ABCB

National Construction Code

Case Study

Small office building

Energy efficiency

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Case study: Energy efficiency of a small office building

General information

Topic	Building energy efficiency
Compliance Solution	Deemed-to-Satisfy (DTS)
	NCC 2019, Volume One, Section J
Performance Requirement	JP1
Climate zone	6
Building classification	Class 5
Construction type	Curtain wall façade

Contents

REMINDER

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

The case study also needs to be read in conjunction 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 case study counteract or conflict with the legislative requirements, any references in legal documents, or other documents issued by the Administration or any directives by the Appropriate Authority.

Introduction

This case study describes developing a DTS Solution for a small Class 5 office building to meet the National Construction Code (NCC) 2019 Volume One energy efficiency Performance Requirement, JP1.

In this case study, there are references to the NCC. As the DTS Provisions for the energy efficiency of an office building are in NCC Volume One Section J, they are in the form of Jx. To read these references, refer to the NCC, available from the ABCB website (ncc.abcb.gov.au).

The case study targets practitioners with a basic understanding of the NCC energy efficiency provisions and an overall understanding of the performance-based NCC.

Purpose and limitations

This case study aims to demonstrate the practical application of the NCC energy efficiency requirements when proposing to design an office building that accounts for passive and active design principles with the intention of minimising the need for artificial cooling and heating of the building.

The case study design is responsive to the mild temperature climate in which the office is to be located. It includes air-cooled chillers, natural gas boilers, conditioned air ventilation and mechanical ventilation.

Given its location, the case study does not consider other design issues such as construction in cyclone, bushfire or flood prone areas. Diagrams included in the case study are only intended to explain issues directly relating to Section J of the NCC 2019 Volume One.

The guidance in this case study is limited to the energy efficiency requirements in Section J and developing a DTS Solution using the relevant DTS Provisions. This does not demonstrate full NCC compliance, as all NCC Performance Requirements need to be met.

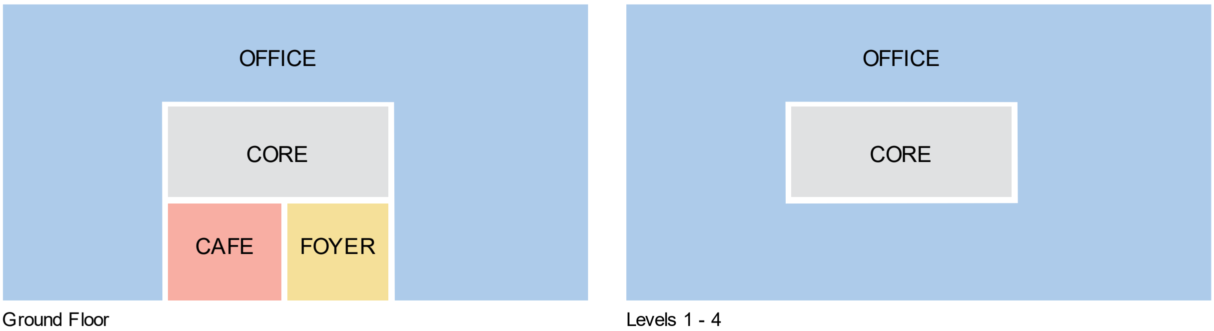
Users of the case study are encouraged to check for any relevant State and Territory NCC variations and additions that may apply in their jurisdiction. Furthermore, users should be aware of any applicable legalisation within their jurisdiction that may have a bearing on the content of this case study.

The Design

An ecologically/environmentally sustainable design (ESD) consultant is contracted to ensure a small Class 5 office building meets the DTS Provisions of Section J (Volume One of the NCC 2019), Part J1 to Part J8.

The office building is located in Melbourne, Victoria; and consists of 5 levels, including the ground floor. Each level is approximately 2,345 m^2. A central core consists of bathroom facilities, lifts and stairwells on each level, with the surrounding floor area containing office spaces. A commercial cafe is located on the ground floor.

Figure 1 Spatial floor plan of the office building



Building fabric

The building façade is a curtain wall (i.e. opaque glass spandrels and double glazing). Each floor from ground floor to Level 3 are 3.8 m high slab-to-slab with ceiling heights of 2.85 m and glazing from 0.05 m to 2.85 m above floor height. Level 4 is 5.4 m high slab-to-slab but has the same ceiling and glazing height as the other floors. This results in a glazed area of 68% of the total façade area across all floors and orientations.

The wall construction and glazing properties are discussed in detail in Part J1 Building fabric of The Solution.

Building sealing

The building is sealed to limit openings in the building envelope that may cause conditioned air to leak out. All doors and openable windows of the building envelope are sealed and an air-lock is installed at the main entrance to the building.

The building sealing design is discussed in detail in Part J3 Building sealing of The Solution.

Air-conditioning and ventilation systems

The mechanical plant is located above Level 4 and consists of two fan-forced boilers for heating and two air-cooled chillers. Conditioned air is provided to each of the perimeter zones.

Standard variable air volume (VAV) systems zoned per perimeter and internal zones are installed to ventilate the office building.

The air-conditioning and ventilation systems are discussed in detail in Part J5 Air-conditioning and ventilation systems of The Solution.

Lighting and power

The lighting consists of LED lighting throughout the building. Troffer luminaires are used in the office spaces on each level. Corridors, bathrooms, stairways, lobbies, the cafe and the foyer consist of downlights of varying wattage dependent on the space type. The communications (comms) room contains batten lighting. Motion sensors are used in each stairway and programmable dimming on all other lighting in the office.

The building contains four lifts in the central core of the building.

The lighting and lift designs are discussed in detail in Part J6 Artificial lighting and power of The Solution.

Heated water supply

A heated water system is provided by gas boilers to be used for air-conditioning and domestic hot water.

The heated water supply design is discussed in detail in Part J7 Heated water supply and swimming pool and spa pool plant of The Solution.

Facilities for energy modelling

The office building has a Building Management System (BMS) that controls and monitors the HVAC, lighting, appliance power, central hot water supply and lifts.

The BMS is discussed in detail in Part J8 Facilities for energy monitoring of The Solution.

Design plans

Figure 2 Floor plan for the ground floor of the office building

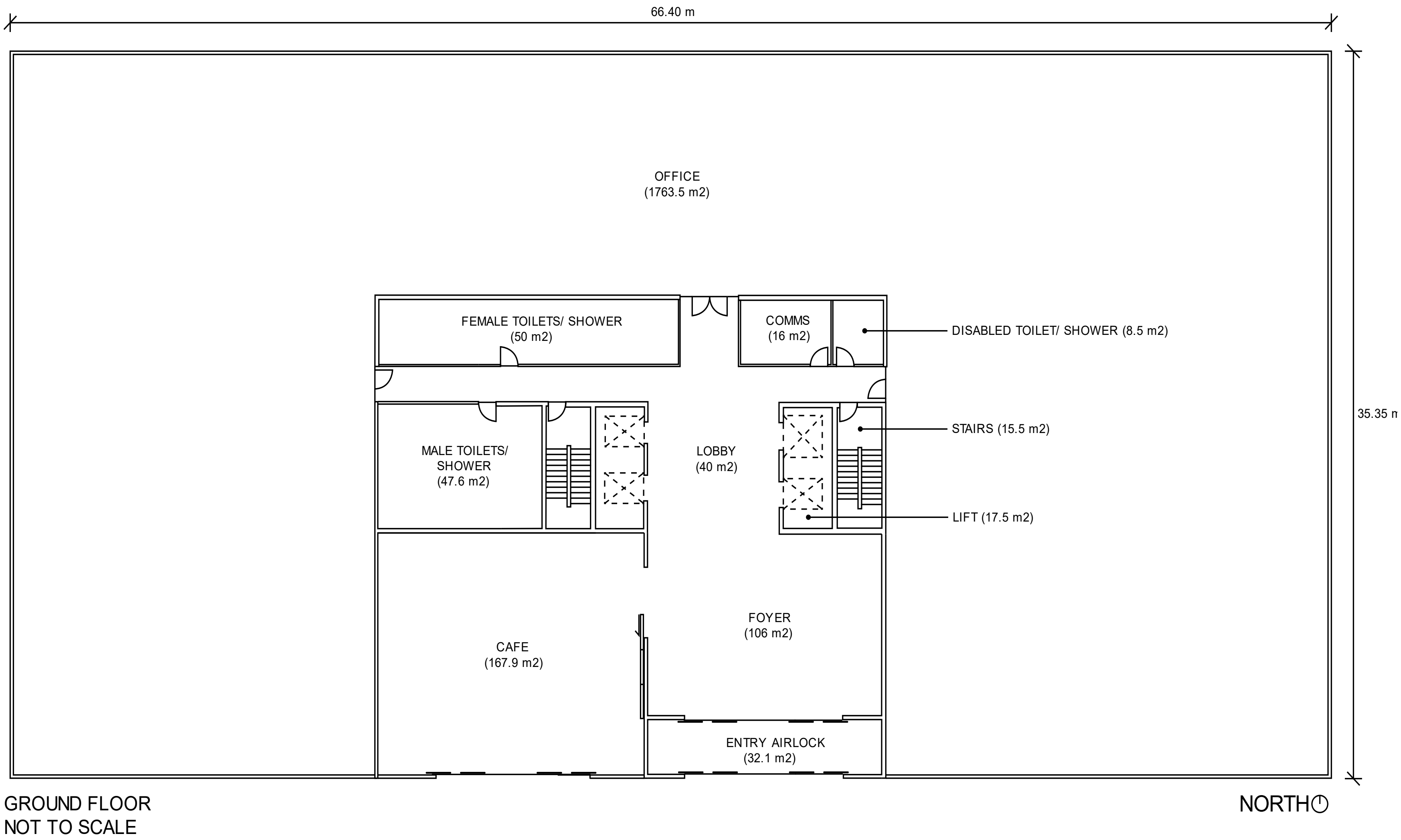
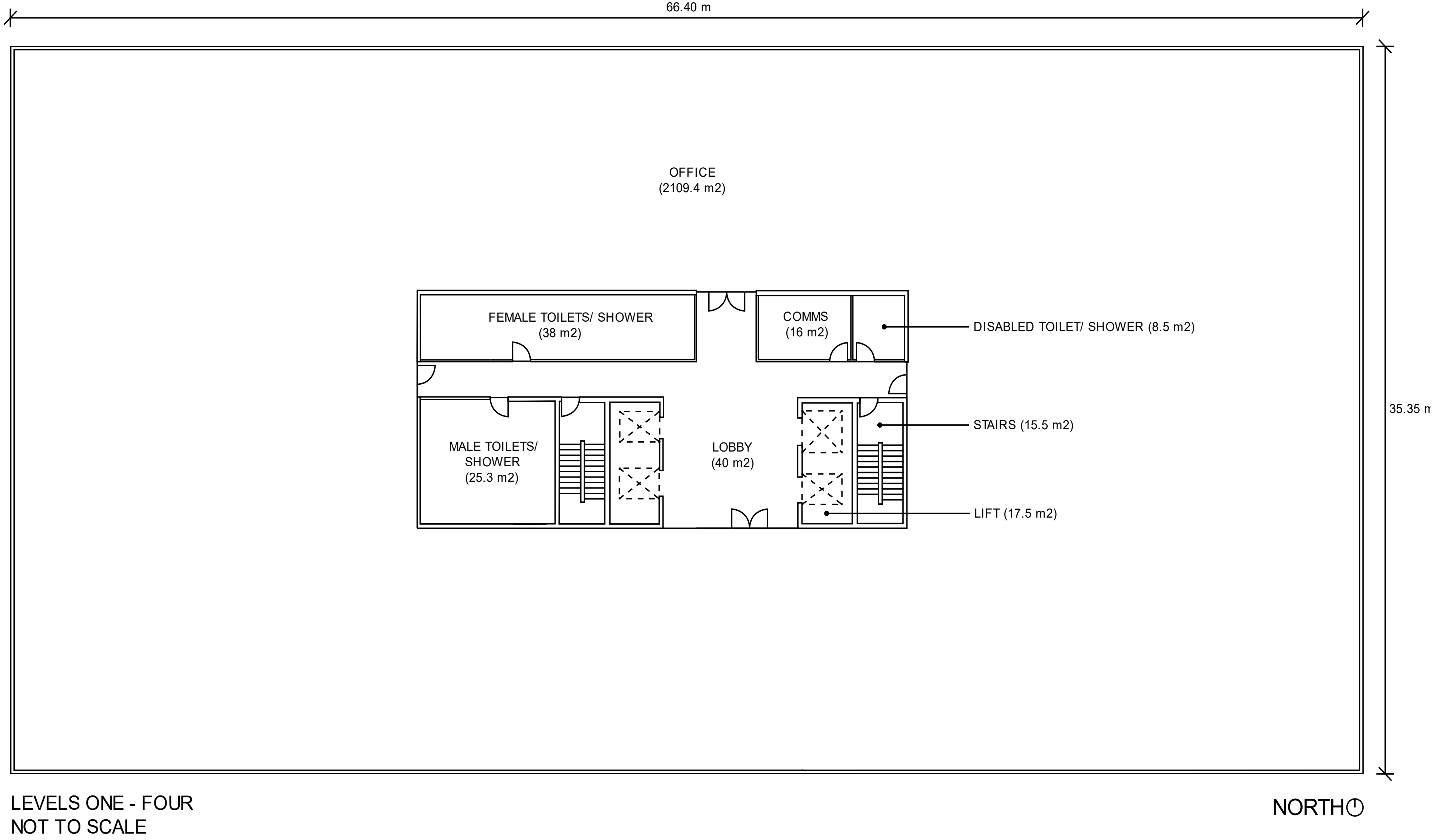


Figure 3 Floor plan for levels 1 to 4 of the office building



The Solution

NCC climate zone

The DTS Provisions use ‘climate zones’ to specify the technical requirements for energy efficiency. The climate zones group together parts of Australia with broadly similar climatic conditions. The first step in developing a solution is to determine the NCC climate zone.

Alert

‘Climate zone’ is a defined term in the NCC. An explanation of this term is contained within Schedule 3 Definitions of Volume One. There is also a map of Australia showing the extent of each zone and an accompanying table detailing the climate zone for common locations. For locations that are more difficult to determine, a suite of State and Territory climate zone maps may also be viewed on the ABCB website (abcb.gov.au).

As the office building is located in Melbourne, the building falls within NCC climate zone 6 (mild temperate). The main characteristics of this climate zone are:

- low diurnal (daily) temperature range near coast
- high diurnal range inland
- four distinct seasons
- mild to cool winters with low humidity
- hot to very hot summers with moderate humidity.

J1 Building fabric

The building fabric requirements apply to the building elements forming the envelope, including the external roof, roof lights, walls and glazing, and floor. The provisions contained in Part J1 determine the construction practices and minimum thermal performance is required for the different components that form the envelope of the office building.

J1.1 Application of part

As the building is Class 5, the DTS requirements of Part J1 apply to the building elements forming the envelope of the building.

J1.2 Thermal construction – general

To comply with J1.2, a broad range of general requirements that apply to insulating the building fabric must be met to ensure the required thermal performance for the building is achieved.

Design

Insulation requirements were determined by the ESD consultant and specified to the architect. The required Total R-Value and Total System U-Value specified by the ESD consultant includes allowances for thermal bridging as follows:

- roof and floor calculated in accordance with AS/NZS 4589.2
- wall-glazing construction calculated in accordance with Specification J1.5a
- soil or sub-floor spaces calculated in accordance with Specification J1.6 for Section 3.5 of CIBSE Guide A.

The architect has detailed the required insulation and construction requirements that meet the specified requirements. It will be at the discretion of the builder to ensure the insulation is installed correctly. The architect has selected insulation products that comply with AS/NZS 4859.1 – Materials for the thermal insulation of buildings. This requires the manufacturer to test their products using a specified method and provide a data sheet explaining the thermal performance properties and the installation requirements.

