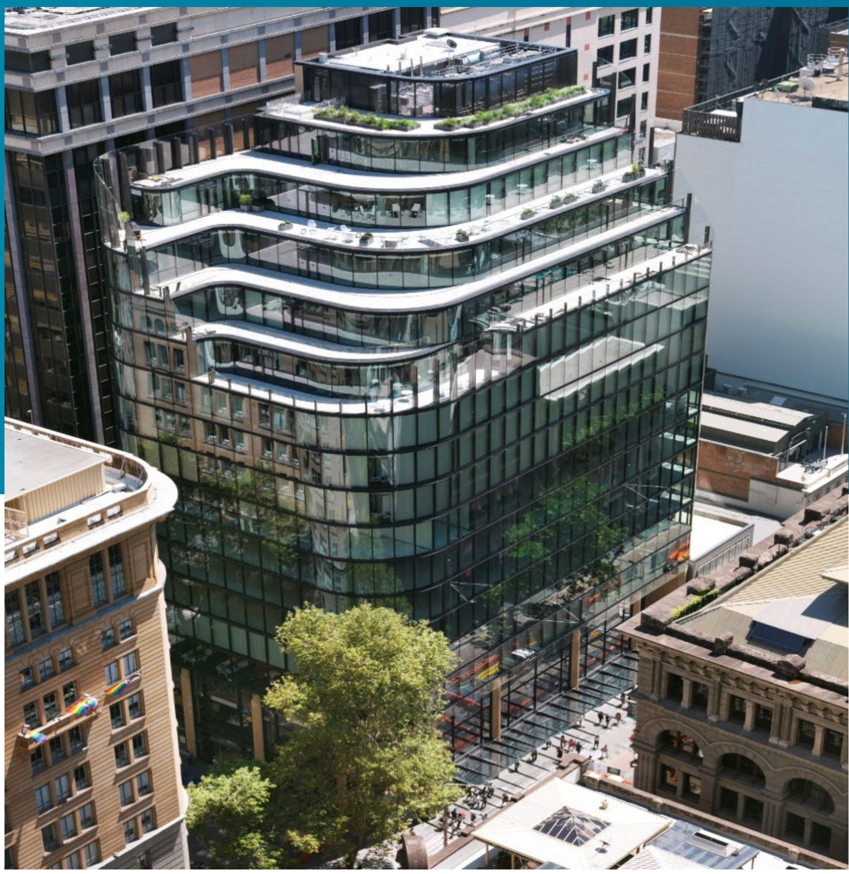
Handbook

Estimating NABERS ratings

Version 3.2 — November 2024



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1 Introduction

1.1 General

This Handbook has been developed by the **National Administrator**. It outlines how a **space type's** energy consumption (and therefore its NABERS performance star rating) can be estimated prior to operation. This **estimation** can be used in a **NABERS Energy Commitment Agreement**.

A **NABERS Energy Commitment Agreement** permits the use of the relevant NABERS energy trademark after specific conditions have been met and prior to completing an accredited rating.

Note: **Estimation** alone does not permit the use of the NABERS trademark.

This Handbook must be read in conjunction with the following:

a) Current version of the **NABERS Energy Commitment Agreement** contract.

b) Current version of the NABERS **Rules** for the relevant **space type** current at the **date of agreement**.

c) Any further NABERS **Rulings** for the relevant **space type**.

These documents take precedent over any information provided in this Handbook.

This Handbook will supersede the following documents:

1) *NABERS Handbook for estimating NABERS ratings,* v2.0, 2021.

2) *NABERS Energy Guide to Building Energy estimation*, 2011 (withdrawn).

3) *NABERS Energy Guide to Tenancy Energy estimation*, 2011 (withdrawn).

1.2 Background

1.2.1 Who this Handbook is for

This Handbook is provided for those developing an **estimate** (i.e. the **Estimator**) of the energy consumption of a **space type** for a **NABERS Energy Commitment Agreement**.

If you are a developer or project manager entering into a **Commitment Agreement** and you require guidance on procuring or using a NABERS **estimate**, refer to the information available on the NABERS website and/or your **Commitment Agreement** contract.

1.2.2 NABERS Energy Commitment Agreement

The **NABERS Energy Commitment Agreement** allows developers, building owners and tenants to promote and market the expected greenhouse performance of a new or refurbished space type from the design stage.

1.2.3 NABERS Independent Design Review

After entering a **Commitment Agreement**, the proponent must develop an energy **estimate** in accordance with this Handbook.

This **estimate** must then be reviewed by a NABERS **Independent Design Reviewer**. The **Reviewer** must be independent of the design team and the review must be undertaken sufficiently early in the design process to enable design changes to be made. The cut-off for the Independent Design Review is the granting of a construction certificate (or equivalent) for the project.

The NABERS **Independent Design Reviewer** will review all aspects of the assumptions, design documentation and model used by the **Estimator** to identify risks and opportunities in relation to the NABERS rating. The **National Administrator** will review the Independent Design Review report and get back to the **Independent Design Reviewer** with any questions as part of the approval process. Based on the suggestions made by the **Independent Design Reviewer** and the **National Administrator**'s reasonable opinion, the **National Administrator** may terminate the **Commitment Agreement** or modify the star rating target.

1.2.4 Relationship to requirements by the GBCA, NCC, NatHERS and BASIX

The purpose of this Handbook is to create an energy consumption **estimate** that reflects how the **space type** is expected to operate. This is distinct from energy consumption **estimates** that are developed for the purpose of verifying that a design complies with the **National Construction Code (NCC)** or Green Star design targets.

However, where the **Estimator** reasonably believes that principles or inputs used in Green Star, Section J of the **NCC**, NatHERS, BASIX or elsewhere match expected operation then these may be used to **estimate** aspects of performance for a **Commitment Agreement**.

1.2.5 The role of estimation in design

Estimation in accordance with this Handbook is compulsory for all NABERS **Commitment Agreements**. A checklist for reporting the **estimate** to **Independent Design Reviewer** can be found in Section 5.7 of this Handbook.

Estimation works best when—

a) it is used to inform decisions from early design through to post-construction tuning;

b) assumptions made about the operation of systems reflect expected operation; and

c) limitations are clearly disclosed.

The use of estimation purely for a single-point prediction of performance or compliance represents poor practice and is discouraged.

For estimations used with the **Commitment Agreement**, a range of **off-axis scenarios** must be addressed as part of an energy efficiency risk assessment. **Off-axis scenarios** test the building's response to changes in operating patterns. Minimum requirements around **off-axis scenarios** and **off-axis models** are outlined in Section 4.13 of this Handbook.

1.2.6 Disclaimer

It is the responsibility of the **Estimator** to comply with all requirements as far as is possible.

Where an issue of technical interpretation cannot be resolved between the **Estimator** and the **Independent Design Reviewer**, the NABERS **National Administrator** may be approached to resolve the issue.

No party associated in any way with the production or distribution of this Handbook accepts any liability for any loss, financial or otherwise, caused directly or indirectly in association with the use of this Handbook. In all cases, the sole responsibility for the estimation lies with the project team, not the NABERS Administrator.

Persons or organisations quoting NABERS energy ratings that are not substantiated by a NABERS certified rating or a signed NABERS Energy **Commitment Agreement** contract are in breach of trademark and may be subject to legal proceedings. This includes advertising and/or promoting projects to achieve a NABERS rating or a specific star rating without a formal **Commitment Agreement** in place.

1.3 How to use this document

Text appearing **dark green** and **bold** is a defined term. Defined terms can be found in Chapter 2 of this Handbook or in the terms and definitions chapter of related documents.

The following formatting conventions may appear in this text:

⚠ Important requirements and/or instructions are highlighted by an information callout box.

Note: Text appearing with a grey background is explanatory text only.

Example: Text appearing with a green background is intended to demonstrate a worked example of the corresponding text.

1.4 Related documents

The following documents have been referenced within this Handbook:

2021 ASHRAE Handbook — Fundamentals, Materials, Chapter 29 Refrigerants

AIRAH, *Methods of calculating Total Equivalent Warming Impact (TEWI) 2012*

ANSI/ASHRAE Standard 140-2020 — *Method of Test for the Evaluating Building Performance Simulation Software*

AS 1668.2—2012, *The use of ventilation and airconditioning in buildings, Part 2: Mechanical ventilation in buildings*

ASHRAE TC9.9, *Data Center Power Equipment Thermal Guidelines and Best Practices*, 2016

Australian Building Codes Board, NCC 2022 Building Code of Australia, Volume 1

CIBSE, *Guide A: Environmental Design*, Chapter 6 Internal Heat Gains, Section 6.6 Electric motors, 8th ed, 2015

GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*, at www.gbca.org.au

W.B Gosney and H.A. Olama, “Heat and Enthalpy Gains through Cold Room Doorways”, *The proceedings of the Institute of Refrigeration*, Environmental Science and Technology, The Polytechnic of the South Bank, London, 1975, pp 35–38

ISO 25745-2:2015, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*

Neil Rasmussen, *Electrical Efficiency Modeling for Data Centers*, White Paper 113, Revision 2, Schneider Electric, 2011

NZS 4214:2006, *Methods of determining the total thermal resistance of parts of buildings*

Tim Ward, Graeme Hannah and Chris Sanders, *Conventions for calculating linear thermal transmittance and temperature factors* (BR 497 2nd ed), BRE Electronic Publications, 2016

2 Terms and definitions

This chapter lists the key terms and their definitions that are integral to the proper use of this document.

Term	Definition
after-hours air conditioning (AHAC)	The delivery and maintenance of a facility's heating and air-conditioning services, outside regular operating hours, for the benefit of a tenant.
Assessor(s)	An accredited person authorised by the National Administrator to conduct NABERS ratings.
base case model	A reference model that represents the space type as it is expected to operate.
co-located residential aged care and retirement living facility(ies)	A facility that has a residential aged care facility and retirement living facility located within the same site area.
date of agreement	Agreement date means the date the Commitment Agreement fee payment has been received and NABERS/NSW Government have counter-signed the Commitment Agreement contract. The agreement date will be designated by NABERS/NSW Government.
estimate(s)/estimation	A realistic estimate of the NABERS rating of a new or refurbished space type, developed in accordance with the requirements of this Handbook. **Note:** The estimate does not constitute a NABERS Accredited Assessment.
Estimator(s)	The person who develops the NABERS estimate. While there are no compulsory requirements for the Estimator's qualifications or experience, the Estimator's skills should include the following: a) Ability to conduct a NABERS performance assessment for the relevant project type. This could be demonstrated, e.g. if the Estimator is a NABERS Assessor. b) Ability to construct a thermal simulation in an appropriate simulation package.

Term	Definition
	c) Ability to identify performance risks that are likely to emerge for the types of building, services and technology covered by the estimate. This could be demonstrated, e.g. by the Estimator's experience working in existing buildings of this type.
Gross Lettable Area Retail (GLAR)	The floor area, determined in accordance with the Measurement Standard for shopping centres, of spaces that can be used as retail tenancies within the premises to be rated. **Note:** This is essentially the space within the permanent walls of the building, excluding spaces for the following: a) Public access and use (including stairs, escalators, lift lobbies and passageways). b) Building, mechanical, air conditioning, electrical and other utility services. c) Staff and cleaning facilities (including toilets, tea rooms and cleaners' cupboards) which are not part of a tenant's fit out. Tenant storage areas not adjacent to the tenancy are also excluded.
heating, ventilation and air conditioning (HVAC)	Any system that is used for heating, ventilating or conditioning the air in an enclosed space.
Independent Design Reviewer(s)	A person appointed by the project proponent to review the NABERS estimate for compliance with this Handbook. The Reviewer will also assess all aspects of the design, documentation and project team assumptions for NABERS risks and opportunities and report back to the project design team. The Independent Design Reviewer must have the following attributes: a) Member of the NABERS Independent Design Review panel (appointed and maintained by the NABERS National Administrator). b) Independent of the project design team. c) Independent of the NABERS Estimator.
metering system	Device(s) providing an individual measurement which include all of the following:

Term	Definition
	a) Meter. b) Processes that convert the initial meter signal into an energy reading (e.g. current transformers and K factors for electricity meters and pressure correction factors for gas meters). c) Interface through which the meter reading is taken, e.g. manual readings, utility software or a building management system.
minimum energy coverage	Minimum scope of energy consumption to be included in a NABERS rating. The minimum energy coverage is defined in the relevant version of the Rules.
NABERS Energy Commitment Agreement(s) (Commitment Agreement(s))	A contract between the NABERS National Administrator, the NSW Government and the building proponent to design, build and commission the premises to achieve a NABERS energy star rating of four (4) or more. For office base buildings, a minimum star target rating is five (5) stars. If this contract is used to meet NCC energy efficiency requirements, the minimum star target ratings that apply for relevant space types are as follows: a) Office base building: 5.5 stars. b) Apartment building: Four (4) stars. c) Hotel: Four (4) stars. d) Shopping centre: 4.5 stars.
National Administrator	The body responsible for administering NABERS, in particular the following: a) Establishing and maintaining the standards and procedures to be followed in all aspects of the operation of the system. b) Determining issues that arise during the operation of the system and the making of ratings. c) Accrediting Assessors and awarding accredited ratings in accordance with NABERS standards and procedures.

Term	Definition
	The functions of the National Administrator are undertaken by the NSW Government.
National Construction Code (NCC)	The National Construction Code is Australia's primary set of technical design and construction provisions for buildings. As a performance-based code, it sets the minimum requirements for the safety, health, amenity, accessibility and sustainability of specific buildings. **Note:** Where the NCC is referenced in this Handbook, the relevant version to be used is the one that applies to that project. This version information is usually determined by the date the project was lodged with the local council or relevant authority and is determined by the State or Territory department governing building regulations in the State or Territory the project is located in. NCC sections referenced are for the 2022 version.
off-axis model(s)	A model that represents the space type after factoring in a minimum of four (4) off-axis scenarios.
off-axis scenario(s)	A scenario representing operational change(s), such as how a building is occupied, controlled or maintained. Off-axis scenarios are designed to test a building's ability to reach the targeted star rating with modelled changes to assumptions and inputs.
online calculator	The online calculator is available on the NABERS website. It allows the calculation of the star rating that would be achieved given specific rating calculation inputs.
prediction tool	The prediction tool is available on the NABERS website. Prediction tools estimates the potential impact on NABERS energy ratings due to forecasted National Greenhouse Accounts (NGA) Emissions Factors on 1 July 2025 and 1 July 2030.

Term	Definition
rating period	The 12-month base period for the rating, requiring at least 12 continuous months of acceptable data upon which the rating is based.
rating scope	The rating scope identifies what energy coverage is required for a rating, and what inputs and methodologies are required to calculate the rating result. For offices, rating scope includes the following: a) Base building. b) Tenancy. c) Whole building. For data centres, rating scope includes the following: 1) IT equipment. 2) Infrastructure. 3) Whole facility. For residential aged care and retirement living, rating scope includes the following: i) Residential aged care. ii) Retirement living. iii) Co-located residential aged care and retirement living.
Rules	Authoritative document produced by the National Administrator that specifies what must be covered by an Assessor in order to produce a rating.
Ruling(s)	An authoritative decision by the National Administrator which acts as an addition or amendment to the Rules.
simulation model(s)	An entire building energy model used to calculate the thermal performance of a building in response to its external environment (e.g. weather) and internal loads, e.g. occupants and equipment. The calculation process must account for hourly changes in loading, internal conditions, and the impact of the thermal inertia of the building. Minimum outputs from the simulation model include energy consumption, internal temperatures achieved and plant and equipment loading.

Term	Definition
	The thermal simulation model may be supplemented by a variety of other estimates such as simple spreadsheet calculations (e.g. for lift energy) or other simulation tools, e.g. for light levels.
simulation package(s)	A software package used to input, run and report on the thermal simulation model. The simulation package must meet the requirements of ANSI/ASHRAE Standard 140. The simulation must contain a thermodynamic representation of the building, its content and its environment. The thermal simulation model may be supplemented by other simulation tools (such as a simulation of light levels or data centre IT equipment) for small/low energy consuming systems. All large systems, such as the HVAC central plant, must be modelled in an appropriate simulation package. **Note:** A variety of other estimation techniques may be used for small/low energy consuming systems, but all methodologies and assumptions must be described and disclosed for the Independent Design Review. For refrigeration systems, a separate software package may be used to input, run and report on refrigeration system energy consumption.
space type(s)	A building, or part of a building able to have its future operational performance Estimated through a NABERS Commitment Agreement. The space types covered by the Commitment Agreement process are as follows: a) Office. b) Office tenancy. c) Shopping centre. d) Hotel. e) Data centre. f) Apartment building. g) Residential aged care and retirement living. h) Warehouse and Cold Store. i) School. j) Retail store. Some space types have multiple rating scopes available.

Term	Definition
	For further information on rating scopes that apply for the relevant space types, see the rating scope definition above.

3 Determining inputs and scope using NABERS Rules

3.1 General

NABERS energy awards stars are based on greenhouse gas performance, with a higher number of stars for better performance.

Note: A NABERS rating **estimation** does not constitute an accredited NABERS rating.

An accredited rating can only be provided after a period of operation and must be performed by an **Assessor**.

An **Assessor** should be consulted prior to the project entering into a **Commitment Agreement.**

If there is any doubt as to the application of the NABERS energy **Rules** to the project, advice should be sought from an **Assessor**.

3.2 NABERS rating inputs

An estimated NABERS rating is calculated using an **estimate** of energy consumption along with a number of other inputs. These inputs are then entered into the NABERS **online calculator** at www.nabers.gov.au. A list of these inputs (current at the time of publishing) is listed at Table 3.2, however the calculator should be checked for the input requirements current at the **date of agreement**.

These input calculations can be found in the relevant section of the NABERS **Rules** and other **Rulings** released by the **National Administrator**.

For each rating input, the intended operational value should be used. Variations on these inputs, including vacancy rates, should be modelled in **off-axis scenarios**.

An estimated NABERS rating, and the performance rating used to verify the outcome of a **Commitment Agreement**, is always a rating calculated without GreenPower™ or other off-site renewable energy.

Table 3.2: Rating inputs

Rating type	Rating scope	Rating inputs
Office	Base building	a) Address. b) Postcode. c) Rated area.

Rating type	Rating scope	Rating inputs
		d) Rated hours. e) Annual energy consumption.
	Whole building	a) Address. b) Postcode. c) Rated area. d) Rated hours. e) Annual energy consumption. f) Computer count.
	Tenancy	a) Address. b) Floor/level. c) Postcode. d) Rated area. e) Rated hours. f) Annual energy consumption. g) Computer count.
Shopping centre	N/A	a) Address. b) Postcode. c) Rated area. d) Centrally serviced shopping centre area. e) Mechanically ventilated car parking spaces. f) Naturally ventilated car parking spaces. g) Annual number of trading days. h) Weekly hours of service. i) Floor configuration. j) Annual energy consumption.
Hotel	N/A	a) Address. b) Postcode c) Hotel star rating. d) Hotel rooms. e) Hotel rooms with full-service laundering. f) Function room seats. g) Surface area of heated pools. h) Annual energy consumption
Data centre	IT equipment	a) Address. b) Postcode. c) Processing capacity. d) Storage capacity.

Rating type	Rating scope	Rating inputs
		e) Annual energy consumption.
	Infrastructure	a) Address. b) Postcode. c) Annual energy consumption of IT equipment. d) Annual energy consumption of whole data centre.
	Whole facility	a) Address. b) Postcode. c) Processing capacity. d) Storage capacity. e) Annual energy consumption.
Apartment building	N/A	a) Address. b) Postcode. c) Number of apartments. d) Service categories for energy, e.g. central air conditioning, lifts, pools, gym. e) Car parking spaces. f) Annual energy consumption.
Residential aged care and retirement living facility	Residential aged care	a) Postcode. b) Occupied bed days (OBDs). c) Heated pool surface area. d) Presence of on-site heavy laundry (Yes/No). e) Number of meals cooked on-site for non-residential aged care residents.
	Retirement living	a) Postcode. b) Average weekly meals cooked on-site. c) Number of dwellings. d) Heated pool/unheated pool surface area. e) Number of serviced apartments. f) Site area.
	Co-located residential aged care and retirement living	a) Postcode. b) Occupied bed days (OBDs). c) Presence of on-site heavy laundry (Yes/No). d) Number of dwellings. e) Heated pool surface area. f) Site area.

Rating type	Rating scope	Rating inputs
		g) Average weekly meals cooked on-site for non-residents. h) Average weekly meals served to residential living residents.
Warehouse and cold store	N/A	a) Postcode. b) Conditioned area. c) Non-conditioned area. d) Cold room volume. e) Cool room volume. f) Weekly operating hours. g) Full-time equivalent employees. h) Annual turnover ratio. i) Annual energy consumption.
School	N/A	a) Postcode b) School Sector c) Remoteness area classification. d) Gross floor area (GFA). e) Students enrolled f) Student types g) Presence of swimming pool or spa (Yes/No) h) Annual energy consumption.
Retail Store	N/A	a) Postcode b) Rated Area c) Retail Category d) Location type e) Servicing arrangement f) Weekly trading hours

4 Estimating energy using a simulation

4.1 General

Energy consumption must be estimated by simulating a new or refurbished **space type** as it is expected to operate in situ using best practice inputs and principles.

Estimates for major energy systems and equipment, such as **heating, ventilation and air conditioning (HVAC)**, must be completed using a compliant dynamic **simulation software package**. However, it is recognised that for other small/low energy consuming systems, a spreadsheet will often be sufficient (such as for domestic hot water or back-of-house lighting). When supplementary manual calculations have been used, they must be disclosed for the **Independent Design Review**, along with justification for use. This should include a description of the methodology and commentary on any limitations of this calculation method. Effects on the results of the calculation must be described.

This section outlines best practice inputs and principles. The **Estimator** must address all relevant items and comply with any requirements described. If variations are necessary, they must be adequately noted and justified. **Off-axis scenarios** modelled and their impact on predicted rating results should be listed in the **Estimator's** report.

Wherever possible, the inputs to the model should reflect expected operation. If this information is not available, Appendix A provides guidance on defaults that can be used. Any use of defaults should be a last resort. The use of defaults must be justified by the **Estimator**.

The **Estimator** must distinguish between the energy consumed by appliances or lighting, and the **HVAC** heat loads produced by this equipment. The **Estimator** must ensure that each impact is treated in accordance with the NABERS **Rules**.

Example: For an office base building rating, tenant equipment loads must be considered as an **HVAC** load, but the actual energy consumption of the plug load is not considered. In the office whole building rating however, both the **HVAC** load and the plug load must be included in the **estimate**.

In addition, not all sections are required for all **rating types**, e.g. in this chapter, only Sections 4.3, 4.7 and 4.11 are relevant to a NABERS Data Centre IT equipment rating.

4.2 HVAC software simulation package and model

Simulation packages should be used for the calculation of all **HVAC** energy.

All **HVAC simulation packages** and models have limitations. It is critical that the client and the **Estimator** understand the limitations of the simulations and any models developed in order to adequately interpret the validity of the final results.

The **Estimator** is to confirm the ability of the proposed **simulation packages** to model the **space type** as part of the report delivered to the **Independent Design Reviewer**. The **Estimator** will do the following:

a) Establish that the **simulation package(s)**—
   1) supports the development of a dynamic energy **simulation model**, assessing performance on an hourly basis for a full year; and
   2) validates through ANSI/ASHRAE Standard 140.

b) Establish that the **HVAC** plant and system **simulation package(s)**—
   1) represents the proposed air conditioning system and controls with reasonable accuracy; and
   2) allows part load/low load performance, staging (if applicable), minimum downturn and control strategy characteristics of plant and system components to be included. Most models make compromises in this area and these can lead to significant differences between predicted (simulated) energy use and actual (operational) energy use.

c) Establish that the glazing or window model—
   1) accounts for the varying angles of incidence of direct solar radiation;
   2) accounts for the total U-value and total SHGC performance; and
   3) calculates daylighting effects (if applicable).

d) Identify any other aspects that have not been modelled accurately or where compromises have been made.

4.3 Data centre IT equipment simulation package

When IT equipment energy use is estimated for an IT equipment or whole facility **Commitment Agreement**, an appropriate Cloud **simulation package** must be used to represent the proposed hardware architecture.

Such implementation will require specialist input from a data centre analyst.

4.4 Refrigeration system

When refrigeration equipment energy use is estimated for any refrigerated areas in a warehouse (such as a cold room, cool room or any blast freezing connected to the same system as the cold and cool room(s)), an appropriate **simulation package** or spreadsheet-based calculation will be used to represent the proposed refrigeration process load.

If a **simulation package** is used, it will be capable of the following:

a) Dynamic simulation and representation of the system size.

b) Representation of the thermodynamic properties of different refrigerant types.

c) Refrigeration system calculations at a component level.

d) Analysis of operating conditions.

e) Transient simulation based on different refrigerated product types, product throughput, product temperature pre- and post-entering the cold or cool room.

The **Estimator** will ensure that the energy calculations include the following:

1) *Refrigerant types*: This includes where multiple refrigerants are used in the system.
2) *Set up of the system*: This includes whether it is a conventional or cascade configuration.
3) *Condenser types*: This includes whether it is water-cooled or air-cooled.
4) *Defrost technologies.*
5) *Evaporator set up*: This includes whether it is liquid overfeed, flooded evaporators or otherwise.

Regardless of the method used to calculate the refrigeration system energy consumption, the calculation process must align with AIRAH, *Methods of calculating Total Equivalent Warming Impact (TEWI) 2012.*

Note: The AIRAH methods provide best practice guidelines for calculating indirect emissions factors, i.e. total annual electricity consumption.

4.5 Weather data

4.5.1 General

Weather data used in the energy **estimation** must be sourced from a weather station with a climate that represents the local **space type**. Caution must be taken in some cities which exhibit a range of distinct weather patterns across the urban area.

Weather data should include a reference year dataset for a local weather station representative of the area. Weather data must use actual recorded solar radiation, temperature and humidity data from the local weather station or other site-specific source.

Climate data must consist of one of the following:

a) ACADS-BSG/CSIRO Nominated Test Reference Year (TRY).
b) Typical Meteorological Year (TMY).
c) Variants of Weather Year for Energy Calculations (WYEC).
d) International Weather Year for Energy Calculation (IWEC).
e) Other standard weather year data.

Consideration should be given as to whether current or predicted future climate files are relevant to the project or **off-axis scenarios**.

4.5.2 Alternative analysis

If no climate files are available for the site, then any alternative methodology used (i.e. multiple years) must be justified by the **Estimator**.

Additional analysis should be used to quantify the potential effect of non-average weather conditions and climate change on future ratings. Predictive (future) weather files have been developed and are available on the Commonwealth Scientific and Industrial Research Organisation (CSIRO) website for this purpose.

Two types of weather files are being made available for modelling commercial buildings, first, updated 'typical meteorological year' weather files and second, 'predictive weather' files. The typical meteorological year weather files were developed in 2016. The predictive weather files will allow building designs to be simulated against expected weather to test performance more accurately. These files use detailed Australian weather data, up to and including the year 2015, across 80 Australian locations.

The CSIRO has also developed predictive weather files for commercial buildings based on the 2016 files. The CSIRO provides both sets of files, available for free, on its Ag Climate Data Shop website. This is the central portal for all of CSIRO's agriculture-related weather and climate data.

Note: A user guide for each set of files is available at the following links:

a) Typical meteorological year weather files for building energy modelling at Ag Climate Data Shop (csiro.au).

b) Predictive weather files for building energy modelling at Ag Climate Data Shop (csiro.au).

Care should be taken by the **Estimator** if manipulating weather data files. Changes due to climate change could potentially be modelled by using the site-specific weather data with the highest dry bulb data in the last 10 years.

4.6 Building elements

The building model used in the simulation software must be a close representation of the designed building's physical shape and materials. The building should be modelled in zones that represent the operational and thermal characteristics of its location. This includes representation of the building in which a data centre or tenancy is housed. The following items must be taken into account, where relevant:

a) *Building form*: The building form must be modelled completely, with all levels represented (for multi-storey centres).

b) *External shading*: Shading must be represented comprehensively, including shading devices such as awnings, fins and overhangs, self-shading by parts of the structure and shading by neighbouring buildings and trees. In locations where hills cause the horizon to be substantially higher than a flat plane, additional shading or horizon modelling must be included to represent the impact of this on building performance.

c) *Glazing systems*: Window/glazing systems must be modelled with an incident angle modifier function. The model should allow for specification of a complex glazing system by using NFRC/AFRC product spectral data or custom measurements from an appropriate measurement laboratory. This is particularly important when the window-to-wall ratio exceeds 25 %. Impact of frame U-values must also be considered.

d) *Insulation*: Model input must account for thermal bridging effects in insulated wall, floor and ceiling systems.

