 = 1200 × 100 = 120000 mm^2 = 0.12 m^2

Area 4 = 1300 × 120 = 156000 mm^2 = 0.156 m^2

Edge region (width of 127 mm):

Area 5 = 1030 × 127 = 130810 mm^2 = 0.131 m^2

Area 6 = 1046 × 127 = 132842 mm^2 = 0.133 m^2

Area 7 = 1030 × 127 = 130810 mm^2 = 0.131 m^2

Area 8 = 1046 × 127 = 132842 mm^2 = 0.133 m^2

Centre region:

Area 9 = 1046 × 776 = 811696 mm^2 = 0.812 m^2

Step 2: Total System U-Value

Based on the U-Values provided and the calculated areas the Total System U-Value can be determined for the spandrel panel. First, individual components of the equation will be solved.

$U_{cs}A_{cs}$:

$U_{cs}A_{cs} = 0.355 \times 0.812 = 0.288$

$\sum U_{es}A_{es}$:

$\sum U_{es}A_{es} = (1.9 \times 0.131) + (1.9 \times 0.133) + (1.9 \times 0.131) + (1.6 \times 0.133)$

$\sum U_{es}A_{es} = (0.249) + (0.253) + (0.249) + (0.213)$

$\sum U_{es}A_{es} = 0.964$

$\sum U_{fs}A_{fs}$:

$\sum U_{fs}A_{fs} = (10 \times 0.12) + (11.8 \times 0.065) + (10 \times 0.12) + (4.6 \times 0.156)$

$\sum U_{fs}A_{fs} = (1.2) + (0.767) + (1.2) + (0.718)$

$\sum U_{fs}A_{fs} = 3.885$

A_{cs}:

$A_{cs} = 0.812$ m^2

$\sum A_{es}$:

$\sum A_{es} = 0.131 + 0.133 + 0.131 + 0.133$

$\sum A_{es} = 0.528$ m^2

$\sum A_{fs}$:

$\sum A_{fs} = 0.12 + 0.065 + 0.12 + 0.156$

$\sum A_{fs} = 0.461$ m^2

Result

The above determined values can now be used in the equation provided in Clause S38C3 of Specification 38 to determine the Total System U-Value of the spandrel panel.

$$U_{sp} = \frac{U_{cs}A_{cs} + \sum U_{es}A_{es} + \sum U_{fs}A_{fs}}{A_{cs} + \sum A_{es} + \sum A_{fs}}$$

$$U_{sp} = \frac{0.288 + 0.964 + 3.885}{0.812 + 0.528 + 0.461}$$

$$U_{sp} = 2.852$$

Calculated in accordance with the formula provided in Clause S38C3 of Specification 38, the Total System U-Value of the spandrel panel is 2.852.

D.2 Fan and duct systems

D.2.1 Static efficiency

The fan has a static pressure equal to 150 Pa.
The static efficiency at BEP is therefore equal to:

η_{static} = 0.13 × ln(p) – 0.3

η_{static} = 0.13 × ln(150) – 0.3

η_{static} = 0.13 × 5.01 – 0.3

η_{static} = 35%

D.2.2 Full load efficiency

A centrifugal backward curved fan is installed with free inlet and outlet conditions. The fan installation type is therefore type A.

The motor input power of the fan is 10 kW.

$P = 10\ kW$

As the fan is a centrifugal backward curved fan with installation type A, the minimum performance grade of 64 is determined from Table J6D5a.

$N = 64$

The regression coefficients a and b are obtained from Table J6D5b and J6D5c respectively.

From Table J6D5b it is determined that for a centrifugal backward curved fan with a motor input power ≥10 kW the regression coefficient a is equal to 1.1.

From Table J6D5c it is determined that for a centrifugal backward curved fan with a motor input power ≥10 kW the regression coefficient b is equal to 2.6.

$a = 1.1$

$b = 2.6$

Using the coefficients determined above, the minimum efficiency at the full load operating point is calculated using the following formula.

$\eta_{min} = 0.85 \times (a \times \ln(P) - b + N) \div 100$

$\eta_{min} = 0.85 \times (1.1 \times \ln(10) - 2.6 + 64) \div 100$

$\eta_{min} = 0.85 \times (1.1 \times \ln(10) - 2.6 + 64) \div 100$

$\eta_{min} = 54\%$

Result

In this instance, the minimum required static efficiency is equal to 54%.

D.2.3 Fan and duct system component compliance

Example

Consider a workshop that requires an in-duct supply fan and a roof mounted exhaust fan.

The following details apply to both the supply and exhaust fans:

- Axial fan not as a component of an AHU or FCU (i.e. other)
- Fan inlet = ducted
- Fan outlet = ducted

- Motor input power = 0.4 kW
- System efficiency = 70%
- Air flow rates = 240 L/s
- Static pressure = 150 Pa
- Fouling risk = yes

Supply fan index run components:

- Duct run 1 (3 m in length, 300 × 250 mm, 0.49 Pa/m pressure drop)
- Duct run 2 (3 m in length, 300 × 250 mm, 0.49 Pa/m pressure drop)
- Louvre (single stage, 20 Pa pressure drop)
- Contraction (2.74 Pa pressure drop)
- Expansion (13.70 Pa pressure drop)
- Fire damper 1 (15 Pa pressure drop)
- T branch (1.92 Pa pressure drop)
- Fire damper 2 (15 Pa pressure drop)
- Turn (0.21 Pa pressure drop)
- Flexible ductwork (1 m, 200 mm diameter, 0.88 Pa/m pressure drop)
- Diffuser (10 Pa pressure drop)

Note the pressure drop across each component has been calculated using a duct friction loss chart.

Exhaust fan index run components:

- Duct run 1 (3 m in length, 300 × 250 mm, 0.49 Pa/m pressure drop)
- Duct run 2 (3 m in length, 300 × 250, 0.49 Pa/m pressure drop)
- Turn (1.85 Pa pressure drop)
- T branch (1.64 Pa pressure drop)
- Louvre (single stage, 20 Pa pressure drop)
- Contraction (2.74 Pa pressure drop)
- Expansion (13.70 Pa pressure drop)
- Fire damper 1 (15 Pa pressure drop)
- Fire damper 2 (15 Pa pressure drop)
- Roof cowl (25 Pa pressure drop)

Note the pressure drop across each component has been calculated using a duct friction loss chart.

As per J6D5(1), fans, ductwork and duct components that form part of an air-conditioning system or mechanical ventilation system must either separately comply with the requirements of J5.4(2), (3), (4) and (5) or achieve whole of system compliance (i.e. the proposed fans, ductwork and duct components achieve a fan motor input power lower than that of a system designed to meet the DTS requirements of J6D5(2), (3), (4) and (5)).

The following example will be checked at a component level. Please note the Fan System Calculator determines if compliance is met at both a component and system level.

For the purposes of this example it is assumed that the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the duct they are connected to.

Step 1: Fans

J6D5(2) details fan requirements that must be met to achieve component compliance (i.e. J6D5(1)(a)).

Variable speed control:

Since the airflow for both fans is less than 1000 L/s, variable speed control is not required.