The builder is required to ensure insulation is installed so that it abuts or overlaps adjoining insulation, forms a continuous barrier and does not affect the safe or effective operation of a service or fitting. The insulation must maintain its position and thickness other than where it is compressed for structural reasons.

The building surveyor will determine if the above is performed appropriately.

Compliance approach

Table 1 demonstrates how the thermal construction within the office building complies with each of the requirements in J1.2.

Table 1 Clause J1.2 Compliance approach

Clause	Application
J1.2(a)	As specified by the architect, the insulation complies with AS/NZS 4859.1 and is installed so that it: • Abuts or overlaps adjoining insulation other than at supporting members such as studs, noggings, joints, furring channels and the like where the insulation must be against the member. • Forms a continuous barrier with ceilings, walls, bulkheads, floors or the like that inherently contribute to the thermal barrier. • Does not affect the safe or effective operation of a service or fitting. The building surveyor will verify that the above meets the requirements of J1.2(a).
J1.2(b)	Reflective insulation is not installed in this case study and therefore the requirements of part J1.2(b) do not apply.
J1.2(c)	Bulk insulation will be installed by the builder so that: • It maintains its position and thickness, other than where it is compressed between cladding and supporting members, water pipes, electrical cabling or the like. • In a ceiling, where there is no bulk insulation or reflective insulation in the wall beneath, it overlaps the wall by not less than 50mm. The building surveyor will verify if the above meets the requirements of J1.2(c).
J1.2(d)	All the roof, ceiling, wall and floor materials used to calculate the overall R-Value in Section J1.3, J1.5 and J1.6, below, meet the properties listed in Specification J1.2.
J1.2(e)	As completed by the ESD consultant, the required Total R-Value and Total System U-Value, including allowance for thermal bridging are: • Calculated in accordance with AS/NZS 4589.2 for a roof or floor. • Determined in accordance with Specification J1.5a for wall-glazing construction. • Determined in accordance with Specification J1.6 for Section 3.5 of CIBSE Guide A for soil or sub-floor spaces.

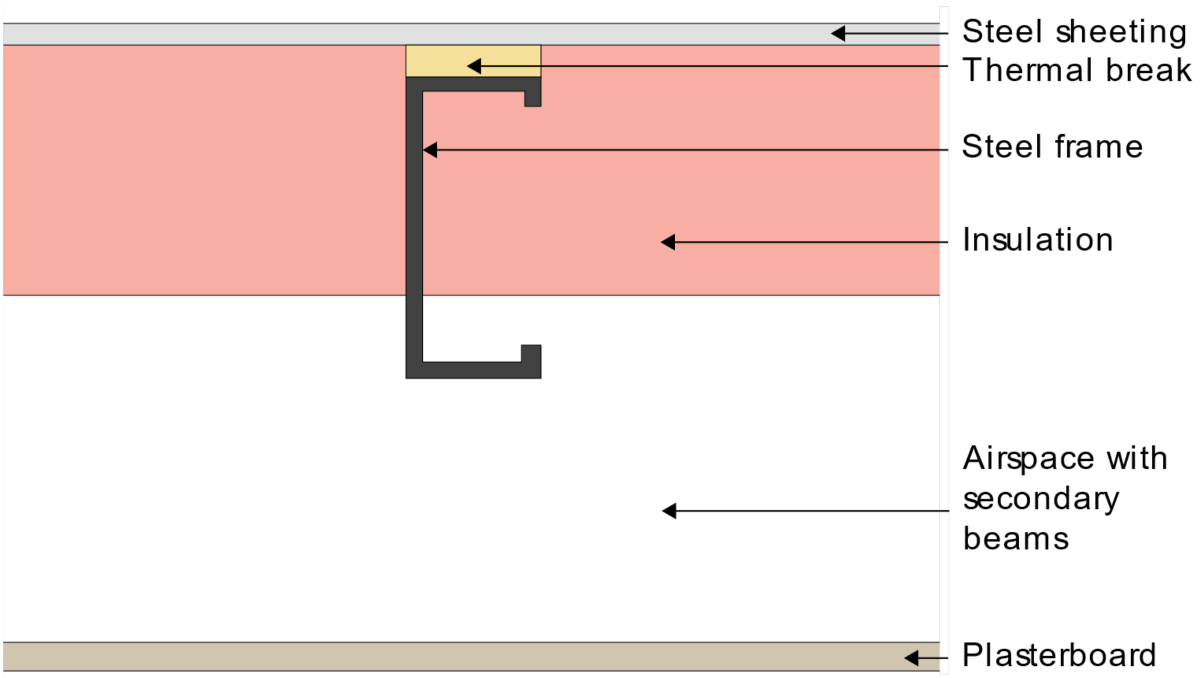
J1.3 Roof and ceiling construction

To comply with J1.3, requirements for roofs, including their ceiling must be met to ensure the required thermal performance for the building is achieved. The construction and thermal properties of the office building roof are depicted in Figure 4 and Table 2 below.

Design

Figure 4 depicts the cross section of the roof. The roof structure consists of steel sheeting, a pliable building membrane, a thermal break, supporting steel purlins and secondary beams, insulation, an air cavity, and plasterboard. The steel purlins create a thermal bridge between the external steel sheeting and internal plasterboard.

Figure 4 Roof system cross section



The steel roof is a light grey colour to reflect heat from the roof. This aims to keep the building cooler on hot days.

Table 2 Roof thermal properties

Layer	Material	Thickness (mm)	Thermal Conductivity (W/m².K)	R-Value (m².K/W)
Exterior surface resistance	-	-	-	0.030
Layer 1	Steel sheeting	3	47.5	0.000063
Layer 2	Pliable building membrane	<1.0	negligible	negligible
Layer 3 (Thermal Bridge)	Thermal break	12	0.024	0.500
Layer 3 (Thermal Bridge)	Steel purlins	203	47.5	0.004
Layer 3 (Thermal Bridge)	Bulk insulation	140	0.042	3.300
Layer 3 (Thermal Bridge)	Unventilated, non-reflective air space	360	-	0.220
Layer 4	Gypsum plasterboard	13	0.17	0.076
Interior surface resistance	-	-	-	0.160

Based on the above construction materials, the Total System R-Value can be calculated in accordance with AS/NZS 4859.1. The steel purlins act as a thermal bridge within the roof. For the Total System R-Value calculations, the path of heat transfer within the structure can be considered as per Figure 5 below.

Figure 5 Path of heat transfer in roof system

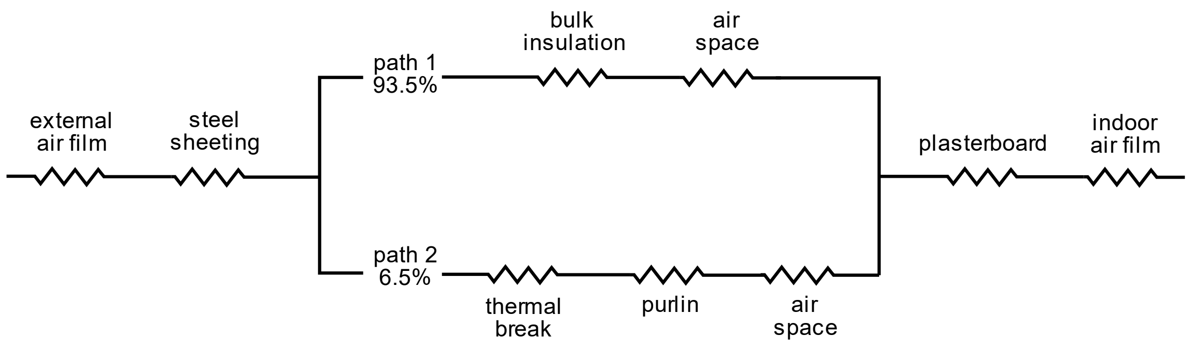


Table 3 Total Roof System R-Value

Roof Total R-Value (as per AS/NZS 4859.1) (m^2.K/W)
R3.29

Compliance approach

Table 4 demonstrates how the office building, with the above detailed construction, complies with each of the requirements in J1.3.

Table 4 Clause J1.3 Compliance approach

Clause	Application
J1.3(a)	The roof achieves a Total R-Value of just over R3.2, for a downward direction of heat flow, as required for climate zone 6. This value was arrived at after following the calculation method proscribed in NZ 4214 to account for the impact of thermal bridging on the roof construction and using the thermal resistance properties for the roof elements in Table 2.
J1.3(b)	The solar absorptance of the light grey roof is equal to 0.45 and therefore meets the requirements of J1.3(b).

J1.4 Roof lights

The office building does not have roof lights; therefore, this section does not apply.

J1.5 Walls and glazing

To comply with J1.5, requirements for the walls and glazing must be met to ensure the required thermal performance for the building is achieved. For a DTS design approach, this is best demonstrated using the Facade Calculator, available from the ABCB website (abcb.gov.au).

Design

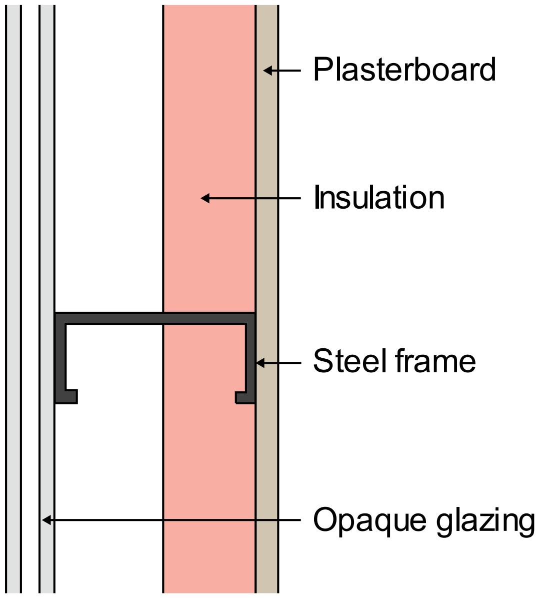
The building façade is a curtain wall (i.e. opaque glass spandrels and double glazing). Each floor from the ground floor to Level 3 are 3.8 m high slab-to-slab with ceiling heights of 2.85 m and glazing from 0.05 m to 2.85 m above floor height. Level 4 is 5.4 m high slab-to-slab but has the same ceiling and glazing height as other floors. This results in a glazed area of 68% of the total façade area across all floors and orientations. The construction and thermal properties of the office building walls and glazing are presented in Table 5 and Figure 6 below.

Table 5 Glazing systems properties

Parameter	Value
System Type	Fixed
Glass Type	Custom low-e, tinted, double glazing
Frame Type	Aluminium thermally broken (assumption)
Methodology	AFRC (True module size)
Total System U-Value (W/m^2.K)	2.35
Total System SHGC	0.17

The spandrel panels (i.e. opaque glass) make up 32% of the total façade area across all floors and orientations. The spandrel panel construction is detailed in Figure 6 below. The steel frame acts as a thermal bridge between the double glazing on the outside of the building to the plasterboard on the inside of the building.

Figure 6 Spandrel wall thermal construction



The design, as detailed above, is entered into the Façade Calculator to demonstrate DTS compliance. The required inputs and calculated results in the Façade Calculator are located in Appendix A.

Compliance approach

Table 6 below demonstrates how the office building, with the above detailed construction, complies with each of the requirements in J1.5.

Table 6 Clause J1.5 Compliance approach

Clause	Application
J1.5(a)	The Total System U-Value of each wall-glazing construction is calculated to be U1.9. As this is less than U2.0, the requirements for a Class 5 building are met. The ABCB Façade Calculator results in Appendix A shows the wall glazing area results and demonstrates that the proposed glazing properties meet this requirement.
J1.5(b)	Display glazing refers to glazing used to display retail goods in a shop or showroom directly adjacent to a walkway or footpath, therefore, this clause is not applicable in this case study.
J1.5(c)	The Total System U-Value of wall-glazing construction is calculated using the Façade Calculator. This is in accordance with Specification J1.5(a).
J1.5(d)	The wall components of the wall-glazing construction achieve a Total R-Value of R1.01. As this is greater than R1.0, the requirements of the clause are met as the wall is less than 80% of the area. The Façade Calculator in Appendix A shows the average wall R-Value results and demonstrates that the requirements of this clause are met.
J1.5(e)	The solar admittance of externally facing wall-glazing construction, as determined using the Façade Calculator, is 0.125 and is therefore less than the maximum allowable values of Table J1.5b for climate zone 6: • Eastern aspect = 0.13 • Northern aspect = 0.13 • Southern aspect = 0.13 • Western aspect = 0.13 Appendix A shows the wall glazing area results using the Façade Calculator. The proposed glazing properties meet this requirement.
J1.5(f)	The solar admittance of a wall-glazing construction is calculated using the Façade Calculator and meets the requirements of Specification J1.5a.
J1.5(g)	There is no display glazing in the office building, therefore this clause does not apply to the office building.

J1.6 Floors

To comply with J1.6, requirements for floors that are part of the building envelope must be met to ensure the required thermal performance for the building is achieved.

Design

The ground floor slab is in direct contact with the ground (i.e. a slab on ground). The ground slab is 200 mm thick concrete and the flooring does not have in slab heating or cooling.

Compliance approach

Table 7 demonstrates how the office building, with the above detailed design, complies with each of the requirements in J1.6.

Table 7 Clause J1.6 Compliance approach

Clause	Application
J1.6(a)	In accordance with Table 2b in Specification J1.6, the R-Value of the soil achieves an equivalent R-Value of R2.7 based on: • Ratio of floor area to floor perimeter of 11.5. • Floor slab thickness of 200 mm. As the minimum Total R-Value requirement for floors in climate zone 6 for a floor without in slab heating or cooling is R2.0, the ground floor meets the requirements. There are no suspended floors for the Case Study model, which are required to achieve a minimum Total R-Value of R2.0.
J1.6(b)	The building is in climate zone 6 and does not have an in-slab heating or cooling, therefore this is not applicable to the office building.
J1.6(c)	As there is no insulation applied to the floors of the office building, this clause is not applicable.

J3 Building sealing

Openings in the building envelope may cause conditioned air to leak if the building openings are poorly sealed. Part J3 determines the minimum sealing performance required to reduce the impact of infiltration and leakage on the building thermal performance.

J3.1 Application of part

As the building is Class 5 and located in climate zone 6 the DTS requirements of Part J3 are applied to the building elements forming the envelope of the building.

J3.2 Chimneys and flues

There are no chimneys or flues in the office building, so this clause is not applicable.

J3.3 Roof lights

The office building does not have roof lights; therefore, this clause does not apply.

J3.4 Windows and doors

To comply with J3.4, requirements for external windows and doors that form part of the building envelope must be met to ensure the building is appropriately sealed.

Design

All doors and openable windows on the building envelope are sealed with draft protection devices on the bottom edge of doors, and rubber compression strips on other edges of doors and openable windows. The entrance door to the building foyer is an airlock with self-closing doors. The café also has self-closing doors.

Compliance approach

Table 8 demonstrates how the office building complies with each of the requirements in J3.4.

Table 8 Clause J3.4 Compliance approach

Clause	Application
J3.4(a)	As per the requirements of J3.4(a) all doors, openable windows and the like on the envelope of the building are sealed.
J3.4(b)	Fire doors, smoke doors and security doors are not required to be sealed to the requirements of J3.4(a).

Clause	Application
J3.4(c)	The sealing provided to restrict air infiltration for the bottom edge of the door for J3.4(a) is a draft protection device. The sealing provided to restrict air infiltration for the other edges of the door as well as edges of openable windows for J3.4(a) is a rubber compression strip. Therefore, the requirements of J3.4(c) are met.
J3.4(d)	The entrance to the building foyer is through an airlock, which meets the requirements for a conditioned space larger than 50 m^2. The entrance door to the café is a self-closing door, which also meets the requirements for a conditioned space larger than 50 m^2.
J3.4(e)	There are no loading dock entrances, so this clause is not applicable.