Note: For further guidance on how to model thermal bridging, the **Estimator** can refer to NZS 4214 or Ward, Hannah and Sanders, *Conventions for calculating linear thermal transmittance and temperature factors*.

e) *Orientation*: Building orientation must be correctly modelled.

f) *Impact of car parks on **HVAC** loads*: Where basement parking is provided, at least one (1) level of basement car park must be modelled to account for heat transfer/comfort impacts between unconditioned basement and conditioned ground floor. Infiltration rates in the basement should reflect the car park ventilation system in operation.

g) *Car park lighting and ventilation*: Where car park lighting and ventilation energy is to be estimated, schedules accounting for movement sensor lighting control and CO controlled car park ventilation should be applied if fitted.

4.7 Occupancy

The modelled occupancy should reflect a realistic projection of the operating patterns of the site.

This can be based on the operating patterns of the previous site(s) if such data is available. If a space is not intended for occupancy by people, such as in a data centre, then this should be modelled.

Note: Variation in occupancy at different times of the year should be considered where appropriate, e.g. in summer for shopping centres and during school holidays for schools.

Variation in occupancy throughout the week, e.g. working from home patterns, may also need to be considered for some **space types**.

Where occupation is unknown, a default value and schedule as deemed appropriate by the **Estimator** can be used, see examples of defaults in Appendix A.

Design occupant densities should not be used as these are normally intended to be maximum loads rather than typical operational loads.

4.8 Lighting

4.8.1 General

The **Estimator** should distinguish between the lighting electricity consumption and the **HVAC** heat load produced by the lighting, to ensure that each element is treated correctly under NABERS.

Lighting energy consumption **estimates** should be based on the specified design and expected operating patterns for the intended occupants.

Where the lighting design is unknown, a default value and schedule as deemed appropriate by the **Estimator** can be used. Examples of defaults are given in Appendix A, however, the **appropriateness** of these default values should be considered in relation to project specifics.

Lighting energy consumption should also include any exterior lighting or signage which is covered by the NABERS **Rules** under **minimum energy coverage** for the relevant **rating type** and **rating scope**.

4.8.2 Power density

The installed lighting power should be assessed from the lighting layout drawings and luminaire schedules.

The power consumption used for individual fittings must include the power consumption of the lamp along with any associated control gear and transformers. The total circuit watts of these components should be confirmed by manufacturer's data or by in situ measurement.

4.8.3 Hours of use

The lighting schedule should be set to represent the expected operating pattern, including the effect of automatic control systems. **Estimators** are also advised to give particular consideration of the after-hours operation of lights for occupancy, cleaning, security and council requirements, including for external lighting.

Consideration should also be given to using different lighting schedules in the common areas used to service after-hours spaces and any sections with different operating hours.

Where daylight controls are to be fitted, a **simulation package** with daylight modelling capability should be selected. If this is not available, then a separate assessment of daylighting effects should be undertaken and incorporated into the model.

Note: Occupancy detectors will require some judgement in relation to expected occupancy patterns.

In shopping centres, hotels and residential aged care facilities, there will be a degree of variation between the different areas in the buildings.

Further guidance is provided in Appendix A in relation to the development and application of operating schedules for various types of spaces. **Estimators** should consider this information when establishing operating schedules for their **estimate**, even where defaults are not used.

4.9 Equipment

4.9.1 General

The **Estimator** should distinguish between the equipment electricity consumption and the **HVAC** heat load produced by the equipment, to ensure that each element is treated correctly under the NABERS **Rules**.

If the fit out and occupants are known, the specified loads should be modelled. Hourly operating schedules should be developed based on the intended occupants/tenants. Back-of-house equipment energy consumption should also be included.

Where the equipment levels are unknown, a default value and schedule as deemed appropriate by the **Estimator** can be used, examples of defaults in Appendix A.

Note: Back-of-house equipment energy consumption may also need to be included. For further information, refer to energy coverage under the NABERS **Rules**.

4.9.2 Equipment loads

Loads based on fit outs should be modelled on a zonal basis to ensure that the variability of loads passed through to the air-conditioning is captured, see system loads when modelling equipment loads in Section 4.10.3.

4.9.3 Equipment hours of operation

The equipment schedule should be set to represent the expected operating pattern. It is common during this process for a portion of equipment to be left operating overnight, or on standby.

In shopping centres and hotels, there will be a degree of variation between the different areas in the buildings.

Note: For further information on the development and application of operating schedules for various types of spaces, see Appendix A.

Estimators should consider this information when establishing operating schedules for their **estimate**, even where defaults are not used.

4.9.4 Data centre IT equipment

As specified in Section 4.3, where IT equipment is specified (e.g. in relation to a whole facility or IT equipment **Commitment Agreement**), IT equipment energy should be simulated using an appropriate Cloud **simulation package** to represent the energy consumption of the proposed hardware architecture. This will require specialist input from a data centre analyst.

For IT infrastructure projects, where the details of IT equipment selections are unlikely to be available, a range of equipment loads should be simulated to allow for uncertainties, e.g. varying from 50 % to 150 % of the projected load based on business forecasting.

Note: For further guidance and background information, see Section A.7.3.

The **estimate** should also represent diverse IT equipment loading across different parts of the facility in areas served from different air conditioning systems and PDUs. In particular, loading on individual air handling units (AHUs) or power distribution units (PDUs) could be varied from 10 % to 100 % of design loads while maintaining the overall loading in the centre at a fixed value set with reference to the business growth projection.

4.9.5 Warehouse and cold stores automation equipment

Simulation of the energy consumption for automation equipment, such as conveyor belts and automated machinery, should be in accordance with similar principles outlined in Sections 4.9.2 and 4.9.3.

The intended operation listed in design documentation or provided by the production team should be developed based on the following:

a) Expected equipment load.

b) Duty cycle.

c) Equipment hourly operating profiles.

d) Zonal variation.

The above information may require specialist input from a warehouse process engineer.

If site-specific information regarding the automation equipment and intended operation of automation equipment cannot be determined, the **Estimator** will provide a best **estimate** based on available data, experience and/or reference from comparable sites. This may require specialist input from a warehouse process engineer or business representative with a strong knowledge of the relevant warehouse and/or cold store operation and processes.

4.10 HVAC plant and systems

4.10.1 HVAC configuration

The **HVAC** plant and system input to the simulation program must be an accurate representation of intended operation. This includes the specified number, capacity and configuration of plant and equipment, including but not limited to the following:

a) Air handling units.

b) Boilers.

c) Chillers.

d) Cooling towers.

e) Fan coil units.

f) Pumps.

g) Terminal units.

Default performance curves built into the **simulation package** for part load and low load operation must be replaced by realistic performance data for the specified equipment.

Estimators should also note that plant performance quoted by manufacturers is generally presented under standard condenser air and water conditions which do not correctly represent part load conditions. The **Estimator** should contact the manufacturer to request performance data that represents the intended condenser air and temperature controls.

4.10.2 System control

The **Estimator** must consider how well the simulated control system represents the designed control system. Some key problem areas where there is often misalignment are as follows:

a) Economy cycle for an air-based system.

b) Primary duct temperature control for air-based systems.

c) Control of airflow for variable speed fan systems.

d) Chiller sequencing and part load performance for larger chilled water plant.

e) Turndown ratios for large equipment.

f) Control loop type, e.g. proportional, proportional-integral (PI) or proportional-integral-derivative (PID).

Estimators must also consider target temperature control ranges. While there is no specific range required for NABERS, air conditioning within the conditioned space should meet requirements outlined in the **NCC**. NABERS **Rules** requirements should also be considered regarding plant warm-up time before rated hours when the space should be safe, lit and comfortable. Temperature ranges may also differ throughout different areas of a project, e.g. in patient rooms in aged care facilities.

4.10.3 System loads

Internal loads are not likely to be evenly distributed in the space. Zonal variation should be built into the model.

In addition, fans place a heat load on **HVAC** systems which must be considered in addition to their power use.

4.10.4 Additional considerations for data centres

In addition to the items listed in Section 4.9.4, the following items should be considered for data centres:

a) *Hot/cold aisle and UFAD representation*: These types of data centre cooling systems *require* careful model setup. In order to represent this, the data centre *space* must be divided into multiple zones based on the hot and cold areas of the space, contrary to the ‘fully mixed zone’ default assumption in energy **simulation models**. This means that zoning should be set up with hot aisle, cold aisle and in-rack temperatures as appropriate.

b) *Electrical infrastructure efficiencies*: Part-load efficiencies of Uninterruptible Power Supply (UPS) and Power Distribution Unit (PDU) components are technology-dependent and should be based on manufacturer’s curves or verified performance data.

c) *Redundancy*: The model should represent the proposed redundancy configuration as this will affect the way the load is spread between the plant and electrical components.

4.10.5 Additional considerations for conditioned area in warehouses

In addition to the items listed in Section 4.9.5, the following items should be considered for conditioned area in a warehouse and cold store facility:

a) Thermal mass and specific heat of products stored in conditioned areas.

b) Temperature of products pre-entering conditioned areas.

c) Product throughput (average weekly or similar depending on the site activity).

d) Infiltration to conditioned area, including where activity patterns, e.g. number of workers entering/exiting the conditioned area to move product.

e) Cooling loads from automation equipment.

4.11 Refrigeration plant and systems

4.11.1 Refrigeration system configuration

The refrigeration plant and system input to the **simulation package** or spreadsheet calculation will be an accurate representation of the intended operation. This input information should include the specified number, capacity and configuration of plant and equipment, including, but not limited to, any of the following:

a) Compressors.

b) Cooling towers.

c) Pumps.

d) Evaporators.

e) Other terminal units.

For high-rise systems, stratification effects should be considered.

Default performance curves built into the **simulation package** for part load and low load operation are to be replaced by realistic performance data for the specified equipment.

Note: **Estimators** should also be aware that the plant performance quoted by manufacturers is generally presented under standard condenser air and water conditions which do not correctly represent part-load conditions.

The **Estimator** should contact the manufacturer to request performance data that represents the intended condenser air and temperature controls.

4.11.2 Refrigeration system control

The **Estimator** will consider how well the simulated control system represents the designed control system. Some key areas to be considered are as follows:

a) Control of airflow for variable speed fan systems.

b) Chiller compressor's sequencing and part-load performance.

c) Turndown ratios for large equipment.

d) Control loop type, e.g. proportional, proportional-integral (PI) or proportional-integral-derivative (PID).

e) Defrost control.

f) Control of discharge pressure and suction pressure.

g) Control of cascade system.

h) Liquid overfeed control, if applicable.

i) Temperature set points.

Estimators must consider target temperature control ranges. Refrigeration system control parameters must align with the requirements outlined in the project design documentation.

Note: Target temperature ranges may differ throughout different areas of a project, e,g, cold rooms and cool rooms.

4.11.3 Refrigeration system loads

Evaporator fans place a heat load on refrigeration systems, for which its thermal load must be included in the refrigeration system energy estimate in addition to the fan power use.

In addition to the items listed in Section 4.11.2, the following items should be considered for warehouses and cold stores specifically:

a) Thermal mass and specific heat of different products stored in cold rooms and/or cool rooms.

b) Temperature of products pre-entering cold rooms and/or cool rooms.

c) Product throughput (average weekly or similar depending on the site activity).

d) Modelling of infiltration to cold rooms and cool rooms.

e) Infiltration loads, including those via loading docks and loading activities.

f) Cooling loads from automation equipment.

g) Loading pattern of product moving in and out of the refrigerated space.

h) Product respiration and transpiration rates.

i) Thermal loads arising from automation equipment within the space.

4.12 Other items

The **Estimator** must ensure that the **estimate** covers all other energy uses within the scope of the relevant **rating type** and **rating scope**.

> **Note:** Calculation methods for many of these items can be found in the Green Building Council of Australia (GBCA) *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*, available from www.gbca.org.au

These energy uses could include the following:

a) Supplementary air conditioning loops. The electrical input into supplementary units should be determined on the basis of realistic loads.

b) Standby system and/or generator fuel (including sump heaters and any other standing loads).

c) Lifts and other vertical transport.

d) Domestic hot water.

e) Car park ventilation and lighting.

f) Servicing of back-of-house areas.

g) Communications equipment.

h) Security systems.

i) Fire protection systems.

j) Building Management System (BMS).

k) Access control systems.

l) Hydraulic pumps.

m) Other building services.

n) On-site generation, in accordance with the NABERS **Rules**. Excess generation exported from the site cannot be used to improve a NABERS rating.

o) Any additional energy consumption which may need to be included due to limitations of the energy **metering system**. If energy use outside the scope of the rating cannot be excluded using metering, then it must be included in the assessed energy consumption. This reflects what will happen in practice when the project receives an actual NABERS rating.

Note: No GreenPower™ or off-site renewable energy can be used when calculating an **estimate** for a rating.

4.13 Modelling margin

As the modelling is conducted prior to construction and operation, various factors may prevent the building from reaching the targeted rating. Modellers usually incorporate a modelling margin to account for these unforeseen circumstances.

Estimators should not use a specific margin. However, NABERS requires **Estimators** to implement and justify an appropriate modelling margin for each project. This should be based on project specifics and related risk, including but not limited to the stage of the project, complexity of the **HVAC** system and level of detail/completeness of design documentation.

In cases where the Independent Design Review highlights risks associated with the modelled design, operation or control of a building, the **Independent Design Reviewer** can recommend a higher margin than the **Estimator's** original modelling margin.

Modelling margins apply to the total estimated energy. As such, the total estimated energy with modelling margin would be calculated as follows:

Total estimated energy with margin = total estimated energy × (1 + margin in %)

For the **base case model**, the estimated rating obtained with the **online calculator** will need to be calculated using the total estimated energy with margin figure.

The modelling margin does not need to be added to the **off-axis model** estimated energy consumption as outlined in Section 4.16. Rather, the modelling margin should be recalculated to understand the impact of each **off-axis scenario** modelled.

4.14 Additional considerations for data centres

The energy use of electrical power infrastructure is significant in all data centres. Key components that should be represented include the following:

a) *Uninterruptible Power Supply (UPS) losses*: UPS systems have good efficiency at high load but as loads reduce the fixed losses in these systems can become large as a proportion of total supply. These losses are a direct energy waste and can be a significant load on the **HVAC** system. Manufacturer's data on efficiency versus load characteristics for the UPS systems must be incorporated into the model, including accurate representation of efficiency at part load.

b) *Back-up power*: Back-up systems, such as generators, carry some fixed losses in terms of jacket heating plus energy consumption during regular testing. These should be represented in the model as well.

There is no need to include losses from distribution unless they are expected to be unusually high. The NABERS Energy Data Centre rating already includes a default figure of 3 % in its calculations.

Finally, if in-rack cooling fan energy is not able to be distinguished through the proposed metering arrangement, the **estimate** must include 24/7 operation of in-rack cooling fans at full rated load.

4.15 Additional considerations for hotels

Consideration should be given to the hotel grading or star rating which classifies hotels according to the level of services and facilities provided, e.g. a 2-star hotel would provide fewer amenities than a 4-star hotel. A 1-star hotel may offer more basic facilities, such as only a bed and bathroom, limited reception hours and no on-site restaurant. Ultimately, a 5-star hotel would provide more facilities and offer additional amenities such as the following:

a) 24/7 reception services.

b) Large screen TVs.

c) Minibar or fridges.

d) Hair dryers.

e) Heated pools, on-site gyms or fitness centres.

These differences, and other project-specific ones, should be considered and taken into account when modelling energy use in all hotel projects.

4.16 Additional considerations for schools

Considerations should be given to the type of students attending the schools. e.g. a school with only primary school students may have fewer workshops, specialised teaching equipment, and student laptops than a secondary school.

Should a school design include specialised equipment for the purpose of teaching, the energy usage of this equipment must be included in simulations. Additional consideration should be made where the following facilities are provided in the school:

a) Heated pools, on-site gyms or fitness centres.

b) Theatres/ auditoriums and performing arts halls - equipment used to operate these areas and run school events.

c) Power and lighting to sports halls and outdoor fields and courts.

d) Energy consumption of teaching equipment depending on the school curriculum such as the presence of kilns, metal/wood-work machinery, fume hoods.

The use of school facilities will vary throughout the year, and if the school is used by the community. As such, the following should also be considered:

1) School term and school holiday periods.

2) Community use of school facilities outside teaching hours.

The modelled duration of school terms should by default align to the relevant state's school terms but preferably be matched to the actual school term duration and timing for the school being modelled. The **Estimator** should be careful to ensure that the term start and end dates used represent the duration of terms accurately, and that start dates have been selected to coordinate with the weekday/date relationship of the weather file.

4.17 Off-axis model based on performance risks

4.17.1 General

The **base case model** should be varied in order to explore the building's resilience to real-world performance risks. The scenarios modelled should consider the risks most likely to impact the project. **Off-axis scenarios** may include the following:

a) Incomplete specification or substitution of equipment.

b) Incomplete specification or in-use change of controls.

c) Commissioning errors or omissions.

d) Changes or uncertainty in occupancy and other operating patterns including the impacts of extended low vacancies.

e) Comfort or capacity problems.

f) Challenges around the use of sub-meters to include or exclude energy from the rating.

g) Impact on the target rating of changes to emissions factors due to predicted grid decarbonisation or a rapid decarbonisation scenario.

All projects should also conduct analysis on the impact of changing emissions factors on future rating results. This is covered in more detail in Section 4.17.2. This analysis is in addition to required **off-axis scenarios** and should be reported on in the **Estimator's** report.

To quantify these risks (and opportunities), model variations should encompass a minimum of four (4) changes called **off-axis scenarios**. This will provide valuable input to the design and delivery process, and to energy management when the building is in use.

The **National Administrator** requires an absolute minimum of two (2) models for **Commitment Agreements**. The first model is a **base case model** and second is an **off-axis model** incorporating a minimum of four (4) **off axis scenarios**. Analysis on the impact of changing emissions factors is in addition to the **base case model** and **off-axis scenarios**.

The scenarios should be chosen to test the impact of parameters that are the least well defined, have the potential for high impact to a project or are deemed to have a high likelihood of occurring.

Potential parameters are listed in Sections 4.17.3 to 4.17.10. These parameters apply to a variety of **space types** and **rating types** but should be adapted based on the servicing arrangements in each individual project being assessed.

> **Note:** For further information on data centres, see Section 4.17.11. For further information on warehouses and cold stores, see Section 4.17.12.

The modelling margin as outlined in Section 4.13 does not need to be applied to the **off-axis model estimate**.

4.17.2 Grid decarbonisation and changing emissions factors

In July 2021, after extensive stakeholder consultation, NABERS updated the way that energy ratings are calculated to reflect that the electricity grid is decarbonising. This means that energy performance ratings will now be calculated based on greenhouse gas emissions factors that are updated every five (5) years with the latest emissions factors. This is instead of the fixed emissions factors used when NABERS energy ratings were first developed.

This change means that the emissions factors current at the design stage of a building may be different to the emissions factors current when the required performance rating is undertaken for the building.

To help **Estimators**, **Independent Design Reviewers** and building owners understand the potential impact of these changes, NABERS has released the **prediction tool**.

The **prediction tool** is available on the NABERS website and uses available data to provide an **estimate** of what star ratings may be when the emissions factors are next updated. These **estimates**, or others deemed appropriate and justifiable by the **Estimator**, should be used to understand any impacts to future performance ratings of changing emissions factors.

Note: As the target rating for a **Commitment Agreement** is calculated using the emission factors current at the **date of agreement**, there is potential uncertainty if a certified performance rating is calculated using different emission factors. As such, all **Commitment Agreement** projects retain the right to request that the achievement of a **Commitment Agreement** target rating is determined based on a rating result calculated using the emissions factors current at the time of the **Commitment Agreement** being signed with NABERS.

All projects will still need to get a certified performance rating to verify the outcome of the target rating. However, if the target rating is not achieved in the first two (2) ratings, and the project team can demonstrate that the target rating would have been achieved using the emissions factors current at the time of the **date of agreement**, the **National Administrator** can approve the agreement as being "achieved" on the NABERS website and provide confirmation of this to third parties if required.

4.17.3 HVAC controls

Common control failure modes for the particular building or system configuration are to be identified. Consideration should be given to simulating the impact of control changes or failures.

Potential scenarios include the following:

a) Increased overnight infiltration rates, e.g. due to failure to switch off tenant kitchen exhaust fans overnight.

b) Failed CO_2 sensors leading to the system continually operating at design ventilation rates rather than ramping down.

c) Failed or disabled economy mode/cycle.

d) Tighter control bands on temperature control, e.g. no deadband and heating and cooling proportional bands only 0.5 °C each.

4.17.4 After-hours operation

Some **HVAC** systems may be unable to turn down to match low occupancy or other low loads. It is particularly important to determine how efficiently the plant can respond to the low loads generated from partial or after-hours operation.

Testing the effect of significant **AHAC** hours for small zones, leading to the system running at low load, should be considered in addition to **base case** after-hours assumptions for relevant projects.

4.17.5 Lighting hours of use

Where there are no specific technologies in place, lighting can operate much longer than expected. The impact of these longer hours of operation on the **estimate** should be considered.

Technology failures leading to longer lighting hours should also be considered.

4.17.6 HVAC loads

Almost all buildings will contain areas with atypical loads that can cause, e.g. cooling demand in the middle of winter. The effect of this on system performance must be considered and any inputs used or assumptions made outlined in the **Estimator's** report for the **Independent Design Review**. Specific items may include the following:

a) Variation in temperature set point.
b) Lower or higher occupant density or other internal loads.
c) Failed lighting controls.
d) Chiller energy consumption at low level base loads, e.g. a 24/7 major tenant in a shopping centre.
e) Fan turndown capability, and how this affects the minimum area to be served in response to an after-hours request.

4.17.7 Infiltration

Sensitivity of the model should be tested to a range of infiltration scenarios, in recognition of the difficulty of infiltration to predict. This is due to the possibility of infiltration increasing if façade construction is poor, doors are left open or exhaust fans are left running longer than expected.

4.17.8 Compound effects

Buildings, tenancies and data centres are highly interactive systems, so it is important to consider the compound effects of a single system not functioning as expected. Consider the flow-on effects to other systems to more accurately assess the total potential impacts of one system malfunctioning or functioning at lower efficiency than predicted.

The four (4) **off-axis-scenarios** in the **off-axis model** should address the related and compound effects of each scenario on the others if relevant.

4.17.9 Risk factors around other NABERS inputs

Variability around the other NABERS inputs should also be considered, as shown in the following examples:

a) Lower or higher NABERS rated area due to differences in lease rate or servicing arrangements.
b) Longer or shorter operating hours or trading hours.
c) Long periods of low occupancy during the **rating period**.
d) Changes to emissions factors impacting rating results as the grid decarbonises.

4.17.10 Metering systems

Where sub-meters (and in particular thermal meters) will be used to calculate a NABERS rating, it is important that the **Estimator** consider the associated operational risks.

The effects of sub-meters (in particular thermal meters) not functioning as designed (leading to all exclusions measured by that meter being included in a rating), should be considered for projects relying on this equipment for a large proportion of exclusions.

See also the metering descriptions requirements in Section 5.3.

4.17.11 Data centres

In addition to those parameters listed in Sections 4.17.3 to 4.17.10, the following should also be considered for data centres:

a) Tighter temperature and humidity control bands in the data areas. While the ASHRAE TC9.9 White Paper (2011) recommends a wide operating temperature/moisture envelope and allows an even wider envelope under some circumstances, many data centres function within very tight temperature and humidity limits.

> **Note**: The operating envelope recommended by ASHRAE TC9.9 is bounded by dry bulb temperatures of 18 °C to 27 °C dry bulb temperature, and dew points of 5.5 °C to 15 °C, with a RH limit of 60 %.

b) Greater diversity in IT equipment loading than is modelled in the base case, i.e. with greater variations in PDU and air conditioning loads. This should allow for very low loads in some areas, e.g. to represent the fact that UPS systems and Computer Room Air Conditioners (CRACs) typically run at very low efficiency below 30 % load.
c) Failed or modified controls on occupancy sensing systems for lighting, and fresh air ventilation, if applicable.
d) Failed economy cycle control.
e) Increased infiltration due to poor construction quality, particularly if airtightness is not specified or tested as part of the design process.
f) Poor water flow turndown for water-cooled CRACs, representing missing or poorly controlled isolating controls and head pressure controls.
g) Increase fan pressure due to, e.g. poor duct construction or dirty filters.
h) Failed thermal metering on heat rejection systems if the data centre will reject heat into a general-purpose condenser water loop that also serves other systems in the building. In this case, the NABERS **Rules** allow the rating to proceed with an assumption that the heat rejection energy is 40 W/kW.

4.17.12 Warehouse and cold stores

In addition to the parameters listed in Sections 4.17.3 to 4.17.10, the following should also be considered for warehouse and cold stores:

a) Failed refrigeration system control.
b) Increased infiltration due to poor construction quality, maintenance or warehouse operation (such as high forklift use and movement in and out of the space).
c) Impact of unused (vacant) cold or cool rooms, including its impact on refrigeration system cooling load.
d) Poor door management or control by operators.
e) Coils that have iced up.
f) Oversized plant.
g) Forklift charging within refrigerated spaces.
h) Inappropriate blast freezer locations within the facility.
i) Poor or lack of dehumidification practices, and its impact on high defrost frequencies.
j) Inappropriate valve station designs causing poor defrost efficiency.
k) Unintended internal hot gas bypass causing artificial loads.
l) Excess liquid overfeed ratios.
m) Excess compression ratios.
n) Poor maintenance or design leading to refrigerant leaks.

5 Report requirements for estimators

5.1 General

For an **estimation** to comply with this Handbook, a report must be provided to the selected Independent Design Review which contains the following:

a) Input data and assumptions.
b) Metering description.
c) Simulation results including the following:
   1) **Off-axis scenarios** modelled and impact to the predicted rating.
   2) Analysis on changing emissions factors and impact on the predicted and future ratings.
d) Risk assessment.
e) Disclaimer.
f) Compliance checklist.

The format for each of these items is provided in the sections below. While exact use of the format provided is not essential, at a minimum the documentation must cover the information required in a clear and concise manner. The documentation requirements have been designed to provide a degree of error checking. The forms also provide an opportunity to list all the potential issues with the **simulation model** and the associated results.

> **Note**: **Estimators** should be open and transparent in identifying problems and compromises in the **estimate**.

Once the final report is complete, **Estimators** must email (nabers@environment.nsw.gov.au) it to NABERS. The **Estimator's** report provided to the **National Administrator** is not deemed as verified by **National Administrator** prior to the approval of the Independent Design Review Report.

5.2 Input data and assumptions for base case model

Input data, as listed in Table 5.2, must be outlined in the report for the Independent Design Review and any compromises and assumptions that have been made must be outlined and justified.

For each input, any differences between specification documents and what has been modelled must be outlined. Provide reasons for any discrepancies and describe any measures taken to mitigate the impact of differences on **estimation** results.

This is not a comprehensive list and there may be additional information that is needed dependent on project specifics.

Table 5.2: Input data for base case model

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Manual calculations	Describe where computer software was used and where manual calculations, such as spreadsheets, were used. Provide justification and outline assumptions for any manual calculations. Simulation software, not spreadsheets, must be used for all major systems and equipment, except for refrigeration systems.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Default inputs	Describe where default values were used and what assumptions have been used for **estimates** in the model. Outline why no better information was available for items where defaults have been used.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Simulation package	Provide an overview of the **simulation package's** capabilities, as outlined in Section 5.1.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
	Highlight any features or characteristics which may cause inaccuracies in modelled consumption and describe how these have been mitigated/treated.									
Climate data	Describe type of data and weather station locations used.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓	✓ Note 6	✓	✓
Energy coverage	Describe the energy uses and types covered.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
	Describe what is covered by each meter and highlight any end uses that may need to be apportioned, excluded or included for a NABERS energy rating. Highlight any use of thermal meters and energy uses covered by these meters. Identify any exclusions or any items outside the scope of a NABERS energy rating that have had to be included in the energy coverage because of lack of metering.									