Minimum efficiency:

Since the static pressure of both fans is less than 200 Pa (i.e. 150 Pa), the minimum overall static efficiency must be more than 13 × ln(Pa) – 30 as per J6D5(2)(b).

$$13 \times \ln(Pa) - 30 = 13 \times \ln(150) - 30 = 35.1\%$$

Since the total system efficiency (70%) is more than the calculated minimum efficiency (35.1%), the requirements of J6D5(2)(b) are met.

Step 2: Ductwork

J6D5(3) details requirements for the ductwork that must be met to achieve component compliance (i.e. J6D5(1)(a)).

For the purposes of this calculation, only the index run will be checked. Please note that in all duct runs flexible duct must not be longer than 6 m in length.

Index run pressure drop:

Supply fan:

The straight sections of rigid and all sections of flexible ductwork in the supply fan include duct run 1, duct run 2 and the flexible ductwork.

As the total length of the straight duct is 7 m (3 m + 3 m + 1 m), the maximum allowable pressure drop is 7 Pa.

Summing the calculated pressure drops across the straight ducts gives:

$$(0.49 \text{ Pa/m} \times 3 \text{ m}) + (0.49 \text{ Pa/m} \times 3 \text{ m}) + (0.88 \text{ Pa/m} \times 1 \text{ m}) = 3.82 \text{ Pa}$$

As 3.82 Pa is less than the allowable pressure drop of 7 Pa, the sections of straight duct in the supply fan meet the requirements of J6D5(3)(a).

Exhaust fan:

The straight sections of rigid and all sections of flexible ductwork in the supply fan include duct run 1 and duct run 2.

As the total length of the straight duct is 6 m (3 m + 3 m), the maximum allowable pressure drop is 6 Pa.

Summing the calculated pressure drops across the straight ducts gives:

$$(0.49 \text{ Pa/m} \times 3 \text{ m}) + (0.49 \text{ Pa/m} \times 3 \text{ m}) = 2.94 \text{ Pa}$$

As 2.94 Pa is less than the allowable pressure drop of 6 Pa, the sections of straight duct in the supply fan meet the requirements of J6D5(3)(a).

Flexible ductwork:

The flexible ductwork in the supply fan is at a length of 1 m. Therefore, the requirements of J6D5(3)(b) are met as the flexible ductwork does not account for more than 6 m in length.

Upstream connections:

As the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the duct they are connected to, compliance is met with J6D5(3)(c)

Please note that the Fan System Calculator does not check whether upstream connections to ductwork bends, elbows and tees in the index run have the same diameter to the connected duct.

Turning vanes:

As the fan system is serving a workshop, there is a fouling risk within this example. Therefore, turning vanes are not required in all rigid ductwork elbows of 90° or less in the index run.

Step 3: Ductwork components in the index run

J6D5(4) details requirements for the index run that must be met to achieve component compliance (i.e. J6D5(1)(a)).

Please note not all components listed in J6D5(4) are included in this example. Only the specific battery room index run components will be examined.

Intake louvres:

Supply and exhaust fans: Since the single stage louvre pressure drop (20 Pa) is less than that of the requirement J6D5(4)(d)(i) (30 Pa), the DTS requirements are met.

Fire dampers:

Supply and exhaust fans: Since the fire damper pressure drop (15 Pa) is not more than that of the requirements in J6D5(4)(h) (15 Pa). This requirement is met.

Supply air diffusers:

Supply fan: Since the diffuser pressure drop (10 Pa) is less than that of the requirement J6D5(4)(j) (40 Pa), the DTS requirements are met.

Roof cowl:

Exhaust fan: Since the roof cowl pressure drop (25 Pa) is less than that of requirement J6D5(4)(f) (30 Pa), the DTS requirements are met.

Contraction:

The requirements for contractions are not specified in J6D5(4). Therefore, they are deemed compliant.

Expansion:

The requirements for expansions are not specified in J6D5(4). Therefore, they are deemed compliant.

T branch:

The requirements for T branches are not specified in J6D5(4). Therefore, they are deemed compliant.

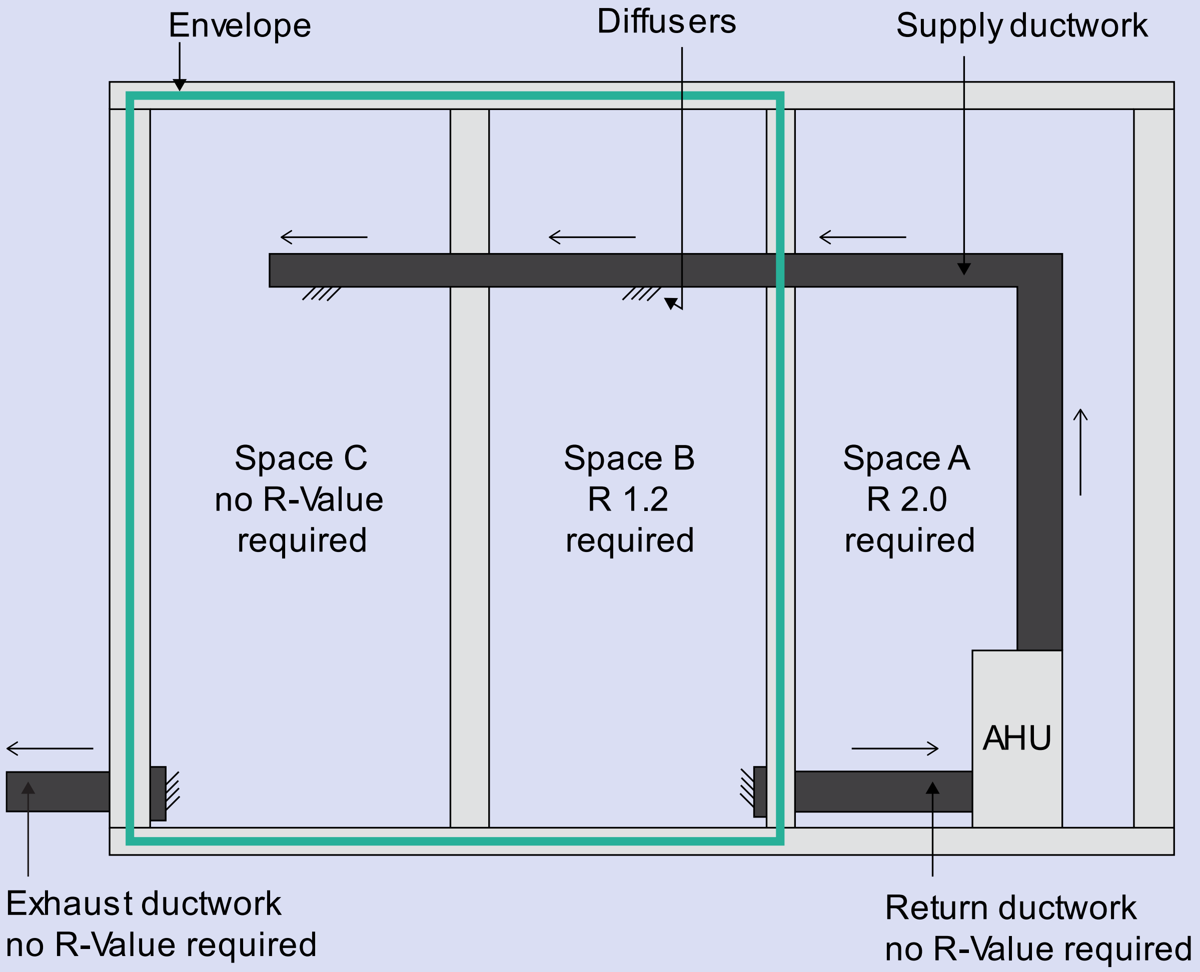
Turn:

The requirements for turns are not specified in J6D5(4). Therefore, they are deemed compliant.