J3.5 Exhaust fans

To comply with J3.5, requirements for exhaust fans located in the envelope of a conditioned space must be met to ensure the building is appropriately sealed.

Design

There are several exhaust fans in the envelope of a conditioned space. These include:

- general exhaust fans to the base building core rooms
- toilet exhaust
- kitchen exhaust
- outdoor air fans
- smoke exhaust fans
- stair pressurisation.

Each exhaust fan listed above is fitted with a self-closing damper.

Compliance approach

Table 9 demonstrates how the office building complies with each of the requirements in J3.5.

Table 9 Clause J3.5 Compliance approach

Clause	Application
J3.5(a)	All exhaust fans for conditioned spaces are fitted with self-closing dampers as per the requirements of this clause.

J3.6 Construction of ceilings, walls and floors

To comply with J3.6, requirements for the construction of ceilings, walls and floors that form part of the envelope of the building must be met to ensure there is no air leakage and the building is appropriately sealed.

Design

The architect detailed a design for all ceilings, walls, floors, window frames and door frames so that air leakage is minimised by sealing junctions and penetrations with close fitting architraves, skirtings and cornices.

The building surveyor will ensure that the above will be constructed appropriately by the builder.

Compliance approach

Table 10 demonstrates how the office building complies with each of the requirements in J3.6.

Table 10 Clause J3.6 Compliance approach

Clause	Application
J3.6(a)	As per the requirements of J3.6(a) ceilings, walls, floors, window frames and door frames are constructed to minimise air leakage in accordance with J3.6(b). The building surveyor will verify that the above meets the requirements of J3.6(a).
J3.6(b)	Sealing all junctions and penetrations with close fitting architrave, skirting and cornices meets the requirements of J3.6(b).
J3.6(c)	Grilles that are required for smoke hazard management are not required to have sealing.

J3.7 Evaporative coolers

Evaporative coolers are not used within the office building; therefore, this clause is not applicable.

J5 Air-conditioning and ventilation systems

Part J5 provides guidance on the minimum efficiencies of equipment used to provide air-conditioning and ventilation to the building with the aim of reducing energy consumption.

J5.1 Application of part

As the building is Class 5, the DTS requirements of Part J5 apply.

J5.2 Air-conditioning system control

To comply with J5.2, requirements for the control of air-conditioning systems must be met to ensure the consumption of energy is limited.

Design

The air conditioning system is controlled by the BMS that is based on a time clock and occupant sensors. Options for user-controlled variations are provided. Each of the air-conditioning zones have thermostatic sensors that control the temperature of each zone, controls to prevent actively heated air from mixing with actively cooled air and limit reheating to a 7.5 K rise in temperature at the nominal supply air rate.

All air handling unit (AHU) controls have a control dead band of 2 °C. All AHUs have balancing dampers and balancing valves to ensure that the maximum design air and fluid flow is achieved, but not exceeded by more than 15% above design flow rate.

Each floor and zone of the building has provision to terminate airflow independent of the remainder of the system to allow for different operating times.

The outdoor air and return air systems have dampers that close when not actively being controlled.

Time switches are provided to control all air-conditioning systems. The time switches are capable of switching electric power on and off at variable pre-programmed times and days.

Compliance approach

Table 11 demonstrates how the office building complies with each of the requirements in J5.2.

Table 11 Clause J5.2 Compliance approach

Clause	Application
J5.2(a)	As per the requirements of J5.2(a): The air conditioning system is controlled by a BMS that deactivates the system when the building is not occupied. Each of the air-conditioning zones: • have thermostatic sensors that control the temperature of each zone. • have controls to prevent actively heated air from mixing with actively cooled air. • limit reheating to a 7.5K rise in temperature at the nominal supply air rate. All AHUs are capable of operating in outdoor air economy cycle. All AHUs are controlled by the BMS such that water flow to the heating and cooling coils is prevented when the AHUs are not operating in heating or cooling modes respectively. All AHUs have fans capable of variable speeds. This clause is not applicable to the case study building as it only applies to a sole-occupancy unit in a Class 3 building. As part of the BMS, control components are provided to specify comfort conditions in the building to regulate operation of the central plant. All AHU controls have a control dead band of not less than 2°C. All AHUs have balancing dampers and balancing valves to ensure that the maximum design air and fluid flow is achieved, but not exceeded by more than 15% above design flow rate. Each floor and zone of the building has provision to terminate airflow independent of the remainder of the system to allow for different operating times.

Clause	Application
	As part of the BMS, automatic variable temperature operation of heating water and chilled water circuits are provided. The outdoor air and return air systems have dampers that close when not actively being controlled. Therefore, the design complies with J5.2(a).
J5.2(b)	For any additional tenant air-conditioning systems that serve the same space as the base building systems, the BMS prevents these systems from operating in opposing heating and cooling modes.
J5.2(c)	As per the requirements of J5.2(c): Time switches are provided to control all air-conditioning systems. The time switch is capable of switching electric power on and off at variable pre-programmed times and days. This clause is not applicable to the case study building as this exemption applies to sole-occupancy units in a Class 2, 3 or 9c building, a Class 4 part of a building, or conditioned spaces where air-conditioning is required for 24-hours continuous use. Therefore, the design complies with J5.2(c).

J5.3 Mechanical ventilation system control

To comply with J5.3, requirements for the control of mechanical ventilation systems must be met to ensure the consumption of energy is limited.

Design

Mechanical ventilation systems are controlled by the BMS and are deactivated when the building is not occupied.

All fan systems within the building have motors capable of varying speed. Similarly, all have time switch. The time switches are controlled by the BMS to be operational based on pre-programmed times and days.

Compliance approach

Table 11 demonstrates how the office building complies with each of the requirements in J5.3.

Table 12 Clause J5.3 Compliance approach

Clause	Application
J5.3(a)	As per the requirements of J5.3(a), mechanical ventilation systems in the case study building: Are controlled by the BMS to be deactivated when the building or part of the building is not occupied. For systems serving conditioned spaces with outside air flow in excess of 500 L/s, have demand control ventilation in accordance with AS 1668.2. The ventilation systems are designed not to exceed the requirements of Part F4. All fans with flow in excess of 1,000 L/s have variable speed fans. Therefore, the requirements of J5.3(a) are met.
J5.3(b)	All exhaust fans with air flow rates of more than 1,000 L/s have controls to stop the motor when not needed.
J5.3(c)	The office building does not contain any carparks, and therefore carpark exhaust systems are not included. Therefore, this clause is not applicable.
J5.3(d)	Time switches have been provided for all mechanical ventilation systems with flow in excess of 1,000 L/s. The time switches are controlled by the BMS to be operational based on pre-programmed times and days. Therefore, the design complies with J5.3(d).

J5.4 Fan systems

To comply with J5.4, requirements for fans, ductwork and duct components used as part of an air-conditioning system or mechanical ventilation must be met to ensure energy consumption limited. For a DTS design approach, this is best demonstrated using the ABCB Fan System Calculator, available from the ABCB website (abcb.gov.au).

Design

The fan flow rates have been determined using an energy modelling software in accordance with ANSI/ASHRAE Standard 140 and Specification JVb. The energy model is reflective of the diagram as described in The Design section for the different AHU systems for the building. These are summarised in Table 13 and Table 14 below. The properties of other mechanical ventilation fans are summarised in Table 15. Refer to Appendix F for further modelling calculations.

Table 13 Calculated supply air fan properties for the building AHUs

AHU	Space Served	Area (m^2)	S/A Flow (L/s)	O/A Flow (L/s)	Supply Air Fan System Pressure (Pa)	Supply Air Fan Motor Power (kW)
AHU-Café	GF Café	167.9	2015	2014	650	3
AHU-IE	Internal East	3972.3	7838	4171	700	10
AHU-IW	Internal West	3615.3	7611	3796	700	10
AHU-PE	East Perimeter	482.5	2090	507	650	3
AHU-PN	North Perimeter	951.0	5484	999	650	7
AHU-PS	South Perimeter	875.6	2258	920	650	3
AHU-PW	West Perimeter	482.5	2744	507	650	4

Table 14 Calculated return air fan properties for the building AHUs

AHU	Space Served	Area (m^2)	R/A Flow (L/s)	Return Air Fan System Pressure (Pa)	Return Air Fan Motor Power (kW)
AHU-Café	GF Café	167.9	2015	400	1.5
AHU-IE	Internal East	3972.3	7838	450	6.0
AHU-IW	Internal West	3615.3	7611	450	6.0
AHU-PE	East Perimeter	482.5	2090	400	1.5
AHU-PN	North Perimeter	951.0	5484	400	4.0
AHU-PS	South Perimeter	875.6	2258	400	1.5
AHU-PW	West Perimeter	482.5	2744	400	2.2

Table 15 Calculated mechanical ventilation fan properties for the building

AHU	Service	Fan Flow (L/s)	Return Air Fan Sys Pressure (Pa)	Fan Motor Power (kW)
GEF-01	General Exhaust	428	350	0.55
TEF-01	Toilet Exhaust 1	3675	400	4.0
TEF-02	Toilet Exhaust 2	3675	400	4.0
KEF-01	Kitchen Exhaust	3353	350	3.0

AHU	Service	Fan Flow (L/s)	Return Air Fan Sys Pressure (Pa)	Fan Motor Power (kW)
OAF-01	Outside Air 1	193	200	0.4
OAF-02	Outside Air 2	3539	300	2.2
SPF-01	Stair Pressurisation 1	2317	300	2.2
SPF-02	Stair Pressurisation 2	2317	300	2.2
SPF-03	Stair Pressurisation 3	2317	300	2.2
SEF-01	Smoke Extract 1	10533	400	11.0
SEF-02	Smoke Extract 2	10533	400	11.0

The fan system pressure is calculated using the Fan System Calculator based on simplified supply and return air paths as shown in Figure 7 and Figure 8.

Figure 7 Supply air path diagram for duct run

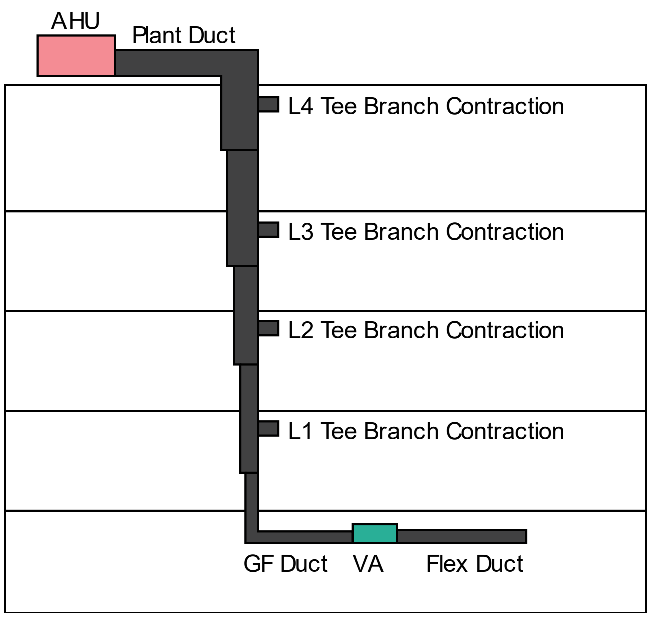
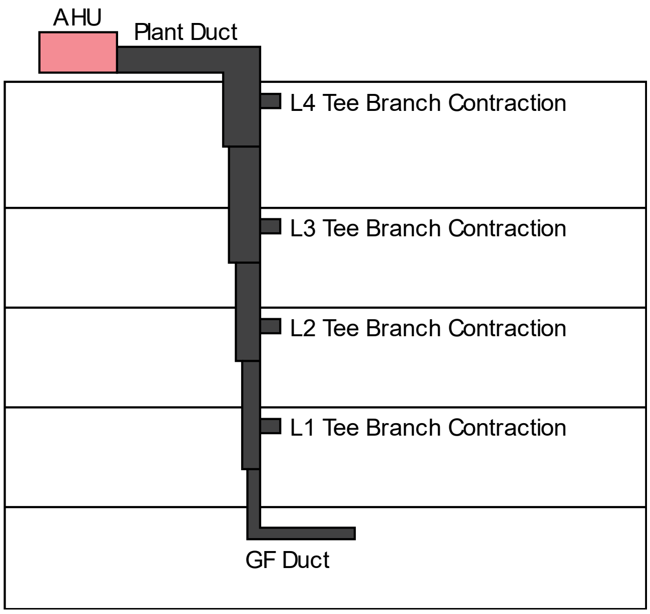


Figure 8 Return air path diagram for duct run



The design, as detailed above, is entered into the Fan System Calculator to demonstrate it satisfies the DTS Provisions. The required inputs and calculated results in the Fan System Calculator are provided in Appendix A.

Compliance approach

Table 16 demonstrates how the office building complies with each of the requirements in J5.4.

Table 16 Clause J5.4 Compliance approach

Clause	Application
J5.4(a)	Fans, ductwork and duct components that form part of the air-conditioning system have been calculated to comply with the requirements of J5.4(b), (c), (d) and (e).
J5.4(b)	The fans have been evaluated using the NCC Volume One Fan System Calculator. The results of the calculations are summarised in Appendix B.
J5.4(c)	The average pressure drop for the index run across all straight sections of rigid ductwork and all sections of flexible ductwork has been calculated to not exceed 1 Pa/m. Flexible ductwork has been limited to 6 m across the length of the duct run.
J5.4(d)	Ductwork components meet the maximum allowable pressure drops as shown in the Fan System Calculator located in Appendix B:

Clause	Application
	• Heating coils are in 2 rows with a maximum pressure drop of 50 Pa. • Cooling coils are in 6 rows with a maximum pressure drop of 130 Pa. • The air filters have a minimum efficiency reporting value (MERV) of 14, and therefore have a pressure drop of 110 Pa. • Louvres have a pressure drop of 30 Pa. • VAV boxes have a pressure drop of 25 Pa. • Attenuators have a pressure drop of 40 Pa. • Fire dampers have a pressure drop of 15 Pa. • Balancing and control dampers have a pressure drop of 25 Pa when in the fully open position. • Supply air diffusers and grilles have a pressure drop of 40 Pa. • Exhaust grills have a pressure drop of 30 Pa.
J5.4(e)	The requirements of J5.4(a), (b), (c) and (d) are not required to apply to fans in packaged units and direct expansion (DX) units with a supply air capacity of less than 1,000 L/s, smoke spill fans, process fans and kitchen exhaust systems. As such they do not apply to the kitchen exhaust fan in this case study.

J5.5 Ductwork insulation

To comply with J5.5, requirements for ductwork and fittings in an air-conditioning system must be met to reduce energy loss.

Design

Ductwork and fittings in the air-conditioning system are provided with insulation that complies with AS/NZS 4859.1. The insulation has an R-Value of R1.0 for flexible ductwork, R1.2 for ductwork and fittings within a conditioned space, R3.0 for ductwork and fittings exposed to direct sunlight and R2.0 for all other locations. All insulation is protected against the effects of weather and sunlight and is installed so that it forms a continuous barrier and maintains its position thickness where required. Where ductwork conveys cooled air, the insulation is protected by a vapour barrier on the outside of the insulation.

Compliance approach

Table 17 demonstrates how the office building complies with each of the requirements in J5.5.

Table 17 Clause J5.5 Compliance approach

Clause	Application
J5.5(a)	Ductwork and fittings in air-conditioning systems are to be provided with insulation that complies with AS/NZS 4859.1. The insulation R-Values meet the requirements of that specified in Table J5.5 and therefore meet the requirements of J5.5(a).
J5.5(b)	Insulation is to be installed as per the requirements of J5.5(b) to protect against the effects of weather and sunlight, and is installed so that it abuts adjoining insulation to form a continuous barrier and maintains its position. The insulation maintains its position and thickness, other than at flanges and supports, is protected by a vapour barrier on the outside of the insulation when conveying cooled air and is installed so that adjoining sheets of the membrane overlap by at least 50 mm and are bonded or taped together. Therefore, the requirements of J5.5(b) are met.
J5.5(c)	As per J5.5(c) the requirements of J5.5(a) do not apply to: • ductwork at fittings located within the last room served by the system • fittings that form part of the interface with the conditioned space • return air ductwork, in or passing through a conditioned space • ductwork for outdoor air and exhaust air associated with an air-conditioning system • packaged air conditioners • flexible fan connections.
J5.5(d)	All fittings (i.e. all non-active components of the ductwork system) comply with the above requirements. All active components are exempt.