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Document referencing	List drawing and specification versions and dates used to source information (for each input).	✓	✓	✓	✓	✓	✓	✓	✓	✓
Building form	Describe how this has been represented. Any simplifications must be identified.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓
External shade	Describe how this has been represented in the model. Describe any variations from current shading to the site.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Glazing	Describe the type of glazing and how it has been represented in the model.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓
Insulation	Describe how insulation levels have been modelled.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓
Car parks	Describe what has been modelled for car parks.	✓ Note 2	✓	✓	N/A	✓	✓	✓	✓	✓
Floor area	Describe the modelled floor area, which may not be the same as the rated floor area. Differences should be described in the report.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Lighting	*Lighting power density*: Identify lighting power density in each area of the model.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓
	Lighting hours: Provide a full description of the schedule. Include assumptions about the operation of cleaners or after-hours workers on site.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓
	Lighting controls: Describe controls that have been modelled, including notes on how control effects were modelled.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Equipment	*Equipment density*: Describe equipment type, power consumption per unit and number of units (if known). Include assumptions made for equipment load per person or per space in the model (if applicable).	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Equipment hours: Describe the pattern of equipment use assumed for the model and the consequent effective equipment operating hours.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Occupancy	*Occupant density*: Describe how this figure was derived, e.g. based on tenancy type or **space type**.	✓	✓	✓	✓ Note 4	✓ Note 7	✓ Note 7	✓	✓	✓
	Occupancy hours: Describe the hours for each space and how this was derived and modelled.	✓	✓	✓	✓ Note 4	✓ Note 7	✓ Note 7	✓	✓	✓
HVAC system type	Describe the system that has been modelled and any differences between the design and modelled systems.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓ Note 6

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
	For shopping centres and offices, the description should address whether or not the area is centrally serviced.									
HVAC hours	Describe the hours of operation of the **HVAC** plant.	✓ Note 1	✓	✓	N/A	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓ Note 6
HVAC after-hours	Describe the representation of after-hours operation use and why this figure has been used.	✓ Note 1	✓	✓	N/A	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓ Note 6

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
HVAC plant	Describe the plant sizes used and specifically note any areas where the simulation was allowed to default rather than use data from the design. Describe the chiller and boiler efficiencies. Describe any miscellaneous plant items, e.g. toilet exhaust systems. Describe how any limitations of the selected system(s) have been modelled. Describe how low loads have been modelled.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓ Note 6

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
HVAC zoning	Describe the zoning of the **HVAC** systems and identify any differences between the design and the model. For offices and shopping centres, describe how **HVAC** zoning has been considered when modelling **AHAC**/extended hours for a NABERS energy rating.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓ Note 6
HVAC control	Describe the differences between the known or likely control methodologies of the actual system and those modelled.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓ Note 6

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
HVAC commissioning	Describe any known commissioning plans or strategies.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓ Note 6
Refrigeration system type	Describe the refrigeration system configuration (e.g. conventional or cascade) and refrigerants used.	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	✓ Note 9	N/A Note 10	N/A Note 11
Refrigeration plant	Describe the number of refrigeration equipment (e.g. compressors/evaporators/pumps) and the capacity.	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	✓ Note 9	N/A Note 10	N/A Note 11
Refrigeration plant cooling loads	Identify the different cooling loads served by the refrigeration plant and describe how these have been calculated.	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	N/A Note 10	✓ Note 9	N/A Note 10	N/A Note 11

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Refrigeration system zoning	Describe how the refrigeration system is zoned, especially where there are different areas or diverse cooling loads downstream of the system. Identify any differences between the design and model/calculations, and any limitations.	N/A	N/A	N/A	N/A	N/A	N/A	✓ Note 9	N/A	N/A Note 11
Refrigeration system control	Describe the differences between the known or likely control methodologies of the actual system and those modelled.	N/A	N/A	N/A	N/A	N/A	N/A	✓ Note 9	N/A	N/A Note 11

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Automation systems or internal transport	Identify automation systems or internal transport used in the building, including quantities and use patterns. Describe how the energy consumption for the equipment and internal transport has been estimated, including any differences between the design, likely operation and the model/calculations. Identify if the heat gain from the equipment has been included in the thermal model.	N/A	N/A	N/A	N/A	N/A	N/A	✓ Note 9	N/A	N/A

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Infiltration	Describe how infiltration is modelled in internal and external zones.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓
Domestic hot water	Identify system type and end-use fitting selections, e.g. shower heads and taps. Describe assumptions around how hot water will be used (e.g. per occupant) and hot water distribution losses.	✓	✓ Note 5	✓	N/A	✓ Note 5	✓ Note 5	✓	✓	N/A
Trading days/trading hours	Identify trading days and ensure that other schedules are developed with a consideration of trading days.	N/A	N/A	✓	N/A	N/A	N/A	N/A	N/A	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouses and cold storage	Schools	Retail Stores
Term times	Identify term times and the representation of activity in and out of term time	NA	NA	NA	NA	NA	NA	NA	✓	N/A
Room rental rate and number of occupants per room	Described and/or build into the occupancy schedule.	N/A	✓	N/A	N/A	N/A	✓	N/A	N/A	N/A
Swimming pool area and heating arrangements	Identify the area, heating hot water equipment, distribution equipment and controls modelled.	N/A	✓	N/A	N/A	✓ Note 8	✓ Note 8	N/A	✓ Note 8	N/A

Notes

Note 1 May not be required for **estimates** used with tenancy **Commitment Agreements** if no tenant AC equipment is fitted.

Note 2	Only applies to whole building and base building ratings.
Note 3	Only applies to infrastructure and whole facility ratings.
Note 4	Only applies to infrastructure and whole facility ratings if there is occupancy within the data halls.
Note 5	Hot water is typically a minor end use for this **space type** and an appropriate default may be used.
Note 6	May not be required for apartment building, retirement living, warehouse,or non-centrally serviced retail stores **estimates** if no **HVAC** system is installed.
Note 7	May not be required for apartment building or retirement living **estimates** if no occupied spaces are included in the rating, in accordance with the NABERS **Rules**.
Note 8	May not be required if there is no pool.
Note 9	May not be required if a site does not have either refrigerated areas.
Note 10	In general, if refrigeration equipment is present in this **space type** it can be treated as part of the general equipment load.
Note 11	In general, if single-phase refrigeration equipment is present in this **space type** it can be treated as part of the general equipment load. Three-phase commercial/industrial refrigeration can be excluded.

5.3 Metering description requirements

This information must provide a full description of the metering arrangements assumed or required to allow the NABERS energy rating to be conducted, see Table 5.3. Any risks around metering and the NABERS scope should be identified. In addition, if sub-meters are to be used to calculate the NABERS rating, the risks associated with this method should be noted, see Section 4.17.10.

Table 5.3: Metering arrangements

Metering requirements	Energy coverage
Meter 1 description and location	Describe the energy items covered by this meter.
Meter *n* description and location	Repeat as necessary for additional meters. Include any sub-metering required to exclude non-rated energy from the assessment.

The project team may also find it useful to have a monthly breakdown of expected energy consumption by meter or meter group for use during building operation. This may assist with fault detection.

As discussed in Section 4.17.10, it is important that the **Estimator** note the operational risks associated with sub-meters. Where there are no specific risks which can be modelled, the **Estimator** may note the following in their Energy Efficiency Risk Assessment:

> "There are operational risks associated with the use of sub-meters to calculate NABERS ratings, for example, relating to commissioning, record-keeping, reliability and accuracy across the full load range. In general, ratings that rely on thermal metering are more likely to be problematic. A meter management plan should be developed to identify and mitigate these risks."

5.4 Simulation inputs and results for base case and off-axis models

5.4.1 General

A minimum of two (2) models must be completed, the first being a **base case model** and the second being an **off-axis model** representing a minimum of four (4) **off-axis scenarios**, i.e. four (4) operational changes or failures.

Additional analysis on the impact of changing emission factors must also be done to understand predicted future ratings results. This includes the use of the NABERS **prediction tool** to forecast scenarios estimating the impact of different emission factors on the rating.

This section of the report must list each scenario, identifying the following:

a) Any changes between this scenario and the **base case**.

b) Purpose of the scenario.

c) Results for the scenarios and model in the format presented in the following sections.

For the inputs into the NABERS energy rating calculation, see Chapters 3 and 4.

5.4.2 NABERS rating inputs summary

The following information about each input detailed in Section 3.2 must be presented for the **base case model** and each **off-axis model**, see Table 5.4.2.

Table 5.4.2: Input details

Item	Data used for NABERS rating	Notes
Each input should have a separate line item, e.g. postcode, rated area, rated hours, computer count, etc.		Explain how this data was determined.

Additionally, identify the modelling margin used and describe why this data is appropriate for the building being modelled. Consider stage of design and specification drawings, any unknown factors relating to design, construction or operation and limitations of modelling **simulation software** when deciding on and describing the appropriateness of the selected modelling margin.

5.4.3 NABERS rating energy consumption summary

For the energy consumption inputs, the information must be presented as follows for the **base case model** and each **off-axis model**, see Table 5.4.3.

For the **base case model**, total energy consumption and total energy consumption with margins must be clearly detailed.

Table 5.4.3: Energy consumption inputs

Energy end use	Total electricity use	Total gas/fuel use	Electricity included in rating	Gas/fuel included in rating
Each end use should have a separate line, e.g. lighting, equipment				
Total for all energy end uses				
Total for all energy end uses with margin (**base case model** only)				

5.4.4 NABERS rating results summary

The estimated NABERS rating for the **base case model** and the **off-axis model** (or each **off-axis scenario** if relevant) must be obtained using the **online calculator** and the inputs detailed in Sections 5.4.2 and 5.4.3. The results obtained must be presented and include the following information:

a) NABERS energy star rating (without GreenPower™ or other off-site renewable energy only).

b) Performance level in MJ p.a. and kg CO_2-e p.a.

c) Intensity values (MJ p.a./m^2, kg CO_2-e p.a./m^2) when relevant for the **rating type** considered.

d) Modelling margin or buffer for **base case model** and each **off-axis model**.

e) Rating results, taking into account the impact of changing emission factors (use of the NABERS **prediction tool**).

For the **base case model**, the total energy consumption with modelling margin figures should be used to obtain the estimated NABERS rating results.

5.5 Risk assessment

The **Estimator** must summarise any risk factors that may prevent the project from achieving its estimated rating. These risks must include, at a minimum, the following:

a) Differences between the specification documents and model.

b) Building design.

c) Materials specified.

d) Equipment specified.

e) Risks as derived from the **off-axis scenarios**.

f) Risks as derived from analysis of the impact of changing emissions factors.

g) Risks associated with changes made after the design phase.

h) Risks associated with commissioning and controls when in operation.

i) Risks associated with changes in site operation or loading.

j) Any other risks identified through assumptions and inputs used when estimating the rating.

Other risks for a specific project must also be included in the report for the **Independent Design Reviewer**.

For each risk outlined, the **Estimator** must describe the potential impact as well as how the risk has been or may be mitigated. Table 5.5 can be used for this requirement.

Table 5.5: Risk assessments

Risk	Potential impact	Potential mitigation
Describe the area of risk, e.g. “Mechanical equipment hours of use sensitivity”.	Describe the potential impact, e.g. “Changing mechanical equipment hours of use changed the rating from four (4) stars to three (3) stars”.	Describe how the problem may be approached, e.g. “Ensure adequate plant run time monitoring is in place to avoid mechanical equipment running unintentionally or unnecessarily”.

In addition, the following information, at a minimum, must be provided for each model (excluding NABERS Data Centre IT equipment and apartment building ratings where there is no central **HVAC** system):

a) Percentage of occupied hours that any conditioned spaces lie outside the nominated control range, i.e. temperature control targets not being met.

b) Percentage of plant operation hours that the **HVAC** plant fails to meet the system load demands, i.e. system failing to meet peak demand.

5.6 Disclaimer

The report must include, as a minimum, the following disclaimer:

> “Computer simulation and all engineering calculations provide an estimate of performance. This estimate is based on simplifications that do not and cannot fully represent all of the intricacies of performance once built. As a result, simulation results only represent an interpretation of the potential performance. No guarantee or warrantee of performance in practice can be based on simulation results alone.”

5.7 Compliance checklist

Table 5.7 must be completed in the report submitted to the **Independent Design Reviewer**. A complying **estimation** must include all the items listed in the compliance table.

Table 5.7: Compliance checklist

Item	Included	Notes
Input data, including assumptions and source documentation referencing for **base case model**.	Yes/No	
Metering requirements.	Yes/No	
Off-axis scenarios and **off-axis model** listing.	Yes/No	
Analysis of the impact of changing emissions factors using the NABERS **prediction tool**.	Yes/No	

Item	Included	Notes
NABERS rating inputs summary for **base case** and **off-axis models**.	Yes/No	
NABERS energy end-use summary for **base case** and **off-axis models**.	Yes/No	
NABERS rating simulation results for **base case**, **off-axis models** and results based on changing emissions factors.	Yes/No	
Risk assessment.	Yes/No	
Disclaimer.	Yes/No	

6 Report requirements for Independent Design Reviewers

6.1 General

The role of an Independent Design Review is to provide an additional level of certainty that the assumptions, inputs and model appear reasonable for a **space type** and are likely to reflect its operational performance.

6.2 Independent Design Review components

6.2.1 Risk assessment

An Independent Design Review should include a risk assessment of the assumptions, model, design and related documentation used by the **Estimator**. The risk assessment should include a clear and detailed description of each risk to enable the design team to propose appropriate responses, actions or changes to manage identified risks. Risks identified during the Independent Design Review are for consideration by the design team, who retain responsibility for the completed **estimate** reflecting the energy consumption of the **space type** when operational.

6.2.2 Design and equipment review

An Independent Design Review should also include a review of a **space type's** design and equipment, to ensure that both are capable of achieving their intended outcomes and good environmental performance. The Independent Design Review report should include **off-axis scenarios** modelling and the impact of changing emissions factors, as well as any impacts on the predicted rating results.

6.2.3 Report contents

Where an Independent Design Review is being undertaken in compliance with this Handbook, the Independent Design Review report must contain, at a minimum, the following:

a) Project summary, see Section 6.4.

b) Risk assessment for each of the following categories, as detailed in the **Estimator** report and following review of the model (see Section 6.5):

   1) Input data and assumptions for **base case model**.

   2) Metering description.

   3) Simulation results for **base case** and **off-axis model**.

4) Report on buffer/margin above target for **base model**, **off-axis scenarios** and analysis on the impact of changing emissions factors.
5) Design and equipment review.
6) **Estimator's** risk assessment.
7) Disclaimer.
8) Compliance checklist.

c) Final risk assessment checklist, see Section 6.6.

A format for each of these items is provided in Sections 6.3 to 6.6. While exact use of the format provided is not essential for most items, at a minimum all items listed must be reviewed. The Independent Design Review report must cover all information required in a clear and concise manner.

6.3 Independent Design Reviewers and Estimators

6.3.1 General

Independent Design Reviewers should review and assess some items covered in Table 6.5 more comprehensively than others, e.g. the design and equipment review should cover more than just the points provided in the table. **Independent Design Reviewers** must use their judgement and expertise to assess how in-depth area or topic reviews are to be for a particular project.

6.3.2 Documentation review

Items needed to satisfy an **Independent Design Reviewer** that a project's assumptions, model, documentation, design features and equipment selection meet its specific requirements and are capable of achieving their intended outcomes should be reviewed and reported on. This information should be presented in a format the **Independent Design Reviewer** determines to be appropriate.

Estimators and **Independent Design Reviewers** are expected to work from documents that can reasonably represent the **space type** as constructed, or the most appropriate documents given the design stage of the building. **Independent Design Reviewers** should include a risk assessment of design documentation if required for a specific project, e.g. on reviews done early in the design process.

Documents that must be reviewed include, at a minimum, the following:

a) Mechanical drawings and specifications.
b) Electrical drawings and specifications.
c) Control strategies documents.
d) Architectural plans and specifications.

Other documents may also be reviewed dependent on the project.

6.3.3 Independent Design Review report

If the **Estimator's** report does not contain the minimum details as outlined in Section 5, missing information must be requested before the Independent Design Review report can be finalised. Similarly, any **estimates** or assumptions made by the **Estimator** that the **Independent Design Reviewer** deems inaccurate or a risk to the target rating being achieved must be addressed or justified before the final Independent Design Review report is sent to NABERS.

Once the final Independent Design Review report and **Estimator's** report are complete, **Independent Design Reviewers** must email (nabers@environment.nsw.gov.au) them to NABERS. Upon reviewing the Independent Design Review report, the **National Administrator** will get back to the **Independent Design Reviewer** with any questions or concerns regarding the energy simulation report before formally signing off this part of the **Commitment Agreement** process as complete. Once the Independent Design Review report has been signed off by the **National Administrator**, the **Commitment Agreement** certificate will be sent to the applicant.

For all **Commitment Agreements**, the Independent Design Review must be conducted by a member of the NABERS Independent Design Review Panel (refer to www.nabers.gov.au/ratings/commitment-agreements/independent-design-review-panel), or an **Independent Design Reviewer** who was a member at the **date of agreement** if contracted before membership expired. Panel members must always be independent of the design team.

Note: The purpose of the Independent Design Review is to provide a clear indication on whether the target rating is on track to be achieved or not. The Independent Design Review report should identify inconsistencies or errors and give recommendations to ensure that the project appears to be capable of achieving the target rating.

6.4 Project summary

6.4.1 Report executive summary

At the beginning of the Independent Design Review report, **Independent Design Reviewers** must note the target rating and identify whether this target appears reasonable for the project. **Independent Design Reviewers** will also state at what stage of the project's development process the Independent Design Review report was completed.

Independent Design Reviewers must complete Table 6.4.1 to show the NABERS rating for the base case model, the off-axis model(s) (or each **off-axis scenario**, if relevant) and the impact of changing emissions factors. The table is intended to clearly summarise the key outcomes of the modelling and review process.

Table 6.4.1: Independent Design Reviewer's overview of modelled scenarios and outcomes

	Base case model	Off-axis model(s)	Impact of changing emissions factors
Description of model conditions			

	Base case model	Off-axis model(s)	Impact of changing emissions factors
NABERS rating inputs			
NABERS rating			
Modelling margin (%)			

Independent Design Reviewers must also provide a summary of key risks associated with the project. This aspect of the summary should be provided in list form, the risks to be considered are outlined in Section 6.5.

6.4.2 Report summary statement

After completing the final risk assessment checklist (see Section 6.6), **Independent Design Reviewers** will provide a clear, short summary in their report for the project stating whether they are satisfied or not that the project is likely to achieve the targeted star rating. **Independent Design Reviewers** can add conditions to this statement, based on the risks identified and suggestions made, including the following:

a) Key or all identified risks are addressed.
b) Key or all suggestions are actioned.
c) Any other reasonable conditions are met.

Where there are significant concerns about a project reaching the targeted star rating, the **Independent Design Reviewer** must outline any steps that need to be taken to rectify the issue(s) to the applicant. Where necessary, a change to the star rating target may be considered by the applicant and discussed with the **National Administrator** before the Independent Design Review report is finalised and issued.

6.5 Identified risks

Table 6.5 outlines the minimum categories, as well as their sub-category items, that are to be covered in the Independent Design Review report.

For each item, confirm that what has been specified in design documentation and what has been modelled are the same. Any assumptions or simplifications should be reasonable and unlikely to create a significant difference between modelled and operational energy use. For each item, at a minimum, **Independent Design Reviewers** should clearly identify and detail risks relating to the following:

a) Inputs used for the design and model.
b) Differences between design documentation and model.
c) Assumptions regarding design and equipment choices.
d) A building's first or subsequent rating results given changes to emissions factors over time.

After the review, **Independent Design Reviewers** must be able to make a clear statement whether they are satisfied or not with the following:

1) Model’s ability to reasonably represent the building’s actual energy performance.

2) Building’s likelihood of meeting the targeted star rating.

The below format is not required for an Independent Design Review, however, at a minimum, all information outlined in Table 6.5 must be included by the **Independent Design Reviewer** in the Independent Design Review report in a clear and concise format.

Table 6.5: Independent design review report — Minimum categories

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Input data and assumptions										
Manual calculations	Confirm all major systems and equipment have been modelled in simulation software as opposed to manual calculations being used, e.g. spreadsheets. Confirm that assumptions used appear reasonable and are used appropriately in the building simulation. Review manual calculations, such as those calculated in spreadsheets, where used.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Default values	Confirm assumptions and default values used appear reasonable and are used appropriately in the building simulation.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Simulation package	Confirm **simulation package** meets the minimum requirements as outlined in Section 4.2.	✓	✓	✓	✓	✓	✓	✓ Note 11	✓	✓
Refrigeration system energy	Confirm **simulation package** or spreadsheet-based calculation meets the minimum requirements as outlined in Section 4.4.	N/A	✓ Note 10	N/A	N/A	N/A	✓ Note 10	✓ Note 10	✓ Note 10	N/A
Climate data	Review type of data used and weather station locations.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Energy coverage	Review the energy uses and fuel types covered. Confirm meters and energy uses covered by each simulated meter are correct according to specification documents. Confirm any exclusions or any items outside the scope of the NABERS energy rating that are not appropriately metered have been included in energy consumption calculations.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Document referencing	Review all drawing and specification versions and dates used to source information (for each input). Confirm what has been modelled matches appropriate specification documents.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Building form	Review representation of building.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓	✓ Note 6	✓	✓
External shade	Review external shade representation and confirm any assumptions appear reasonable.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓
Glazing	Confirm that glazing and glazing thermal performance have been appropriately represented in the model.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Insulation	Confirm that insulation has been appropriately represented in the model for walls, roofs and floors.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓
Car parks	Review what has been modelled for car parks.	✓ Note 2	✓	✓	N/A	✓	✓	✓	✓	✓
Floor area	Review the modelled floor area, which may not be the same as the rated floor area. When appropriate for the **rating type** considered, confirm that rated area assumptions are reasonable and comply with the NABERS **Rules**.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Volume	Review the modelled volume for cold and cool rooms. Confirm that the rated volume assumptions are reasonable and in line with the **Rules**.	N/A	N/A	N/A	N/A	N/A	N/A	✓	N/A	N/A
Lighting	*Lighting power density*: Confirm that lighting power densities have been appropriately represented in the model. Confirm density used is appropriate and does not have unconsidered impacts on heat loads or energy **estimation**.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
	Lighting hours: Review schedule and assumptions about the operation of cleaners or after-hours workers on site. Confirm it has been appropriately modelled.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓
	Lighting controls: Review modelled controls and assumptions. Confirm assumptions match control brief.	✓	✓	✓	✓ Note 3	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Equipment	*Equipment density*: Confirm that equipment densities have been appropriately represented in the model. Confirm density assumptions have been appropriately documented (equipment type, power consumption per unit and number of units) and do not have further impacts on energy **estimation**. Review assumptions made for equipment load per person or per space (if applicable).	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
	Equipment hours: Review assumed pattern of equipment use and the consequent effective equipment operating hours.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Occupancy	*Occupant density*: Review the figure used.	✓	✓	✓	✓ Note 4	✓ Notes 7	✓ Note 7	✓	✓	✓
	Occupancy hours: Review the hours assumed for each space and confirm they appear reasonable.	✓	✓	✓	✓ Note 4	✓ Notes 7	✓ Note 7	✓	✓	✓
HVAC system type	Review the system that has been modelled. Confirm there are no unacceptable differences between modelled system and specified and/or designed system.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
HVAC hours	Review the hours of operation of the **HVAC** plant.	✓ Note 1	✓	✓	N/A	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓
HVAC after-hours	Review the representation of after-hours operation used and confirm it appears reasonable.	✓ Note 1	✓	✓	N/A	✓ Note 6	✓ Note 6	✓ Note 6	✓	✓

HVAC plant	Confirm that all components of **HVAC** plant have been appropriately represented in the model. Specifically, review assumptions for any areas where the simulation was allowed to default rather than use data from the design. Review all parameters that could impact the predicted energy consumption, e.g. efficiencies, plant size, capacity of the system to operate at part load/low load. Review all included miscellaneous plant (e.g. toilet exhaust systems) and confirm completeness.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6
HVAC zoning	Review the zoning of **HVAC**. Confirm this has been taken into consideration when estimating the	✓ Note 1	✓ Note 3	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
	AHAC hours for a NABERS rating.									
HVAC control	Review the differences between the known or likely control methodologies of the actual system and those modelled. Confirm assumptions and modelled inputs appear reasonable. Confirm that modelled **HVAC** control is based on control briefs.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6
Infiltration	Review how infiltration is modelled in internal and external zones. Confirm assumptions and modelled inputs appear reasonable.	✓ Note 1	✓	✓	✓ Note 3	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6	✓ Note 6

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Refrigeration system type	Review the refrigeration system configuration and refrigerant types correctly reflect the design.	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	✓ Note 10	N/A Note 12	N/A Note 13

Refrigeration plant	Review the number of refrigeration equipment modelled and capacities. Confirm that all components of the refrigeration plant has been appropriately represented in the mode. Specifically, review assumptions for any areas where defaults have been used instead of design data. Review all parameters that could impact the predicted energy consumption (efficiencies, plant size, capacity of the system to operate at part load/low load). Ensure that part load performance of the refrigeration plant has been correctly represented in the model.	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	✓ Note 10	N/A Note 12	N/A Note 13

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Refrigeration plant cooling loads	Review the different cooling loads served by the refrigeration plant and the underlying assumptions used to determine the cooling loads.	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	✓ Note 10	N/A Note 12	N/A Note 13
Refrigeration system zoning	Review the zoning of the refrigeration system. Confirm that these reflect the proposed design. Specifically, pay attention to how different areas or diverse cooling loads have been treated in the model or calculations.	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	✓ Note 10	N/A Note 12	N/A Note 13

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Refrigeration system control	Review the differences between the known or likely control methodologies of the actual system and those modelled. Confirm assumptions and modelled inputs appear reasonable. Confirm that modelled refrigeration system control is based on control briefs.	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	N/A Note 12	✓ Note 10	N/A Note 12	N/A Note 13

Automation System or Internal Transport	Confirm that all automation system equipment or internal transport (e.g. forklifts or buggies) used in the building, including quantities and use patterns are correctly represented in the model or calculations. Confirm that all assumptions regarding how the energy consumption for the equipment and internal transport has been estimated have been appropriately documented (equipment type, power consumption per unit, quantities). Review the assumed pattern of equipment use and the consequent effective equipment operating hours.	N/A	N/A	N/A	N/A	N/A	N/A	✓	N/A	N/A
Domestic hot water	Review system type and end-use fitting	✓	✓ Note 5	✓	N/A	✓ Note 5	✓ Note 5	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
	selections, e.g. shower heads and taps. Review assumptions regarding use of hot water (e.g. per occupant) and modelled hot water distribution losses.									
Trading days/trading hours	Review trading days and confirm that other schedules are developed with a consideration of trading days.	N/A	N/A	✓	N/A	N/A	N/A	N/A	N/A	✓
Term times	Confirm suitability of term times and the representation of activity in and out of term time	NA	NA	NA	NA	NA	NA	NA	✓	N/A
Room rental rate and number of occupants per room	Confirm that this has been described explicitly and/or built into the occupancy schedule.	N/A	✓	N/A	N/A	N/A	✓	N/A	N/A	N/A

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Swimming pool area and heating arrangements	Review the area, heating hot water plant, distribution equipment, and controls modelled.	N/A	✓	N/A	N/A	✓ Note 8	✓ Note 8	N/A	✓ Note 8	N/A

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Metering requirements										
Meter descriptions and locations	Review the locations and coverage descriptions of all meters. Confirm what has been modelled is specified in design documents. Confirm arrangement of proposed meters and submeters results in appropriately metered end uses for the relevant NABERS **rating scope**. Confirm any required apportioning can be calculated in accordance with NABERS **Rules** for any shared services or facilities.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Simulation results										
Off-axis scenarios	Confirm a minimum of two (2) models, including one (1) **base case model** and one (1) **off-axis model** including four (4) **off-axis scenarios**, have been modelled. Review description of **off-axis scenarios** and confirm inputs and purpose are reasonable. Confirm the impact on modelling margins is reasonable and assess the impact of changing emission factors on performance rating results.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
NABERS rating inputs	Review NABERS inputs for the **base case model** and **off-axis model**. Confirm they are in accordance with the NABERS **Rules**, and match the design documentation, model inputs and the assumptions used. Confirm **estimates** or assumptions for these items are reasonable.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
NABERS rating energy consumption	Review information provided for the **base case model** and **off-axis model**. Confirm total included energy use figures are in accordance with the model and calculation outputs. Confirm a suitable modelling margin has been used for the **base case model**. Highlight any risks with the modelling margin.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
NABERS rating results summary	Review estimated performance in MJ/(rating unit), kg CO_2-e and NABERS energy stars. Review scenarios and caveats and confirm reasonable.	✓ MJ/m²	✓ MJ/ room	✓ MJ/m²	✓ Note 9	✓ MJ/ apartment	✓ MJ/m²	✓ MJ/m²	✓ MJ/m²	✓ MJ/m²
Design and equipment review										

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Design review	Review design features and confirm they are capable of achieving project-specific requirements. Review design features and confirm they are capable of achieving intended outcomes and good environmental performance.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Equipment review	Review equipment selection and confirm selections are capable of achieving project-specific requirements. Review equipment selection and confirm selections are capable of achieving intended outcomes and good environmental performance.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Risk assessment										
Risk assessment	Review described risk factors, level of risk and mitigation strategies and confirm that actions taken to mitigate risks so far are appropriate. Highlight any risks that have not been mitigated or have been inappropriately mitigated. Confirm stated risks are unlikely to prevent the building achieving its targeted star rating if managed as described.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
	Review **Estimator** comments on system and plant performance. Confirm inputs and assumptions are appropriate. Review additional information provided and confirm percentage hours where temperature or load demands are not met are reasonable and as expected. Include a risk matrix table identifying the probability/likelihood and severity of each risk factor.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Other items										
Disclaimer	Review disclaimer in **Estimator** report and confirm it meets minimum requirements and is reasonable for the simulation.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Compliance checklist	Review the compliance checklist prepared by the **Estimator** and confirm all items have been covered in the report. If required, request any missing information before the Independent Design Review is finalised.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Item	Description	Office	Hotel	Shopping centre	Data centre	Apartment buildings	Residential aged care and retirement living facility	Warehouse and cold stores	Schools	Retail Stores
Commissioning plans	Review commissioning plans and confirm they appear to be good practice. If no commissioning plans are available, assess risk for the project and recommend future commissioning if required.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes

Note 1 May not be required for Independent Design Reviews used with tenancy **Commitment Agreements** if no tenant AC equipment is fitted.