As all components of the fan system meet the compliance requirements of J6D5(2), (3) and (4), the fan system complies on a component level.

D.2.4 Ductwork insulation

Table D.1 Ductwork section



The building is in climate zone 5 and the ductwork is greater than 3 m in length.

Space A is not conditioned; therefore, insulation must be installed to the supply and return ductwork with a minimum R-value of R 2.0 as per Table J6D6.

Space B is a conditioned space; therefore, insulation with a minimum added R-Value of R 1.2 from Table J6D6 is required to be installed on the supply ductwork. No insulation is needed for the return ductwork in Space B as it is exempted by J6D6(3)(c).

Space C is a conditioned space. Since it is the last room served by the system, the insulation requirements of J6D6(1) do not apply to the ductwork.

In Space B and C, the diffuser forms the interface with the conditioned space and is therefore exempt from the insulation requirements of J6D6(1) by J6D6(3)(b).

The exhaust ductwork is exempt from the insulation requirements of J6D6(1) by J6D6(3)(d).

Note that the requirements of Section C - Fire resistance in NCC Volume One may also apply.

D.2.5 J6D8(5)(b) exemption check

An air-conditioning system operates for less than 5000 hours per annum. The system is a distributive (i.e. has branches), variable speed system. A segment of pipe within the index run of the air-conditioning system has a flow rate of 6 L/s and a diameter of 150 mm.

Pressure drop

The pressure drop requirements for the distributive, variable speed system is found in Table J6D8d. Therefore, for any pipe size in the index run of this system, the maximum pressure drop is 400 Pa/m.

Velocity

First the velocity of the proposed segment of pipe is determined. The segment of pipe analysed is a copper Type B to AS 1432 pipe, with a water temperature of 6°C. The surface roughness of the copper pipe is 0.0015 mm. Based on these characteristics, and the known flow rate of 6 L/s and diameter of 150 mm, the velocity of liquid in the segment of pipe is 0.35 m/s.

Note that the ABCB's Pump System Calculator can calculate the velocity of each segment of pipe within the index run.

Determining smallest compliant pipe size

The diameter of the segment of pipe can be decreased until the pressure drop no longer complies with the requirements of J6D8(4), which for this example is found Table J6D8d.

150 mm diameter:	9.3 Pa/m pressure drop and 0.35 m/s velocity
125 mm diameter:	22.1 Pa/m pressure drop and 0.50 m/s velocity
100 mm diameter:	66.5 Pa/m pressure drop and 0.79 m/s velocity
90 mm diameter:	128.7 Pa/m pressure drop and 1.05 m/s velocity
80 mm diameter:	277.7 Pa/m pressure drop and 1.44 m/s velocity
65 mm diameter:	651.6 Pa/m (above maximum allowable pressure drop)

Therefore, the smallest pipe size compliant with J6D8(4) is 80 mm. However, when the smallest pipe size is chosen, the velocity is above 0.70 m/s (1.44 m/s).

Result

Therefore, while the proposed velocity of the pipe is less than 0.70 m/s, this segment of pipework is not exempt from the requirements of J6D8(4) as the smallest compliant pipe size results in a velocity greater than 0.70 m/s.

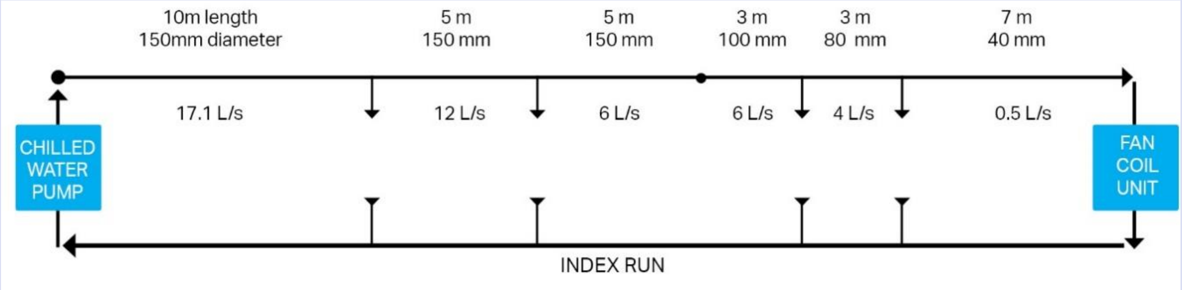
D.2.6 Pump system component compliance

Consider a chilled water pump located in a university. The chilled water pump operates for approximately 12 hours a day with a fluid temperature of 6°C. The pumps water flow rate is 17.1 L/s. The system head is 300 kPa and the efficiency at the BEP is 75%.

The Minimum Efficiency Index of the pump is equal to 0.55 when calculated in accordance with European Union Commission Regulation No. 547/2012.

The pipe system is a variable speed, distributive system. The straight segments of pipework along the index can be represented with the following diagram.

Figure D.10 Straight pipework in index run



Straight segments of pipework along the index run include:

1: Copper Type B to AS 1432, 150 mm diameter, 10 m length, 0.0015 mm roughness, 17.1 L/s flow rate, 60.1 Pa/m pressure drop

2: Copper Type B to AS 1432, 150 mm diameter, 5 m length, 0.0015 mm roughness, 12 L/s flow rate, 31.9 Pa/m pressure drop

3: Copper Type B to AS 1432, 150 mm diameter, 5 m length, 0.0015 mm roughness, 6 L/s flow rate, 9.3 Pa/m pressure drop

4: Copper Type B to AS 1432, 100 mm diameter, 3 m length, 0.0015 mm roughness, 6 L/s flow rate, 66.5 Pa/m pressure drop

5: Copper Type B to AS 1432, 80 mm diameter, 3 m length, 0.0015 mm roughness, 4 L/s flow rate, 134.8 Pa/m pressure drop

6: Copper Type B to AS 1432, 40 mm diameter, 7 m length, 0.0015 mm roughness, 0.5 L/s flow rate, 104.8 Pa/m pressure drop

7: Copper Type B to AS 1432, 40 mm diameter, 7 m length, 0.0015 mm roughness, 0.5 L/s flow rate, 104.8 Pa/m pressure drop

8: Copper Type B to AS 1432, 80 mm diameter, 3 m length, 0.0015 mm roughness, 4 L/s flow rate, 134.8 Pa/m pressure drop

9: Copper Type B to AS 1432, 100 mm diameter, 3 m length, 0.0015 mm roughness, 6 L/s flow rate, 66.5 Pa/m pressure drop

10: Copper Type B to AS 1432, 150 mm diameter, 5 m length, 0.0015 mm roughness, 6 L/s flow rate, 9.3 Pa/m pressure drop

11: Copper Type B to AS 1432, 150 mm diameter, 5 m length, 0.0015 mm roughness, 12 L/s flow rate, 31.9 Pa/m pressure drop

12: Copper Type B to AS 1432, 150 mm diameter, 10 m length, 0.0015 mm roughness, 17.1 L/s flow rate, 60.1 Pa/m pressure drop

Please note the pressure drop across each component has been calculated using a pipe friction loss chart.