J5.6 Ductwork sealing

To comply with J5.6, requirements for ductwork sealing in an air-conditioning system must be met to reduce energy loss.

Design

All ductwork in the air-conditioning system is sealed against air loss in accordance with the duct sealing requirements of AS 4254.1 and AS 4254.2 for the static pressure in the system, excluding the last room served by the system. These standards include requirements for materials, construction and installation as construction errors can cause major leaks that can severely compromise the system performance.

Compliance approach

Table 18 demonstrates how the office building complies with each of the requirements in J5.6.

Table 18 Clause J5.6 Compliance approach

Clause	Application
J5.6	For the systems with a capacity greater than 3000 L/s this clause applies. The clause is met as all air-conditioning ductwork is sealed against air loss in accordance with the duct sealing requirements of AS 4254.1 and AS 4254.2, excluding the last room served by the system.

J5.7 Pump systems

To comply with J5.7, requirements for pump systems that form part of an air-conditioning system must be met to ensure energy consumption limited. For a DTS design approach, this is best demonstrated using the ABCB Pump System Calculator, available from the ABCB website (abcb.gov.au).

Design

The pump system design is determined using the Pump System Calculator. The Pump System Calculator is provided in Appendix C.

Compliance approach

Table 19 demonstrates how the office building complies with each of the requirements in J5.7.

Table 19 Clause J5.7 Design approach

Clause	Application
J5.7(a)	Pumps and pipework that form part of the air-conditioning system comply with J5.7(b), (c) and (d).
J5.7(b)	This clause applies to circulator pumps. The pumps within the office building come under the ‘other pumps’ category (i.e. pumps in accordance with Articles 1 and 2 of European Union Commission Regulation No. 547/2012), therefore this clause is not applicable to the office building.
J5.7(c)	The NCC Volume One J5.7 Pump System Calculator has been used to show J5.7(c) is satisfied. The results of this calculation are summarised in Appendix C.
J5.7(d)	The systems are distributive and variable speed; and operate less than 5,000 hours per annum. Therefore, for all piping systems, the maximum pressure drops across straight segments of pipework are 400 Pa/m.
J5.7(e)	The requirements of J5.7(d) were not applied to valves and fittings and where the smallest pipe sizes compliant with (d) achieves a velocity of 0.7 m/s. This check is carried out using the Pump System Calculator.

J5.8 Pipework insulation

To comply with J5.8, insulation requirements for piping, vessels, heat exchangers and tanks that contain heating and cooling fluids that form part of an air-conditioning system must be met to reduce energy loss.

Design

The heating hot water and chilled water pipes that are part of the air-conditioning system have been insulated with insulation in accordance with AS/NZS 4859.1. The insulation is protected against the effects of weather and sunlight and is able to withstand the temperatures within the risers. The insulation is protected by a vapour barrier on the outside of the insulation.

The fluid temperature in the chilled water pipes is approximately 6-12 °C. The riser is insulated with an R-Value appropriate to those in Table J5.8a based on the nominal pipe diameters.

The fluid temperature in the hot water pipes is approximately 60-80 °C and insulated with an R-Value appropriate to those in Table J5.8a based on the nominal pipe diameters.

Refill and pressure relief piping has an insulation R-Value equal to the required insulation R-Value of the connected pipe, vessel or tank within 500 mm of the connection.

Compliance approach

Table 20 demonstrates how the office building complies with each of the requirements in J5.8.

Table 20 Clause J5.8 Compliance approach

Clause	Application
J5.8(a)	As the heating hot water and chilled water pipes are provided with insulation that complies with AS/NZS 4859.1 and the minimum R-Values are in accordance with Table J5.8a of Part J5 for piping and Table J5.8b for vessels, heat exchangers or tanks, the requirements are met for J5.8(a).
J5.8(b)	As the insulation is protected against the effects of weather and sunlight and are made from materials designed to withstand the temperature of the piping, the requirements for J5.8(b) are satisfied.
J5.8(c)	A vapour barrier on outside of the insulation is provided and therefore the requirements of J5.8(c) are met.
J5.8(d)	As per the requirements of J5.8(d), insulation is not required for piping, vessels or heat exchangers located within the last room served by the system, encased within a concrete slab or panel which is part of the heating or cooling system, supplied as an integral part of a chiller, boiler, or unitary air-conditioner complying with the requirements of J5.9, J5.10 and J5.11 or inside an air-handling unit, fan coil unit or the like.
J5.8(e)	As per J5.8(e), heating fluids include refrigerant, heated water, steam and condensate and cooling fluids include refrigerant, chilled water, brines and glycol mixtures.

J5.9 Space heating

To comply with J5.9, requirements for energy sources that are used for heating a space directly must be met to reduce energy consumption.

Design

Heating is provided by two gas boilers of 350 kW_{heat} each. Each of the gas boilers are rated to consume 500 MJ/hr of gas or less. They each have a gross thermal efficiency of 86%.

Compliance approach

Table 21 demonstrates how the office building complies with each of the requirements in J5.9.

Table 21 Clause J5.9 Compliance approach

Clause	Application
J5.9(a)	A gas heater is a compliant heater used for space heating under J5.9(a) and therefore the requirements are met.
J5.9(b)	This clause is not applicable to the office building as it applies to electric heaters in a Class 2, 3, 9a or 9c bathroom.
J5.9(c)	This clause is not applicable to the office building as there are no heating or cooling appliances that moderate the temperature of outdoor spaces within the design.
J5.9(d)	Each of the gas heaters are rated to consume 500 MJ/hr of gas or less. They meet the minimum gross thermal efficiency of 86%.

J5.10 Refrigerant chillers

To comply with J5.10, requirements for refrigerant chillers that are part of an air-conditioning system must be met to reduce energy consumption.

Design

The air-conditioning system consists of two x 450 kW air-cooled chillers that comply with the Minimum Energy Performance Standards (MEPS). MEPS is a mandatory scheme administrated by the Australian Government containing a number of performance requirements for energy consuming devices.

The chillers have a full load energy efficiency ratio of 2.985 and an integrated part load value of 4.048 when determined in accordance with AHRI 551/591.
AHRI 551/591 is the American Air-Conditioning & Refrigeration Institute standard for

the "Performance rating of water-chilling and heat pump water-heating packages using the vapour compression cycle".

Compliance approach

Table 22 demonstrates how the office building complies with each of the requirements in J5.10.

Table 22 Clause J5.10 Compliance approach

Clause	Application
J5.10	J5.10 requires an air-conditioning system refrigerant chiller to comply with MEPS and the full load operation energy efficiency ratio and integrated part load energy efficiency ratio in Table J5.10a or Table H5.10b. The chillers comply with Table J5.10a. For a capacity of less than 528 kWr the minimum full load operation is 2.985 ($W_r/W_{input\ power}$) and the minimum integrated part load is 4.048 ($W_r/W_{input\ power}$). The chillers also meet MEPS. The chillers energy efficiency ratios meet these requirements and therefore comply with J5.10.

J5.11 Unitary air-conditioning equipment

To comply with J5.11, requirements for unitary air-conditioning equipment must be met to reduce energy consumption.

Design

The building has one DX comms unit at 11 kW on each floor. The systems are less than 65 kWr. Each system complies with MEPS.

Compliance approach

Table 23

Clause	Application
J5.11	As the unitary air-conditioning units comply with MEPS, the requirements for J5.11 are met.
J5.11(a)	J5.11(a) applies to systems with a capacity greater than 65 kWr. As the system capacities are less than this, the clause does not apply. Small systems require no further improvements.

Clause	Application
J5.11(b)	J5.11(b) applies to systems with a capacity greater than 65 kWr. As the system capacities are less than this, the clause does not apply.

J5.12 Heat rejection equipment

There is no heat rejection equipment within the office building. Therefore, this clause is not applicable.

J6 Artificial lighting and power

Lighting is responsible for a large amount of electricity used in office buildings. Similarly, power consumption in lifts can be excessive if inefficient systems are in place or if they are not configured to save energy when not in use. The provisions contained in Part J6 are designed to curb unreasonable energy use in lighting systems, and the power to certain equipment, including vertical transport.

J6.1 Application of Part

As the building is Class 5, the DTS requirements of Part J6 apply.

J6.2 Artificial lighting

To comply with J6.2, requirements for artificial lighting must be met to reduce energy consumption within the building. For a DTS design approach, this is best demonstrated using the ABCB Lighting Calculator (available on the ABCB website (abcb.gov.au)).

Design

The lighting design and layout is presented in Figure 9 and Figure 10.

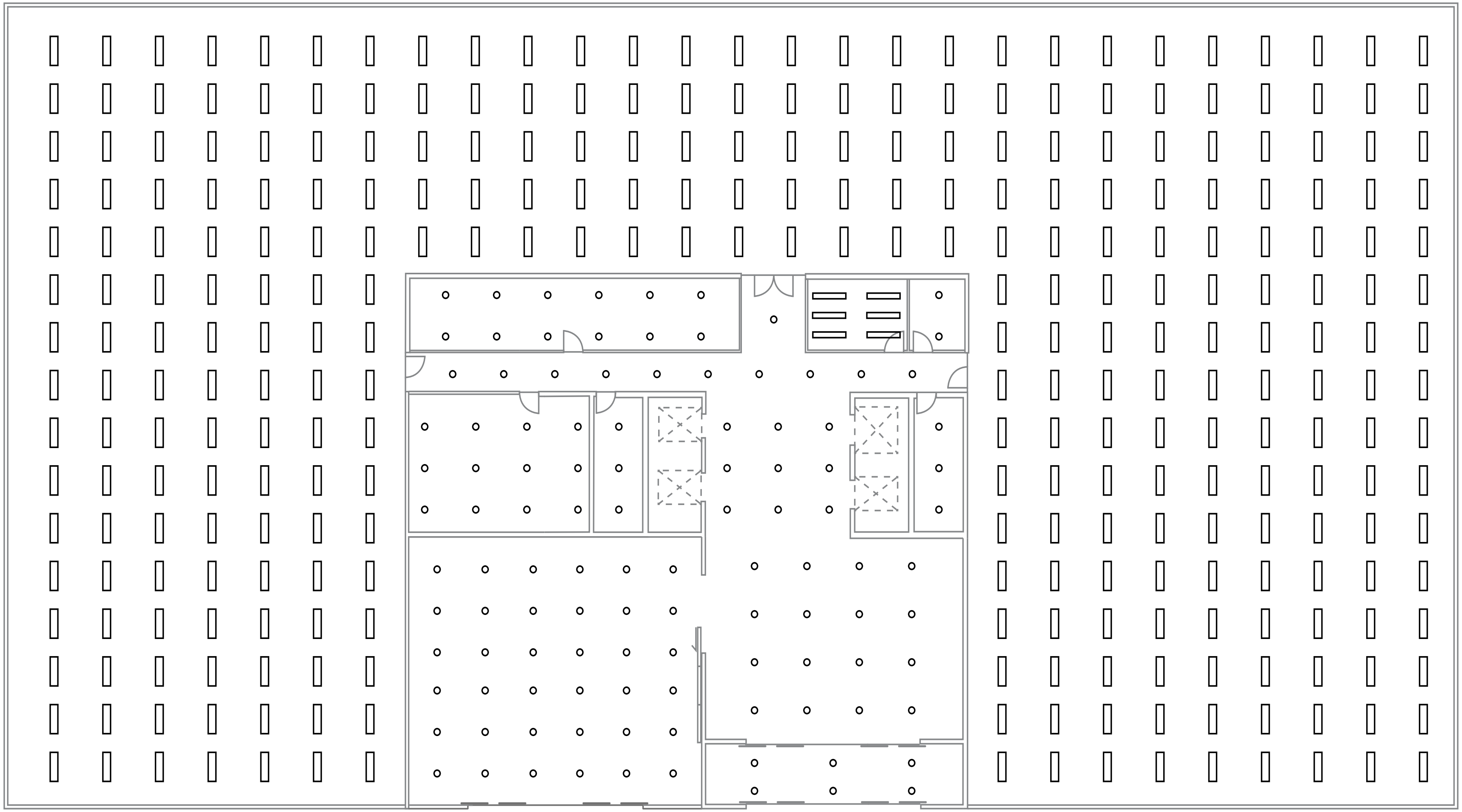
The lighting in each staircase contains motion sensors to ensure lights are dimmed or switched off when not in use. The motion sensors are capable of sensing movement of 500 mm within the useable part of the space and detecting a person before they have entered 1 m into the space. All other lighting is controlled by a time switch. The time switches are capable of switching on and off electric power at variable pre-programmed times and days, and switch off the lights at times where the space is designated to be unoccupied. The time switches are capable of being overridden to turn the lights on for up to 2 hours and off by a manual switch.

All emergency lighting is designed in accordance with Part E4. Emergency lighting is required to facilitate safe evacuation in an emergency. This includes required illuminance levels and operation times for paths of travel to an exit, and floor levels and treads in fire-isolated stairways, fire-isolated passageways, fire-isolated ramps, non-fire-isolated stairways and non-fire-isolated ramps.

Lift lighting is as determined by the lift manufacturer to meet the J6.2.

The Lighting Calculator results and calculations for applicable room adjustment factors are provided in Appendix D and E.

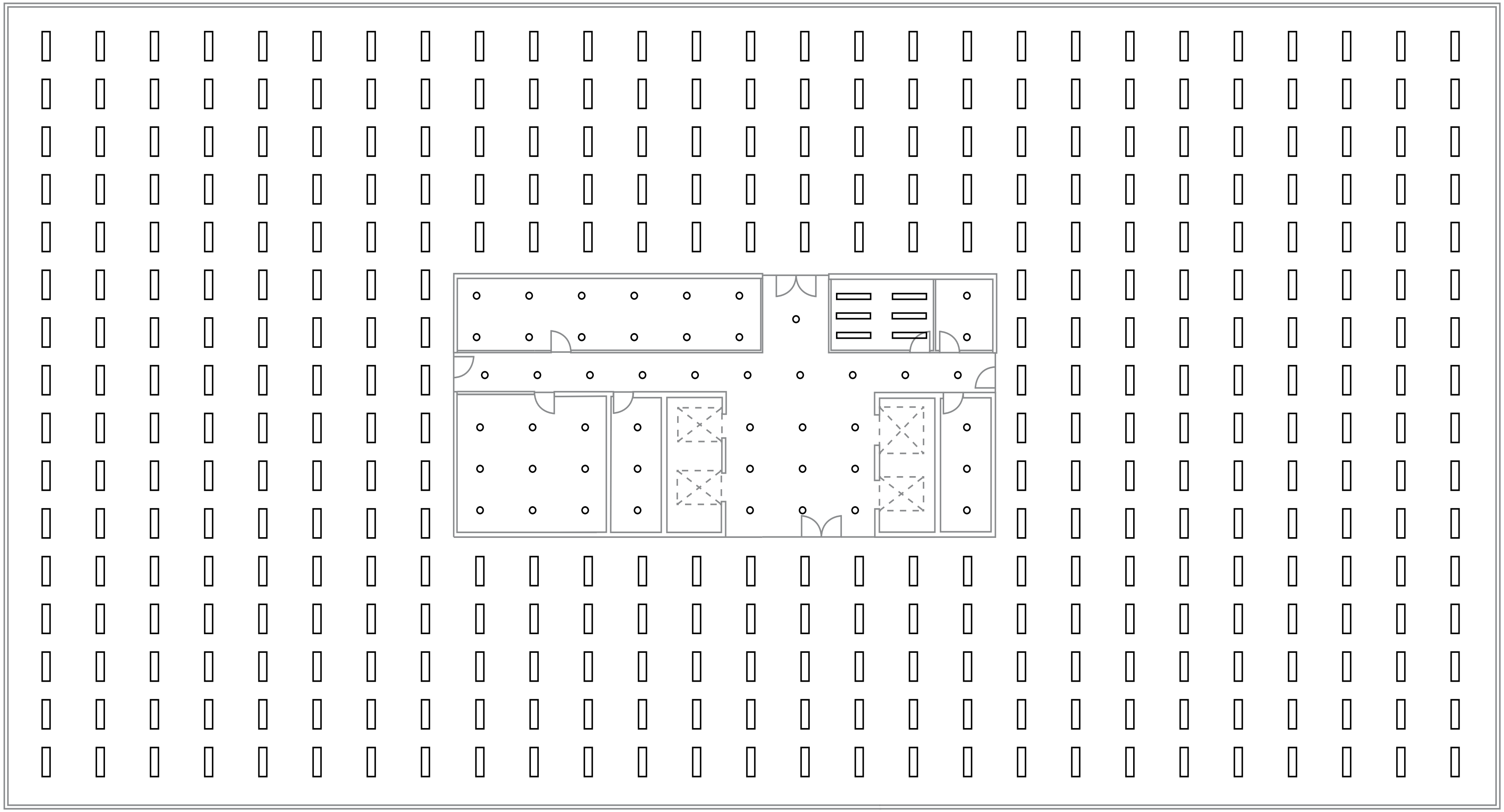
Figure 9 Ground floor lighting layout



GROUND FLOOR
NOT TO SCALE

NORTH

Figure 10 Levels 1 – 4 lighting layout



LEVELS ONE - FOUR
NOT TO SCALE

NORTH

Compliance approach

Table 23 demonstrates how the office building complies with the above detailed design, for each of the requirements in J6.2.