Note 2 Only applies to whole building and base building ratings.

Note 3 Only applies to infrastructure and whole facility ratings.

Note 4 Only applies to infrastructure and whole facility ratings if there is occupancy within the data halls.

Note 5 Hot water is typically a minor end use for this space type and an appropriate default may be used.

Note 6 May not be required for apartment building, retirement living, warehouse and cold stores, or non-centrally serviced retail stores Independent Design Reviews if **HVAC** systemis installed.

Note 7 May not be required for apartment building or retirement living Independent Design Reviews if no occupied spaces are included in the rating, in accordance with the NABERS **Rules**.

Note 8 May not be required if no pool is included in the rating.

Note 9 kWh/GHz for IT equipment and whole facility ratings and PUE for infrastructure ratings.

Note 10	Required if present.
Note 11	Only applies to simulation packages for HVAC systems. For refrigeration systems simulation packages, see “Refrigeration system energy” table entry.
Note 12	In general, if refrigeration equipment is present in this **space type**, it can be treated as part of the general equipment load.
Note 13	In general, if single-phase refrigeration equipment is present in this **space type** it can be treated as part of the general equipment load. Three-phase commercial/industrial refrigeration can be excluded.

6.6 Final risk assessment checklist

Following the risk assessment process, **Independent Design Reviewers** should complete a risk assessment summary as shown in the example in Table 6.6. The table is intended to clearly summarise results of the review and clearly identify and detail the risks that could prevent the project from achieving its targeted star rating. Each risk should be detailed enough to enable the design team to clearly understand the issue and propose an action to address the issue or mitigate the risk. **Independent Design Reviewers** can also propose potential mitigations or provide guidance on how the design could be made more efficient.

Risks that could jeopardise a model's ability to accurately represent the **space type** as designed and specified, or a design's ability to meet the star rating targeted, should be located at the top of the table for clarity and marked as "high risk".

The risk assessment summary must be included in all Independent Design Review reports to make it clear what the largest risks to achieving the target rating are and how these risks are being addressed. **Independent Design Reviewers** may also choose to add a column to indicate the likelihood of a risk occurring so that high risk, high likelihood issues can be addressed as a priority.

Example: Table 6.6: Independent Design Reviewer's risk assessment summary

Description of identified risk	Comment	Potential solution (optional)	Risk category
For example, "Modelled hours of 70 h/week are unlikely to be accurate and give a misleading rating result".	For example, "The design team should consider alternative ways of reducing energy consumption in the building if more appropriate rated hours in the model result in a decreased rating result or a result below the targeted modelling margin. If lower modelled hours result in a decreased rating result or a result below the targeted modelling margin, there is a high risk the building will not achieve the targeted star rating".	For example, "Consider modelling rated hours of 45 h/week and ensure that updated results maintain the targeted modelling margin".	"High"

Description of identified risk	Comment	Potential solution (optional)	Risk category
For example, “Modelled chilled water efficiency at low load is unlikely to be accurate and may give a misleading rating result”.	For example, “Chilled water system efficiency modelled at low loads appears optimistic given the current arrangement of equally sized chillers”.	For example, “Readjust model to accurately represent operation of specified system. Consider reviewing the chiller arrangement or staging to improve efficiency at low load”.	Medium
For example, “Design documentation specifies an optimum start strategy for mechanical equipment, which has not been effectively modelled to incorporate longer pre-start periods on very hot or cold days”.	For example, “The Estimator should model variable start-up conditions that account for longer pre-start periods for key mechanical equipment”.	For example, “Consider 60 to 90 min pre-start periods in the middle of summer and winter, decreasing to 30 to 45 min in shoulder seasons”.	Medium

Appendix A Estimate defaults

A.1 General

Wherever possible, **estimates** must include data from the design and expected operation of the **space type** being modelled.

Where this is not available, the following defaults or other appropriate defaults can be used. The **Estimator** must explain and justify any use of defaults.

Note: All time is displayed in 24-h format.

A.2 Office — Base building

A.2.1 Occupancy

Default peak occupancy can be set at 1/10 m^2. However, the maximum typical occupancy is 70 % of the peak, as listed in the default schedule in Section A.2.4.

A.2.2 Equipment loads

Installed equipment loads are likely to vary from zone-to-zone and this should be represented in the model. By default, zone loads should be set at 50 %, 70 %, and 90 % of design equipment loads in ratios of 1:2:1 to give an average load of approximately 70 % of the design equipment load. If the design equipment load is unknown, a default of 15 W/m^2 should be used.

A.2.3 Lighting

The default lighting load in tenancies can be set at the relevant minimum compliance value as detailed in the **NCC**.

A.2.4 Schedules

A.2.4.1 Weekdays (all zones)

Default schedules which can be used are provided in Table A.2.4.1.

The schedules correspond notionally to a 50 h a week schedule. However, this is sensitive to the relative size of the after-hours zones.

Table A.2.4.1: Weekdays (all zones)

Time	Occupancy	Lighting (automated time of use control)	Lighting (limited control)	Equipment load	HVAC operation
00:00–01:00	0 %	5 %	15 %	25 %	Off
01:00–02:00	0 %	5 %	15 %	25 %	Off
02:00–03:00	0 %	5 %	15 %	25 %	Off
03:00–04:00	0 %	5 %	15 %	25 %	Off
04:00–05:00	0 %	5 %	15 %	25 %	Off
05:00–06:00	0 %	5 %	15 %	25 %	Off
06:00–07:00	0 %	5 %	15 %	25 %	Off
07:00–08:00	10 %	30 %	40 %	65 %	On
08:00–09:00	20 %	75 %	90 %	80 %	On
09:00–10:00	70 %	100 %	100 %	100 %	On
10:00–11:00	70 %	100 %	100 %	100 %	On
11:00–12:00	70 %	100 %	100 %	100 %	On
12:00–13:00	70 %	100 %	100 %	100 %	On
13:00–14:00	70 %	100 %	100 %	100 %	On
14:00–15:00	70 %	100 %	100 %	100 %	On
15:00–16:00	70 %	100 %	100 %	100 %	On
16:00–17:00	70 %	100 %	100 %	100 %	On
17:00–18:00	35 %	75 %	80 %	80 %	On
18:00–19:00	10 %	25 %	60 %	65 %	Off
19:00–20:00	5 %	15 %	60 %	55 %	Off
20:00–21:00	5 %	15 %	50 %	25 %	Off
21:00–22:00	0 %	5 %	15 %	25 %	Off
22:00–23:00	0 %	5 %	15 %	25 %	Off
23:00–24:00	0 %	5 %	15 %	25 %	Off

A.2.4.2 Saturdays (after-hours zones)

The schedule in Table A.2.4.2 (which operates the **HVAC** from 09:00 to 12:00 on Saturday) can be applied to a single after-hours zone of the building, e.g. the smaller of 10 % of the building, one (1) storey, or an individual and distinct tenancy with area greater than 5 % of the total building.

Table A.2.4.2: Saturdays (after-hours zones)

Time	Occupancy	Lighting (automated time of use control)	Lighting (limited control)	Equipment load	HVAC operation
00:00–01:00	0 %	5 %	15 %	25 %	Off
01:00–02:00	0 %	5 %	15 %	25 %	Off
02:00–03:00	0 %	5 %	15 %	25 %	Off
03:00–04:00	0 %	5 %	15 %	25 %	Off
04:00–05:00	0 %	5 %	15 %	25 %	Off
05:00–06:00	0 %	5 %	15 %	25 %	Off
06:00–07:00	0 %	5 %	15 %	25 %	Off
07:00–08:00	0 %	5 %	15 %	25 %	Off
08:00–09:00	5 %	40 %	25 %	25 %	Off
09:00–10:00	15 %	40 %	40 %	25 %	On
10:00–11:00	15 %	40 %	40 %	25 %	On
11:00–12:00	15 %	40 %	40 %	25 %	On
12:00–13:00	5 %	15 %	25 %	25 %	Off
13:00–14:00	5 %	15 %	25 %	25 %	Off
14:00–15:00	5 %	15 %	25 %	25 %	Off
15:00–16:00	5 %	15 %	25 %	25 %	Off
16:00–17:00	5 %	15 %	25 %	25 %	Off
17:00–18:00	0 %	5 %	15 %	25 %	Off
18:00–19:00	0 %	5 %	15 %	25 %	Off
19:00–20:00	0 %	5 %	15 %	25 %	Off
20:00–21:00	0 %	5 %	15 %	25 %	Off
21:00–22:00	0 %	5 %	15 %	25 %	Off
22:00–23:00	0 %	5 %	15 %	25 %	Off
23:00–24:00	0 %	5 %	15 %	25 %	Off

A.2.4.3 Weekends and holidays (non-after-hours zones), Sundays and holidays (after-hours zones)

Default schedules which can be used for weekends and holidays (non-after-hours zones), Sundays and holidays (after-hours zones) are provided in Table A.2.4.3.

Table A.2.4.3: Weekends and holidays (non-after-hours), Sundays and holidays (after-hours zones)

Time	Occupancy	Lighting (automated time of use control)	Lighting (limited control)	Equipment load	HVAC operation
00:00–01:00	0 %	5 %	15 %	25 %	Off
01:00–02:00	0 %	5 %	15 %	25 %	Off
02:00–03:00	0 %	5 %	15 %	25 %	Off
03:00–04:00	0 %	5 %	15 %	25 %	Off
04:00–05:00	0 %	5 %	15 %	25 %	Off
05:00–06:00	0 %	5 %	15 %	25 %	Off
06:00–07:00	0 %	5 %	15 %	25 %	Off
07:00–08:00	0 %	5 %	15 %	25 %	Off
08:00–09:00	5 %	15 %	25 %	25 %	Off
09:00–10:00	5 %	15 %	25 %	25 %	Off
10:00–11:00	5 %	15 %	25 %	25 %	Off
11:00–12:00	5 %	15 %	25 %	25 %	Off
12:00–13:00	5 %	15 %	25 %	25 %	Off
13:00–14:00	5 %	15 %	25 %	25 %	Off
14:00–15:00	5 %	15 %	25 %	25 %	Off
15:00–16:00	5 %	15 %	25 %	25 %	Off
16:00–17:00	5 %	15 %	25 %	25 %	Off
17:00–18:00	0 %	5 %	15 %	25 %	Off
18:00–19:00	0 %	5 %	15 %	25 %	Off
19:00–20:00	0 %	5 %	15 %	25 %	Off
20:00–21:00	0 %	5 %	15 %	25 %	Off
21:00–22:00	0 %	5 %	15 %	25 %	Off
22:00–23:00	0 %	5 %	15 %	25 %	Off
23:00–24:00	0 %	5 %	15 %	25 %	Off

A.2.5 Tenant supplementary air-conditioning

Where the tenant is unknown, the energy use can be estimated based on the following:

a) COP as required by the Mandatory Energy Performance Standards (MEPS).

b) Cooling loads at 50 % of the system capacity for 10 h each day.

c) Cooling loads at 20 % of the system capacity for the remainder of the time.

Where the tenant is known, the energy use of the tenant units must be derived on the basis outlined in Section A.3. This can be used as an input to reasonable modelling of the cooling tower and pump operation.

A.2.6 Vertical transportation

Lift energy may be calculated using one of the following methods in order of priority:

a) *Method 1*: ISO 25745-2, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*.

b) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

A.2.7 Domestic hot water

A default which can be used for domestic hot water demand is 4 L/person/day. If there are no end-of-trip facilities and if basin taps are Water Efficiency Labelling and Standards (WELS) 4 star or above, it may be appropriate to use a lower demand **estimate**. To convert the hot water demand **estimate** to an energy consumption **estimate**, the **Estimator** will need to consider distribution and generation losses. This consumption can be done using the domestic hot water calculation method in the GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

A.2.8 Infiltration

For general building envelope infiltration, where no envelope air tightness testing data is available (e.g. in a refurbished building or from a similar building), use 0.7 air changes/h throughout all zones during hours when the zone has no mechanically supplied outside air and 0.35 air changes/h at all other times.

A simplified empirical methodology such as described in *PNNL-20026 Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings* is appropriate for this application, or the **Estimator** may use detailed infiltration modelling considering wind direction and speed, i.e. using air network method or similar.

A.3 Office — Tenancy

A.3.1 Occupancy

The occupant density can be modelled as one (1) person/workstation.

> **Note:** For information on the default schedule for occupancy, see Section A.2.4.

A.3.2 Lighting

A.3.2.1 Power density

The lighting power density must be modelled in accordance with the tenancy fit out. No alternative is acceptable.

A.3.2.2 Hours of use

Lighting in accordance with the expected operation should be modelled, with detailed assessment of the effectiveness of the intended controls.

For guidance, the following should be used:

a) De-rate operating power from 100 % to 90 % where motion detectors control an area of 200 m^2 or less, and motion sensors control groups of more than six (6) fittings.
b) De-rate operating power from 100 % to 70 % where motion detectors control groups of three (3) to six (6) light fittings.
c) De-rate operating power from 100 % to 55 % where motion detectors control groups of two (2) or fewer light fittings.
d) During daylight hours, de-rate operating power from 100 % to 50 % for light fittings adjacent to windows or roof lights that are controlled by daylight sensors.

Where daylight linking is claimed, daylight modelling should be used to demonstrate the percentage reduction in use.

A.3.3 Equipment loads

A.3.3.1 General

The energy associated with equipment use in the tenancy should refer to the actual expected equipment use. Where required, Tables A.3.3.2 and A.3.3.5 can be used to **estimate** in-use and standby equipment loads for each item.

A.3.3.2 Computers

Actual measurements should be used to establish equipment loads for installed computers in use and in standby mode. The methodology used for such **estimates** must be clearly documented.

Where actual measurements are unavailable (e.g. at the early stage of a project), the following data in Table A.3.3.2 can be used.

Table A.3.3.2: Load estimate data — Computer consumption

Case	Operating mode (W/unit)	Standby mode (W/unit)
Standard desktop computer, unknown screen type	120 W	8 W
Standard desktop computer, LCD screen	90 W	5 W
Laptop computer using inbuilt screen	35 W	3 W

Case	Operating mode (W/unit)	Standby mode (W/unit)
Laptop computer using external LCD screen only 50 W	50 W	5 W
Laptop computer using both inbuilt and external LCD screen	65 W	5 W

The number of computers per workstation modelled should be in accordance with the NABERS **Rules**.

A.3.3.3 Server rooms

Server room energy use can be estimated by measurement of in-situ energy consumption or where this is unavailable, one of the following:

a) 140 W/server room computer, plus 4.5 W/computer for all computers in the tenancy.
b) Estimated lump consumption of the server room energy use. The methodology used for this **estimate** must be clearly documented.

A.3.3.4 Refrigerators, freezers, refrigerated drink dispensers and hot water/chilled water units

Refrigerator/freezer energy consumption must be referenced to the annual energy consumption shown on the energy rating label (refer to www.energyrating.gov.au) or, if not available, determined by measurement or by default set at 32+0.1Vr W (Vr is the number of litres of refrigerated storage) plus 38+0.2Vf W (Vf is the number of litres of freezer storage).

Refrigerated drink dispensers can be set to 110 W continuous.

Hot water units can be modelled based on manufacturer's data for standing losses, in-situ measured data for standing loss or 100 W default standing loss plus 12.5 kWh (i.e. equivalent to 5 W/person for 10 h/day)/person/annum served by the unit.

Chilled water units can be modelled based on the manufacturer's data for energy use in standing loss, in-situ measured data for standing loss or 50 W default. Where the unit is operated by a time clock, the standing losses must be limited to 70 h a week.

A.3.3.5 Other equipment

Energy use associated with other equipment can be referenced to the annual energy consumption shown on the energy rating label (refer to www.energyrating.gov.au) if available.

Measurements of the equipment to be installed can also be used to verify energy consumption in use and after-hours (standby). Alternatively, use Table A.3.3.5 to **estimate** the energy use for each item. If an item is not listed, an alternative figure could be obtained, preferably through in-situ measurements. The methodology used for such **estimates** must be clearly documented.

Table A.3.3.5: Estimation of equipment energy use

Item	Operating mode (W/unit)	Standby mode (W/unit)
A4 laser printer	110	22
Fax/inkjet printer	20	5
Copier	150	5
TV	65	5
Shredder	10	2
Electronic whiteboard	10	2
Scanner	8	8
Laminator	65	37.2
Binder	8	2
Dishwasher	46	0
Oven	60	0
Microwave	62	2
Small kitchen appliances, e.g. jug, toaster, griller	100	0
Coffee machine	150	0
Hot water service, showers	200	200

A.3.4 Equipment schedule

The default schedule for equipment loads is covered in Section A.2.4. The schedules outline the proportion of computers and equipment operating in “operating” mode. The remainder of the equipment can be modelled as operating in “standby” mode.

When developing schedules, consider operational control of equipment to determine the likelihood of certain equipment operating during core hours and after hours. Poor/low level control implies that efficiency is reliant on individual tenant behaviour, which often sees equipment left on after hours and overnight. Good control implies that systems are in place that will ensure (independent of tenant behaviour) that the equipment will switch off or move into a hibernation/sleep mode when not in use or after hours. Strategies to ensure this occurs may include the following:

a) Settings that cannot be changed by staff, which guarantee sleep/hibernate mode operation during non-occupancy hours for all computers and office equipment (with the contract for IT staff stipulating this requirement).
b) Software program is implemented to initiate automatic shutdown procedure to the computers after hours (with the contract for IT staff stipulating this requirement).
c) Hard-wired electrical relay isolates power to office equipment and computers.

A.3.5 Tenant supplementary air-conditioning

The default methodology for the calculation of tenant loads attributable to supplementary air-conditioning is as follows:

a) Where the total design cooling load by supplementary systems for the tenancy is less than 100 kW of cooling, calculate as follows:

   Air conditioning for server, communication and other rooms with continuous loads must operate at 75 % of full design cooling load 24 h a day. If dehumidification is installed, reheat elements must be counted as operating at 15 % duty 24 h a day. Such systems may, at the energy modeller's discretion, be modelled under the provisions of Item (b) below.

   Air-conditioning for other spaces must be assumed to operate at full load for two (2) h a day if provided with demand-based switching. If not provided with demand-based switching, such systems must be assumed to operate at full load four (4) h a day and fan only for six (6) h a day.

b) Where the total cooling load from supplementary systems for the tenancy is greater than 100 kW of cooling, the energy use of the system must be modelled with a thermal **simulation package** meeting the requirements of this Handbook.

In either Item (a) or Item (b), the calculation can be based on the intended control arrangement, including the following:

1) Staging.
2) Running of redundant units.
3) Fan energy.
4) Fresh air inputs.
5) Lighting energy in the space.

A.4 Office — Whole building

A whole building rating is the combination of the base building rating and tenancy rating, see Sections A.2 and A.3 for further details.

A.5 Shopping centres

A.5.1 Hours of service

No default hours of service are provided in this Handbook — these details are expected to be known by the developer. Hours will vary in different jurisdictions.

A.5.2 Trading days

No default trading days are provided in this Handbook — these details are expected to be known by the developer.

A.5.3 Common area operations

A.5.3.1 Occupant density

Default peak occupancy rates for common areas are generally based on **NCC** egress requirements as follows:

a) *General mall areas*: 3.5 m^2/person on ground floor and 5 m^2/person on other floors.

b) *Food court areas*: 1 m^2/person.

However, typical maximum occupancy is well under peak occupancy, as defined in the following schedules.

A.5.3.2 Occupancy schedule

Shopping centre occupancy has a significant impact on energy use by the **HVAC** system, as people contribute to heating loads, both sensible and latent. Outcomes become even more sensitive to occupancy schedules when fresh air controls are linked to occupant numbers. Therefore, it is critical that the design team takes special effort to understand the operation and occupancy of the proposed shopping centre.

“Occupancy” in this instance refers to the number of shoppers visiting the shopping centre and is represented as a percentage of the design occupancy. Typically, many shopping centres have late night trading on a given weekday, and slightly shorter trading hours on a Sunday. Fridays and Saturdays often seem to have higher occupancy. With these considerations, Table A.5.3.2 shows an example of a typical week occupancy schedule.

Example: **Table A.5.3.2: Typical week occupancy schedule**

Hour beginning	Hour ending	Percentage of peak occupancy				
		Mon–Wed	Thu	Fri	Sat	Sun
00:00	01:00	0 %	0 %	0 %	0 %	0 %
01:00	02:00	0 %	0 %	0 %	0 %	0 %
02:00	03:00	0 %	0 %	0 %	0 %	0 %
03:00	04:00	0 %	0 %	0 %	0 %	0 %
04:00	05:00	0 %	0 %	0 %	0 %	0 %
05:00	06:00	0 %	0 %	0 %	0 %	0 %
06:00	07:00	1 %	1 %	1 %	1 %	1 %
07:00	08:00	3 %	3 %	3 %	3 %	2 %
08:00	09:00	8 %	12 %	12 %	9 %	5 %
09:00	10:00	16 %	22 %	22 %	20 %	13 %
10:00	11:00	20 %	23 %	23 %	27 %	20 %
11:00	12:00	24 %	25 %	28 %	30 %	21 %
12:00	13:00	20 %	24 %	25 %	26 %	18 %
13:00	14:00	18 %	23 %	22 %	22 %	16 %
14:00	15:00	16 %	22 %	21 %	18 %	13 %

15:00	16:00	14 %	21 %	20 %	14 %	10 %
16:00	17:00	12 %	18 %	16 %	10 %	6 %
17:00	18:00	6 %	12 %	8 %	5 %	4 %
18:00	19:00	3 %	8 %	3 %	3 %	2 %
19:00	20:00	1 %	5 %	1 %	1 %	1 %
20:00	21:00	0 %	3 %	0 %	0 %	0 %
21:00	22:00	0 %	1 %	0 %	0 %	0 %
22:00	23:00	0 %	0 %	0 %	0 %	0 %
23:00	24:00	0 %	0 %	0 %	0 %	0 %

This “typical week” occupancy schedule must be modified for periods of known higher occupancy, e.g. in school holiday periods and the Easter break, occupancy is typically higher than usual. The weeks before and after Christmas/New Year usually have the highest occupancy in the year. Therefore, a multiplication factor of two (2) could be used for the school holiday and Easter periods, a multiplication factor of three (3) could be used for the two (2) weeks leading up to Christmas and New Year.

It is reiterated that the project modelling team must review these default schedules for relevance to their proposed shopping centre design. The schedules should be modified as appropriate. Documentation of these assumptions must be included in the report.

A.5.3.3 Lighting

A.5.3.3.1 Density

No default lighting density is provided for common area lighting in this Handbook — these details are expected to be known by the developer.

A.5.3.3.2 Schedules

The following default schedules have been determined by NABERS based on generally observed common area lighting operating hours in existing centres. Schedules are defined in relation to shopping centre trading hours, noting that these may vary in different locations. It is should also be noted that control arrangements vary significantly from centre to centre, e.g. overnight lighting operations vary from 10 % to 90 % of daytime loads across the selection of centres sampled (typically in the range of 33 % to 50 %).

In the event that more advanced controls are used, shorter operating hours may be justified, see Table A.5.3.2.

Example: **Table A.5.3.2: Default lighting schedules for lighting load at each operational hour**

Area	Overnight baseload	3 h before opening	2 h before opening	Last hour before opening	Normal trading hours	1, 2, 3 h after closing	4th, 5th h after closing
General mall lighting	45 %	75 %	85 %	100 %	100 %	90 %	75 %
Toilets	20 %	70 %	90 %	100 %	100 %	95 %	65 %
Car park lighting (internal)	20 %	60 %	65 %	65 %	100 % in areas with minimal daylight access. Otherwise, reduce in accordance with expected daylight switching patterns.	100 %	100 %
Car park lighting (external)	50 %	50 %	20 %	10 %	Through to 18:00: 0 % if daylight-sensing control is installed. Otherwise, 5 %. After 18:00: 100 %.	100 % after 18:00	90 %
Back-of-house lighting, e.g. plant rooms	5 %	5 %	5 %	15 %	15 %	15 %	5 %

A.5.3.4 Equipment density

No default equipment density is provided for common area equipment in this Handbook — this item is expected to be known by the developer.

A.5.3.5 Equipment schedule

Default schedule for equipment is as follows:

a) Advertising displays are assumed to run at normal daytime operating load *throughout* the centre during opening hours and at 50 % overnight.
b) Hand-dryer operating loads are assumed to vary in accordance with occupancy rates *throughout* normal centre operating hours.
c) Toilet exhaust fans are assumed to run whenever the centre is open and for two (2) h before opening and two (2) h after closing. Toilets near "*major*" tenants could use ventilation fan operating hours that match the trading hours of the major tenant (plus two (2) h before opening and two (2) h after closing).

A.5.4 Tenancy operations

A.5.4.1 Occupant density

Occupant density is calculated as follows:

a) Default peak occupant density in general retail tenancies is 5 m^2/person.
b) Default peak occupancy in restaurants and cafes is 1 m^2/person.

These values are based on egress provisions of the **NCC** and peak occupancy rates established in Appendix A of AS 1668.2.

A.5.4.2 Occupancy schedule

Occupant density within tenancies is assumed to vary in accordance with general variations in occupancy throughout the shopping centre.

A.5.4.3 Light and power density

No default installed light and power density is set in this Handbook, therefore see hourly schedules in Section A.5.4.4 which define total tenancy operating loads.