As per J6D8(1), pumps and pipework that form part of an air-conditioning system must either separately comply with the requirements of J6D8(2), (3) and (4) or achieve whole of system compliance (i.e. the proposed pumps and pipework achieve a pump motor input power lower than that of a system designed to meet the DTS requirements of J6D8(2), (3) and (4)).

The following example will be checked at a component level. Please note the Pump System Calculator determines if compliance is met at both a component and system level.

Step 1: Circulator pumps

J6D8(2) details requirements for the EEI for circulator pumps that must be met to achieve component compliance (i.e. J6D8(1)(a)).

Circulator pumps are glandless impeller pumps used in a closed loop system with a rated hydraulic power output below 2.5 kW.

The EEI must be calculated in accordance with European Union Commission Regulation No. 622/2012. The ABCB's Pump System Calculator calculates the EEI using this method.

However, as the specified pump in the example is not a circulator pump this requirement is not relevant.

Step 2: Other pumps

J6D8(3) details requirements for the Minimum Efficiency Index of other pumps that must be met to achieve component compliance (i.e. J6D8(1)(a)).

Other pumps refer to pumps not covered by J6D8(2) (i.e. pumps that are not circulator pumps).

The Minimum Efficiency Index must be calculated in accordance with European Union Commission Regulation No. 547/2012. The ABCB's Pump System Calculator calculates the Minimum Efficiency Index using this method.

As the Minimum Efficiency Index (0.55) is greater than that specified in J6D8(3) (0.4), compliance is met with J6D8(3).

Please note the Pump System Calculator will determine the Minimum Efficiency Index in accordance with European Union Commission Regulation No. 547/2012 for component level compliance. However, if a whole of system check is required under J6D8(1)(b), an alternate method is used. This method uses the procedure within EU Commission Regulation No. 547/2012 to compute the required efficiency and compare it with the actual efficiency.

Step 3: Pipework

J6D8(4) specifies average maximum pressure drops for straight segments of pipework along the index run that must be met to achieve component compliance (i.e. J6D8(1)(a)).

As the pipework system is distributive and variable speed, the pressure drop of straight segments of pipework must not be more than the values nominated in Table J6D8e.

The operating hours per annum for a system that operates for approximately 12 hours a day fall between 2000 and 5000 hours (multiply the operating hours per day by the number of days in operation to determine the number of hours per annum).

Table J6D8e specifies that all nominal pipe diameters for the above range in hours have an average maximum allowable pressure drop of 400 Pa/m.

As pipes 1 to 6 have pressure drops below that specified in Table J6D8e (400 Pa/m), compliance is evidently met with the requirements of J6D8(4). If the segments of pipework do not all meet the requirements of the maximum allowable pressure drop, the average pressure drop is calculated by summing the pressure drop (Pa) of each segment of pipe and dividing this by the total length of all segments; as follows:

$$\frac{2 \times \left((60.1 \times 10) + (31.9 \times 5) + (9.3 \times 5) + (66.5 \times 3) + (134.8 \times 3) + (104.8 \times 7)\right)}{2 \times (10 + 5 + 5 + 3 + 3 + 7)}$$

$$Average\ pressure\ drop = 65.0\ Pa/m$$

Step 4: Exemptions

Valves and fittings are exempt from the pipework requirements J6D8(4).

The smallest pipe size compliant with J6D8(4) for each segment pipework would result in a velocity of greater than 0.7 m/s. Therefore, no segments of pipework are exempt from the requirements of J6D8(4).

Result

As the components of the pump system meet the compliance requirements of J6D8(3) and (4) (excluding J6D8(2) as the pump is not a circulator pump) the pump system complies on a component level.

D.3 Water pump

D.3.1 Example 6: A chilled water pump located in a commercial building

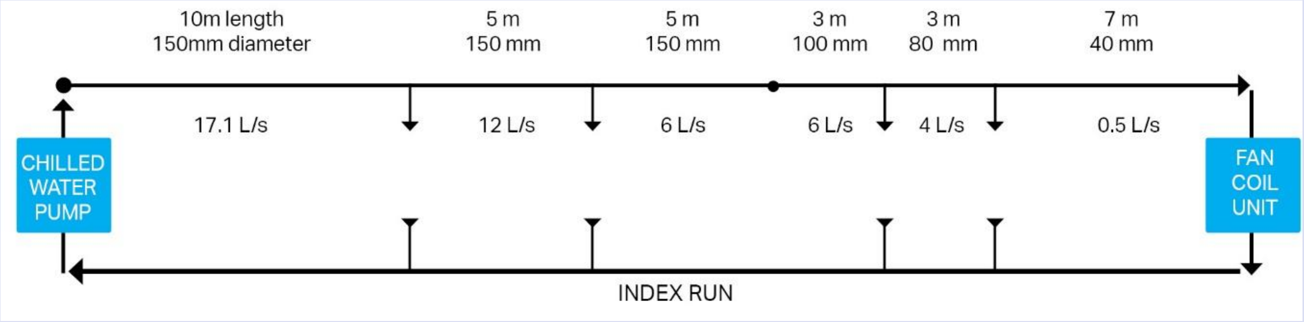
Introduction

Consider a chilled water pump located in a commercial building. The chilled water pump operates for approximately 12 hours a day with a fluid temperature of 6°C. The pumps water flow rate is 17.1 L/s. The system head is 300 kPa and the efficiency at the BEP is 75%.

The Minimum Efficiency Index of the pump is equal to 0.55 when calculated in accordance with European Union Commission Regulation No. 547/2012.

The pipe system is a distributive variable speed system. The straight segments of pipework along the index can be represented with the following diagram.

Figure D.11 Ductwork section



5: Copper Type B to AS 1432, 80 mm diameter, 3 m length, 0.0015 mm roughness, 4 L/s flow rate, 134.8 Pa/m pressure drop

6: Copper Type B to AS 1432, 40 mm diameter, 7 m length, 0.0015 mm roughness, 0.5 L/s flow rate, 104.8 Pa/m pressure drop

7: Copper Type B to AS 1432, 40 mm diameter, 7 m length, 0.0015 mm roughness, 0.5 L/s flow rate, 104.8 Pa/m pressure drop

8: Copper Type B to AS 1432, 80 mm diameter, 3 m length, 0.0015 mm roughness, 4 L/s flow rate, 134.8 Pa/m pressure drop

9: Copper Type B to AS 1432, 100 mm diameter, 3 m length, 0.0015 mm roughness, 6 L/s flow rate, 66.5 Pa/m pressure drop

10: Copper Type B to AS 1432, 150 mm diameter, 5 m length, 0.0015 mm roughness, 6 L/s flow rate, 9.3 Pa/m pressure drop

11: Copper Type B to AS 1432, 150 mm diameter, 5 m length, 0.0015 mm roughness, 12 L/s flow rate, 31.9 Pa/m pressure drop

12: Copper Type B to AS 1432, 150 mm diameter, 10 m length, 0.0015 mm roughness, 17.1 L/s flow rate, 60.1 Pa/m pressure drop

Note that the pressure drop across each component has been calculated using a pipe friction loss chart.