Table 24 Clause J6.2 Compliance approach

Clause	Application
J6.2(a)	This clause applies to sole-occupancy units and Class 4 part of a building and is therefore not applicable to the office building.
J6.2(b)	The aggregate design illumination power load does not exceed the allowances obtained by multiplying the area of each space by the maximum illumination power density in Table J6.2a. Calculations are provided in Appendix D.
J6.2(c)	The only exemption applicable to the office building in clause J6.2(c) is for emergency lighting in accordance with Part E4. Therefore, the calculations undertaken in J6.2(b) take the exemptions in this clause into consideration.
J6.2(d)	The motion sensors within the stairways comply with Specification J6.

J6.3 Interior artificial lighting and power control

To comply with J6.3, requirements for switching and control of lighting must be met to ensure rooms or spaces are not unnecessarily using artificial lighting or power when unoccupied.

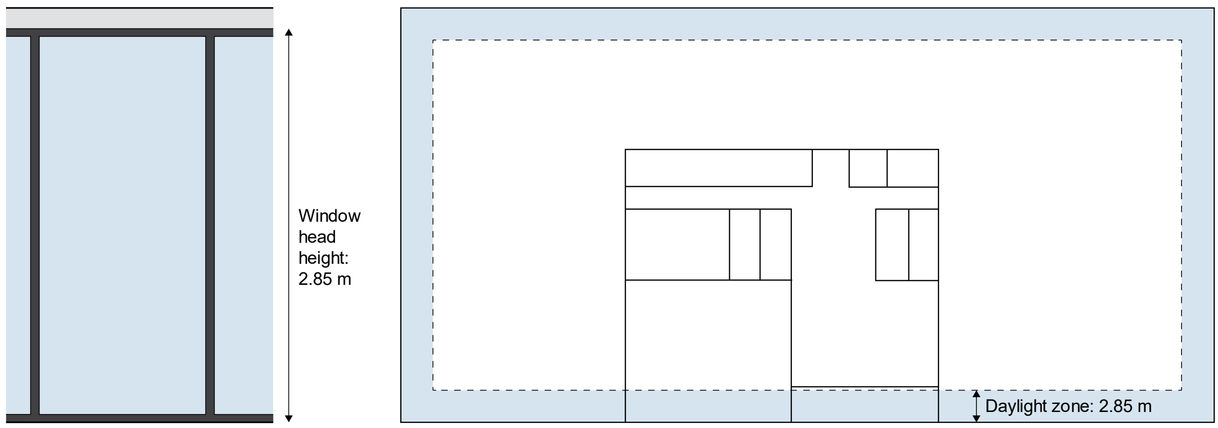
Design

All artificial lighting is controlled by a switch and the BMS. All artificial lighting switches operate an area of less than 250 m^2 and are located in visible and easily accessible positions or in an adjacent space from which 90% of the lighting being switched is visible.

As specified previously, the lighting in each staircase contains motion sensors that are capable of sensing movement of 500 mm within the useable part of the space and detecting a person before they have entered 1 m into the space. All other lighting is controlled by a time switch. The time switches are capable of switching on and off electric power at variable pre-programmed times and days, and switch off the lights at times where the space is designated to be unoccupied. The time switches are capable of being overridden to turn the lights on for up to 2 hours and off by a manual switch.

Separate controls for artificial lighting in the natural lighting zone adjacent to windows, and for general lighting not in the natural lighting zone are provided. The natural lighting zone applies to the office spaces and café.

Figure 11 Diagram of window head height (section) and equivalence to natural lighting zone (plan)



Compliance approach

Table 24 demonstrates how the office building complies with the above detailed design, for each of the requirements in J6.3.

Table 25 Clause J6.3 Compliance approach

Clause	Application
J6.3(a)	As all artificial lighting in each room or space are individually operated by a switch, BMS control or a combination of both, the design complied with the requirements of J6.3(a).
J6.3(b)	This clause applies to Class 3 buildings and therefore does not apply to the office building.
J6.3(c)	All artificial lighting switches and control devices are located in visible and easily accessible positions in the room or space being switched, or in an adjacent room or space from which 90% of the lighting being switched is visible. The switches and devices do not operate lighting for an area of more than 250 m^2.

Clause	Application
J6.3(d)	All areas of the office building, excluding the staircases, are controlled by a time switch in accordance with Specification J6, therefore, meeting the requirements of J6.3(d).
J6.3(e)	Artificial lighting in natural lighting zones adjacent to windows are separately controlled from lighting in non-natural lighting zones. This includes the areas adjacent to the windows in the office space and café equal to a distance of the distance from the floor to the head height of the windows.
J6.3(f)	Artificial lighting in fire-isolated stairways, passageways and ramps are controlled by motion detectors in accordance with Specification J6 to minimise power when not in use, therefore, meeting the requirements of J6.3(f).
J6.3(g)	Since no foyers, corridors or circulation spaces are adjacent to windows, this clause does not apply to the office building.
J6.3(h)	There is no carpark within the design and therefore this clause does not apply.
J6.3(i)	Emergency lighting is excluded for J6.3(a), (b), (c), (d), (e), (f), (g) and (h).
J6.3(j)	For plantrooms and lift motor rooms, the requirements of J6.3(d) does not apply.

J6.4 interior decorative and display lighting

No interior decorative and display lighting are provided in the office building and therefore this clause is not applicable.

J6.5 Exterior artificial lighting

To comply with J6.5, requirements for lighting attached to or directed at the façade of a building must be met to reduce energy consumption.

Design

On the exterior of the building, 12 x 28 W LED lamps are used for security and safe access for building occupants. The lighting is controlled by a daylight sensor to minimise energy consumption. An alternative to this would be a time switch that is capable of switching on an off at variable pre-programmed times and days.

Compliance approach

Table 25 demonstrates how the office building complies with the above detailed design, for each of the requirements in J6.5.

Table 26 Clause J6.5 Compliance approach

Clause	Application
J6.5 (a)	As all exterior lighting is controlled by a daylight sensor and all lighting uses LED luminaires, compliance with J6.5(a) is met.
J6.5 (b)	Exterior emergency lighting does not have any specified requirements. As the building is an office building, all lighting, that is not emergency lighting, complies with that described above in J6.5(a).

J6.6 Boiling water and chilled water storage units

To comply with J6.6, requirements for boiling water and chilled water storage units must be met to reduce energy consumption.

Design

There are boiling and chilled water storage units located in the cafe on the ground floor. Power supply to all boiling water and chilled water storage units are controlled by a time switch. The time switch is capable of switching on and off electric power and variable pre-programmed times and days. The time switch is capable of being overridden by a manual switch or a security access system that senses a person’s presence. The system remains overridden for up to 2 hours, after which if there is no further presence detected the time switch resumes control.

Compliance approach

Table 26 demonstrates how the office building complies with the above detailed design, for each of the requirements in J6.6.

Table 27 Clause J6.6 Compliance approach

Clause	Application
J6.6	As the boiling and chilled water storage units are controlled by a time switch in accordance with Specification J6, compliance with J6.6 is met.

J6.7 Lifts

To comply with J6.7, requirements for lifts must be met to reduce energy consumption.

Design

The office building contains four lifts within the central core. The lifts are configured to turn off artificial lighting and ventilation in the car when they are unused for 15 minutes. The lifts are sized to a rated load of 17 passengers (1275 kg). The idle standby energy performance level in accordance with ISO 25745-2 is 3.

Compliance approach

Table 27 demonstrates how the office building complies with each of the requirements in J6.7.

Table 28 Clause J6.7 Compliance approach

Clause	Application
J6.7(a)	Lifts are configured to turn off artificial lighting and ventilation when the car is not in use after 15 minutes.
J6.7(b)	As the rated load is within the range of 801 to 1000 kg, the required idle and standby energy performance level is 3. Therefore, the requirements for J6.7(b) are met.
J6.7(c)	Lifts achieve the required energy efficiency class in Table 6.7b of Part J6.

J6.8 Escalators and moving walkways

There are no escalators within the office building, therefore, this clause does not apply to the office building.

J7 Heated water supply and swimming pool and spa pool plant

The provisions contained in Part J7 have been developed to minimise the amount of energy used in providing sanitary heated water supply to a building and any pool or spa heating and pumping.

J7.2 Heated water supply

To comply with J7.2, requirements for heated water supply systems for food preparation and sanitary purposes must be met to reduce energy consumption.

Design

The heated water supply system for food preparation and sanitary purposes within the office building is designed and installed in accordance with Part B2 of NCC Volume Three – Plumbing Code of Australia

Compliance approach

Table 28 demonstrates how the office building complies with each of the requirements in J7.2.

Table 29 Clause J7.2 Compliance approach.

Clause	Application
J7.2	As the systems are designed and installed in accordance with Part B2 of NCC Volume Three – Plumbing Code of Australia, compliance is met with J7.2. Note that a system that is MEPS compliant will be compliant with this clause.

J7.3 Swimming pool heating and pumping

As there are no swimming pools in the design, this clause does not apply to the office building.

J7.4 Spa pool heating and pumping

As there are no spa pools in the design, this clause does not apply to the office building.

J8 Facilities for energy monitoring

The provisions contained in Part J8 have been developed to ensure the building is designed to enable energy monitoring to be carried out easily. The intent of requiring monitoring facilities is to enable factual information on the energy consumption of the building or its main services to be provided in order to identify and rectify any excessive use of energy.

J8.1 Application of part

As the building is Class 5, the DTS requirements of Part J8 apply.

J8.3 Facilities for energy monitoring

To comply with J8.3, requirements for the facilitation of energy modelling must be met to monitor energy consumption, and therefore correct excessive uses of energy.

Design

The office building has a BMS that controls and monitors the HVAC, lighting, appliance power, central hot water supply and lifts. The BMS interfaces with energy meters that are configured to record the time-of-use consumption of gas and electricity.

The BMS system provides a single interface monitoring system where time-of-use energy data can be stored, analysed and reviewed. This allows the building facilities manager to maintain energy efficiency and occupant comfort levels as well as ensure occupant safety and lower operating costs.

Compliance approach

Table 29 demonstrates how the office building complies with each of the requirements in J6.7.

Table 30 Clause J8.3 Compliance approach

Clause	Application
J8.3 (a)	The office has energy meters configured to record the time-of-use consumption of gas and electricity, therefore meeting the requirements for a building with a floor area greater than 500 m^2.
J8.3 (b)	The energy meters configured to record time-of-use consumption of gas and electricity, monitor the consumption of: • air conditioning plant • artificial lighting • appliance power • central hot water supply • lifts. Therefore, meeting the requirements of J8.3(b) for a building with a floor area greater than 2500 m^2.
J8.3 (c)	The BMS enables the energy meters to be interlinked by a communication system that collates the time-of-use energy consumption data to a single interface monitoring system. Therefore, meeting the requirements of J8.3(c).
J8.3 (d)	This clause applied to Class 2 buildings and therefore does not apply to the office.

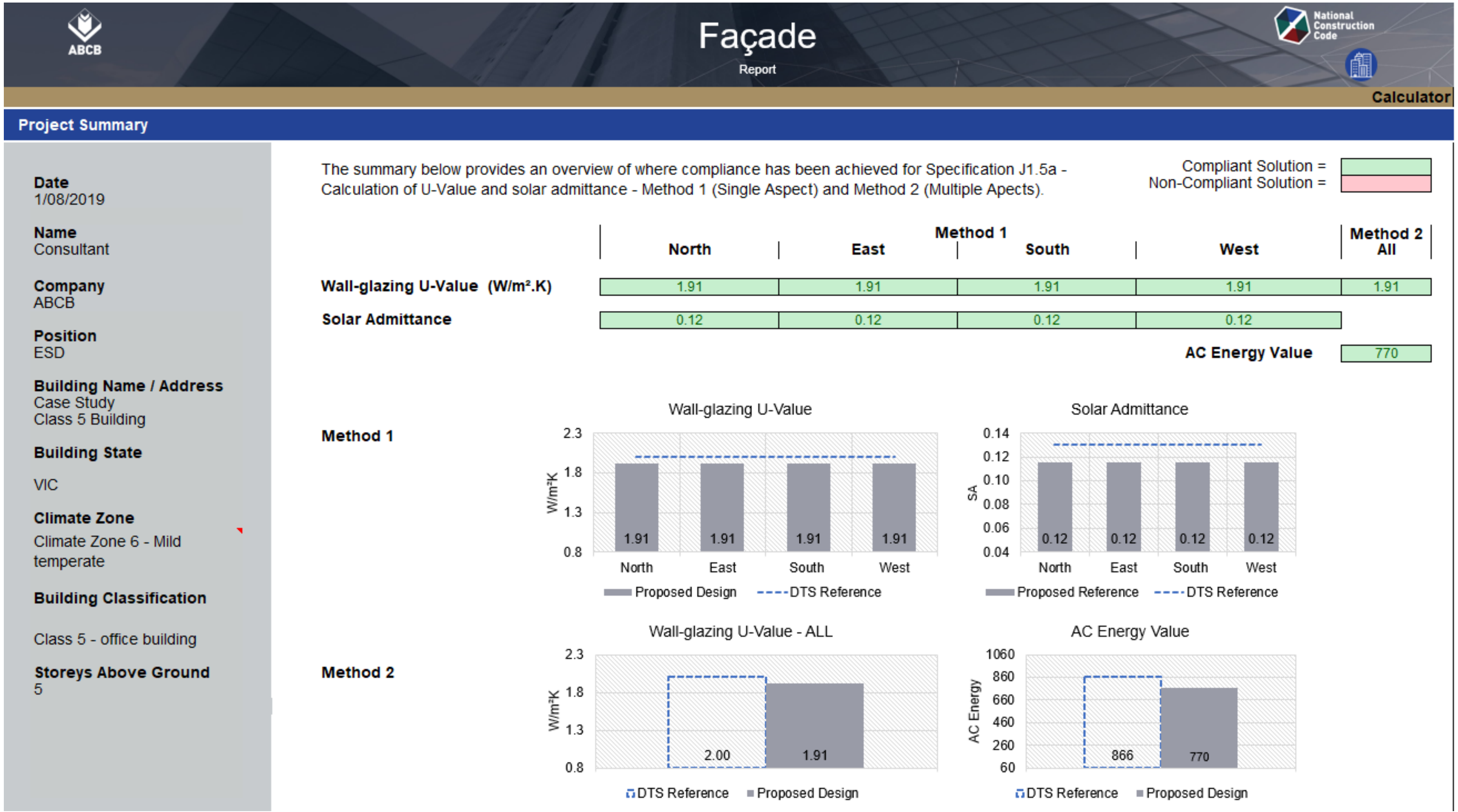
Summary

This case study provides a detailed understanding of the DTS Provisions for energy efficiency in Volume One of the NCC. It shows how a small Class 5 office building constructed in climate zone 6 can use a DTS Solution to comply with the Performance Requirement JP1.