A.5.4.4 Light and power schedule

A.5.4.4.1 Operating loads

Default schedules listed in Table A.5.4.4.1(A) represent operating loads (as opposed to installed loads) in a variety of tenancy types (other than prepared food sales, which are shown in Table A.5.4.4.2). The schedules are defined relative to the opening hours of the centre and should be adjusted to recognise extended trading hours at peak times, e.g. around Christmas.

If tenancy types are not known, **Estimators** should use a variety of tenancy types and also test different tenancy types through an **off-axis model** covering four (4) **off-axis scenarios**.

Table A.5.4.4.1(A): Lighting and equipment load — Speciality goods, fresh food, and services tenancies

Tenancy type	Lighting and equipment load in each time period (W/m² of tenancy area)			
	Within centre trading hours	**1 h after closing**	**Last hour before opening**	**Other times outside centre trading hours**
Bags and luggage	11	8	2	1
Banks and other financial, government or administrative services	11	9	9	4
Communication, electronics and games	11	10	7	5
Fashion, accessories and footwear	12	13	3	1
Fresh food	35	33	23	19
Gifts and flowers	8	9	3	3
Hair, beauty and massage	10	9	4	2
Homewares	7	7	1	1
Newsagent and stationary	6	2	13	2
Optometrist and health services	17	13	9	5
Pharmacy and health retail	8	5	7	2

Some examples of how this schedule is applied in a shopping centre with standard New South Wales trading hours (as summarised below) are shown in Table A.5.4.4.1(B):

a) *Monday to Wednesday, Friday*: 09:00 to 17.30.

b) *Thursday*: 09:00 to 21:00.

c) *Saturday*: 09:00 to 17:00.

d) *Sunday*: 10:00 to 16:00.

Example: **Table A.5.4.4.1(B): Tenancy lighting and equipment schedules applied to NSW standard trading hours**

Time	Bags and luggage — Lighting and equipment load (W/m²)				Banks and other financial, government or administrative services — Lighting and equipment load (W/m²)				Communication, electronics and games — Lighting and equipment load (W/m²)			
	Mon–Wed, Fri	Thu	Sat	Sun	Mon–Wed, Fri	Thu	Sat	Sun	Mon–Wed, Fri	Thu	Sat	Sun
00:00–01:00	1	1	1	1	4	4	4	4	5	5	5	5
01:00–02:00	1	1	1	1	4	4	4	4	5	5	5	5
02:00–03:00	1	1	1	1	4	4	4	4	5	5	5	5
03:00–04:00	1	1	1	1	4	4	4	4	5	5	5	5
04:00–05:00	1	1	1	1	4	4	4	4	5	5	5	5
05:00–06:00	1	1	1	1	4	4	4	4	5	5	5	5
06:00–07:00	1	1	1	1	4	4	4	4	5	5	5	5
07:00–08:00	1	1	1	1	4	4	4	4	5	5	5	5
08:00–09:00	2	2	2	1	9	9	9	4	5	5	5	5

09:00–10:00	11	11	11	2	11	11	11	9	11	11	11	5
10:00–11:00	11	11	11	11	11	11	11	11	11	11	11	11
11:00–12:00	11	11	11	11	11	11	11	11	11	11	11	11
12:00–13:00	11	11	11	11	11	11	11	11	11	11	11	11
13:00–14:00	11	11	11	11	11	11	11	11	11	11	11	11
Time	**Bags and luggage — Lighting and equipment load (W/m^2)**				**Banks and other financial, government or administrative services — Lighting and equipment load (W/m^2)**				**Communication, electronics and games — Lighting and equipment load (W/m^2)**			
	Mon–Wed, Fri	**Thu**	**Sat**	**Sun**	**Mon–Wed, Fri**	**Thu**	**Sat**	**Sun**	**Mon–Wed, Fri**	**Thu**	**Sat**	**Sun**
14:00–15:00	11	11	11	11	11	11	11	11	11	11	11	11
15:00–16:00	11	11	11	11	11	11	11	11	11	11	11	11
16:00–17:00	11	11	11	8	11	11	11	9	11	11	11	10
17:00–18:00	9.5	11	8	1	10	11	9	4	10.5	11	10	5
18:00–19:00	4.5	11	1	1	6.5	11	4	4	7.5	11	5	5

19:00–20:00	1	11	1	1	4	11	4	4	5	11	5	5
20:00–21:00	1	11	1	1	4	11	4	4	5	11	5	5
21:00–22:00	1	8	1	1	4	9	4	4	5	10	5	5
22:00–23:00	1	1	1	1	4	4	4	4	5	5	5	5
23:00–24:00	1	1	1	1	4	4	4	4	5	5	5	5

A.5.4.4.2 Operating loads for food tenancies

Operating light and equipment loads for food tenancies are listed in Table A.5.4.4.2. The hours are defined with respect to the trading hours of the tenancy, in recognition that the operating hours of these tenancies may differ from the general centre trading hours — particularly where the tenancy has its own external access and may provide a dinner service as well as a lunch service. The default assumption could be that only a lunch service is provided, with the lunchtime peak period defined as 11:30 to 15:00. Dinner service can be assumed to run from 17:00 to 20:00 if the tenancy is open for evening trading.

It is also noted that a large proportion of the daytime electrical loads set out in Table A.5.4.4.2 will be associated with cooking, washing and exhaust fans. Much of the heat associated with these items is directly extracted (e.g. through the range hood or to the sewer), rather than introduced or recirculated as a heat load to the space. Therefore, only 50 % of the load above the baseload should be applied to the **HVAC** heat loads.

Similarly, gas consumption is not considered, in recognition that gas cooking equipment will be located under range hoods and therefore the extent of heat introduced to the space will be minimal.

Table A.5.4.4.2: Lighting and equipment loads in pre-prepared food tenancies (cafes, restaurants and takeaways)

Tenancy type	Lighting and equipment load in each time period (W/m^2 of tenancy area)			
	Overnight baseload	Peak meal service periods, e.g. lunch, dinner	Other trading hours outside of peak periods	Prep period (2 h before opening) clean up period (2 h after closing)
Cafes and restaurants (with seating within tenancy)	18	70	50	40
Food court and takeaway (no seating within tenancy)	11	85	70	40

The figures in Table A.5.4.4.2 are based on fully centrally serviced tenants and therefore do not include any energy consumption associated with tenant-fitted fan coil supply fans. Energy consumption of these fans needs to be included in the heat load calculation where chilled water or heating water is supplied to the tenancies. This could be based on design selection, or, where this information is unavailable, the default figure is 2.5 W/m^2 based on 5 $L/s/m^2$ air delivery at 250 Pa total pressure rise and 50 % total efficiency including fan and motor losses.

A.5.5 Vertical transport

Lift energy may be calculated using one of the following methods in order of priority:

a) *Method 1*: ISO 25745-2, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*.

b) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

The annual default of 1.5 kWh/average m² of **GLAR** per floor can also be used. Average **GLAR** per floor can be calculated by dividing **GLAR** served by the lift by the number of floors served by the lift.

A.5.6 Domestic hot water

No default allowance is made for showering and sinks within tenancies or hot water associated with cleaning and dishwashing in food tenancies in this handbook, since water heating for use in these applications will in most cases be on the tenant's meter.

In the event that domestic hot water is provided to these spaces through the landlord's meter, the hot water use can be estimated using the Green Star Potable Water Calculator, refer to www.gbca.org.au.

Basin tap hot water use in mall bathroom and baby care rooms can be estimated based on the following equation:

$$\textit{Hot water use (L/h)} = 0.26 \textit{ (tap uses/h) x number of building occupants x 20 (use/s) x tap flow rate}$$

where:

a) The number of occupants in the building is determined based on the design occupant density, de-rated using the appropriate schedule. This assessment should consider all spaces in the building, including spaces that are not centrally serviced.

b) 0.26 tap uses/h is the value assumed in the Green Star Potable Water Calculator across commercial **space types**.

> **Note:** Cinema and gymnasium occupants can be excluded if these spaces provide their own toilets for patrons and staff.

To convert the hot water consumption figure to energy consumption, the GBCA's *Energy Consumption and Greenhouse Gas Emissions Calculator Guide* (refer to www.gbca.org.au) can be used.

The following parameters can also be used if required for conversions:

1) A delivered temperature of 42 °C.
2) An average distribution system efficiency of 90 %.

A.5.7 Infiltration

Infiltration schedules for modelling should be based on the typology of the shopping centre. Large, covered shopping centres with a limited number of access doorways (particularly with motorised doors) will have limited infiltration deep in the centre.

The manner in which the model has been divided into thermal zones will also impact infiltration. Zones near the perimeter will have higher infiltration rates compared to zones located in the interior.

The preferred method of modelling should involve simulating openings based on wind direction and speed, i.e. using air network method or similar.

Alternatively, where no envelope air tightness testing data is available (e.g. in a refurbished building or from a similar building), use 0.7 air changes/h throughout all zones during hours when the zone has no mechanically supplied outside air and 0.35 air changes/h at all other times. This number should be reviewed and increased for shopping centres that have a more village-like design, i.e. many of the buildings having exposure to the outside.

A simplified empirical methodology such as described in *PNNL-20026 Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings* is appropriate for this application, or the **Estimator** may use detailed infiltration modelling considering wind direction and speed, i.e. using air network method or similar.

A.6 Hotels

A.6.1 General

Where no site-specific information is available, the following default values should be used.

The following defaults do not account for variations in occupancy at different times of the year or different days of the week. These patterns are expected to be different for CBD business hotels than hotels that are orientated towards the leisure market (e.g. in regional locations) and need to be assessed on a case-by-case basis.

Consideration should also be given to the hotel grading or star rating (from 1 star to 5 stars) which classifies hotels according to the services and facilities provided. These services and facilities will influence equipment and operation, and these variations should be taken into account.

The **Estimator** should ensure that any default used is appropriate for the hotel being modelled. These values should be used only if actual schedules are not known.

A.6.2 Hotel rooms

A.6.2.1 Occupant density

The default number of occupants per guest room is 1.6.

A.6.2.2 Light and power density

No default lighting density is provided for hotel rooms in this Handbook, therefore this should be set as per design.

Equipment loads should be established based on the planned fit out of each space. A small additional allowance should be made for guest IT equipment such as phones and laptops that are likely to be charged and used within the rooms.

In the event that the fit out is not known, a default load figure of 160 W/room should be used (excluding fridge). Where present, 70 W (continuous) should be added for bar fridges, 150 W for TVs and 50 W for guest IT equipment.

A.6.2.3 Schedules

The default occupancy schedules for occupancy, equipment and lighting operation in guest rooms are outlined below.

Note: The percentages in the equipment schedule are expressed as a proportion of the in-room equipment load, including an allowance for guest IT equipment.

The installed load associated with irons, kettles, hair dryers, microwaves and other small, high-power devices does not need to be explicitly considered when calculating the room equipment load.

Example: If a room has 200 W of IT, TV and audio equipment, plus a 1.5 kW hair dryer, then room load is taken as 200 W and the operating percentages in the schedule are applied to this.

However, the default operating schedule does make an implicit allowance for some short periods of use for this type of equipment. Fridges need to be explicitly added to the equipment load and the operating schedule by assuming they run continuously at the average load indicated on their energy rating label.

Consideration should be given to guest room lighting during “welcome” mode operation, including when and how this is initiated. If such operating patterns are not known, then the default schedules provided with this Handbook may be used. However, these schedules are based on generally observed lighting hours of operation at existing hotel sites, where lighting controls and controllability are likely to be poorer than at new hotel sites, e.g. due to increased use of LED fittings at new sites compared with less responsive lighting types such as HID and fluorescents. These schedules are therefore considered to be conservative. In all areas, modellers are advised to consider setup and cleaning times.

If key cards or occupancy sensing are used to prevent lights from being left on in vacant rooms, the **Estimator** can also consider reducing lighting hours during low-occupancy periods, e.g. with minimum daytime lighting loading falling from 20 % to 5 %.

Many hotels have financial or business models with expected occupancy for the hotel being designed, based on occupancy patterns of similar hotels. If these models exist and seem appropriate, they should be used instead of the occupancy outlined in Table A.6.2.3. However, changes in occupancy patterns throughout the day, as shown in the schedule below in Table A.6.2.3, should be modelled as appropriate given the maximum occupancy determined from the hotel’s financial or business model.

Table A.6.2.3: Occupancy and lighting patterns

Time	Weekdays (Mon–Thu)			Fri			Sat			Sun		
	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment
00:00–01:00	90 %	30 %	20 %	90 %	30 %	20 %	100 %	31 %	21 %	100 %	31 %	21 %
01:00–02:00	90 %	20 %	20 %	90 %	20 %	20 %	100 %	21 %	21 %	100 %	21 %	21 %
02:00–03:00	90 %	20 %	15 %	90 %	20 %	15 %	100 %	21 %	16 %	100 %	21 %	16 %
03:00–04:00	90 %	20 %	15 %	90 %	20 %	15 %	100 %	21 %	16 %	100 %	21 %	16 %
04:00–05:00	90 %	20 %	15 %	90 %	20 %	15 %	100 %	21 %	16 %	100 %	21 %	16 %
05:00–06:00	80 %	20 %	15 %	80 %	20 %	15 %	100 %	21 %	16 %	100 %	21 %	16 %
06:00–07:00	70 %	20 %	40 %	70 %	20 %	40 %	87 %	21 %	42 %	87 %	21 %	42 %
07:00–08:00	60 %	30 %	80 %	60 %	30 %	80 %	75 %	31 %	84 %	75 %	31 %	84 %
08:00–09:00	60 %	40 %	50 %	60 %	40 %	50 %	75 %	42 %	52 %	75 %	42 %	52 %
09:00–10:00	30 %	40 %	30 %	30 %	40 %	30 %	37 %	42 %	31 %	37 %	42 %	31 %
10:00–11:00	10 %	20 %	20 %	10 %	20 %	20 %	12 %	21 %	21 %	12 %	21 %	21 %

Time	Weekdays (Mon–Thu)			Fri			Sat			Sun		
	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment
11:00–12:00	10 %	20 %	20 %	10 %	20 %	20 %	12 %	21 %	21 %	12 %	21 %	21 %
12:00–13:00	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %
13:00–14:00	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %
14:00–15:00	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %
15:00–16:00	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %	10 %	20 %	20 %
16:00–17:00	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	18 %	20 %	20 %
17:00–18:00	30 %	50 %	40 %	37 %	52 %	42 %	37 %	52 %	42 %	27 %	43 %	35 %
18:00–19:00	40 %	60 %	40 %	50 %	63 %	42 %	50 %	63 %	42 %	36 %	52 %	35 %
19:00–20:00	50 %	70 %	50 %	62 %	73 %	52 %	62 %	73 %	52 %	45 %	61 %	43 %
20:00–21:00	60 %	70 %	60 %	75 %	73 %	63 %	75 %	73 %	63 %	54 %	61 %	52 %
21:00–22:00	70 %	60 %	60 %	87 %	63 %	63 %	87 %	63 %	63 %	63 %	52 %	52 %
22:00–23:00	70 %	60 %	40 %	87 %	63 %	42 %	87 %	63 %	42 %	63 %	52 %	35 %

Time	Weekdays (Mon–Thu)			Fri			Sat			Sun		
	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment
23:00–24:00	90 %	40 %	20 %	100 %	42 %	21 %	100 %	42 %	21 %	81 %	35 %	17 %

A.6.3 Common areas (lobbies, foyer and corridors)

A.6.3.1 General

Consideration should be given to the hotel grading or star rating from 1 star to 5 stars which classifies hotels according to the services or facilities provided. The **Estimator** should ensure that any schedule used is appropriate for the hotel being modelled.

A.6.3.2 Occupant density

Occupant density in corridors and hotel lift lobbies is not included in calculations due to the transient nature of occupancy in these spaces.

Peak occupant density for the main entry lobby can be set at one (1) person/1.5 m² in the area immediately adjacent to the reception counter, i.e. in front of the reception counter and to a depth of 5 m. Elsewhere in the foyer, the peak occupant density can be set to one (1) person/6 m².

For dining rooms, function rooms and adjacent breakout spaces, see the relevant sections below.

A.6.3.3 Occupancy schedule

Default occupancy schedule for the foyer is listed in Table A.6.3.3.

Table A.6.3.3: Foyer occupancy schedule

Time	Weekdays (Mon–Thu)	Weekend (Fri–Sun)
00:00–01:00	0 %	0 %
01:00–02:00	0 %	0 %
02:00–03:00	0 %	0 %
03:00–04:00	0 %	0 %
04:00–05:00	0 %	0 %
05:00–06:00	10 %	0 %
06:00–07:00	20 %	10 %
07:00–08:00	50 %	20 %
08:00–09:00	90 %	50 %
09:00–10:00	50 %	100 %
10:00–11:00	30 %	50 %
11:00–12:00	30 %	30 %
12:00–13:00	30 %	50 %
13:00–14:00	30 %	50 %
14:00–15:00	30 %	30 %
15:00–16:00	30 %	30 %

Time	Weekdays (Mon–Thu)	Weekend (Fri–Sun)
16:00–17:00	30 %	30 %
17:00–18:00	50 %	50 %
18:00–19:00	90 %	50 %
19:00–20:00	50 %	50 %
20:00–21:00	30 %	30 %
21:00–22:00	30 %	30 %
22:00–23:00	20 %	30 %
23:00–24:00	10 %	20 %

A.6.3.4 Lighting

A.6.3.4.1 Density

No default lighting density is provided for these spaces in this Handbook, therefore design values should be used.

A.6.3.4.2 Schedule

Lighting should be assumed to run continuously at 100 % of installed power except where automatic controls are provided. No adjustment is made for scheduled ON/OFF controls, i.e. due to the likely unreliability of this control method in most circulation spaces in hotels, which could be sporadically occupied at any time of day.

Table A.6.3.4.2 shows the fraction of common area lighting that is assumed to operate during each hour for a variety of other automatic control arrangements (expressed as a percentage of the installed lighting). Where daylight sensors are also in use, their effectiveness should be evaluated through an appropriate **simulation package** and applied as an additional factor together with any occupancy-sensing controls.

Table A.6.3.4.2: Common area lighting

Time	No automatic controls	Motion detectors controlling 7+ fittings	Motion detectors controlling 3–6 fittings	Motion detectors controlling 1–2 fittings	Daylight sensors — For internal fittings adjacent to roof lights and windows
00:00–01:00	100 %	90 %	70 %	55 %	100 %
01:00–02:00	100 %	90 %	70 %	55 %	100 %
02:00–03:00	100 %	90 %	70 %	55 %	100 %
03:00–04:00	100 %	90 %	70 %	55 %	100 %

Time	No automatic controls	Motion detectors controlling 7+ fittings	Motion detectors controlling 3–6 fittings	Motion detectors controlling 1–2 fittings	Daylight sensors — For internal fittings adjacent to roof lights and windows
04:00–05:00	100 %	90 %	70 %	55 %	100 %
05:00–06:00	100 %	90 %	70 %	55 %	100 %
06:00–07:00	100 %	90 %	70 %	55 %	100 %
07:00–08:00	100 %	90 %	70 %	55 %	50 %
08:00–09:00	100 %	90 %	70 %	55 %	50 %
09:00–10:00	100 %	90 %	70 %	55 %	50 %
10:00–11:00	100 %	90 %	70 %	55 %	50 %
11:00–12:00	100 %	90 %	70 %	55 %	50 %
12:00–13:00	100 %	90 %	70 %	55 %	50 %
13:00–14:00	100 %	90 %	70 %	55 %	50 %
14:00–15:00	100 %	90 %	70 %	55 %	50 %
15:00–16:00	100 %	90 %	70 %	55 %	50 %
16:00–17:00	100 %	90 %	70 %	55 %	50 %
17:00–18:00	100 %	90 %	70 %	55 %	50 %
18:00–19:00	100 %	90 %	70 %	55 %	50 %
19:00–20:00	100 %	90 %	70 %	55 %	100 %
20:00–21:00	100 %	90 %	70 %	55 %	100 %
21:00–22:00	100 %	90 %	70 %	55 %	100 %

Time	No automatic controls	Motion detectors controlling 7+ fittings	Motion detectors controlling 3–6 fittings	Motion detectors controlling 1–2 fittings	Daylight sensors — For internal fittings adjacent to roof lights and windows
22:00–23:00	100 %	90 %	70 %	55 %	100 %
23:00–24:00	100 %	90 %	70 %	55 %	100 %

The de-rating operating power for motion detectors should be as follows:

a) 100 % to 90 % where motion detectors control an area of 200 m^2 or less, and motion sensors control groups of more than six (6) light fittings.

b) 100 % to 70 % where motion detectors control groups of three (3) to six (6) light fittings.

c) 100 % to 55 % where motion detectors control groups of two (2) or fewer light fittings.

d) During daylight hours, de-rate operating power from 100 % to 50 % for light fittings adjacent to windows or roof lights that are controlled by daylight sensors.

A.6.3.5 Equipment

A.6.3.5.1 Density

No default equipment density is provided for these spaces in this Handbook, therefore the values as expected in operation should be used.

A.6.3.5.2 Schedule

Monitors and associated computers used for directional displays or tourist information displays in public spaces should be assumed to run at 100 % from 06:00 to 22:00 and 75 % outside these hours.

Water features should be assumed to run at 100 % on a 24/7 basis, provided that the **Estimator** makes adequate allowance for normal duty cycling of the pumping equipment.

A.6.4 Dining areas (restaurant and cafes)

A.6.4.1 Occupant density

Occupant density should be established based on the planned fit out of the space. If this information is not available, then a default figure of one (1) person/3 m² could be used.

If the facility is a bar only (i.e. no restaurant), the peak occupant density could be set to 1 m²/person.

A.6.4.2 Occupancy schedule

Occupancy schedule for hotel restaurants should be confirmed with consideration of the trading hours of the facility.

Default occupancy schedules for restaurants are shown in Table A.6.4.2. Peak occupancy hours should be extended during the earlier and later evening if the facility functions as a bar.

Table A.6.4.2: Restaurant occupancy schedules

Time	Weekdays (Mon–Thu	Weekend (Fri–Sun)
00:00–01:00	0 %	0 %
01:00–02:00	0 %	0 %
02:00–03:00	0 %	0 %
03:00–04:00	0 %	0 %
04:00–05:00	0 %	0 %
05:00–06:00	10 %	10 %
06:00–07:00	60 %	30 %
07:00–08:00	80 %	60 %
08:00–09:00	60 %	80 %
09:00–10:00	30 %	60 %
10:00–11:00	10 %	30 %
11:00–12:00	30 %	30 %
12:00–13:00	80 %	80 %
13:00–14:00	60 %	80 %
14:00–15:00	30 %	60 %
15:00–16:00	10 %	30 %

16:00–17:00	10 %	10 %
17:00–18:00	30 %	30 %
18:00–19:00	60 %	60 %
19:00–20:00	80 %	80 %
20:00–21:00	80 %	80 %
21:00–22:00	60 %	60 %
22:00–23:00	30 %	30 %
23:00–24:00	10 %	30 %

A.6.4.3 Lighting and power density and schedule

A.6.4.3.1 Restaurant lighting and power density

Lighting and power density for the eating area of the restaurant should be established based on the planned fit out of the space.

If no automatic controls are fitted in the space, the lighting could be assumed to operate from two (2) h before the start of the first service until one (1) h after the end of the last service, with lighting running at 100 % during service periods and for one (1) h before and one (1) h after and switch off down to 30 % of normal service lighting hours overnight.

If automatic occupancy sensing is installed, then lighting could be assumed to switch down to 5 % of its full power during times that the restaurant is closed, allowing for one (1) h set up and clean-up before and after each meal service.

If programmable scene controls are fitted without occupancy sensing, then lighting could be assumed to switch down to 15 % of its full power during times that the restaurant is closed, allowing for one (1) h set up and clean-up before and after each meal service.

A.6.4.3.2 Restaurant equipment schedule

By default, in-restaurant equipment (e.g. toasters, bain-maries, coffee machines) could be assumed to run at 60 % of the installed load during service periods. The default assumption is that two-thirds of the heat gain from these appliances is sensible, one-third is latent.

Note: There is an assumption that no exhaust hoods are applied to food preparation equipment in the dining area.

Most equipment will be switched off between service periods, except for coffee machines which are likely to be left in standby mode. Installed load could be established from the unit specification, or a default value of 2 kW/unit could be used if no other information is available.

Refrigeration equipment located within the dining/service area (i.e. not walk-in refrigerators) could be assumed to run at 320 W/unit on a 24/7 basis if the size and type of the unit is unknown. Where the size is known, energy consumption should be based on the energy label, advice from the manufacturers or Table 5 of Chapter 29, *2021 ASHRAE Handbook — Fundamentals*.

Note: The values provided in this section are 24 h averages which consider variation in loads at different times of the day. They are not full rated power.

An example schedule for a restaurant with breakfast, lunch and dinner service periods is shown in Table A.6.4.3.2. The total equipment schedule should be built up based on the proportions of refrigeration equipment versus other food and beverage equipment in the space. When applying these schedules, the **Estimator** should consider whether the equipment is likely to be used during all service periods, e.g. a toaster is typically only switched on at breakfast.

Example: **Table A.6.4.3.2: Restaurant service schedule**

Time	Refrigeration equipment		Other in-restaurant food prep/heating equipment	
	Weekday (Mon–Thu)	Weekend (Fri–Sun)	Weekday (Mon–Thu)	Weekend (Fri–Sun)
00:00–01:00	100 %	100 %	10 %	10 %
01:00–02:00	100 %	100 %	10 %	10 %
02:00–03:00	100 %	100 %	10 %	10 %
03:00–04:00	100 %	100 %	10 %	10 %
04:00–05:00	100 %	100 %	10 %	10 %
05:00–06:00	100 %	100 %	30 %	30 %
06:00–07:00	100 %	100 %	60 %	30 %
07:00–08:00	100 %	100 %	60 %	60 %
08:00–09:00	100 %	100 %	60 %	60 %
09:00–10:00	100 %	100 %	30 %	60 %
10:00–11:00	100 %	100 %	10 %	30 %
11:00–12:00	100 %	100 %	30 %	30 %
12:00–13:00	100 %	100 %	60 %	60 %
13:00–14:00	100 %	100 %	60 %	60 %
14:00–15:00	100 %	100 %	30 %	60 %

15:00–16:00	100 %	100 %	10 %	30 %
16:00–17:00	100 %	100 %	10 %	10 %
17:00–18:00	100 %	100 %	30 %	30 %
18:00–19:00	100 %	100 %	60 %	60 %
19:00–20:00	100 %	100 %	60 %	60 %
20:00–21:00	100 %	100 %	60 %	60 %
21:00–22:00	100 %	100 %	60 %	60 %
22:00–23:00	100 %	100 %	30 %	60 %
23:00–24:00	100 %	100 %	10 %	20 %

A.6.5 Kitchen equipment energy use

Kitchen energy use will vary depending on the following:

a) Operating hours.
b) Menu type.
c) Appliance selection.
d) Layout.
e) Operator behaviour.

International research shows relatively strong relationships between kitchen energy use and financial turnover. The preferred method of estimating consumption should involve creating a benchmark using operational data from similar sites (e.g. other sites operated as part of the same hotel chain), adjusted for projected sales.

Otherwise, a default kitchen energy consumption figure of 2.4 kWh/meal could be used for electricity and 1.9 kWh/meal used for gas. This figure is for cooked meals with multiple courses and does not include lighting and ventilation energy use, which must be modelled and accounted for separately. The appropriateness of this figure should be considered for the hotel being modelled and could be adjusted to reflect simpler or uncooked meals. The number of meals should be based on business projections for the hotel. If this is not available, a default figure of 2.5 meals/guest/day can be used. The **Estimator** should ensure that the default energy use is appropriate for the hotel type.

Alternatively, if the fit out is broadly known, appliance energy consumption in Table 5 of Chapter 29, *2021 ASHRAE Handbook — Fundamentals* can be used.

No time of use profiles are presented as the kitchen equipment is assumed to have only a very limited impact on thermal load in the hotel due to the typical practice of providing supply/exhaust ventilation in this area, i.e. so that air is not recirculated.

A.6.6 Laundry equipment energy use and schedule

In the absence of other information, the laundry equipment energy use could be estimated as 23,100 MJ/annum/guest room (gas) with full laundry service (all sheets, towels and other items washed at the on-site laundry). This figure can be scaled down where needed and should be adjusted for the proportion of rooms receiving full or part laundry services.