As per J6D8(1), pumps and pipework that form part of an air-conditioning system must either separately comply with the requirements of J6D8(2) to (4) or achieve whole of system compliance (i.e. the proposed pumps and pipework achieve a pump motor input power lower than that of a system designed to meet the DTS requirements of J6D8(2) to (4).

The following example will be checked at a component level. Please note the Pump System Calculator determines if compliance is met at both a component and system level.

Step 1: Circulator pumps

J6D8(2) details requirements for the EEI for circulator pumps that must be met to achieve component compliance (i.e. J6D8(1)(a)).

Circulator pumps are glandless impeller pumps used in a closed loop system with a rated hydraulic power output below 2.5 kW.

The EEI must be calculated in accordance with European Union Commission Regulation No. 622/2012. The ABCB's Pump System Calculator, which is available from the ABCB website, calculates the EEI using this method.

However, as the specified pump in the example is not a circulator pump this requirement is not relevant.

Step 2: Other pumps

J6D8(c) details requirements for the Minimum Efficiency Index of other pumps that must be met to achieve component compliance (i.e. J6D8(1)(a)).

Other pumps refer to pumps not covered by J6D8(2) (i.e. pumps that are not circulator pumps).

The Minimum Efficiency Index must be calculated in accordance with European Union Commission Regulation No. 547/2012. The ABCB's Pump System Calculator calculates the Minimum Efficiency Index using this method.

As the Minimum Efficiency Index (0.55) is greater than the minimum of 0.4 that is specified in J6D8(3), compliance is met with J6D8(3).

Please note the Pump System Calculator will determine the Minimum Efficiency Index in accordance with European Union Commission Regulation No. 547/2012 for component level compliance. However, if a whole of system check is required underJ6D8(1)(b), an alternate method is used. This method uses the procedure within EU Commission Regulation No. 547/2012 to compute the required efficiency and compare it with the actual efficiency.

Step 3: Pipework

J6D8(4) specifies average maximum pressure drops for straight segments of pipework along the index run that must be met to achieve component compliance (i.e. J6D8(1)(a)).

As the pipework is a distributive variable speed system, the pressure drop of straight segments of pipework must not be more than the values nominated in Table J6D8d.

The operating hours per annum for a system that operates for approximately 12 hours a day fall between 2000 and 5000 hours (multiply the operating hours per day by the number of days in operation to determine the number of hours per annum).

Table J6D8d specifies that all nominal pipe diameters for the above range in hours have an average maximum allowable pressure drop of 400 Pa/m.

As pipes 1 to 6 have pressure drops below that specified in Table J6D8(5) (400 Pa/m), compliance is evidently met with the requirements of J6D8(4). If the segments of pipework do not all meet the requirements of the maximum allowable pressure drop, the average pressure drop is calculated by summing the pressure drop (Pa) of each segment of pipe and dividing this by the total length of all segments as follows:

$$\frac{2 \times (60.1 \times 10 + 31.9 \times 5 + 9.3 \times 5 + 66.5 \times 3 + 134.8 \times 3 + 104.8 \times 7)}{2 \times (10 + 5 + 5 + 3 + 3 + 7)}$$

$$verage\ pressure\ drop = 65.0\ Pa/m$$

Step 4: Exemptions

Valves and fittings are exempt from the pipework requirements J6D8(4).

The smallest pipe size compliant with J6D8(4) for each segment pipework would result in a velocity of greater than 0.7 m/s. Therefore, no segments of pipework are exempt from the requirements of J6D8(4).

Result

As the components of the pump system meet the compliance requirements of J6D8(3) and (4) (excluding J6D8(2)) as the pump is not a circulator pump) the pump system complies on a component level.

Where the system is considered complex or does not meet individual component compliance but may meet whole of system compliance, the ABCB Pump System Calculator can provide a quicker way to undertake the calculations.

D.4 Artificial lighting

D.4.1 Illumination power load for a small laboratory

Example

A laboratory is 5 m by 7 m, therefore its floor area is 35 m^2 and the perimeter is 24 m. The ceiling is 2.6 m high. The lighting design has a proposed aggregate design illumination power load (load for all lighting fittings) of 300 W which includes all ballasts. The design incorporates a programmable dimming system which operates all the lights as a single block.

Design

The design illumination power load is 300 W.

Allowance

From Table J7D3a, the maximum illumination power density allowed for a laboratory is 6 W/m^2.

Adjustment factors

From Table J7D3b, the illumination power density adjustment factor for a programmable dimming system that controls at least 75 percent of the floor area is 0.85.

From Table J7D3a Note 4, the adjustment factor for room size depends upon the room aspect ratio (see J7D3a, below for more detail on room aspect ratio adjustments):

$$room\ aspect\ ratio = \frac{A}{H \times C}$$

Where:

A = the area of the enclosed space

H = the height of the space measured from the floor to the highest part of the ceiling

C = the perimeter of the enclosed space

Therefore, the room aspect ratio is:

$$= \frac{35}{(2.6 \times 24)}$$

= 0.56

Since the room aspect ratio is less than 1.5, Note 2 of Table J7D3a allows an adjustment factor for room aspect. The factor is calculated as:

$$Adjustment\ factor\ =\ 0.5 + \frac{room\ aspect\ ratio}{3}$$

$$=\ 0.5 + \frac{0.56}{3}$$

$$= 0.69$$

To determine the new allowance the maximum illumination power density for a laboratory from Table J7D3a is divided by the adjustment factor calculated above.

This means 6 W/m^2 is divided by 0.69 to give 8.70 W/m^2.

Note 4 of Table J7D3a allows the adjustment factor from Table J7D3b for the manual dimming system to be applied in addition to the adjustment for room aspect. The new allowance then becomes:

8.7 ÷ 0.95 = 9.15 W/m^2

The illumination power load allowance is space area x maximum illumination power density, which is 35 × 9.15 = 320.4 W

Result

As the aggregate design illumination power load of 300 W is less than the illumination power load allowance of 320.4 W, the design complies.

D.4.2 Adjustment factors

A conference room is 8 m by 6 m, therefore its floor area is 48 m^2 and the perimeter is 28 m. The ceiling is 2.8 m high. The lighting design has a proposed aggregate design illumination power load (load for all lighting fittings) of 700 W.

The board room is used infrequently and is in an area that receives large amounts of natural light. Therefore, the board room has incorporated a motion detector and a daylight sensor. The board room is fitted with LED lighting with a CRI of 90 and a CCT of 3000 K.

Design

The design illumination power load is 700 W.

Allowance

From Table J7D3a, the maximum illumination power density allowed for a conference room is 5 W/m^2.