APPENDICES

Appendix A ABCB Façade Calculator Results

Figure 12 Façade Calculator Report page 1



ABCB — Façade Report — National Construction Code — Calculator

Project Summary

Date
1/08/2019

Name
Consultant

Company
ABCB

Position
ESD

Building Name / Address
Case Study
Class 5 Building

Building State
VIC

Climate Zone
Climate Zone 6 - Mild temperate

Building Classification
Class 5 - office building

Storeys Above Ground
5

The summary below provides an overview of where compliance has been achieved for Specification J1.5a - Calculation of U-Value and solar admittance - Method 1 (Single Aspect) and Method 2 (Multiple Apects).

Compliant Solution =
Non-Compliant Solution =

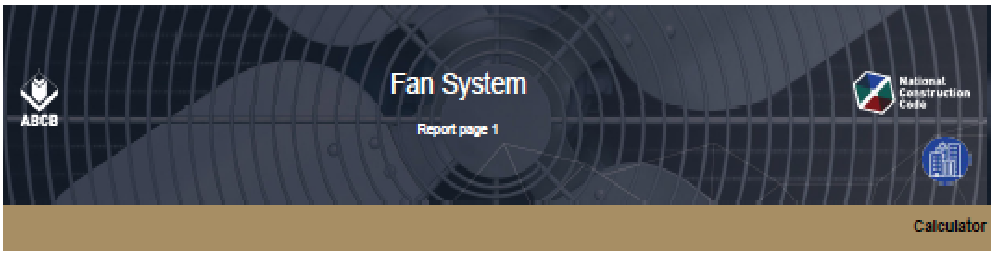
	Method 1 North	Method 1 East	Method 1 South	Method 1 West	Method 2 All
Wall-glazing U-Value (W/m².K)	1.91	1.91	1.91	1.91	1.91
Solar Admittance	0.12	0.12	0.12	0.12	
AC Energy Value					770

Method 1

Method 2

Appendix B ABCB Fan System Calculator Results

Figure 13 Fan Calculator results for the café fan system



Project Information			
Building Name and Description	**Project Number**	**Designer**	**Company**
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SAF-01
Description:	AHU-Café SAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Free
Outlet:	Ducted
Flow Rate:	2015 L/s

Calculation Summary		
Component	**System**	**Allowable**
Pressure Drop	561.4 Pa	565.5 Pa
Straight PD	41.7 Pa	45.8 Pa
Fitting PD	519.7 Pa	519.7 Pa
Fan Efficiency	50.0%	41.0%
Motor Input Power	2.62 kW	3.22 kW

Requirements Applicable
Applicable

Component Level		
Index Run	**Fan**	**Overall**
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	**Pressure Drop**	**Motor Power**	**Overall**
-18.1%	-0.7%	-18.7%	Satisfies Part J5.4

Result

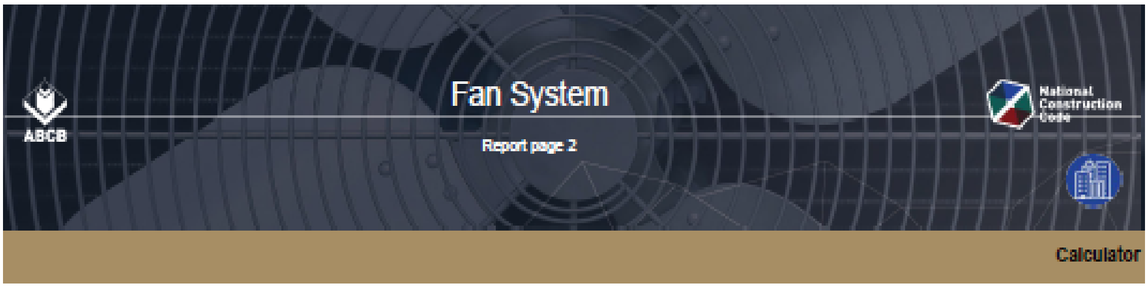
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 14 Fan Calculator results for the main office system 1



Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SAF-02
Description:	AHU-IE SAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Free
Outlet:	Ducted
Flow Rate:	7838 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	608.7 Pa	611.9 Pa
Straight PD	42.6 Pa	45.8 Pa
Fitting PD	566.1 Pa	566.1 Pa
Fan Efficiency	50.0%	43.7%
Motor Input Power	10.97 kW	12.62 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-12.6%	-0.5%	-13.0%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 15 Fan Calculator results for the main office system 2

ABCB

Fan System

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National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SAF-03
Description:	AHU-IW SAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Free
Outlet:	Ducted
Flow Rate:	7611 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	607 Pa	609.5 Pa
Straight PD	43.3 Pa	45.8 Pa
Fitting PD	563.7 Pa	563.7 Pa
Fan Efficiency	50.0%	43.7%
Motor Input Power	10.66 kW	12.24 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-12.6%	-0.4%	-13.0%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

IMPORTANT NOTICE AND DISCLAIMER IN RESPECT OF THIS FAN SYSTEM CALCULATOR

Figure 16 Fan Calculator results for the main office system 3

ABCB

Fan System

Report page 4

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SAF-04
Description:	AHU-PE SAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Free
Outlet:	Ducted
Flow Rate:	2090 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	564.9 Pa	567.5 Pa
Straight PD	43.1 Pa	45.8 Pa
Fitting PD	521.7 Pa	521.7 Pa
Fan Efficiency	50.0%	41.0%
Motor Input Power	2.72 kW	3.33 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-18.1%	-0.5%	-18.5%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 17 Fan Calculator results for the main office system 4

ABCB

Fan System

Report page 5

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SAF-05
Description:	AHU-PN SAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Free
Outlet:	Ducted
Flow Rate:	5484 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	592.4 Pa	596 Pa
Straight PD	42.1 Pa	45.8 Pa
Fitting PD	550.2 Pa	550.2 Pa
Fan Efficiency	50.0%	42.9%
Motor Input Power	7.13 kW	8.36 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-14.1%	-0.6%	-14.7%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 18 Fan Calculator results for the main office system 5

ABCB

Fan System

Report page 6

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SAF-06
Description:	AHU-PS SAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Free
Outlet:	Ducted
Flow Rate:	2258 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	562.6 Pa	567.2 Pa
Straight PD	41.2 Pa	45.8 Pa
Fitting PD	521.4 Pa	521.4 Pa
Fan Efficiency	50.0%	41.0%
Motor Input Power	2.94 kW	3.61 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-18.1%	-0.8%	-18.8%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 19 Fan Calculator results for the main office system 6

ABCB

Fan System

Report page 7

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SAF-07
Description:	AHU-PW SAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Free
Outlet:	Ducted
Flow Rate:	2744 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	569.1 Pa	574 Pa
Straight PD	40.8 Pa	45.8 Pa
Fitting PD	528.2 Pa	528.2 Pa
Fan Efficiency	50.0%	41.6%
Motor Input Power	3.57 kW	4.32 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-16.8%	-0.9%	-17.5%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 20 Fan Calculator results for the main office system 7

ABCB

Fan System

Report page 8

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	RAF-01
Description:	AHU-Café RAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	2015 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	238.5 Pa	242.6 Pa
Straight PD	41.6 Pa	45.8 Pa
Fitting PD	196.8 Pa	196.8 Pa
Fan Efficiency	50.0%	39.3%
Motor Input Power	1.61 kW	2.08 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-21.3%	-1.7%	-22.7%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 21 Fan Calculator results for the main office system 8

ABCB

Fan System

Report page 9

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	RAF-02
Description:	AHU-IE RAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	7838 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	289.3 Pa	292.7 Pa
Straight PD	42.4 Pa	45.8 Pa
Fitting PD	246.9 Pa	246.9 Pa
Fan Efficiency	50.0%	42.6%
Motor Input Power	7.05 kW	8.38 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-14.9%	-1.2%	-15.9%	Satisfies Part J5.4

Result

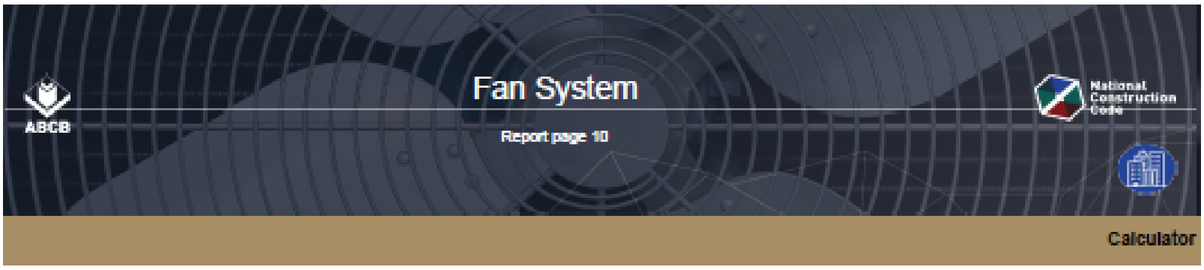
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 22 Fan Calculator results for the main office system 9



Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	RAF-03
Description:	AHU-IW RAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	7611 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	288.9 Pa	290.9 Pa
Straight PD	43.8 Pa	45.8 Pa
Fitting PD	245.1 Pa	245.1 Pa
Fan Efficiency	50.0%	42.6%
Motor Input Power	6.85 kW	8.1 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-14.9%	-0.7%	-15.5%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 23 Fan Calculator results for the main office system 10

Fan System

Report page 11

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	RAF-04
Description:	AHU-PE RAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	2090 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	242.5 Pa	245.3 Pa
Straight PD	43 Pa	45.8 Pa
Fitting PD	199.5 Pa	199.5 Pa
Fan Efficiency	50.0%	39.3%
Motor Input Power	1.57 kW	2.15 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-21.3%	-1.1%	-22.2%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 24 Fan Calculator results for the main office system 11

ABCB

Fan System

Report page 12

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	RAF-05
Description:	AHU-PN RAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	5484 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	269.9 Pa	274.6 Pa
Straight PD	41.1 Pa	45.8 Pa
Fitting PD	228.8 Pa	228.8 Pa
Fan Efficiency	50.0%	41.6%
Motor Input Power	4.39 kW	5.36 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-16.8%	-1.7%	-18.2%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

IMPORTANT NOTICE AND DISCLAIMER IN RESPECT OF THIS FAN SYSTEM CALCULATOR

Figure 25 Fan Calculator results for the main office system 12

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Fan System

Report page 13

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	RAF-06
Description:	AHU-PS RAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	2258 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	239.5 Pa	244.9 Pa
Straight PD	40.4 Pa	45.8 Pa
Fitting PD	199.1 Pa	199.1 Pa
Fan Efficiency	50.0%	39.3%
Motor Input Power	1.81 kW	2.35 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-21.3%	-2.2%	-23.1%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 26 Fan Calculator results for the main office system 13

ABCB

Fan System

Report page 14

National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	RAF-07
Description:	AHU-PW RAF
Type:	Axial - as a component of an air handling unit or fan coil unit
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	2744 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	247 Pa	252.7 Pa
Straight PD	40 Pa	45.8 Pa
Fitting PD	206.9 Pa	206.9 Pa
Fan Efficiency	50.0%	40.2%
Motor Input Power	2.2 kW	2.79 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-19.5%	-2.3%	-21.4%	Satisfies Part J5.4

Result

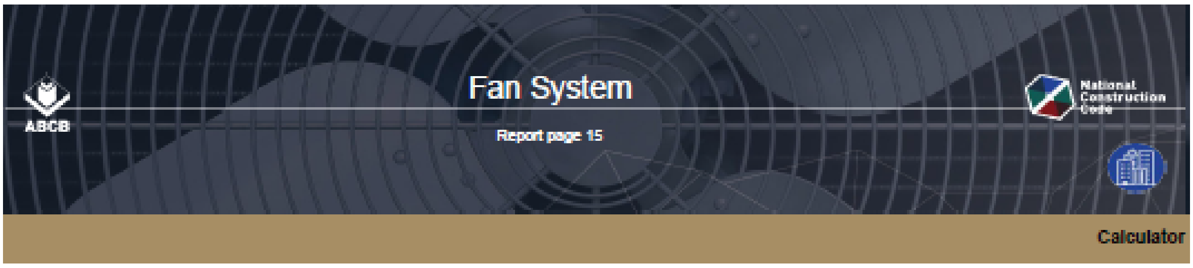
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 27 Fan Calculator results for the general exhaust



Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	GEF-01
Description:	General Exhaust
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	428 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	222.3 Pa	236.1 Pa
Straight PD	26 Pa	39.8 Pa
Fitting PD	196.3 Pa	196.3 Pa
Fan Efficiency	50.0%	45.1%
Motor Input Power	0.3 kW	0.35 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-9.8%	-5.8%	-15.1%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 28 Fan Calculator results for the toilet exhaust 1

ABCB

Fan System

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National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	TEF-01
Description:	ToiletExhaust 1
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	3675 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	242.8 Pa	244.7 Pa
Straight PD	27.8 Pa	29.8 Pa
Fitting PD	214.9 Pa	214.9 Pa
Fan Efficiency	50.0%	49.7%
Motor Input Power	2.94 kW	2.98 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-0.6%	-0.8%	-1.4%	Satisfies Part J5.4

Result

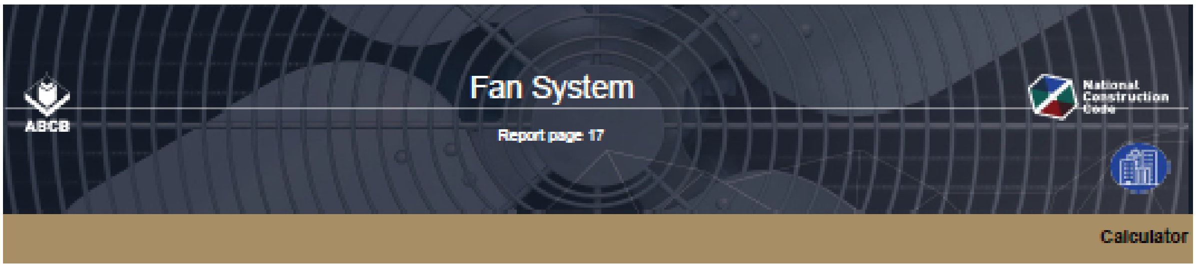
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 29 Fan Calculator results for the toilet exhaust 2



Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	TEF-02
Description:	ToiletExhaust 2
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	3675 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	242.8 Pa	244.7 Pa
Straight PD	27.8 Pa	29.8 Pa
Fitting PD	214.9 Pa	214.9 Pa
Fan Efficiency	50.0%	49.7%
Motor Input Power	2.94 kW	2.98 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-0.6%	-0.8%	-1.4%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 30 Fan Calculator results for the kitchen exhaust

ABCB

Fan System

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National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	KEF-01
Description:	Kitchen Exhaust
Type:	Axial - other
Role:	Kitchen exhaust
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	3353 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	245.3 Pa	250.1 Pa
Straight PD	35 Pa	39.8 Pa
Fitting PD	210.3 Pa	210.3 Pa
Fan Efficiency	50.0%	49.0%
Motor Input Power	2.35 kW	2.44 kW