Equipment power density should be estimated from the fit out or use of the space, e.g. for a laundry. When modelling laundry heat loads, take care to adjust for any equipment that is directly exhausted (e.g. gas dryers), as this will reduce the contribution of the equipment to the heat loads in the space.

In the absence of other information, laundry equipment density can be based on default laundry energy **estimate**, evenly divided over the operating hours of the laundry.

A.6.7 Back-of-house areas

A.6.7.1 Occupant density

Occupant density should be assessed on the following basis:

a) One (1) person/15 m^2 for management office areas, kitchens and laundries, or based on peak shift size in laundry and kitchen areas.
b) One (1) person/20 m^2 for maintenance workshop areas or based on peak shift size.
c) Negligible occupancy in plant rooms and corridors.

A.6.7.2 Occupancy schedule

Occupancy schedule should be assessed based on the planned staffing roster for each area.

A.6.7.3 Lighting

A.6.7.3.1 Density

Lighting density in these spaces should be established based on lighting drawings.

A.6.7.3.2 Schedule

Back-of-house corridor lighting should be modelled as operating 24/7, unless automatic controls are provided. Where automatic controls are provided, lighting power density can be de-rated as described below.

Workspace lighting time of use and management office equipment defaults are shown in Table A.6.7.3.2. These schedules assume service hours of 08:00 to 19:00. The schedules could be adapted for areas with longer and shorter operating hours, e.g. based on shift times.

Table A.6.7.3.2: Workspace lighting schedule

Time	Lighting (limited time of use control: manual or time clock)	Lighting (advanced time of use control, e.g. occupancy sensors)
00:00–01:00	15 %	5 %
01:00–02:00	15 %	5 %
02:00–03:00	15 %	5 %

Time	Lighting (limited time of use control: manual or time clock)	Lighting (advanced time of use control, e.g. occupancy sensors)
03:00–04:00	15 %	5 %
04:00–05:00	15 %	5 %
05:00–06:00	15 %	5 %
06:00–07:00	40 %	30 %
07:00–08:00	90 %	75 %
08:00–09:00	100 %	100 %
09:00–10:00	100 %	100 %
10:00–11:00	100 %	100 %
11:00–12:00	100 %	100 %
12:00–13:00	100 %	100 %
13:00–14:00	100 %	100 %
14:00–15:00	100 %	100 %
15:00–16:00	100 %	100 %
16:00–17:00	100 %	100 %
17:00–18:00	100 %	100 %
18:00–19:00	100 %	100 %
19:00–20:00	80 %	75 %
20:00–21:00	60 %	25 %
21:00–22:00	60 %	15 %
22:00–23:00	50 %	15 %
23:00–24:00	15 %	5 %

A.6.7.4 Equipment density and schedule

Equipment density and schedule should be assessed based on the planned staffing roster and use of each space. For office spaces, the default values provided in Section A.2 could be used.

A.6.8 Conference areas (including function rooms)

A.6.8.1 Occupant density

Occupant density in these rooms is highly variable and could be based on the number of advertised seats in the room. For function room foyers, the occupant density should be based on the advertised capacity.

A.6.8.2 Occupancy schedule

The use of function rooms is highly variable. The default schedule is based on analysis of 12 months of booking patterns at an existing business hotel, see Table A.6.8.2. The schedule reflects both the probability that a room will be booked, and the number of occupants for the booking relative to the maximum advertised capacity of the room. Where no further details are available, the default schedule could be applied across all the rooms, with Day 1 to Day 7 reassigned on a rolling basis, i.e. so that for Room 1: Day 1 = Monday, Room 2: Day 1 = Tuesday, Room 3: Day 1 = Wednesday, etc.

Table A.6.8.2: Function room occupancy schedule

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch (afternoon)	All day	No booking	Evening
00:00–01:00	0 %	0 %	0 %	0 %	0 %	0 %	0 %
01:00–02:00	0 %	0 %	0 %	0 %	0 %	0 %	0 %
02:00–03:00	0 %	0 %	0 %	0 %	0 %	0 %	0 %
03:00–04:00	0 %	0 %	0 %	0 %	0 %	0 %	0 %
04:00–05:00	0 %	0 %	0 %	0 %	0 %	0 %	0 %
05:00–06:00	0 %	0 %	0 %	0 %	0 %	0 %	0 %
06:00–07:00	0 %	0 %	20 %	0 %	0 %	0 %	0 %
07:00–08:00	0 %	20 %	20 %	0 %	20 %	0 %	0 %
08:00–09:00	0 %	20 %	80 %	0 %	40 %	0 %	0 %
09:00–10:00	0 %	20 %	80 %	0 %	40 %	0 %	0 %
10:00–11:00	0 %	20 %	80 %	20 %	60 %	0 %	0 %
11:00–12:00	0 %	40 %	60 %	40 %	60 %	0 %	0 %
12:00–13:00	0 %	40 %	60 %	40 %	60 %	0 %	0 %
13:00–14:00	0 %	40 %	20 %	40 %	80 %	0 %	0 %
14:00–15:00	0 %	40 %	0 %	40 %	60 %	0 %	0 %

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch (afternoon)	All day	No booking	Evening
15:00–16:00	0 %	40 %	0 %	100 %	40 %	0 %	20 %
16:00–17:00	0 %	40 %	0 %	100 %	20 %	0 %	20 %
17:00–18:00	0 %	20 %	0 %	100 %	20 %	0 %	40 %
18:00–19:00	0 %	20 %	0 %	20 %	20 %	0 %	80 %
19:00–20:00	0 %	0 %	0 %	0 %	0 %	0 %	100 %
20:00–21:00	0 %	0 %	0 %	0 %	0 %	0 %	80 %
21:00–22:00	0 %	0 %	0 %	0 %	0 %	0 %	60 %
22:00–23:00	0 %	0 %	0 %	0 %	0 %	0 %	60 %
23:00–24:00	0 %	0 %	0 %	0 %	0 %	0 %	20 %

A.6.8.3 Light and power density

No default is set for conference room lighting power density in this Handbook, therefore this should be assessed based on the design fit out.

Equipment should be based on the fit-out information if available, allowing in addition for 20 W of IT equipment/guest for weekday daytime functions. If no information is available on in-room projection and IT equipment, assume 150 W/room.

Bain-maries and tea/coffee urns also need to be allowed, defaults values can be found in Table 5 of Chapter 29, *2021 ASHRAE Handbook — Fundamentals* or Section 6.6 of CIBSE, *Guide A: Environmental Design*.

A.6.8.4 Light and power schedule

The default function room lighting schedule is shown in Table A.6.8.4(A). This schedule includes a set-up/clean-up (bump in/bump out) of one (1) h before and after each booking. The percentage of lighting running outside occupancy times could be reduced from 15 % to 5 % if an automated control system is used to switch off the lights when the space is not in use, e.g. scene controller linked to room booking times. In all areas, modellers are advised to consider setup and cleaning times.

Table A.6.8.4(A): Function room lighting schedule

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch (afternoon)	All day	No booking	Evening
00:00–01:00	15 %	15 %	15 %	15 %	0 %	15 %	15 %
01:00–02:00	15 %	15 %	15 %	15 %	0 %	15 %	15 %
02:00–03:00	15 %	15 %	15 %	15 %	0 %	15 %	15 %
03:00–04:00	15 %	15 %	15 %	15 %	0 %	15 %	15 %
04:00–05:00	15 %	15 %	15 %	15 %	0 %	15 %	15 %
05:00–06:00	15 %	15 %	15 %	15 %	0 %	15 %	15 %
06:00–07:00	15 %	15 %	90 %	15 %	0 %	15 %	15 %
07:00–08:00	15 %	90 %	90 %	15 %	90 %	15 %	15 %
08:00–09:00	15 %	90 %	90 %	15 %	90 %	15 %	15 %
09:00–10:00	15 %	90 %	90 %	15 %	90 %	15 %	15 %
10:00–11:00	15 %	90 %	90 %	90 %	90 %	15 %	15 %
11:00–12:00	15 %	90 %	90 %	90 %	90 %	15 %	15 %
12:00–13:00	15 %	90 %	90 %	90 %	90 %	15 %	15 %
13:00–14:00	15 %	90 %	90 %	90 %	90 %	15 %	15 %
14:00–15:00	15 %	90 %	15 %	90 %	90 %	15 %	15 %

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch (afternoon)	All day	No booking	Evening
15:00–16:00	15 %	90 %	15 %	90 %	90 %	15 %	90 %
16:00–17:00	15 %	90 %	15 %	90 %	90 %	15 %	90 %
17:00–18:00	15 %	90 %	15 %	90 %	90 %	15 %	90 %
18:00–19:00	15 %	90 %	15 %	90 %	90 %	15 %	90 %
19:00–20:00	15 %	15 %	15 %	15 %	15 %	15 %	90 %
20:00–21:00	15 %	15 %	15 %	15 %	15 %	15 %	90 %
21:00–22:00	15 %	15 %	15 %	15 %	15 %	15 %	90 %
22:00–23:00	15 %	15 %	15 %	15 %	15 %	15 %	90 %
23:00–24:00	15 %	15 %	15 %	15 %	15 %	15 %	90 %

The default function room equipment schedule is shown in Table A.6.8.4(B).

Table A.6.8.4(B): Function room equipment schedule

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch (afternoon)	All day	No booking	Evening
00:00–01:00	5 %	5 %	5 %	5 %	5 %	5 %	5 %
01:00–02:00	5 %	5 %	5 %	5 %	5 %	5 %	5 %
02:00–03:00	5 %	5 %	5 %	5 %	5 %	5 %	5 %
03:00–04:00	5 %	5 %	5 %	5 %	5 %	5 %	5 %
04:00–05:00	5 %	5 %	5 %	5 %	5 %	5 %	5 %
05:00–06:00	5 %	5 %	5 %	5 %	5 %	5 %	5 %

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch (afternoon)	All day	No booking	Evening
06:00–07:00	5 %	5 %	70 %	5 %	5 %	5 %	5 %
07:00–08:00	5 %	70 %	70 %	5 %	70 %	5 %	5 %
08:00–09:00	5 %	70 %	70 %	5 %	70 %	5 %	5 %
09:00–10:00	5 %	70 %	70 %	5 %	70 %	5 %	5 %
10:00–11:00	5 %	70 %	70 %	70 %	70 %	5 %	5 %
11:00–12:00	5 %	70 %	70 %	70 %	70 %	5 %	5 %
12:00–13:00	5 %	70 %	70 %	70 %	70 %	5 %	5 %
13:00–14:00	5 %	70 %	70 %	70 %	70 %	5 %	5 %
14:00–15:00	5 %	70 %	5 %	70 %	70 %	5 %	5 %
15:00–16:00	5 %	70 %	5 %	70 %	70 %	5 %	70 %
16:00–17:00	5 %	70 %	5 %	70 %	70 %	5 %	70 %
17:00–18:00	5 %	70 %	5 %	70 %	70 %	5 %	70 %
18:00–19:00	5 %	70 %	5 %	70 %	70 %	5 %	70 %
19:00–20:00	5 %	5 %	5 %	5 %	5 %	5 %	70 %
20:00–21:00	5 %	5 %	5 %	5 %	5 %	5 %	70 %
21:00–22:00	5 %	5 %	5 %	5 %	5 %	5 %	70 %
22:00–23:00	5 %	5 %	5 %	5 %	5 %	5 %	70 %
23:00–24:00	5 %	5 %	5 %	5 %	5 %	5 %	70 %

A.6.9 Swimming pools

No default figure is provided for swimming pool heating energy or pumping energy in this Handbook. This should instead be calculated based on swimming pool latent and sensible heat losses to the surrounding environment. The following factors will also need to be considered in calculations:

a) Pool covering arrangements.
b) Ventilation rate and temperature/humidity set points in the pool room.
c) Heating and pump plant selections and distribution systems.

As a guide, the NABERS hotels correction factor for heated pools is 11,000 MJ gas/year/m^2 of heated pool area. Heating requirements for individual pools will vary based on the factors described above.

A.6.10 Domestic hot water

Hot water use could be assumed to be 75 L/sole occupancy unit/day for hotel guest rooms and 9 L/meal for dining room, restaurant and cafe areas. Where the number of meals is not known, an overall figure of 120 L/day/leased room can be used.

Alternatively, this can be revised based on tapware selections and expected patterns of showering and bathing based on other sites from the same portfolio.

Appropriate allowances for generation and distribution hot water also need to be included.

A.6.11 Vertical transport

Lift energy may be calculated using one of the following methods in order of priority:

a) *Method 1*: ISO 25745-2, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*.
b) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

c) The following default can also be used:

   Annual energy consumption (kWh) = 1,700 x lift floors, where “lift floors” is the total number of floors served by lifts, e.g. a five-floor high building with two (2) five-floor high lifts has 10 lift floors.

A.6.12 Infiltration

Infiltration schedules for modelling should be based on the design of the hotel. Large, covered areas with a limited number of access doorways (particularly with motorised doors) will have limited infiltration deep in the building. The manner in which the model has been divided into thermal zones will also impact infiltration. Zones near the perimeter will have higher infiltration rates compared to zones located in the interior.

The preferred method of modelling should involve simulating openings based on wind direction and speed, i.e. using air network method or similar.

Alternatively, where no envelope air tightness testing data is available (e.g. in a refurbished building or from a similar building), use 0.7 air changes/h throughout all zones during hours when the zone has no mechanically supplied outside air and 0.35 air changes/h at all other times. This number should be reviewed and increased for designs with a large amount of exposure to the outside.

A simplified empirical methodology such as described in *PNNL-20026 Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings* is appropriate for this application, or the **Estimator** may use detailed infiltration modelling considering wind direction and speed, i.e. using air network method or similar.

A.7 Data centres — Infrastructures

A.7.1 General

Where no site-specific information is available, the following default values should be used for infrastructure ratings.

No defaults are provided for IT equipment ratings in this Handbook as the actual equipment values should be used. For whole facility ratings, the client specifications will generally be known and therefore, defaults should not need to be used.

A.7.2 IT equipment density

No default is provided for equipment density in this Handbook, therefore this should be based on expected IT load from business growth models. A range of 50 % to 150 % of the base assumption equipment density should be modelled to allow for the uncertainties in this area.

IT equipment density should be assessed on the following basis:

a) If the data centre clients are known, then IT equipment density should be discussed with IT staff from the client organisations or their IT equipment suppliers.

b) For co-location data centres, the load is difficult to predict. Therefore, power use effectiveness targets should be modelled over ranges of 10 % to 90 % of capacity in order to address this uncertainty.

c) American Power Conversion states the following:

   "Studies conducted by reputable consulting engineering firms and power supply manufacturers indicate that the nameplate rating of most IT devices is well in excess of the actual running load by a factor of at least 33 %."

d) Schneider Electric states the following:

   > "The research is clear: The average data centre operates at 65 % below the design [IT equipment capacity] value."
   >
   > (Source: Neil Rasmussen, *Electrical Efficiency Modeling for Data Centers*, p 10)

   Schneider Electric also indicates that data centres typically take up to five (5) years to ramp up to their normal operating IT load, and that this eventual level is up to one-third below the business expectations.

A.7.3 Equipment schedule

While data centre equipment loads will vary in response to the number and intensity of active processes, the default assumption is that IT equipment power use is flat over a 24/7 basis. For whole facility and it equipment projects with known users, this assumption should be tested based on the existing operating profile.

A.7.4 Lighting density

No default lighting density is provided in this Handbook, therefore the **Estimator** should reference the design values.

A.7.5 Occupant density

Default peak occupant density for the data centre can be set at one (1) person/25 m^2. This is based on the egress provisions of Table D.2.D.18, Section J of the **NCC**. However, typical occupancy is likely to be much lower than this. This is reflected in the default occupancy schedules.

A.7.6 Lighting and occupancy schedule

The default lighting and occupancy schedule is shown in Table A.7.6. Two occupancy schedules are provided (i.e. for standalone data centres and for data centres that are housed as a secondary function within another facility), e.g. a data centre housed within an office building. Occupant densities are likely to be higher in these data centres due to their smaller size and the practice of housing some IT technical staff close to or within the data centre area.

Table A.7.6: Default lighting and occupancy schedule

Time	Lighting — Advanced control	Occupancy — Standalone data centre	Occupancy — Data centre located as a secondary service within another facility
00:00–01:00	5 %	5 %	5 %
01:00–02:00	5 %	5 %	5 %
02:00–03:00	5 %	5 %	5 %
03:00–04:00	5 %	5 %	5 %
04:00–05:00	5 %	5 %	5 %
05:00–06:00	5 %	5 %	5 %
06:00–07:00	5 %	5 %	5 %
07:00–08:00	5 %	5 %	5 %
08:00–09:00	15 %	15 %	30 %
09:00–10:00	15 %	15 %	30 %
10:00–11:00	15 %	15 %	30 %
11:00–12:00	15 %	15 %	30 %

Time	Lighting — Advanced control	Occupancy — Standalone data centre	Occupancy — Data centre located as a secondary service within another facility
12:00–13:00	15 %	15 %	30 %
13:00–14:00	15 %	15 %	30 %
14:00–15:00	15 %	15 %	30 %
15:00–16:00	15 %	15 %	30 %
16:00–17:00	15 %	15 %	30 %
17:00–18:00	15 %	15 %	30 %
18:00–19:00	5 %	5 %	5 %
19:00–20:00	5 %	5 %	5 %
20:00–21:00	5 %	5 %	5 %
21:00–22:00	5 %	5 %	5 %
22:00–23:00	5 %	5 %	5 %
23:00–24:00	5 %	5 %	5 %

A.8 Apartment buildings

A.8.1 General

Where no site-specific information is available, the following default values can be used. However, given variability in apartment buildings, designers and modellers should consider the appropriateness of these values for each project. Any other values used should be justified for the Independent Design Review report.

A.8.2 Apartments

A.8.2.1 Occupant density

The default figure which could be used for occupancy, where occupancy is not known, is two (2) occupants/apartment.

A.8.2.2 Light and power density

Lighting should be based on the lighting design of each apartment. In the event that this is not known, the default lighting load in apartments can be set at the relevant minimum compliance value as detailed in the **NCC**.

Equipment loads should be set at the following levels:

a) Living spaces with a kitchen: 1,100 W (sensible) and 750 W (latent).

b) Living spaces without a kitchen and bedrooms: 0 W.

A.8.2.3 Schedules

The default schedule which could be used for the primary living space within an apartment and for the kitchen space if separate is shown in Table A.8.2.3(A).

Note: This schedule could be used for all days of the week.

Table A.8.2.3(A): Default primary living space schedule

Time	Occupancy	Lighting	Equipment — Sensible	Equipment — Latent	HVAC
00:00–01:00	0 %	0 %	9.1 %	0 %	OFF
01:00–02:00	0 %	0 %	9.1 %	0 %	OFF
02:00–03:00	0 %	0 %	9.1 %	0 %	OFF
03:00–04:00	0 %	0 %	9.1 %	0 %	OFF
04:00–05:00	0 %	0 %	9.1 %	0 %	OFF
05:00–06:00	0 %	0 %	9.1 %	0 %	OFF
06:00–07:00	0 %	0 %	9.1 %	0 %	OFF
07:00–08:00	100 %	60 %	36.4 %	40.3 %	ON
08:00–09:00	100 %	60 %	9.1 %	9.3 %	ON

Time	Occupancy	Lighting	Equipment — Sensible	Equipment — Latent	HVAC
09:00–10:00	50 %	0 %	9.1 %	4.7 %	ON
10:00–11:00	50 %	0 %	9.1 %	4.7 %	ON
11:00–12:00	50 %	0 %	9.1 %	4.7 %	ON
12:00–13:00	50 %	0 %	9.1 %	4.7 %	ON
13:00–14:00	50 %	0 %	9.1 %	4.7 %	ON
14:00–15:00	50 %	0 %	9.1 %	4.7 %	ON
15:00–16:00	50 %	0 %	9.1 %	4.7 %	ON
16:00–17:00	50 %	0 %	9.1 %	4.7 %	ON
17:00–18:00	75 %	100 %	9.1 %	7.0 %	ON
18:00–19:00	75 %	100 %	100 %	100 %	ON
19:00–20:00	75 %	100 %	22.7 %	7.0 %	ON
20:00–21:00	75 %	100 %	22.7 %	7.0 %	ON
21:00–22:00	75 %	100 %	22.7 %	7.0 %	ON
22:00–23:00	0 %	0 %	9.1 %	0 %	ON
23:00–24:00	0 %	0 %	9.1 %	0 %	ON

The default schedule which could be used for the secondary living space within an apartment (excluding kitchens) and for all corridors and amenity spaces within an apartment is shown in Table A.8.2.3(B).

Note: This schedule could be used for all days of the week.

Table A.8.2.3(B): Default secondary living space schedule

Time	Occupancy	Lighting	Equipment — Sensible	Equipment — Latent	HVAC
00:00–01:00	0 %	0 %	0 %	0 %	OFF
01:00–02:00	0 %	0 %	0 %	0 %	OFF
02:00–03:00	0 %	0 %	0 %	0 %	OFF
03:00–04:00	0 %	0 %	0 %	0 %	OFF
04:00–05:00	0 %	0 %	0 %	0 %	OFF
05:00–06:00	0 %	0 %	0 %	0 %	OFF
06:00–07:00	0 %	0 %	0 %	0 %	OFF
07:00–08:00	100 %	60 %	0 %	0 %	ON
08:00–09:00	100 %	60 %	0 %	0 %	ON
09:00–10:00	50 %	0 %	0 %	0 %	ON
10:00–11:00	50 %	0 %	0 %	0 %	ON
11:00–12:00	50 %	0 %	0 %	0 %	ON
12:00–13:00	50 %	0 %	0 %	0 %	ON
13:00–14:00	50 %	0 %	0 %	0 %	ON
14:00–15:00	50 %	0 %	0 %	0 %	ON
15:00–16:00	50 %	0 %	0 %	0 %	ON
16:00–17:00	50 %	0 %	0 %	0 %	ON
17:00–18:00	75 %	100 %	0 %	0 %	ON
18:00–19:00	75 %	100 %	0 %	0 %	ON

Time	Occupancy	Lighting	Equipment — Sensible	Equipment — Latent	HVAC
19:00–20:00	75 %	100 %	0 %	0 %	ON
20:00–21:00	75 %	100 %	0 %	0 %	ON
21:00–22:00	75 %	100 %	0 %	0 %	ON
22:00–23:00	0 %	0 %	0 %	0 %	ON
23:00–24:00	0 %	0 %	0 %	0 %	ON

The default schedule which could be used for bedrooms within an apartment is shown in Table A.8.2.3(C).

Note: This schedule could be used for all days of the week.

Table A.8.2.3(C): Default apartment bedroom schedule

Time	Occupancy	Lighting	Equipment — Sensible	Equipment — Latent	HVAC
00:00–01:00	100 %	0 %	0 %	0 %	ON
01:00–02:00	100 %	0 %	0 %	0 %	ON
02:00–03:00	100 %	0 %	0 %	0 %	ON
03:00–04:00	100 %	0 %	0 %	0 %	ON
04:00–05:00	100 %	0 %	0 %	0 %	ON
05:00–06:00	100 %	0 %	0 %	0 %	ON
06:00–07:00	100 %	0 %	0 %	0 %	ON

Time	Occupancy	Lighting	Equipment — Sensible	Equipment — Latent	HVAC
07:00–08:00	0 %	0 %	0 %	0 %	ON
08:00–09:00	0 %	0 %	0 %	0 %	ON
09:00–10:00	0 %	0 %	0 %	0 %	OFF
10:00–11:00	0 %	0 %	0 %	0 %	OFF
11:00–12:00	0 %	0 %	0 %	0 %	OFF
12:00–13:00	0 %	0 %	0 %	0 %	OFF
13:00–14:00	0 %	0 %	0 %	0 %	OFF
14:00–15:00	0 %	0 %	0 %	0 %	OFF
15:00–16:00	0 %	0 %	0 %	0 %	OFF
16:00–17:00	0 %	0 %	0 %	0 %	ON
17:00–18:00	0 %	0 %	0 %	0 %	ON
18:00–19:00	0 %	0 %	0 %	0 %	ON
19:00–20:00	0 %	100 %	0 %	0 %	ON
20:00–21:00	0 %	100 %	0 %	0 %	ON
21:00–22:00	0 %	100 %	0 %	0 %	ON
22:00–23:00	100 %	100 %	0 %	0 %	ON
23:00–24:00	100 %	0 %	0 %	0 %	ON

A.8.3 Common areas (lobbies, foyer and corridors)

A.8.3.1 Occupant density

Occupant density in corridors and lift lobbies is not included due to the transient nature of occupancy in these spaces.

A.8.3.2 Lighting density

No default lighting density is provided for these spaces in this Handbook, therefore design values should be used.

A.8.3.3 Lighting schedule

Lighting should be assumed to run continuously at 100 % of installed power except where automatic controls are provided. No adjustment is made for scheduled ON/OFF controls, i.e. due to the likely unreliability of this control method in most circulation spaces in apartment buildings, which could be sporadically occupied at any time of day (these are to be treated as having no automatic controls).

Table A.8.3.3 shows the fraction of common area lighting that is assumed to operate during each hour for a variety of other automatic control arrangements (expressed as a percentage of the installed lighting). Where daylight sensors are also in use, their effectiveness should be evaluated through an appropriate **simulation package** and applied as an additional factor together with any occupancy-sensing controls.

Alternatively, the project team may wish to use the default profiles in the **NCC**, but they must justify use in accordance with the control strategy in place.

Table A.8.3.3: Default common area lighting schedule

Time	No automatic controls	Motion detectors controlling 7+ fittings	Motion detectors controlling 3–6 fittings	Motion detectors controlling 1–2 fittings	Daylight sensors — For internal fittings adjacent to roof lights and windows
00:00–01:00	100 %	90 %	70 %	55 %	100 %
01:00–02:00	100 %	90 %	70 %	55 %	100 %
02:00–03:00	100 %	90 %	70 %	55 %	100 %
03:00–04:00	100 %	90 %	70 %	55 %	100 %
04:00–05:00	100 %	90 %	70 %	55 %	100 %
05:00–06:00	100 %	90 %	70 %	55 %	100 %
06:00–07:00	100 %	90 %	70 %	55 %	100 %
07:00–08:00	100 %	90 %	70 %	55 %	50 %
08:00–09:00	100 %	90 %	70 %	55 %	50 %

Time	No automatic controls	Motion detectors controlling 7+ fittings	Motion detectors controlling 3–6 fittings	Motion detectors controlling 1–2 fittings	Daylight sensors — For internal fittings adjacent to roof lights and windows
09:00–10:00	100 %	90 %	70 %	55 %	50 %
10:00–11:00	100 %	90 %	70 %	55 %	50 %
11:00–12:00	100 %	90 %	70 %	55 %	50 %
12:00–13:00	100 %	90 %	70 %	55 %	50 %
13:00–14:00	100 %	90 %	70 %	55 %	50 %
14:00–15:00	100 %	90 %	70 %	55 %	50 %
15:00–16:00	100 %	90 %	70 %	55 %	50 %
16:00–17:00	100 %	90 %	70 %	55 %	50 %
17:00–18:00	100 %	90 %	70 %	55 %	50 %
18:00–19:00	100 %	90 %	70 %	55 %	50 %
19:00–20:00	100 %	90 %	70 %	55 %	100 %
20:00–21:00	100 %	90 %	70 %	55 %	100 %
21:00–22:00	100 %	90 %	70 %	55 %	100 %
22:00–23:00	100 %	90 %	70 %	55 %	100 %
23:00–24:00	100 %	90 %	70 %	55 %	100 %

The de-rating operating power for motion detectors should be as follows:

a) 100 % to 90 % where motion detectors control an area of 200 m^2 or less, and motion sensors control groups of more than six (6) light fittings.

b) 100 % to 70 % where motion detectors control groups of three (3) to six (6) light fittings.

c) 100 % to 55 % where motion detectors control groups of two (2) or fewer light fittings.

d) During daylight hours, de-rate operating power from 100 % to 50 % for light fittings adjacent to windows or roof lights that are controlled by daylight sensors.