Adjustment factors

Room Aspect Ratio:

From Table J7D3a Note 3, the adjustment factor for room size depends upon the room aspect ratio:

$$room\ aspect\ ratio = \frac{A}{H\ \times C}$$

Where:

A = the area of the enclosed space

H = the height of the space measured from the floor to the highest part of the ceiling

C = the perimeter of the enclosed space

Therefore, the room aspect ratio is:

$$= \frac{48}{(2.8\ \times 28)}$$

= 0.61

Since the room aspect ratio is less than 1.5, Note 3 of Table J7D3a allows an adjustment factor for room aspect. The factor is calculated as:

$$Adjustment\ factor\ = 0.5 + \frac{room\ aspect\ ratio}{3}$$

$$= 0.5 + \frac{0.61}{3}$$

$$= 0.70$$

Therefore, the room aspect ratio adjustment factor is 0.70.

Table J7D3b adjustment factors:

Note 3 of Table J7D3a allows adjustment factors from Table J7D3b for control devices.

Three adjustment factors apply for the board room including the factors for:

- motion detectors where a group of light fittings serving less than 100 m^2 is controlled,
- daylight sensor (Class 5 building), and

- lumen depreciation dimming.

As per note 1, a maximum of two adjustment factors for a control device can be applied to an area using the following formula:

$$A \times (B + [(1 - B) \div 2])$$

Where:

A is the lowest applicable adjustment factor, and

B is the second lowest applicable adjustment factor.

The two lowest applicable adjustment factors are for the motion detectors and daylight sensors, both equal to 0.6.

Therefore, in combination, the control device adjustment factor is calculated as:

$$0.6 \times (0.6 + [(1 - 0.6) \div 2]) = 0.48$$

Therefore, the control device adjustment factor is 0.48.

Table J7D3c adjustment factors:

Two adjustment factors can be applied from Table J7D3c based on the board room lighting design. As the CRI is equal to 90 an adjustment factor of 0.9 can be applied, and as the CCT is less than 3500 K an adjustment factor of 0.8 can also be applied.

Maximum illumination power density calculation:

All adjustment factors can now be applied to the illumination power density of 5 W/m^2 specified in Table J7D3a. The new allowance then becomes:

$$5 \div 0.70 \div 0.48 \div 0.9 \div 0.8 \text{ or;}$$

$$5 \div (0.70 \times 0.48 \times 0.9 \times 0.8) = 20.67 \text{ W/m}^2$$

The illumination power load allowance is space area × maximum illumination power density, which is 48 × 20.67 = 992 W

Result

As the aggregate design illumination power load of 700 W is less than the illumination power load allowance of 992 W, the design complies.

D.5 J1V3 Verification using a reference building

A five storey Class 5 building located in Melbourne is proposed to be assessed under Verification Method J1V3. In this case, the building has minimum DTS required insulation to the fabric and envelope of the building whilst the services will have energy efficiency parameters above the minimum standard of the DTS Provisions. The following calculations are made.

Step 1

A theoretical reference building is assessed having minimum DTS Provisions for the fabric as well as minimum DTS Provisions for services. The annual GHG emissions of the reference building are calculated at 32 $kgCO_2$-e/m^2.annum. This is the allowance.

Step 2

The annual GHG emissions of the proposed building with the proposed services is calculated to be 30 $kgCO_2$-e/m^2.annum.

Step 3

The annual GHG emissions of the proposed building with the services modelled to the minimum DTS Provisions is calculated to be 35 $kgCO_2$-e/m^2.annum.

Step 4

By comparing the outcome of step 2 and step 3 with the allowance determined in step 1 we can determine whether the design complies with Verification Method J1V3. The criteria in the J1V3 Verification Method states that annual GHG emissions of both cases modelled (step 2 and step 3) are not to be more than the allowance calculated in step 1.

The proposed building with the proposed services is 30 $kgCO_2$-e/m^2.annum (step 2) is less than the allowance 32 $kgCO_2$-e/m^2.annum determined in step 1 and therefore meets the first criteria of J1V3(1)(a)(i) for Verification Method J1V3.

30 $kgCO_2$-e/m^2 (step 2) < 32 $kgCO_2$-e/m^2 (step 1) = ✓

The proposed building with the services modelled to minimum DTS Provisions (step 3) is greater than the allowance 32 kgCO2-e/m^2.annum determined in step 1. Therefore, the proposed building's annual GHG emissions are greater than the annual GHG emissions of the reference building and thus does not comply with the second criteria in J1V3(1)(a)(ii).

35 $kgCO_2$-e/m^2 (step 3) > 32 $kgCO_2$-e/m^2 (step 1) = ✗

It is worth noting that although the performance of the proposed services was above that required by the minimum DTS Provisions, the performance of the building's fabric cannot be reduced (traded away) below the minimum required by the DTS Provisions.

Result

This means that the design does not comply with the Performance Requirement J1P1 using Verification Method J1V3 and will require either an alternative design to be developed or the use of a different Assessment Method.

D.6 J1V4 Verification of building envelope sealing

Introduction

A Performance Solution to satisfy J1P1(e) and J1P2, assessed using Verification Method J1V4 is proposed to verify the air-tightness of a commercial building.

As per clause A2G2(4) of the NCC, the process for developing Performance Solutions must be followed.

Method 1 of AS/NZS ISO 9972 should be used to verify the air-tightness of a building.

Step 1: Plan ahead

Since Verification Method J1V4 requires verification through testing, the building and/or design professionals need to ensure that their program of work accounts for the associated risks.

Testing should be performed as soon as possible on completion of the building envelope is complete. This will make it easier to undertake improvements with the required personnel.

One month should be allowed between testing and handover of the building. This is because a second test during this period may be needed if the building fails to meet the 5 $m^3/hr.m^2$ requirement. This allows enough time for sealing to be improved and retesting to occur.

The air barrier is continuous and needs to be clearly defined and marked on the building's drawings.

Step 2: Quality construction

Although using Verification Method J1V4 means that the DTS Provisions are not mandatory, they can still be used as guidelines. In some areas, departures from the DTS Provisions may be used as they suit an innovative method, so long as the Performance Requirement is satisfied.

Step 3: Prepare for the test

After the building envelope is complete, the building needs to be made suitable for testing. To follow the requirements of AS/NZS ISO 9972 Method 1, closing the windows, doors, trapdoors, ventilation openings and other openings in the building's envelope is needed. The air terminal devices in the building's ducted air-conditioning system are also sealed so the whole building is treated as a whole system.

Openings in the building's envelope for kitchen, bathrooms and the like exhaust systems are closed, but not specifically sealed, as these systems are intermittent. Continuously operating mechanical ventilation systems shall be sealed.

The blower door testing experts will then mount a blower door assembly at an external door on the building envelope and connect pressure measuring devices to the inside and outside of the building.

Step 4: Test

The blower door testing experts follow the procedures listed in AS/NZS ISO 9972. They check for large leaks and failures of temporarily sealed openings. They record the temperature inside and outside the building, as well as the wind speed.

They also measure the pressure difference between the inside and outside of the building without the blower door providing any airflow, to ensure that this can be accounted for.

The blower door testing experts then turn on the blower door. The test is carried out by taking measurements of blower door air flow rate and indoor/outdoor pressure difference over a range of applied pressure differences in 10 Pa increments.

They repeat this up to 60 Pa, as their attempt to test at 70 Pa proves beyond the capability of their equipment. When pressure differences above 50 Pa can be achieved, the accuracy of the test is enhanced. This is not required by AS/NZS ISO 9972. They repeat this process for both positive and negative pressures.