Requirements Applicable
Not Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Not Applicable

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-1.9%	-1.9%	-3.8%	Not Applicable

Result

The system is of a type covered by J5.4(e), and thus it is not required to comply with the other elements of J5.4. Component results are displayed below only to aid in the design process.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 31 Fan Calculator results for the outside air 1

ABCB

Fan System

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National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	OAF-01
Description:	OA Fan 1
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	193 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	163.2 Pa	166.4 Pa
Straight PD	36.6 Pa	39.8 Pa
Fitting PD	126.6 Pa	126.6 Pa
Fan Efficiency	50.0%	38.9%
Motor Input Power	0.08 kW	0.1 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-22.2%	-1.9%	-23.7%	Satisfies Part J5.4

Result

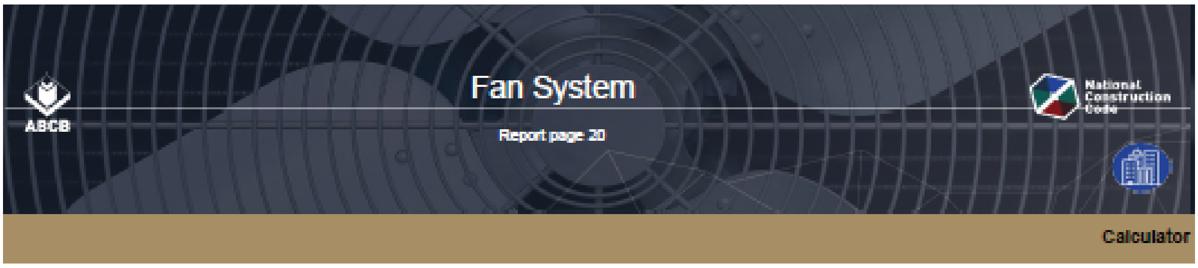
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 32 Fan Calculator results for the outside air 2



Project Information				
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	OAF-02
Description:	OA Fan 2
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	3539 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	217.1 Pa	220.2 Pa
Straight PD	36.6 Pa	39.8 Pa
Fitting PD	180.4 Pa	180.4 Pa
Fan Efficiency	50.0%	48.3%
Motor Input Power	2.12 kW	2.23 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-3.4%	-1.4%	-4.8%	Satisfies Part J5.4

Result

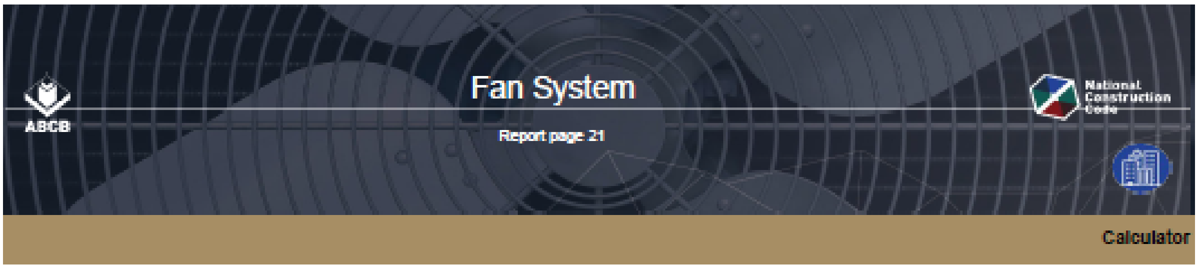
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 33 Fan Calculator results for the stair pressurisation 1



Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SPF-01
Description:	Stair Pressurisation 1
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	2318 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	228.4 Pa	231.8 Pa
Straight PD	24.4 Pa	27.8 Pa
Fitting PD	204 Pa	204 Pa
Fan Efficiency	50.0%	48.3%
Motor Input Power	1.39 kW	1.45 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-3.4%	-1.5%	-4.8%	Satisfies Part J5.4

Result

The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 34 Fan Calculator results for the stair pressurisation 2

Fan System

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Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SPF-02
Description:	Stair Pressurisation 2
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	2318 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	228.4 Pa	231.8 Pa
Straight PD	24.4 Pa	27.8 Pa
Fitting PD	204 Pa	204 Pa
Fan Efficiency	50.0%	48.3%
Motor Input Power	1.39 kW	1.46 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-3.4%	-1.5%	-4.8%	Satisfies Part J5.4

Result

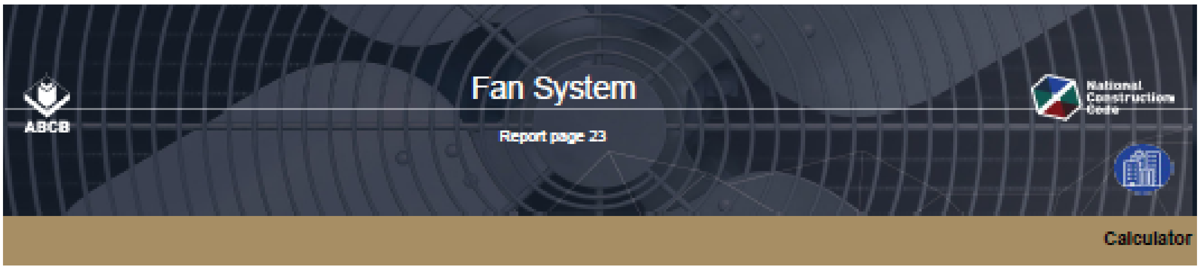
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 35 Fan Calculator results for the stair pressurisation 3



Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SPF-03
Description:	Stair Pressurisation 3
Type:	Axial - other
Role:	Any other air-conditioning or ventilation fan
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	2318 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	228.4 Pa	231.8 Pa
Straight PD	24.4 Pa	27.8 Pa
Fitting PD	204 Pa	204 Pa
Fan Efficiency	50.0%	48.3%
Motor Input Power	1.39 kW	1.45 kW

Requirements Applicable
Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Satisfies Part J5.4

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-3.4%	-1.5%	-4.8%	Satisfies Part J5.4

Result

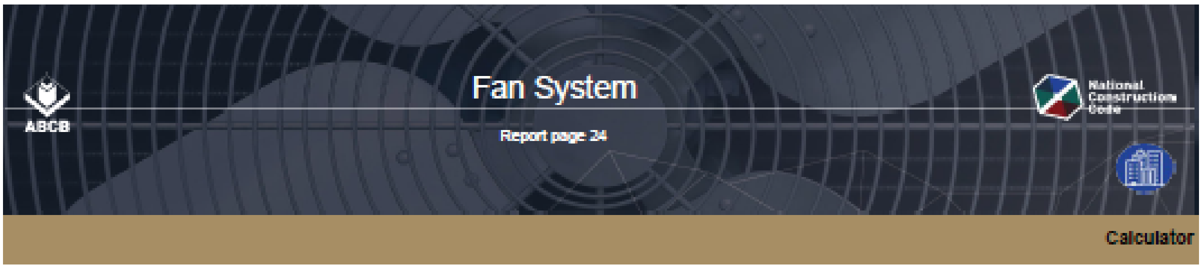
The fan system satisfies Part J5.4 on both component and systemic levels.

The length of flexible duct in the index run satisifes Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 36 Fan Calculator results for the smoke exhaust 1



Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SEF-01
Description:	Smoke Exhaust Fan 1
Type:	Axial - other
Role:	Smoke spill only
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	10533 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	292 Pa	296.1 Pa
Straight PD	35.7 Pa	39.8 Pa
Fitting PD	256.3 Pa	256.3 Pa
Fan Efficiency	55.0%	51.8%
Motor Input Power	7.66 kW	8.24 kW

Requirements Applicable
Not Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Not Applicable

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-5.7%	-1.4%	-7.1%	Not Applicable

Result

The system is of a type covered by J5.4(e), and thus it is not required to comply with the other elements of J5.4. Component results are displayed below only to aid in the design process.

The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Figure 37 Fan Calculator results for the smoke exhaust 2

ABCB

Fan System

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National Construction Code

Calculator

Project Information			
Building Name and Description	Project Number	Designer	Company
NCC Class 5 Case Study	NCC2019-5		

System Information	
Fan Tag:	SEF-02
Description:	Smoke Exhaust Fan 2
Type:	Axial - other
Role:	Smoke spill only
Inlet:	Ducted
Outlet:	Ducted
Flow Rate:	10533 L/s

Calculation Summary		
Component	System	Allowable
Pressure Drop	292 Pa	296.1 Pa
Straight PD	35.7 Pa	39.8 Pa
Fitting PD	256.3 Pa	256.3 Pa
Fan Efficiency	55.0%	51.8%
Motor Input Power	9.56 kW	10.3 kW

Requirements Applicable
Not Applicable

Component Level		
Index Run	Fan	Overall
Satisfies Part J5.4	Satisfies Part J5.4	Not Applicable

System Level			
Efficiency	Pressure Drop	Motor Power	Overall
-5.7%	-1.4%	-7.1%	Not Applicable

Result

The system is of a type covered by J5.4(e), and thus it is not required to comply with the other elements of J5.4. Component results are displayed below only to aid in the design process.

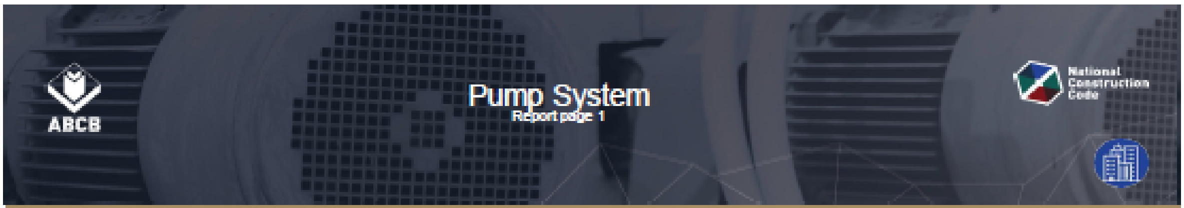
The length of flexible duct in the index run satisfies Part J5.4.
The sections of straight duct in the index run have an average pressure drop which satisfies Part J5.4.
More data is required before the duct fittings in the index run can be evaluated.
Considering these elements, the index run satisfies Part J5.4 on a component level.
The fan's efficiency satisfies Part J5.4 on a component level.

This calculator does not check whether the upstream connections to ductwork bends, elbows and tees in the index run have an equivalent diameter to the connected duct per J5.4(c)(iii). Ensure you check whether your system satisfies this provision, and if not, make suitable allowances in systemic energy usage calculations for the pressure drop differences which would result.

Version number: 1.00

Appendix C ABCB Pump System Calculator Results

Figure 38 Pump System Calculator results for the boiler 1



Project Information			
Building Name and Description	Project Number	Designer	Company
Class 5 Case Study	NCC2019		

System Information	
Pump Tag:	HHWP-01
Description:	Boiler 1 HHW Pump
System Type:	Distributive
Speed Control:	Variable Speed
Operating Hours Per Annum:	Between 2000 and 5000
Pump Configuration:	Other Pump
Pump Design:	End Suction Close Coupled Inline
Pump Stages:	Single Stage
Pump Speed:	2 Pole

Calculation Summary		
Component	System	Allowable
Straight Pressure Drop	400 Pa/m	400 Pa/m
	Note: This value has been entered directly by the user.	
Minimum Efficiency Index	>0.40	>0.40
	Note: This value has been calculated using the user's data.	

Component Level Satisfaction		
Pipe	Pump	Overall
Satisfies Part J5.7	Satisfies Part J5.7	**Satisfies Part J5.7**

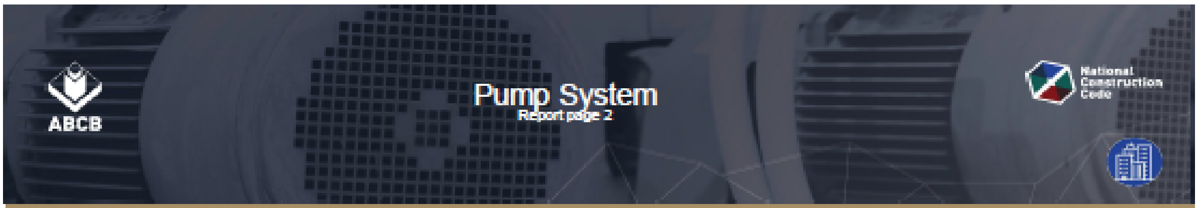
System Level Satisfaction			
Pipe	Pump	Motor Power	Overall
0.0%	-1.4%	-1.4%	**Satisfies Part J5.7**

Result

On both systemic and component levels, the pump system's energy efficiency satisfies Part J5.7.
The pump's efficiency satisfies Part J5.7 on a component level.
The pressure drop through the pipework satisfies Part J5.7 on a component level.

Version number: 1.00

Figure 39 Pump System Calculator Results for the boiler 2



Project Information			
Building Name and Description	Project Number	Designer	Company
Class 5 Case Study	NCC2019		

System Information	
Pump Tag:	HHWP-02
Description:	Boiler 2 HHW Pump
System Type:	Distributive
Speed Control:	Variable Speed
Operating Hours Per Annum:	Between 2000 and 5000
Pump Configuration:	Other Pump
Pump Design:	End Suction Close Coupled Inline
Pump Stages:	Single Stage
Pump Speed:	2 Pole

Calculation Summary		
Component	System	Allowable
Straight Pressure Drop	400 Pa/m	400 Pa/m
	Note: This value has been entered directly by the user.	
Minimum Efficiency Index	>0.40	>0.40
	Note: This value has been calculated using the user's data.	

Component Level Satisfaction		
Pipe	Pump	Overall
Satisfies Part J5.7	Satisfies Part J5.7	**Satisfies Part J5.7**

System Level Satisfaction			
Pipe	Pump	Motor Power	Overall
0.0%	-1.4%	-1.4%	**Satisfies Part J5.7**

Result

On both systemic and component levels, the pump system's energy efficiency satisfies Part J5.7.
The pump's efficiency satisfies Part J5.7 on a component level.
The pressure drop through the pipework satisfies Part J5.7 on a component level.

Version number: 1.00

IMPORTANT NOTICE AND DISCLAIMER IN RESPECT OF THIS PUMP SYSTEM CALCULATOR

The Pump System Calculator has been developed to assist users to develop a better understanding of the NCC Volume One Part J5.7 Pump Systems, Deemed-to-Satisfy provisions. If used correctly, the summary indicates whether the planned pump and pipe arrangements are likely to meet the standards required by the NCC. However, the reliability of the Pump System Calculator's results are dependent upon the accuracy of the data input by users. It remains the user's responsibility to ensure that the planned Pump

Figure 40 Pump System Calculator results for the chiller 1

ABCB

Pump System
Report page 3

National Construction Code

Project Information			
Building Name and Description	Project Number	Designer	Company
Class 5 Case Study	NCC2019		

System Information	
Pump Tag:	CHWP-01
Description:	Chiller 1 CHW Pump
System Type:	Distributive
Speed Control:	Variable Speed
Operating Hours Per Annum:	Between 2000 and 5000
Pump Configuration:	Other Pump
Pump Design:	End Suction Close Coupled Inline
Pump Stages:	Single Stage
Pump Speed:	2 Pole

Calculation Summary		
Component	System	Allowable
Straight Pressure Drop	400 Pa/m Note: This value has been entered directly by the user.	400 Pa/m
Minimum Efficiency Index	>0.40 Note: This value has been calculated using the user's data.	>0.40

Component Level Satisfaction		
Pipe	Pump	Overall
Satisfies Part J5.7	Satisfies Part J5.7	Satisfies Part J5.7

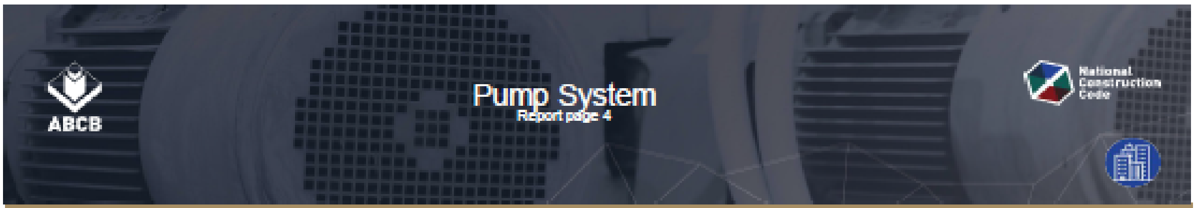
System Level Satisfaction			
Pipe	Pump	Motor Power	Overall
0.0%	-0.7%	-0.7%	Satisfies Part J5.7

Result

On both systemic and component levels, the pump system's energy efficiency satisfies Part J5.7.
The pump's efficiency satisfies Part J5.7 on a component level.
The pressure drop through the pipework satisfies Part J5.7 on a component level.