A.8.3.4 Equipment density

No default equipment density is provided for these spaces in this Handbook, therefore values as expected in operation should be used.

A.8.3.5 Equipment schedule

Monitors and associated computers used for informational displays in common areas should be assumed to run at 100 % from 06:00 to 22:00 and 75 % outside these hours.

Water features should be assumed to run at 100 % on a 24/7 basis, provided that the **Estimator** makes adequate allowance for normal duty cycling of the pumping equipment.

A.8.4 Other facilities

A.8.4.1 Common laundry facilities

No default figure is provided for common laundry facilities in this Handbook as the energy consumption should be based on the design of the facility. When modelling laundry heat loads, take care to adjust for any equipment that is directly exhausted (e.g. gas dryers), as this will reduce the contribution of the equipment to the heat loads in the space.

A.8.4.2 Swimming pools and saunas

No default figure is provided for swimming pool and sauna heating energy or pumping energy in this Handbook. This should instead be calculated based on swimming pool latent and sensible heat losses to the surrounding environment. The following factors will also need to be considered in calculations:

a) Pool covering arrangements.
b) Ventilation rate and temperature/humidity set points in the pool room.
c) Heating and pump plant selections and distribution systems.

Heating requirements for individual pools will vary based on the factors described above. If the apartment building being modelled has a heated pool, contact the **National Administrator** for default heating energy values to be used.

A.8.4.3 Gymnasiums

No default figures are provided for gymnasiums in this Handbook as the energy consumption should be based on the design of the facility.

A.8.5 Back-of-house areas

A.8.5.1 General

Back-of-house areas in apartment buildings could include the following:

a) Building or facility management offices.
b) Strata committee meeting rooms.
c) Storage spaces.
d) Contractor workspaces or other non-apartment spaces not listed above that will be the responsibility of the body corporate.

A.8.5.2 Occupant density

Occupant density should be assessed on the following basis:

a) 1 person/15 m^2 for management office areas.
b) 1 person/ 20 m^2 for maintenance workshop areas.
c) Negligible occupancy in plant rooms, corridors.

A.8.5.3 Occupancy schedule

Occupancy schedule should be assessed based on the expected occupancy or staffing for each area.

A.8.5.4 Light density

Lighting density in these spaces should be established based on lighting drawings.

A.8.5.5 Light schedule

Back-of-house corridor lighting should be modelled as operating 24/7, unless automatic controls are provided. Where automatic controls are provided, lighting power density can be de-rated as described in Table A.8.5.5.

Workspace lighting time of use and management office equipment defaults are as follows. These schedules assume service hours of 08:00 to 19:00. The schedules could be adapted for areas with longer and shorter operating hours, e.g. based on shift times.

Table A.8.5.5: Default back-of-house corridor lighting schedule

Time	Lighting (limited time of use control: manual or time clock)	Lighting (advanced time of use control, e.g. occupancy sensors)
00:00–01:00	15 %	5 %
01:00–02:00	15 %	5 %
02:00–03:00	15 %	5 %
03:00–04:00	15 %	5 %
04:00–05:00	15 %	5 %
05:00–06:00	15 %	5 %
06:00–07:00	40 %	30 %
07:00–08:00	90 %	75 %
08:00–09:00	100 %	100 %
09:00–10:00	100 %	100 %
10:00–11:00	100 %	100 %
11:00–12:00	100 %	100 %
12:00–13:00	100 %	100 %
13:00–14:00	100 %	100 %
14:00–15:00	100 %	100 %
15:00–16:00	100 %	100 %
16:00–17:00	100 %	100 %
17:00–18:00	100 %	100 %
18:00–19:00	100 %	100 %
19:00–20:00	80 %	75 %
20:00–21:00	60 %	25 %
21:00–22:00	60 %	15 %
22:00–23:00	50 %	15 %
23:00–24:00	15 %	5 %

A.8.5.6 Equipment density and schedule

Equipment density and schedule should be assessed based on the planned occupancy or staffing and use of each space. For office spaces, the default values provided in Section A.2 could be used.

A.8.6 Domestic hot water

Hot water use could be assumed to be 75 L/apartment/day if there is a shared system servicing both common areas and apartments. Hot water use should only be included to the extent that it services common areas such as gyms or pools. Requirements for metering to exclude energy not attributable to common areas should be noted in the appropriate version of the NABERS **Rules** to ensure that an eventual performance rating does not need to include more energy than necessary.

Alternatively, hot water use can be calculated based on tapware selections and expected patterns of water use based on other similar apartment buildings.

Appropriate allowances for generation and distribution hot water need to be included.

A.8.7 Vertical transport

Lift energy may be calculated using one of the following methods in order of priority:

a) *Method 1*: ISO 25745-2, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*.

b) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

c) The following default method can also be used:

   Annual energy consumption (kWh) = 1,700 x lift floors, where “lift floors” is the total number of floors served by lifts, e.g. a five-floor high building with two (2) five floor high lifts has 10 lift floors.

A.8.8 Infiltration

Infiltration schedules for modelling should be based on the design of the apartment building. Large, covered areas with a limited number of access doorways (particularly with motorised doors) will have limited infiltration deep in the centre. The manner in which the model has been divided into thermal zones will also impact infiltration. Zones near the perimeter will have higher infiltration rates compared to zones located in the interior.

The preferred method of modelling should involve simulating openings based on wind direction and speed, i.e. using air network method or similar.

Alternatively, where no envelope air tightness testing data is available (e.g. in a refurbished building or from a similar building), use 0.7 air changes/h throughout all zones during hours when the zone has no mechanically supplied outside air and 0.35 air changes/h at all other times. This number should be reviewed and increased for designs with a large amount of exposure to the outside.

A simplified empirical methodology such as described in *PNNL-20026 Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings* is appropriate for this application, or the **Estimator** may use detailed infiltration modelling considering wind direction and speed, i.e. using air network method or similar.

A.9 Residential aged care

A.9.1 General

Where no site-specific information is available, the following default values can be used. However, given the variability of service offerings in aged care facilities, the **Estimator** should consider the appropriateness of these values for each project.

Example: Facilities providing "premium" services may have higher internal equipment loads, specialist lighting and meal options requiring the default values to be scaled up as required.

Any other values used should be justified for the Independent Design Review report.

A.9.2 Bedrooms

A.9.2.1 Occupant density

Occupancy of bedrooms should be as per the design. The default figure which could be used for occupancy, where occupancy is not known, is one (1) occupant/bedroom.

A.9.2.2 Light and power density

Lighting should be based on the lighting design of each bedroom. In the event that this is not known, the default lighting load in apartments can be set at the relevant minimum compliance value as detailed in the **NCC**.

The **Estimator** is to determine the heat load for each bedroom based on the facilities and equipment provided. Default values may be found in Chapters 17 and 18, *2021 ASHRAE Handbook — Fundamentals*. In the event that the fit out is not known, a default load figure of 160 W/room should be used (excluding fridge). 70 W (continuous) should be added for bar fridges where present and 150 W for TVs.

A.9.2.3 Schedules

The default schedule which could be used for bedrooms in standard level care areas is shown in Table A.9.2.3(A).

Note: This schedule could be used for all days of the week.

Table A.9.2.3(A): Default standard level care area bedroom schedule

Time	Occupancy	Lighting	Equipment
00:00–01:00	90 %	30 %	20 %
01:00–02:00	90 %	20 %	20 %
02:00–03:00	90 %	20 %	15 %
03:00–04:00	90 %	20 %	15 %
04:00–05:00	90 %	20 %	15 %
05:00–06:00	80 %	20 %	15 %

Time	Occupancy	Lighting	Equipment
06:00–07:00	70 %	20 %	40 %
07:00–08:00	60 %	30 %	80 %
08:00–09:00	60 %	40 %	50 %
09:00–10:00	30 %	40 %	30 %
10:00–11:00	10 %	20 %	20 %
11:00–12:00	10 %	20 %	20 %
12:00–13:00	10 %	20 %	20 %
13:00–14:00	10 %	20 %	20 %
14:00–15:00	10 %	20 %	20 %
15:00–16:00	10 %	20 %	20 %
16:00–17:00	20 %	20 %	20 %
17:00–18:00	30 %	50 %	40 %
18:00–19:00	40 %	60 %	40 %
19:00–20:00	50 %	70 %	50 %
20:00–21:00	60 %	70 %	60 %
21:00–22:00	70 %	60 %	60 %
22:00–23:00	70 %	60 %	40 %
23:00–24:00	90 %	40 %	20 %

The default schedule which could be used for bedrooms in high level care areas is shown in Table A.9.2.3(B).

Note: This schedule could be used for all days of the week.

Table A.9.2.3(B): Default high level care area bedroom schedule

Time	Occupancy	Lighting	Equipment
00:00–01:00	90 %	30 %	20 %
01:00–02:00	90 %	20 %	20 %
02:00–03:00	90 %	20 %	15 %
03:00–04:00	90 %	20 %	15 %
04:00–05:00	90 %	20 %	15 %
05:00–06:00	80 %	20 %	15 %
06:00–07:00	70 %	20 %	40 %
07:00–08:00	60 %	30 %	80 %
08:00–09:00	60 %	40 %	50 %
09:00–10:00	50 %	40 %	30 %

Time	Occupancy	Lighting	Equipment
10:00–11:00	50 %	20 %	20 %
11:00–12:00	50 %	20 %	20 %
12:00–13:00	50 %	20 %	20 %
13:00–14:00	50 %	20 %	20 %
14:00–15:00	50 %	20 %	20 %
15:00–16:00	50 %	20 %	20 %
16:00–17:00	50 %	20 %	20 %
17:00–18:00	50 %	50 %	40 %
18:00–19:00	60 %	60 %	40 %
19:00–20:00	60 %	70 %	50 %
20:00–21:00	70 %	70 %	60 %
21:00–22:00	90 %	60 %	60 %
22:00–23:00	90 %	60 %	40 %
23:00–24:00	90 %	40 %	20 %

A.9.3 Common areas (lobbies, foyer and corridors)

A.9.3.1 Occupant density

Occupant density in foyers, lobbies, corridors and lift lobbies is not considered due to the transient nature of occupancy in these spaces.

A.9.3.2 Lighting density

Lighting should be based on the lighting design of each space. In the event that this is not known, the default lighting load in apartments can be set at the relevant minimum compliance value as detailed in the **NCC**.

A.9.3.3 Lighting schedule

Lighting should be assumed to run continuously at 100 % of installed power, except where automatic controls are provided. No adjustment is made for scheduled ON/OFF controls (due to the likely unreliability of this control method in most circulation spaces in aged care facilities, which could be sporadically occupied at any time of day), these are to be treated as having no automatic controls.

Table A.9.3.3 shows the fraction of common area lighting that is assumed to operate during each hour for a variety of other automatic control arrangements (expressed as a percentage of the installed lighting). Where daylight sensors are also in use, their effectiveness should be evaluated through an appropriate **simulation package** and applied as an additional factor together with any occupancy-sensing controls.

Alternatively, the project team may wish to use the default profiles in the **NCC**, but they must justify use in accordance with the control strategy in place.

Table A.9.3.3: Default common area lighting schedule

Time	No automatic controls	Motion detectors controlling 7+ fittings	Motion detectors controlling 3–6 fittings	Motion detectors controlling 1–2 fittings	Daylight sensors — For internal fittings adjacent to roof lights and windows
00:00–01:00	100 %	90 %	70 %	55 %	100 %
01:00–02:00	100 %	90 %	70 %	55 %	100 %
02:00–03:00	100 %	90 %	70 %	55 %	100 %
03:00–04:00	100 %	90 %	70 %	55 %	100 %
04:00–05:00	100 %	90 %	70 %	55 %	100 %
05:00–06:00	100 %	90 %	70 %	55 %	100 %
06:00–07:00	100 %	90 %	70 %	55 %	100 %
07:00–08:00	100 %	90 %	70 %	55 %	50 %
08:00–09:00	100 %	90 %	70 %	55 %	50 %
09:00–10:00	100 %	90 %	70 %	55 %	50 %
10:00–11:00	100 %	90 %	70 %	55 %	50 %
11:00–12:00	100 %	90 %	70 %	55 %	50 %
12:00–13:00	100 %	90 %	70 %	55 %	50 %
13:00–14:00	100 %	90 %	70 %	55 %	50 %
14:00–15:00	100 %	90 %	70 %	55 %	50 %
15:00–16:00	100 %	90 %	70 %	55 %	50 %
16:00–17:00	100 %	90 %	70 %	55 %	50 %
17:00–18:00	100 %	90 %	70 %	55 %	50 %
18:00–19:00	100 %	90 %	70 %	55 %	50 %
19:00–20:00	100 %	90 %	70 %	55 %	100 %
20:00–21:00	100 %	90 %	70 %	55 %	100 %
21:00–22:00	100 %	90 %	70 %	55 %	100 %
22:00–23:00	100 %	90 %	70 %	55 %	100 %
23:00–24:00	100 %	90 %	70 %	55 %	100 %

The de-rating operating power for motion detectors should be as follows:

a) 100 % to 90 % where motion detectors control an area of 200 m^2 or less, and motion sensors control groups of more than six (6) fittings.

b) 100 % to 70 % where motion detectors control groups of three (3) to six (6) light fittings.

c) 100 % to 55 % where motion detectors control groups of two (2) or fewer light fittings.

d) During daylight hours, de-rate operating power from 100 % to 50 % for light fittings adjacent to windows or roof lights that are controlled by daylight sensors.

A.9.3.4 Equipment density

No default equipment density is provided for these spaces in this Handbook, therefore values as expected in operation should be used.

A.9.3.5 Equipment schedule

Monitors and associated computers used for directional displays or information displays in public spaces should be assumed to run at 100 % from 06:00 to 22:00 and 75 % outside these hours.

Water features should be assumed to run at 100 % on a 24/7 basis, provided that the **Estimator** makes adequate allowance for normal duty cycling of the pumping equipment.

A.9.4 Lounge/clubrooms

A.9.4.1 Occupant density

Occupant density should be established based on the planned fit out of the space. If this information is not available, then a default figure of one (1) person/2 m² could be used.

A.9.4.2 Light and power density

Lighting should be based on the design values for each space. In the event that this is not known, the default lighting load in apartments can be set at the relevant minimum compliance value as detailed in the **NCC**. The effect of lighting controls can be considered in accordance with Section A.2.3.

The **Estimator** is to determine the heat load for each space based on the facilities and equipment provided. Default values may be found in Chapters 17 and 18, *ASHRAE Handbook — Fundamentals*.

A.9.4.3 Schedules

The default schedule which could be used for lounge areas is shown in Table A.9.4.3.

Note: This schedule could be used for all days of the week.

Table A.9.4.3: Default lounge area schedule

Time	Occupancy	Lighting	Equipment
00:00–01:00	0 %	5 %	5 %
01:00–02:00	0 %	5 %	5 %
02:00–03:00	0 %	5 %	5 %
03:00–04:00	0 %	5 %	5 %
04:00–05:00	0 %	5 %	5 %
05:00–06:00	0 %	5 %	5 %
06:00–07:00	0 %	5 %	5 %

Time	Occupancy	Lighting	Equipment
07:00–08:00	5 %	30 %	5 %
08:00–09:00	15 %	30 %	5 %
09:00–10:00	50 %	60 %	5 %
10:00–11:00	100 %	100 %	5 %
11:00–12:00	90 %	100 %	5 %
12:00–13:00	70 %	90 %	5 %
13:00–14:00	90 %	80 %	5 %
14:00–15:00	100 %	100 %	5 %
15:00–16:00	100 %	100 %	5 %
16:00–17:00	100 %	100 %	5 %
17:00–18:00	100 %	100 %	5 %
18:00–19:00	50 %	60 %	5 %
19:00–20:00	15 %	30 %	5 %
20:00–21:00	5 %	5 %	5 %
21:00–22:00	0 %	5 %	5 %
22:00–23:00	0 %	5 %	5 %
23:00–24:00	0 %	5 %	5 %

A.9.4.4 Equipment density

No default equipment density is provided for these spaces in this Handbook, therefore values as expected in operation should be used.

A.9.5 Dining areas

A.9.5.1 Occupant density

Occupant density should be established based on the planned fit out of the space. If this information is not available, then a default figure of one (1) person/3 m² could be used.

A.9.5.2 Occupancy schedule

Default occupancy schedules for dining areas are shown in Table A.9.5.2.

Table A.9.5.2: Default dining area schedule

Time	Weekday (Mon–Thu)	Weekend (Fri–Sun)
00:00–01:00	0 %	0 %
01:00–02:00	0 %	0 %
02:00–03:00	0 %	0 %

Time	Weekday (Mon–Thu)	Weekend (Fri–Sun)
03:00–04:00	0 %	0 %
04:00–05:00	0 %	0 %
05:00–06:00	10 %	10 %
06:00–07:00	60 %	30 %
07:00–08:00	80 %	60 %
08:00–09:00	60 %	80 %
09:00–10:00	30 %	60 %
10:00–11:00	10 %	30 %
11:00–12:00	30 %	30 %
12:00–13:00	80 %	80 %
13:00–14:00	60 %	80 %
14:00–15:00	30 %	60 %
15:00–16:00	10 %	30 %
16:00–17:00	10 %	10 %
17:00–18:00	30 %	30 %
18:00–19:00	60 %	60 %
19:00–20:00	80 %	80 %
20:00–21:00	80 %	80 %
21:00–22:00	60 %	60 %
22:00–23:00	30 %	30 %
23:00–24:00	10 %	30 %

A.9.5.3 Light and power density and schedule

Lighting should be based on the design values for each space. In the event that this is not known, the default lighting load in spaces can be set at the relevant minimum compliance value as detailed in the **NCC**. The effect of lighting controls can be considered in accordance with Section A.2.3.

By default, service equipment (e.g. toasters, bain-maries, coffee machines) could be assumed to run at 60 % of the installed load during service periods. The default assumption is that two-third of the heat gain from these appliances is sensible, one-third is latent.

Note: There is an assumption that no exhaust hoods are applied to food preparation equipment in the dining area.

Most equipment will be switched off between service periods, except for coffee machines which are likely to be left in standby mode. Installed load could be established from the unit specification, or a default value of 2 kW/unit could be used if no other information is available.

Refrigeration equipment located within the dining/service area (i.e. not walk-in refrigerators) should be calculated as per the specified equipment. Where the size is known, energy consumption should be based on the energy label or advice from the manufacturers or Table 5 of Chapter 29, *2021 ASHRAE Handbook — Fundamentals*.

Note: The values provided in this section are 24-h averages which consider variation in loads at different times of the day. They are not full rated power.

An example schedule for a dining area with breakfast, lunch and dinner service periods is shown in Table A.9.5.3. The total equipment schedule should be calculated based on the proportions of refrigeration equipment versus other food and beverage equipment in the space. When applying these schedules, the **Estimator** should consider whether the equipment is likely to be used during all service periods, e.g. a toaster is only likely to be switched on at breakfast.

Example: Table A.9.5.3: Residential aged care dining area service schedule

Time	Refrigeration equipment		Other in-restaurant food prep/heating equipment	
	Weekday	Weekend	Weekday	Weekend
00:00–01:00	100 %	100 %	10 %	10 %
01:00–02:00	100 %	100 %	10 %	10 %
02:00–03:00	100 %	100 %	10 %	10 %
03:00–04:00	100 %	100 %	10 %	10 %
04:00–05:00	100 %	100 %	10 %	10 %
05:00–06:00	100 %	100 %	30 %	30 %
06:00–07:00	100 %	100 %	60 %	30 %
07:00–08:00	100 %	100 %	60 %	60 %
08:00–09:00	100 %	100 %	60 %	60 %
09:00–10:00	100 %	100 %	30 %	60 %
10:00–11:00	100 %	100 %	10 %	30 %
11:00–12:00	100 %	100 %	30 %	30 %

12:00–13:00	100 %	100 %	60 %	60 %
13:00–14:00	100 %	100 %	60 %	60 %
14:00–15:00	100 %	100 %	30 %	60 %
15:00–16:00	100 %	100 %	10 %	30 %
16:00–17:00	100 %	100 %	10 %	10 %
17:00–18:00	100 %	100 %	30 %	30 %
18:00–19:00	100 %	100 %	60 %	60 %
19:00–20:00	100 %	100 %	60 %	60 %
20:00–21:00	100 %	100 %	60 %	60 %
21:00–22:00	100 %	100 %	60 %	60 %
22:00–23:00	100 %	100 %	30 %	60 %
23:00–24:00	100 %	100 %	10 %	20 %

A.9.6 Kitchen equipment energy use

Kitchen energy use will vary depending on operating hours, menu type (e.g. whether all food is cooked in bulk or if there is an a la carte service), appliance selection, layout and operator behaviour.

The preferred method of estimating consumption should involve creating a benchmark using operational data from similar sites (e.g. other sites operated as part of the same aged care provider), adjusted for number of occupants.

Otherwise, a default kitchen energy consumption figure of 2.0 kWh/meal could be used. Number of meals should be based on the level of service provided. If this is not available, a default figure of 3.5 meals/occupant/day. This does not include lighting and ventilation energy use which must be modelled and accounted for separately.

Alternatively, if the fit out is broadly known, appliance energy consumption in Table 5 of Chapter 29, *2021 ASHRAE Handbook — Fundamentals* can be used.

No time of use profiles are presented as the kitchen equipment is assumed to have only a very limited impact on thermal load in the facility due to the typical practice of providing supply/exhaust ventilation in this area, i.e. so that air is not recirculated.

A.9.7 Laundry equipment energy use and schedule

In the absence of other information, the laundry equipment energy use could be estimated as 5,000 MJ/annum/bedroom (electric).

Equipment power density should be estimated from the fit out or use of the space, e.g. for a laundry. When modelling laundry heat loads, take care to adjust for any equipment that is directly exhausted (e.g. gas dryers), as this will reduce the contribution of the equipment to the heat loads in the space.

In the absence of other information, laundry equipment density can be based on default laundry energy **estimate**, evenly divided over the operating hours of the laundry.

A.9.8 Other facilities (swimming pools and saunas)

No default figure is provided for swimming pool and sauna heating energy or pumping energy in this Handbook. However, this should be calculated based on swimming pool latent and sensible heat losses to the surrounding environment. The following factors will also need to be considered in calculations:

a) Pool covering arrangements.

b) Ventilation rate and temperature/humidity set points in the pool room.

c) Heating and pump plant selections and distribution systems.

Heating requirements for individual pools will vary based on the factors described above. If the residential aged care facility being modelled has a heated pool, contact the **National Administrator** for default heating energy values to be used.

A.9.9 Staff areas

A.9.9.1 Occupant density

Occupant density should be established based on the planned fit out of the space. If this information is not available, then a default figure of one (1) person/10 m² could be used.

A.9.9.2 Light and power density

Lighting should be based on the design values for each space. In the event that this is not known, the default lighting load in apartments can be set at the relevant minimum compliance value as detailed in the **NCC**. The effect of lighting controls can be considered in accordance with Section A.2.3.

The **Estimator** is to determine the heat load for each space based on the facilities and equipment provided. Default values may be found in Section A.2 or Chapters 17 and 18, *2021 ASHRAE Handbook — Fundamentals*.

A.9.9.3 Schedule

The default schedule which could be used for staff areas is shown in Table A.9.9.3.

Note: This schedule could be used for all days of the week.

Table A.9.9.3: Default staff area schedule

Time	Occupancy	Lighting	Equipment
00:00–01:00	10 %	25 %	30 %
01:00–02:00	10 %	25 %	30 %
02:00–03:00	10 %	25 %	30 %
03:00–04:00	10 %	25 %	30 %
04:00–05:00	10 %	25 %	30 %
05:00–06:00	10 %	25 %	30 %
06:00–07:00	10 %	25 %	30 %
07:00–08:00	10 %	25 %	30 %
08:00–09:00	15 %	40 %	50 %
09:00–10:00	60 %	80 %	70 %
10:00–11:00	70 %	100 %	100 %
11:00–12:00	70 %	100 %	100 %
12:00–13:00	70 %	100 %	100 %
13:00–14:00	70 %	100 %	100 %
14:00–15:00	70 %	100 %	100 %
15:00–16:00	70 %	100 %	100 %
16:00–17:00	70 %	100 %	100 %
17:00–18:00	70 %	100 %	100 %
18:00–19:00	50 %	80 %	60 %
19:00–20:00	15 %	60 %	30 %

Time	Occupancy	Lighting	Equipment
20:00–21:00	10 %	40 %	30 %
21:00–22:00	10 %	25 %	30 %
22:00–23:00	10 %	25 %	30 %
23:00–24:00	10 %	25 %	30 %

A.9.10 Domestic hot water

Hot water use should be established based on tapware and shower selections and expected patterns of showering and bathing. Where this is not known, this could be assumed to be 75 L/room/day and 9 L/meal/day.

Appropriate allowances for generation and distribution hot water need to be included.

A.9.11 Vertical transport

Lift energy may be calculated using one of the following methods in order of priority:

a) *Method 1*: ISO 25745-2, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*.

b) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

The **Estimator** determines the number of lift trips based on the following:

1) Number of floors.

2) Resident mobility.

3) Level of care.

4) Building layout.

Either the “Low” or “Medium” lift duty options should be used from the GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

A.9.12 Ancillary allowance

The **Estimator** is to allow for an additional allowance for ancillary uses, which could include, but is not limited to, the following:

a) Cleaning.

b) Motorised beds.

c) Electric cart charging.

d) Electric barbecues.

e) CCTV.

f) Personal device charging.

A.9.13 Cafes and other facilities

The energy use of cafes and other facilities, such as hairdressers, operated primarily for resident and guest use should be considered by the **Estimator** and included in the **estimate**. The **Estimator** determines the estimated energy use based on the following:

a) Operating hours.

b) Menu type.

c) Appliance selection.

d) Layout.

e) Operator behaviour.

A.9.14 Infiltration

Infiltration schedules for modelling should be based on the design of the building. Large, covered areas with a limited number of access doorways (particularly with motorised doors) will have limited infiltration deep in the centre. The manner in which the model has been divided into thermal zones will also impact infiltration. Zones near the perimeter will have higher infiltration rates compared to zones located in the interior.

The preferred method of modelling should involve simulating openings based on wind direction and speed, i.e. using air network method or similar.

Alternatively, where no envelope air tightness testing data is available (e.g. in a refurbished building or from a similar building), use 0.7 air changes/h throughout all zones during hours when the zone has no mechanically supplied outside air and 0.35 air changes/h at all other times. This number should be reviewed and increased for designs with a large amount of exposure to the outside.

Where operable windows are provided, such as in aged care facilities, **Estimators** must incorporate the expected operation of these windows in the simulation including the effect of reasonable human controls.

A simplified empirical methodology such as described in *PNNL-20026 Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings* is appropriate for this application, or the **Estimator** may use detailed infiltration modelling considering wind direction and speed, i.e. using air network method or similar.

A.10 Retirement living

Retirement living buildings are typically very similar to apartments. As such, where no site-specific information is available, the **Estimator** can use the default values presented in Section A.7.

Given variability of service offering in retirement living buildings, where additional services are provided, the **Estimator** can use the default values presented in Section A.8 while considering the appropriateness of these values for each project. Any other values used should be justified for the Independent Design Review report.

A.11 Co-located residential aged care and retirement living facility

When assessing **co-located residential aged care and retirement living facilities**, the **Estimator** can use the default values outlined in Sections A.7 and A.8. The **Estimator** is to carefully consider the energy coverage of these facilities in accordance with the NABERS **Rules**.

A.12 Warehouse and cold stores

A.12.1 Occupancy

For further information on office space in premises, see the following:

a) Default occupancy, see Section A.2.1.

b) Default schedule, see Section A.2.4.

For warehouses and cold stores in premises, default peak occupancy can be set at 1/30 m², see Table D1.13, Section J of the **NCC**, Storage space for the default schedule.

A.12.2 Equipment loads

For office space in premises, see Section A.2.2 for equipment loads.

Any process loads energy consumption must be quantified. All assumptions regarding energy source, full-load power (kW) and equivalent full-load hours run must also be described.

For warehouse and cold stores in premises, the equipment load for automation system must be considered, see Section A.12.5 for further details. The **Estimator** must consider realistic operation of the equipment, and not just peak conditions.

Head loads introduced by internal transport is the internal transport energy consumption as calculated in Section A.12.6.