Step 5: Calculation

The blower door testing experts still need to convert their recordings into an air flow rate at 50 Pa, to verify the results. As part of this process, they refer again to AS/NZS ISO 9972 which sets out the calculations required.

They account for the base pressure difference, convert airflow readings into airflow through the envelope and plot the results to determine the relationship between the airflow through the envelope and induced pressure difference.

By synthesising data from the series of tests as required by the standard, they reduce the error in measurement. The result is calculated as the average result of both positive and negative test results.

Corrections for the environmental conditions universalise the results, so that they can be compared with the requirements of the Verification Method.

Step 6: Test reporting

The blower door testing experts then produce a test report with all the information specified by AS/NZS ISO 9972.

This includes that the test was undertaken using Method 1 of AS/NZS ISO 9972, the status of all building openings, testing apparatus, data, calculations, and results.

Step 7: Check

The building and/or design professionals check the results of the test against the 5 $m^3/hr.m^2$ requirement. Due to the attention paid to construction and quality assurance, their test results show that the building meets the requirement. If they fell short, then they would return to Step 2, rectify any defects and test again.

Appendix E Types of air conditioners

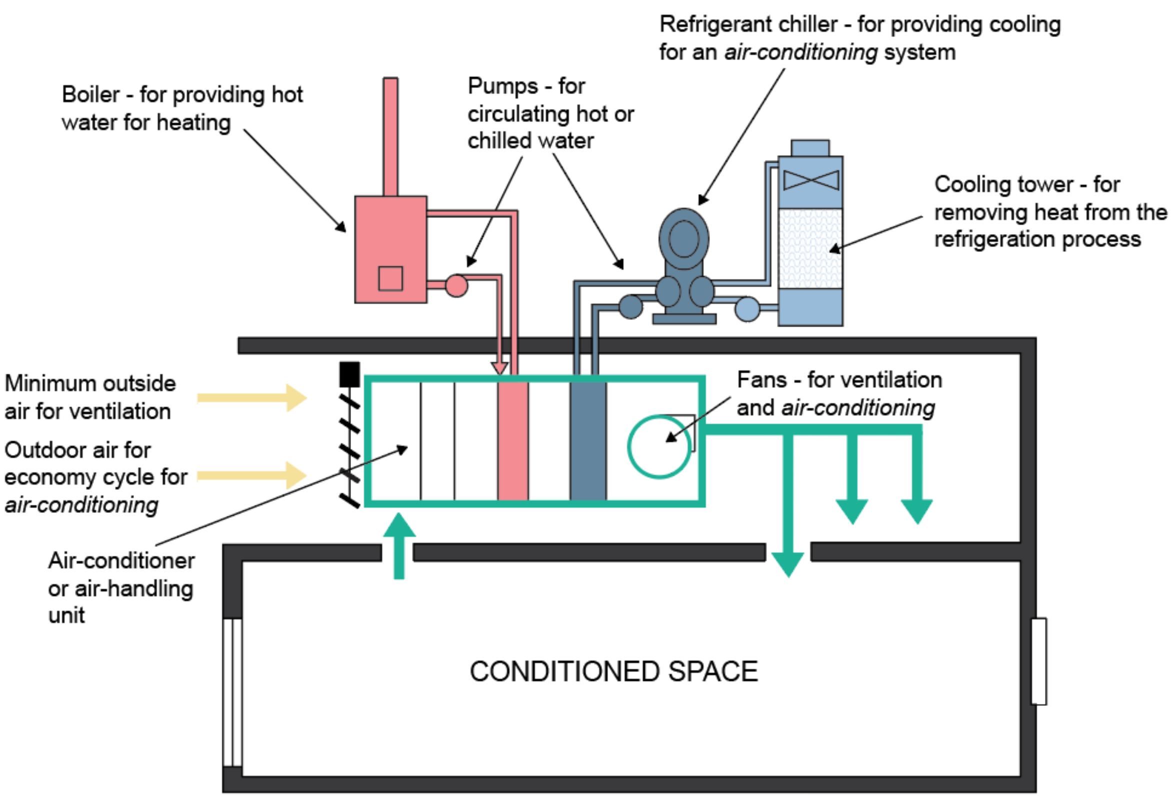
E.1 Types of air-conditioning systems

Examples and descriptions of air-conditioning systems are listed below:

- central chilled water systems
- central condenser water loop systems
- central air-handling units (AHU)
- individual unitary systems for heating and cooling
- evaporative cooling units or systems.

It is worthwhile noting that this list is not exhaustive and there may be many combinations or variations on these types of systems or others depending upon the building. Figure E.1 shows a diagram of a typical AHU served by a central HVAC plant.

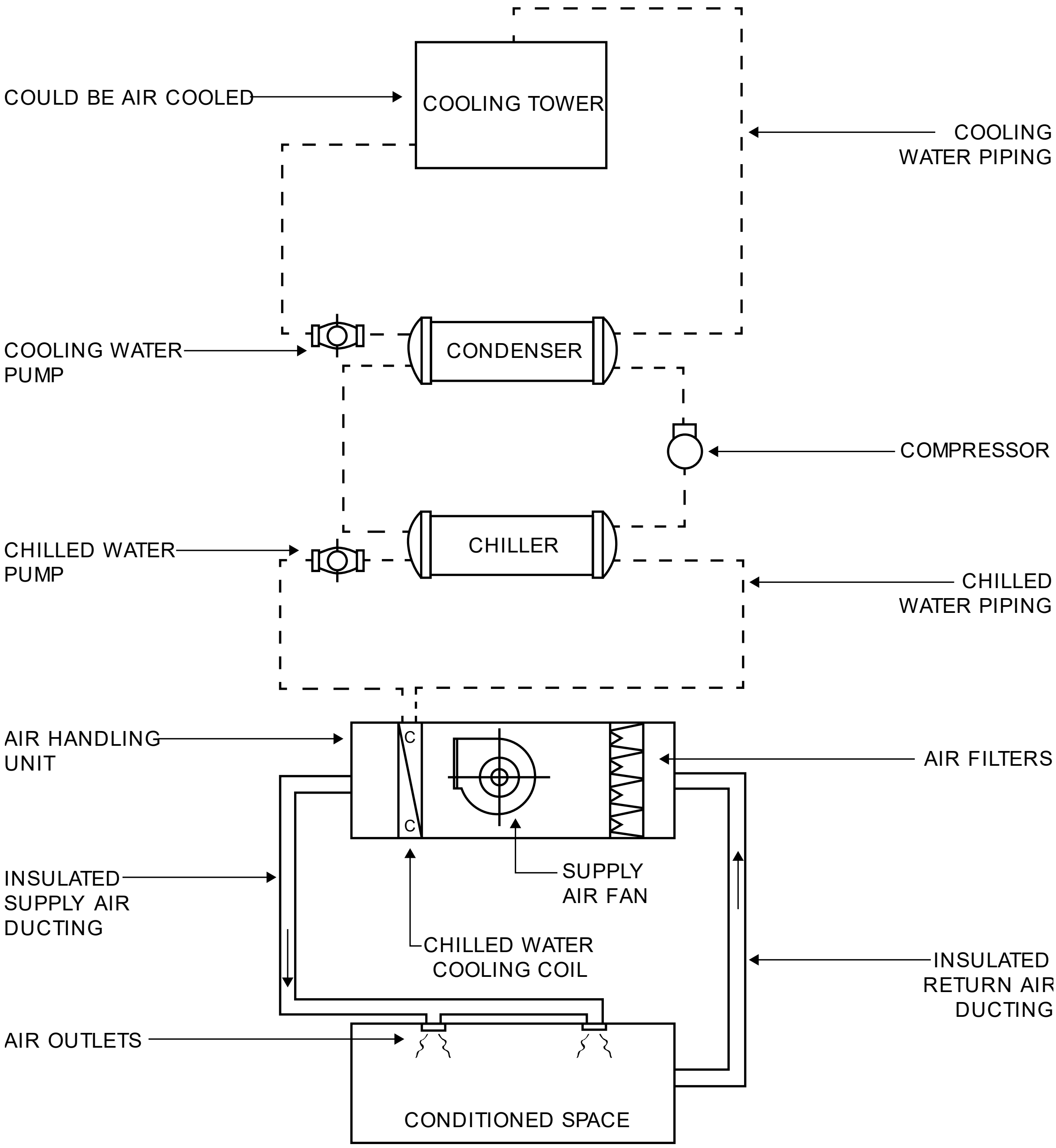
Figure E.1 Diagram of a typical AHU and its central plant connections