Version number: 1.00

Figure 41 Pump System Calculator results for the chiller 2



Project Information			
Building Name and Description	Project Number	Designer	Company
Class 5 Case Study	NCC2019		

System Information	
Pump Tag:	CHWP-02
Description:	Chiller 2 CHW Pump
System Type:	Distributive
Speed Control:	Variable Speed
Operating Hours Per Annum:	Between 2000 and 5000
Pump Configuration:	Other Pump
Pump Design:	End Suction Close Coupled Inline
Pump Stages:	Single Stage
Pump Speed:	2 Pole

Calculation Summary		
Component	System	Allowable
Straight Pressure Drop	400 Pa/m Note: This value has been entered directly by the user.	400 Pa/m
Minimum Efficiency Index	>0.40 Note: This value has been calculated using the user's data.	>0.40

Component Level Satisfaction		
Pipe	Pump	Overall
Satisfies Part J5.7	Satisfies Part J5.7	**Satisfies Part J5.7**

System Level Satisfaction			
Pipe	Pump	Motor Power	Overall
0.0%	-0.7%	-0.7%	Satisfies Part J5.7

Result

On both systemic and component levels, the pump system's energy efficiency satisfies Part J5.7.
The pump's efficiency satisfies Part J5.7 on a component level.
The pressure drop through the pipework satisfies Part J5.7 on a component level.

Version number: 1.00

IMPORTANT NOTICE AND DISCLAIMER IN RESPECT OF THIS PUMP SYSTEM CALCULATOR

The Pump System Calculator has been developed to assist users to develop a better understanding of the NCC Volume One Part J5.7 Pump Systems, Deemed-to-Satisfy provisions. If used correctly, the summary indicates whether the planned pump and pipe arrangements are likely to meet the standards required by the NCC. However, the reliability of the Pump System Calculator's results are dependent upon the accuracy of the data input by users. It remains the user's responsibility to ensure that the planned Pump

Appendix D ABCB Lighting Calculator Results[1]

Figure 42 Lighting Calculator results 1

ABCB

Non-residential Lighting (Beta)

Class 3 and 5-9 buildings

National Construction Code

Main Menu | Help | Multiple Lighting Systems Calculator | Calculator

Building name/description	Classification
Small Class 5 Office Building	Class 5

Number of rows preferred in table below: 25 *(as currently displayed)*

ID	Description	Floor area of the space	Perimeter of the space	Floor to ceiling height	Design Illumination Power Load	Space	Illuminance: Designed Lux Level	Illuminance: Recommended Lux Level	Adjustment Factor One: Adjustment Factor One	Adjustment Factor One: Dimming % Area	Adjustment Factor One: Illuminance Turndown	Adjustment Factor Two: Adjustment Factor Two	Adjustment Factor Two: Dimming % Area	Adjustment Factor Two: Illuminance Turndown	Light Colour Adjustment Factors: Light Colour Adjustment Factor One	Light Colour Adjustment Factors: Light Colour Adjustment Factor Two	SATISFIES PART J6.2: System Illumination Power Load Allowance	SATISFIES PART J6.2: Lighting System Share of % of Aggregate Allowance Used
							These columns do not represent a requirement of the NCC and are suggestions only		Adjustment Factors			Adjustment Factors						
1	G Office	1,763.5 m²			8397 W	Office - artificially lit to an ambient level of 200 lx or more			d)Programmable dimming system	100%							9336 W	40% of 71%
2	G Female Toilets	50.0 m²	37 m	2.9 m	120 W	Toilet, locker room, staff room, rest room and the like			d)Programmable dimming system	100%							267 W	1% of 71%
3	G Male Toilets	47.6 m²	28 m	2.9 m	120 W	Toilet, locker room, staff room, rest room and the like			d)Programmable dimming system	100%							240 W	1% of 71%
4	G Disabled Toilets	8.5 m²	12 m	2.9 m	20 W	Toilet, locker room, staff room, rest room and the like			d)Programmable dimming system	100%							53 W	0% of 71%
5	G Café	167.9 m²	52 m	2.9 m	720 W	Restaurant, café, bar, hotel lounge and a space for the serving and consumption of food or drinks			d)Programmable dimming system	100%							3143 W	3% of 71%
6	G Corridor	49.6 m²	62 m	2.9 m	110 W	Corridors			d)Programmable dimming system	100%							495 W	1% of 71%
7	G Comms	16.0 m²	16 m	2.9 m	183 W	An illuminance more than 400 lx to 600 lx			d)Programmable dimming system	100%							309 W	1% of 71%
8	G Stairs 1	15.5 m²	17 m	2.9 m	30 W	Stairways, including fire-isolated stairways			b)Motion detector								86 W	0% of 71%
9	G Stairs 2	15.5 m²	17 m	2.9 m	30 W	Stairways, including fire-isolated stairways			b)Motion detector								86 W	0% of 71%
10	G Foyer	106.0 m²	42 m	2.9 m	320 W	Entry lobby from outside the building			d)Programmable dimming system	100%							1403 W	2% of 71%
11	G Entry / Air Lock	32.1 m²	29 m	2.9 m	120 W	Entry lobby from outside the building			d)Programmable dimming system	100%							540 W	1% of 71%
12	G Lobby	40.0 m²	25 m	2.9 m	90 W	Entry lobby from outside the building			d)Programmable dimming system	100%							614 W	0% of 71%
13																	*ROW SKIPPED (OK if intentional)*	
14	L1-4 Office	2,109.4 m²			10044 W	Office - artificially lit to an ambient level of 200 lx or more			d)Programmable dimming system	100%							11167 W	48% of 71%
15	L1-4 Female Toilets	38.0 m²	29 m	2.9 m	120 W	Toilet, locker room, staff room, rest room and the like			d)Programmable dimming system	100%							206 W	1% of 71%
16	L1-4 Male Toilets	25.3 m²	20 m	2.9 m	90 W	Toilet, locker room, staff room, rest room and the like			d)Programmable dimming system	100%							138 W	0% of 71%

Figure 43 Lighting Calculator results 2

ABCB

Non-residential Lighting (Beta)

Class 3 and 5-9 buildings

National Construction Code

Main Menu | Help | Multiple Lighting Systems Calculator | Calculator

Building name/description	Classification
Small Class 5 Office Building	Class 5

Number of rows preferred in table below: 25 *(as currently displayed)*

ID	Description	Floor area of the space	Perimeter of the space	Floor to ceiling height	Design Illumination Power Load	Space	Illuminance: Designed Lux Level	Illuminance: Recommended Lux Level (These columns do not represent a requirement of the NCC and are suggestions only)	Adjustment Factor One: Adjustment Factor One (Adjustment Factors)	Adjustment Factor One: Dimming % Area	Adjustment Factor One: Illuminance Turndown	Adjustment Factor Two: Adjustment Factor Two (Adjustment Factors)	Adjustment Factor Two: Dimming % Area	Adjustment Factor Two: Illuminance Turndown	Light Colour Adjustment Factors: Light Colour Adjustment Factor One	Light Colour Adjustment Factors: Light Colour Adjustment Factor Two	SATISFIES PART J6.2: System Illumination Power Load Allowance	SATISFIES PART J6.2: Lighting System Share of % of Aggregate Allowance Used
17	L1-4 Disabled Toilets	8.5 m²	12 m	2.9 m	20 W	Toilet, locker room, staff room, rest room and the like			d)Programmable dimming system	100%							53 W	0% of 71%
18	L1-4 Corridor	44.0 m²	54 m	2.9 m	110 W	Corridors			d)Programmable dimming system	100%							431 W	1% of 71%
19	L1-4 Comms	16.0 m²	16 m	2.9 m	183 W	An illuminance more than 400 lx to 600 lx			d)Programmable dimming system	100%							309 W	1% of 71%
20	L1-4 Stairs 1	15.5 m²	17 m	2.9 m	30 W	Stairways, including fire-isolated stairways			b)Motion detector								86 W	0% of 71%
21	L1-4 Stairs 2	15.5 m²	17 m	2.9 m	30 W	Stairways, including fire-isolated stairways			b)Motion detector								86 W	0% of 71%
22	L1-4 Lobby	40.0 m²	25 m	2.9 m	90 W	Corridors			d)Programmable dimming system	100%							341 W	0% of 71%
23																		
24																		
25																		
				Total	20977 W											Total	29389 W	

if inputs are valid ✓

Appendix E Lighting calculations for Room Aspect Ratio

The lighting requirements for the building are dependent on the dimensions of each space, space type, control method, and lighting colour.

The space dimensions and applicable Room Aspect Ratio adjustment factors for the office building are presented in the table below. The Room Aspect Ratio is calculated using the following equation:

$$room\ aspect\ ratio = \frac{A}{H\ \times C}$$

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

If the Room Aspect Ratio is less than 1.5, the maximum allowable illumination power density may be increased by dividing it by an adjustment factor for room aspect. The adjustment factor is equivalent to:

$$0.5 + \frac{Room\ Aspect\ Ratio}{3}$$

Table 31 Relevant space types for the ground floor

Space	Area (m^2)	Ceiling height (m)	Perimeter (m)	Room Aspect Ratio	Adjustment factor
Office	1288.8	2.85	-	-	-
Office perimeter zone	474.7	2.85	-	-	-
Female toilets	50.0	2.85	37.1	0.47	0.66
Male toilets	47.6	2.85	28.3	0.59	0.70
Disabled toilets	8.5	2.85	11.8	0.25	0.58
Café	167.9	2.85	51.7	1.14	0.88
Corridor	49.6	2.85	61.9	0.28	0.59

Space	Area (m^2)	Ceiling height (m)	Perimeter (m)	Room Aspect Ratio	Adjustment factor
Comms room	16.0	2.85	16.4	0.34	0.61
Stairs 1	15.5	2.85	17.3	0.31	0.60
Stairs 2	15.5	2.85	17.3	0.31	0.60
Lift 1	17.5	2.85	18.0	0.34	0.61
Lift 2	17.5	2.85	18.0	0.34	0.61
Foyer	106.0	2.85	41.5	0.90	0.80
Entry / air lock	32.1	2.85	29.4	0.38	0.63
Lobby (ground floor)	40.0	2.85	25.0	0.56	0.69

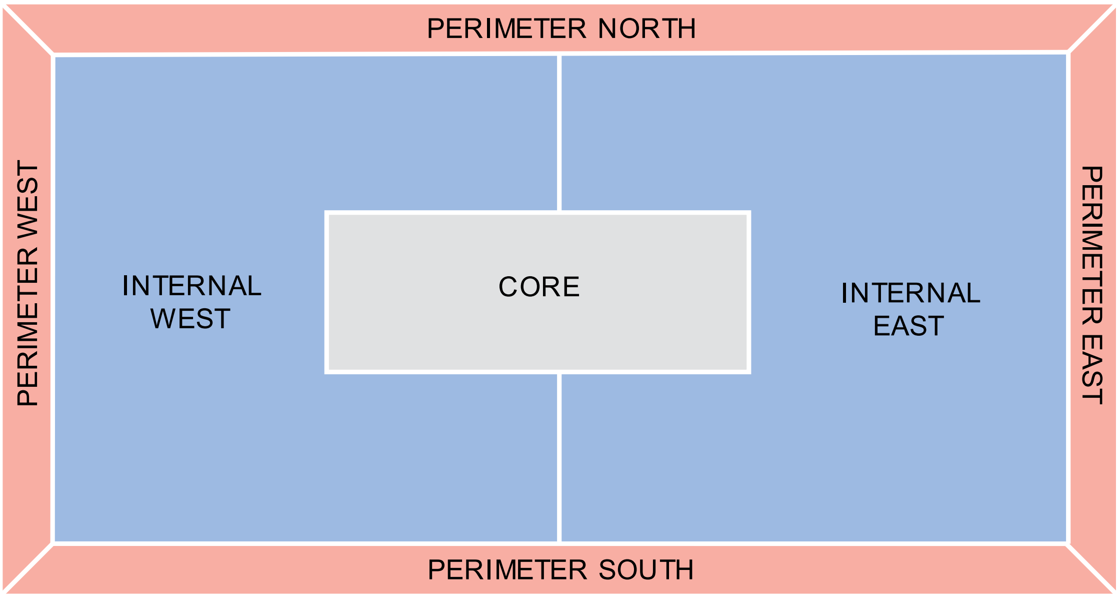
Table 32 Relevant space types for Levels 1 - 4

Space	Area (m^2)	Ceiling height (m)	Perimeter (m)	Room Aspect Ratio	Adjustment factor
Office	1563.1	2.85	-	-	-
Office perimeter zone	546.3	2.85	-	-	-
Female toilets	38.0	2.85	29.4	0.45	0.65
Male toilets	25.3	2.85	20	0.44	0.65
Disabled toilets	8.5	2.85	11.8	0.25	0.58
Corridor	44.0	2.85	53.5	0.29	0.60
Comms room	16.0	2.85	16.4	0.34	0.61
Stairs 1	15.5	2.85	17.3	0.31	0.60
Stairs 2	15.5	2.85	17.3	0.31	0.60
Lift 1	17.5	2.85	18.0	0.34	0.61
Lift 2	17.5	2.85	18.0	0.34	0.61
Lobby	40.0	2.85	25.0	0.56	0.69

Appendix F Energy modelling methodology

All perimeter zones are detailed in Figure 22. The perimeter zones are assumed to be 0.7 air changers per hour (ACH) during non-conditioned hours and 0.35 ACH during conditioned hours.

Figure 44 Typical floor zoning



The building sealing is discussed in detail in Part J3 Building sealing of The Solution.

The AHU fan flow rates in Part J5 are estimated based on the following:

The office spaces are modelled to maintain 21 °C to 24 °C. The occupant, lighting and equipment internal heat gains are calculated with:

- occupant densities of 10 m^2 per person (as defined in Table D1.13),
- lighting loads equivalent to 6.43 W/m^2 in the internal office zone, and 10.59 W/m^2 in the perimeter office zone. This reflects the maximum lighting allowance as calculated in Part J6, and
- equipment gains equivalent to 11 W/m^2 based on Table 2l in Specification JVc of the NCC 2019.
- All the loads vary based on the operational profiles defined in Table 2c and Table 2d of Specification JVc Modelling profiles in the NCC 2019.

The cafe spaces are modelled to maintain 21 °C to 24 °C with:

- maximum occupant densities of 1 m^2 per person (as defined in Table D1.13),
- lighting loads equivalent to 22.73 W/m^2,
- equipment gains equivalent to 5 W/m^2, cooking sensible gains of 5 W/m^2, and latent gains of 25 W/m^2 to meet the requirements of Table 2n in Specification JVc of the NCC 2019.
- All the loads vary based on the operational profiles defined in Table 2f of Specification JVc Modelling profiles in the NCC 2019.

A diagram of the 3D model of the office building is shown in Figure 45. The floor plan for the ground floor is shown in Figure 2 and the other typical floors are shown in Figure 3.

Figure 45 3D diagram of the case study office building showing the extent of glazing area