E.1.1 Central chilled water system

Central chilled water systems provide chilled water as a cooling medium. The chilled water can then be used in a variety of equipment types to provide air-conditioning. Chilled water is generated by a refrigerant chiller. The rejected heat is transferred to the atmosphere, either by a cooling tower, directly by an evaporative condenser or by an air-cooled condenser. Refer to Figure E.2.

Figure E.2 Typical air-conditioning using a central chilled water system (source – AIRAH)



The AHU can be a central system serving more than one area and/or multiple floors, or alternatively, an individual fan coil unit (FCU) can be provided for each individual space. For further information, refer to the explanation of AHU and FCU.

The central AHU can contain heating and/or cooling coils that heat and/or cool the air. This heating and/or cooling can also be provided in each individual FCU.

The chilled or heated water is circulated through coils within the AHUs or FCUs. An air stream, consisting of air returned from the conditioned spaces, outdoor air or a mixture of the two is passed over the coils. This cools or heats the air to the desired temperature, before being supplied into the conditioned space.

There are two main types of central chilled water system; air-cooled and water-cooled:

(1) water-cooled means that heat from the chiller is rejected using water as a transfer medium. This water then transfers heat to the external atmosphere using a cooling tower; and

(2) air-cooled means the heat is rejected by fans that pass air across an outdoor coil containing the refrigerant (like a domestic air-conditioner or refrigerator).

A brief explanation of the refrigerated cooling process is as follows.

Error! Reference source not found. shows the chiller system as made up of a chiller vessel, a compressor and a condenser vessel. Liquid refrigerant evaporates in the chiller vessel by absorbing heat from the chilled water circulating through the evaporative side of the chiller. This cools the chilled water which is then pumped around the chilled water piping circuit and delivered to various chilled water coils in the building for heat exchange. Figure E.1 shows this heat exchange taking place with the supply air stream in an AHU.

The compressor draws refrigerant gas from the chiller and compresses it. This hot gas passes to the condenser where it is cooled and reliquefied with heat transferred to the cooling water loop. The now liquid refrigerant returns from the condenser to the chiller through a pressure reducing device and the cycle is repeated. Heat from inside the building has been effectively transferred through the system to the outside atmosphere.

E.1.2 Central condenser water system

This system uses a cooling tower or other form of cooler and circulates the cooled water to one or more package units. There is no chiller (central or otherwise) used in this system.

The cooling tower cools water for supply to one or more condenser water package units. Each package unit contains its own refrigerant circuit, including a compressor, which discharge the rejected heat to the water and hence to the atmosphere via the cooling tower. The refrigerant then goes to a coil within an indoor unit over which air from the space is passed, conditioned and then recirculated back to the space.

Individual packaged air-conditioning units like this can be provided in a variety of applications.

E.1.3 Individual air-cooled unitary systems for heating and cooling

Individual air-cooled package units or self-contained units vary in size from a split unit or room air-conditioner, through to larger units which are usually located on the roof.

Packaged systems include indoor (the unit on the wall) and outdoor components with the package units containing:

- a refrigeration circuit, which includes a compressor,
- indoor and outdoor coils; and piping; and
- indoor and outdoor fans.

In cooling mode, the compressor increases the temperature of the refrigerant before an outdoor fan passes ambient air over the outdoor evaporator coil, causing the refrigerant to reject heat to the atmosphere. The cooled refrigerant is then rapidly expanded causing it to cool further before passing through an indoor coil. An indoor fan moves air over the indoor coil and thus recirculates cool air to the space.

In heating mode, the most common system is a heat pump, where the refrigeration system works in a reverse cycle.

Different types of split systems include:

- wall mounted split system
- floor or under ceiling mounted split: like the wall mounted system, except the indoor unit is on the floor or under the ceiling
- ceiling cassette: like the wall mounted system, except the indoor unit is inside the ceiling space
- ducted split: like the wall mounted system, except the indoor unit is not visible and uses ducts to deliver air to various rooms.

A package system would include:

- a room air-conditioner; and
- a roof top package system: this contains the entire system of fans, compressor and evaporator and condenser coils.

It is worthwhile noting that all individual package units may feature a reverse cycle which would provide heating as well as cooling. The heating can be provided by reversing the refrigeration cycle within the system.

E.1.4 Evaporative cooling system

Evaporative cooling systems are typical for residential and industrial buildings and are usually placed on the roof.

Evaporative coolers work best in climates where the air is hot, and the humidity is low. They operate by drawing hot outdoor air into the unit through filter pads made wet by a cold-water supply. The air temperature of the air drops because of the evaporation, which also increases the humidity of the air stream.

The cooler, humidified air is discharged indoors, before finally leaving the indoor environment through open windows and doors.

Appendix F Relevant reports and standards

F.1 References

- Canale I, Felici F, Marchetti M, and Ricci B, (1991), Ramp length/grade prescriptions for wheelchair dependent individuals, Spinal Cord, Vol. 29, pp. 479-485.
- Pitt & Sherry with input from BIS Shrapnel and Exergy Pty Ltd, for the DCCEE, Baseline Energy Consumption and GHG Emissions – In Commercial Buildings in Australia, Part 1 – Report, November 2012 (pg. 7)
- Emissions breakdown in Australia (ASBEC, 2017)
- Commission Regulation (EU) No 622/2012, as referenced in J5.7(b)
- Commission Regulation (EU) No 547/2012, as referenced in J5.7(c)
- National Construction Code Volume Two, BCA Class 1 and Class 10 Buildings
- National Construction Code Volume Three, Plumbing Code of Australia

F.2 Further reading

The following reference documents are recommended if further information is required regarding the energy efficiency provisions of NCC Volume One.

Each document, or information about the document, is available from the ABCB upon request:

- ABCB (2018) Energy Efficiency for commercial buildings; Regulation Impact Statement for decision.
- Energy Action (2018), Modelling and Sensitivity Analysis.
- NSW Office of Environment and Heritage (2017) Handbook for estimating NABERS ratings.