A.12.3 Lighting

The default lighting load can be set at the relevant minimum compliance value as detailed in the **NCC**.

The default lighting load in warehouses and cold stores can be set at 1.5 W/m^2.

A.12.4 Schedules

Schedules should be based on the intended operational profile provided by the project process engineers or design team.

Default schedules for refrigerated areas and conditioned spaces should operate 24/7.

The operation schedules for non-refrigerated areas should be modelled based on site-expected operation. If this is not available, the relevant schedule as detailed in the **NCC** or the *Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide* can be used.

A.12.5 Automation system

A site may have automation systems, such as Automated Storage and Retrieval Systems (ASRS), conveyor belts or automated guided vehicles. Where an automation system is in use the energy consumption needs to be estimated, as well as the load as an internal heat gain source.

The load, the operating hours and the duty cycle should be determined as in accordance with the design to estimate the total energy consumption for the automation system. If the automation system is located within a conditioned area or refrigerated area, the hourly profile of the heat gains needs to be determined to simulate the **HVAC** energy consumption and or refrigeration system energy consumption. The default value of the hourly heat gain profile is the hourly energy consumption profile of the automation system unless otherwise demonstrated in the design.

A.12.6 Internal transport

The energy consumption for internal transport, such as forklifts, electric vehicles or buggies, must be estimated as part of the site energy consumption. This can be estimated by calculating the number of internal transportation and their usage factors.

A.12.7 Cooling loads for refrigerated or temperature-controlled products

The cooling loads for refrigerated or temperature-controlled products must be considered in a conditioned area or refrigerated area. The estimate of the cooling loads can be hand-calculated before being input into relevant simulation package software or spreadsheet calculators.

The estimate must consider the following factors:

a) Specific heat of the products.
b) Pre-entering temperature of the products and the temperature of the space.
c) Mass throughput of the products each time.
d) Frequency of the incoming products.
e) Stored product respiration and transpiration.

A.12.8 Infiltration

Infiltration schedules for modelling should be based on the design of the warehouse and cold stores. Large, covered warehouses and cold stores with a limited number of access doorways (particularly with motorised doors) will have limited infiltration deep in the building.

The manner in which the model has been divided into thermal zones will also impact infiltration. Zones near the perimeter will have higher infiltration rates compared to zones located in the interior. This must be considered for both air-conditioned spaces as well as refrigerated areas.

The preferred method of modelling is to simulate openings based on wind direction and speed, i.e. using air network method or similar. For non-refrigerated spaces in a warehouse, default infiltration rates can be used from Table 4.20 of CIBSE, *Guide A: Environmental Design*.

For refrigerated spaces in a warehouse, the following equation can be used:

$$q = 2754.25\, AD_t(gH^{0.5})(h_{outside} - h_{inside})\rho_{inside}\left(1 - \frac{\rho_{outside}}{\rho_{inside}}\right)^{0.5} \times \left[\frac{2}{1 + \left(\frac{\rho_{inside}}{\rho_{outside}}\right)^{\frac{1}{3}}}\right]^{1.5}$$

(Source: W.B Gosney and H.A. Olama, "Heat and Enthalpy Gains through Cold Room Doorways", pp 35–38)

where:

q [kW] = sensible and latent refrigeration load

A [m^2] = doorway area

D_t [W/mK]= thermal conductivity of air taken at the average temperature at the doorway (boundary between the inside and outside of the refrigerated space)

h [kJ/kg] = enthalpy of the air inside (cold) or outside (warm) the refrigerated space

ρ [kg/m^2] = density of the air inside (cold) or outside (warm) the refrigerated space

g [m^2/s] = gravitational acceleration

H [m] = height of doorway

A.12.9 Domestic hot water

Domestic hot water use for showering can be estimated using the Green Star Potable Water Calculator, refer to www.gbca.org.au.

Basin tap hot water use can be estimated based on the following:

Hot water use (L/h) = 0.26 (tap uses/h) x number of building occupants x 20 (use/s) x tap flow rate

where:

a) The number of occupants in the building is determined based on the design occupant density, de-rated using the appropriate schedule. This assessment should consider all spaces in the building, including spaces that are not centrally serviced.

b) 0.26 tap uses/hour is the value assumed in the Green Star Potable Water Calculator across commercial **space types**.

To convert the hot water consumption figure to energy consumption, the GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide* (refer to www.gbca.org.au) can be used.

The following parameters can also be used if required for conversions:

1) A delivered temperature of 42 °C.

2) An average distribution system efficiency of 90 %.

A.12.10 Vertical transport

Lift energy may be calculated using one of the following methods in order of priority:

a) *Method 1*: ISO 25745-2, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators).*

b) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

The **Estimator** determines the number of lift trips based on the following:

1) Number of floors.
2) Resident mobility.
3) Level of care.
4) Building layout.

Either the "Low" or "Medium" lift duty options should be used from the GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

A.13 Schools

A.13.1 General

Where no site-specific information is available, the following default values can be used. However, given the variability in operation between different school types, the **Estimator** should consider the appropriateness of these values for each project. Consideration should be given to the following:

a) School term/school holidays.
b) Use of school facilities outside school hours or during school holidays.

A.13.2 Equipment Load

A.13.2.1 Equipment Load

No default equipment loads are provided, as this information should be available at the time of simulation. The requirements set out in A3.1.1-A3.1.7 apply.

A.13.3 Occupant density

The number of students present in a space has a significant impact on energy use by the **HVAC** system, as people contribute to heating and cooling loads, both sensible and latent.

Default peak occupant density for the school spaces are based on the usage of the space, and the egress provisions of Table D.2.18, of the **NCC**. However, typical occupancy is likely to be lower than this. This is reflected in the default occupancy schedules in Section A.13.5.

The heating loads from occupants also vary depending on activity level. Therefore, it is critical that the design team takes special effort to understand the operation and occupancy of the proposed school, including the age group of students present and the activity level.

A.13.4 Lighting

No default lighting power density figures are provided, as this information should be available at the time of simulation.

A.13.5 Scheduling

Note that lighting schedules represent the hours of enablement as opposed to the hours of operation; in practice occupancy and daylight controls may reduce the numbers further.

A.13.5.1 School Teaching Spaces and Libraries (Primary School)

The profile shown in Table A.13.5.1 should be used for approximately 50% by floor area of teaching spaces, including computer and science laboratories and manual workshops. The selected spaces should be distributed evenly around the school, as opposed to being concentrated together.

The profiles shown in Table A.13.5.2 and Table A.13.5.3 should be used for the remaining floor area of these spaces, plus libraries and gymnasia.

Note: Different schedules should be used for weekdays, weekends, school holidays and during the school term.

Table A.13.5.1: Default Operational Profile (a) for teaching spaces in primary schools

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays			
Time	**Occupancy**	**Lighting**	**Appliances and Equipment**	**HVAC**	**Occupancy**	**Lighting**	**Appliances and Equipment**	**HVAC**
00:00-01:00	0%	0%	5%	Off	0 %	0%	5%	Off
01:00-02:00	0%	0%	5%	Off	0 %	0%	5%	Off
02:00-03:00	0%	0%	5%	Off	0 %	0%	5%	Off
03:00-04:00	0%	0%	5%	Off	0 %	0%	5%	Off
04:00-05:00	0%	0%	5%	Off	0 %	0%	5%	Off
05:00-06:00	0%	0%	5%	Off	0 %	0%	5%	Off
06:00-07:00	0%	0%	5%	Off	0 %	0%	5%	Off
07:00-08:00	0%	0%	5%	Off	0 %	0%	5%	Off
08:00-09:00	10%	50%	5%	On	0 %	0%	5%	Off
09:00-10:00	80%	90%	100%	On	0 %	0%	5%	Off
10:00-11:00	80%	90%	100%	On	0 %	0%	5%	Off
11:00-12:00	50%	90%	100%	On	0 %	0%	5%	Off
12:00-13:00	20%	50%	50%	On	0 %	0%	5%	Off
13:00-14:00	80%	90%	100%	On	0 %	0%	5%	Off
14:00-15:00	80%	90%	100%	On	0 %	0%	5%	Off
15:00-16:00	10%	50%	10%	On	0 %	0%	5%	Off
16:00-17:00	0%	0%	5%	Off	0 %	0%	5%	Off
17:00-18:00	0%	0%	5%	Off	0 %	0%	5%	Off
18:00-19:00	0%	0%	5%	Off	0 %	0%	5%	Off
19:00-20:00	0%	0%	5%	Off	0 %	0%	5%	Off
20:00-21:00	0%	0%	5%	Off	0 %	0%	5%	Off
21:00-22:00	0%	0%	5%	Off	0 %	0%	5%	Off
22:00-23:00	0%	0%	5%	Off	0 %	0%	5%	Off
23:00-24:00	0%	0%	5%	Off	0 %	0%	5%	Off

Table A.13.5.2: Default Operational Profile (b) for teaching spaces, libraries and gymnasia in primary schools

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays except as per Table A13.5.3			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
00:00-01:00	0%	0%	5%	Off	0 %	0%	5%	Off
01:00-02:00	0%	0%	5%	Off	0 %	0%	5%	Off
02:00-03:00	0%	0%	5%	Off	0 %	0%	5%	Off
03:00-04:00	0%	0%	5%	Off	0 %	0%	5%	Off
04:00-05:00	0%	0%	5%	Off	0 %	0%	5%	Off
05:00-06:00	0%	0%	5%	Off	0 %	0%	5%	Off
06:00-07:00	0%	0%	5%	Off	0 %	0%	5%	Off
07:00-08:00	0%	0%	5%	Off	0 %	0%	5%	Off
08:00-09:00	10%	50%	5%	On	0 %	0%	5%	Off
09:00-10:00	80%	90%	100%	On	0 %	0%	5%	Off
10:00-11:00	80%	90%	100%	On	0 %	0%	5%	Off
11:00-12:00	50%	90%	100%	On	0 %	0%	5%	Off
12:00-13:00	20%	50%	50%	On	0 %	0%	5%	Off
13:00-14:00	80%	90%	100%	On	0 %	0%	5%	Off
14:00-15:00	80%	90%	100%	On	0 %	0%	5%	Off
15:00-16:00	10%	50%	10%	On	0 %	0%	5%	Off
16:00-17:00	10%	50%	10%	On	0 %	0%	5%	Off
17:00-18:00	10%	50%	10%	On	0 %	0%	5%	Off
18:00-19:00	0%	0%	5%	Off	0 %	0%	5%	Off
19:00-20:00	0%	0%	5%	Off	0 %	0%	5%	Off
20:00-21:00	0%	0%	5%	Off	0 %	0%	5%	Off
21:00-22:00	0%	0%	5%	Off	0 %	0%	5%	Off
22:00-23:00	0%	0%	5%	Off	0 %	0%	5%	Off
23:00-24:00	0%	0%	5%	Off	0 %	0%	5%	Off

Table A.13.5.3: Default Operational Profile (b), continued, for teaching spaces, libraries and gymnasia in primary schools

	Weekday during school holidays - one week prior to term commencing			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC
00:00-01:00	0%	0%	5%	Off
01:00-02:00	0%	0%	5%	Off
02:00-03:00	0%	0%	5%	Off
03:00-04:00	0%	0%	5%	Off
04:00-05:00	0%	0%	5%	Off
05:00-06:00	0%	0%	5%	Off
06:00-07:00	0%	0%	5%	Off
07:00-08:00	0%	0%	5%	Off
08:00-09:00	0%	0%	5%	On
09:00-10:00	10%	50%	10%	On
10:00-11:00	10%	50%	10%	On
11:00-12:00	10%	50%	10%	On
12:00-13:00	10%	50%	10%	On
13:00-14:00	10%	50%	10%	On
14:00-15:00	10%	50%	10%	On
15:00-16:00	0%	0%	5%	Off
16:00-17:00	0%	0%	5%	Off
17:00-18:00	0%	0%	5%	Off
18:00-19:00	0%	0%	5%	Off
19:00-20:00	0%	0%	5%	Off
20:00-21:00	0%	0%	5%	Off
21:00-22:00	0%	0%	5%	Off
22:00-23:00	0%	0%	5%	Off
23:00-24:00	0%	0%	5%	Off

A.13.5.1 School Teaching Spaces and Libraries (Secondary Schools)

The profile shown in Table A.13.5.4 should be used for approximately 50% by floor area of teaching spaces, including computer and science laboratories, manual workshops and gymnasia. The selected spaces should be distributed evenly around the school, as opposed to being concentrated together.

The profiles shown in Table A.13.5.5 and Table A.13.5.6 should be used for the remaining floor area of these spaces, plus libraries.

Note: Different schedules should be used for weekdays, weekends, school holidays and during the school term.

Table A.13.5.4: Default Operational Profile (a) for teaching spaces in secondary schools and colleges

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
00:00-01:00	0%	0%	5%	Off	0 %	0%	5%	Off
01:00-02:00	0%	0%	5%	Off	0 %	0%	5%	Off
02:00-03:00	0%	0%	5%	Off	0 %	0%	5%	Off
03:00-04:00	0%	0%	5%	Off	0 %	0%	5%	Off
04:00-05:00	0%	0%	5%	Off	0 %	0%	5%	Off
05:00-06:00	0%	0%	5%	Off	0 %	0%	5%	Off
06:00-07:00	0%	0%	5%	Off	0 %	0%	5%	Off
07:00-08:00	0%	0%	5%	Off	0 %	0%	5%	Off
08:00-09:00	50%	50%	50%	On	0 %	0%	5%	Off
09:00-10:00	70%	90%	100%	On	0 %	0%	5%	Off
10:00-11:00	70%	90%	100%	On	0 %	0%	5%	Off
11:00-12:00	50%	90%	100%	On	0 %	0%	5%	Off
12:00-13:00	70%	90%	100%	On	0 %	0%	5%	Off
13:00-14:00	50%	50%	50%	On	0 %	0%	5%	Off
14:00-15:00	70%	90%	100%	On	0 %	0%	5%	Off
15:00-16:00	50%	90%	50%	On	0 %	0%	5%	Off
16:00-17:00	0%	0%	5%	Off	0 %	0%	5%	Off
17:00-18:00	0%	0%	5%	Off	0 %	0%	5%	Off

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
18:00-19:00	0%	0%	5%	Off	0 %	0%	5%	Off
19:00-20:00	0%	0%	5%	Off	0 %	0%	5%	Off
20:00-21:00	0%	0%	5%	Off	0 %	0%	5%	Off
21:00-22:00	0%	0%	5%	Off	0 %	0%	5%	Off
22:00-23:00	0%	0%	5%	Off	0 %	0%	5%	Off
23:00-24:00	0%	0%	5%	Off	0 %	0%	5%	Off

Table A.13.5.5: Default Operational Profile (b) for teaching spaces, libraries and gymnasia in secondary schools and colleges

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays except as per Table A.13.6.3			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
00:00-01:00	0%	0%	5%	Off	0 %	0%	5%	Off
01:00-02:00	0%	0%	5%	Off	0 %	0%	5%	Off
02:00-03:00	0%	0%	5%	Off	0 %	0%	5%	Off
03:00-04:00	0%	0%	5%	Off	0 %	0%	5%	Off
04:00-05:00	0%	0%	5%	Off	0 %	0%	5%	Off
05:00-06:00	0%	0%	5%	Off	0 %	0%	5%	Off
06:00-07:00	0%	0%	5%	Off	0 %	0%	5%	Off
07:00-08:00	0%	0%	5%	Off	0 %	0%	5%	Off
08:00-09:00	50%	50%	50%	On	0 %	0%	5%	Off
09:00-10:00	70%	90%	100%	On	0 %	0%	5%	Off
10:00-11:00	70%	90%	100%	On	0 %	0%	5%	Off
11:00-12:00	50%	90%	100%	On	0 %	0%	5%	Off
12:00-13:00	70%	90%	100%	On	0 %	0%	5%	Off
13:00-14:00	50%	50%	50%	On	0 %	0%	5%	Off
14:00-15:00	70%	90%	100%	On	0 %	0%	5%	Off
15:00-16:00	50%	90%	50%	On	0 %	0%	5%	Off
16:00-17:00	10%	50%	10%	On	0 %	0%	5%	Off
17:00-18:00	10%	50%	10%	On	0 %	0%	5%	Off
18:00-19:00	10%	50%	10%	On	0 %	0%	5%	Off
19:00-20:00	0%	0%	5%	Off	0 %	0%	5%	Off
20:00-21:00	0%	0%	5%	Off	0 %	0%	5%	Off
21:00-22:00	0%	0%	5%	Off	0 %	0%	5%	Off
22:00-23:00	0%	0%	5%	Off	0 %	0%	5%	Off
23:00-24:00	0%	0%	5%	Off	0 %	0%	5%	Off

Table A.13.5.6: Default Operational Profile (b), continued, for teaching spaces, libraries and gymnasia in secondary schools and colleges

	Weekday during school holidays - one week prior to term commencing			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC
00:00-01:00	0%	0%	5%	Off
01:00-02:00	0%	0%	5%	Off
02:00-03:00	0%	0%	5%	Off
03:00-04:00	0%	0%	5%	Off
04:00-05:00	0%	0%	5%	Off
05:00-06:00	0%	0%	5%	Off
06:00-07:00	0%	0%	5%	Off
07:00-08:00	0%	0%	5%	Off
08:00-09:00	0%	0%	5%	On
09:00-10:00	10%	50%	10%	On
10:00-11:00	10%	50%	10%	On
11:00-12:00	10%	50%	10%	On
12:00-13:00	10%	50%	10%	On
13:00-14:00	10%	50%	10%	On
14:00-15:00	10%	50%	10%	On
15:00-16:00	10%	50%	10%	On
16:00-17:00	10%	50%	10%	On
17:00-18:00	0%	0%	5%	Off
18:00-19:00	0%	0%	5%	Off
19:00-20:00	0%	0%	5%	Off
20:00-21:00	0%	0%	5%	Off
21:00-22:00	0%	0%	5%	Off
22:00-23:00	0%	0%	5%	Off
23:00-24:00	0%	0%	5%	Off

A.13.5.2 School common areas

This profile shown in Table A.13.5.7 and Table A13.5.8 should be used for all spaces where students congregate outside class, including canteens and corridors.

Note 1: Different schedules should be used for weekdays and weekends.

Table A.13.5.7: Default Operational Profile for School Canteens and common areas (primary schools)

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
00:00-01:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
01:00-02:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
02:00-03:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
03:00-04:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
04:00-05:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
05:00-06:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
06:00-07:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
07:00-08:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
08:00-09:00	50 %	50 %	20 %	Off	0 %	0 %	20 %	Off
09:00-10:00	10 %	50 %	50 %	Off	0 %	0 %	20 %	Off
10:00-11:00	10 %	100 %	100 %	On	0 %	0 %	20 %	Off
11:00-12:00	50 %	100 %	100 %	On	0 %	0 %	20 %	Off
12:00-13:00	100 %	100 %	100 %	On	0 %	0 %	20 %	Off
13:00-14:00	10 %	50 %	50 %	On	0 %	0 %	20 %	Off
14:00-15:00	0 %	0 %	50 %	On	0 %	0 %	20 %	Off
15:00-16:00	0 %	0 %	20 %	On	0 %	0 %	20 %	Off
16:00-17:00	0 %	0 %	20 %	On	0 %	0 %	20 %	Off
17:00-18:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
18:00-19:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
19:00-20:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
20:00-21:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
21:00-22:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
22:00-23:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
23:00-24:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off

Table A.13.5.8: Default Operational Profile for School Canteens and common areas (secondary schools and colleges)

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
00:00-01:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
01:00-02:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
02:00-03:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
03:00-04:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
04:00-05:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
05:00-06:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
06:00-07:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
07:00-08:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
08:00-09:00	10 %	50 %	20 %	Off	0 %	0 %	20 %	Off
09:00-10:00	20 %	50 %	50 %	Off	0 %	0 %	20 %	Off
10:00-11:00	20 %	50 %	100 %	On	0 %	0 %	20 %	Off
11:00-12:00	50 %	100 %	100 %	On	0 %	0 %	20 %	Off
12:00-13:00	20 %	50 %	100 %	On	0 %	0 %	20 %	Off
13:00-14:00	100 %	100 %	50 %	On	0 %	0 %	20 %	Off
14:00-15:00	20 %	50 %	50 %	On	0 %	0 %	20 %	Off
15:00-16:00	20 %	50 %	20 %	On	0 %	0 %	20 %	Off
16:00-17:00	0 %	0 %	20 %	On	0 %	0 %	20 %	Off
17:00-18:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
18:00-19:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
19:00-20:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off

	School Term - Weekday (Monday – Friday)				Weekend (Saturday – Sunday), and Weekdays during School Holidays			
Time	Occupancy	Lighting	Appliances and Equipment	HVAC	Occupancy	Lighting	Appliances and Equipment	HVAC
20:00-21:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
21:00-22:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
22:00-23:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off
23:00-24:00	0 %	0 %	20 %	Off	0 %	0 %	20 %	Off

A.13.5.2 School Office and Administration Spaces

This profile shown in Table A.13.5.9 should be used for indoor spaces within a school which are used as office spaces, including Staff rooms and school admin areas.

Note: Different schedules should be used for weekdays and weekends, school term and School holidays.

Table A.13.5.9: Default Operational Profile for School Office Spaces

	Weekday (Monday – Friday) **School Term**				Weekday (Monday – Friday) **Last week of school holidays**				Weekend (Saturday – Sunday) and school holidays (other than last week)			
Time	Occupancy	Lighting	Appliances & Equipment	HVAC	Occupancy	Lighting	Appliances & Equipment	HVAC	Occupancy	Lighting	Appliances & Equipment	HVAC
00:00–01:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
01:00–02:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
02:00–03:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
03:00–04:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
04:00–05:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
05:00–06:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
06:00–07:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
07:00–08:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
08:00–09:00	50 %	50 %	50 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
09:00–10:00	100%	100 %	100 %	On	20%	50 %	20 %	On	0 %	0 %	10 %	Off
10:00–11:00	100%	100 %	100 %	On	20%	50 %	20 %	On	0 %	0 %	10 %	Off
11:00–12:00	100%	100 %	100%	On	20%	50 %	20 %	On	0 %	0 %	10 %	Off
12:00–13:00	100 %	100 %	100 %	On	20 %	50 %	20 %	On	0 %	0 %	10 %	Off
13:00–14:00	100%	100 %	100 %	On	20%	50 %	20 %	On	0 %	0 %	10 %	Off
14:00–15:00	100 %	100 %	100 %	On	20 %	50 %	20 %	On	0 %	0 %	10 %	Off
15:00–16:00	100 %	100 %	100 %	On	20 %	50 %	20 %	On	0 %	0 %	10 %	Off

	Weekday (Monday – Friday) **School Term**				Weekday (Monday – Friday) **Last week of school holidays**				Weekend (Saturday – Sunday) and school holidays (other than last week)			
Time	Occupancy	Lighting	Appliances & Equipment	HVAC	Occupancy	Lighting	Appliances & Equipment	HVAC	Occupancy	Lighting	Appliances & Equipment	HVAC
16:00–17:00	50 %	50 %	50 %	On	20 %	50 %	20 %	On	0 %	0 %	10 %	Off
17:00–18:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
18:00–19:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
19:00–20:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
20:00–21:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
21:00–22:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
22:00–23:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off
23:00–24:00	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off	0 %	0 %	10 %	Off

A.13.6 Exterior lighting

Exterior lighting including pathway lighting and external carpark lighting shall be modelled as operating from 6pm-6am every day.

A.13.7 Swimming Pools

No default figure is provided for swimming pool and sauna heating energy or pumping energy in this Handbook. However, this should be calculated based on swimming pool latent and sensible heat losses to the surrounding environment. The following factors will also need to be considered in calculations:

a) Pool covering arrangements.

b) Ventilation rate and temperature/humidity set points in the pool room.

c) Heating and pump plant selections and distribution systems.

A.13.8 Vertical Transport

Lift energy may be calculated using one of the following methods in order of priority:

a) *Method 1: ISO 25745-2, Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*.
b) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

The **Estimator** determines the number of lift trips based on the following:

1) Number of floors.
2) Student/staff mobility.
3) Building layout.

Unless the school is a vertical school, either the “Low” or “Medium” lift duty options should be used from the GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

A.13.9 Domestic Hot Water

The default hot water consumption for schools is 7 L/person/day at 60°C. Alternative figures may be used that capture the profile of the site’s domestic hot water use more accurately, such as using the domestic hot water calculation method in the GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

A.13.10 Infiltration

Infiltration schedules for modelling should be based on the layout of the school. Entrance doors and doors to recreation spaces may have significantly different infiltration profiles due to differences in how and when these doors are used. Furthermore, in secondary schools, where pupils regularly move between classes regularly, door opening patterns will be very different from a primary school where pupils spend more time in a single room. Classrooms and corridors with external doors will be particularly impacted by infiltration, but infiltration effects may also be relevant for classrooms opening into corridors. A simplified empirical methodology such as described in *PNNL-20026 Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings* is appropriate for this application, or the **Estimator** may use detailed infiltration modelling considering wind direction and speed, i.e. using air network method or similar.

For general building envelope infiltration, where no envelope air tightness testing data is available (e.g. in a refurbished building or from a similar building), use 0.7 air changes/h throughout all zones during hours when the zone has no mechanically supplied outside air and 0.35 air changes/h at all other times.

A.14 Retail Stores

A.14.1 Weekly trading hours

No default hours of service are provided in this Handbook — these details are expected to be known by the developer.

A.14.2 Occupation density

Occupant density is calculated as follows:

a) Default peak occupant density in general retail stores is 5 m^2/person.

This value is based on egress provisions of the **NCC** and peak occupancy rates established in Appendix A of AS 1668.2.

A.14.3 Occupation schedule

Similar to Shopping centre occupancy has a significant impact on energy use by the HVAC system within retail stores, as people contribute to heating loads, both sensible and latent.

Occupancy refers to the number of shoppers visiting the retail store and is represented as a percentage of the design occupancy. Refer to Section A.5.3.2 for an example of a typical week occupancy schedule.

A.14.4 Light and power density

No default installed light and power density is set in this Handbook, therefore see hourly schedules in Section A.5.4.4 which define total retail store operating loads.

A.14.4.1 Light and power schedule

A.14.4.1 Operating loads

Default schedules listed in Table 14.4.1 (A) represent operating loads (as opposed to installed loads) in a variety of retail categories. The schedules are defined relative to the opening hours of a shopping centre and should be adjusted to recognise extended trading hours at peak times, e.g. around Christmas for retail stores.

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Table A.14.4.1(A): Lighting and equipment load — Speciality goods, fresh food, and services tenancies

Tenancy type	Lighting and equipment load in each time period (W/m² of retail store area)			
	Within centre trading hours	**1 h after closing**	**Last hour before opening**	**Other times outside centre trading hours**
Bags and luggage	11	8	2	1
Banks and other financial, government or administrative services	11	9	9	4
Communication, electronics and games	11	10	7	5
Fashion, accessories and footwear	12	13	3	1
Gifts and flowers	8	9	3	3
Hair, beauty and massage	10	9	4	2
Homewares	7	7	1	1
Newsagent and stationary	6	2	13	2
Pharmacy and health retail	8	5	7	2

In the case the retail store category is not listed in the table, a density default of 40W/m^2 for equipment and 20 40W/m^2 for lighting. These values are based on the Greenstar retail centre energy calculator guide V1.

Some examples of how this schedule is applied in retail stores in shopping centre with standard New South Wales trading hours (as summarised below) are shown in Table 14.4.1 (B):

e) *Monday to Wednesday, Friday*: 09:00 to 17.30.
f) *Thursday*: 09:00 to 21:00.
g) *Saturday*: 09:00 to 17:00.
h) *Sunday*: 10:00 to 16:00.

Example: Table A.14.4.1 (B) Retail store lighting and equipment schedules applied to NSW standard trading hours

Time	Bags and luggage — Lighting and equipment load (W/m²)				Banks and other financial, government or administrative services — Lighting and equipment load (W/m²)				Communication, electronics and games — Lighting and equipment load (W/m²)			
	Mon–Wed, Fri	Thu	Sat	Sun	Mon–Wed, Fri	Thu	Sat	Sun	Mon–Wed, Fri	Thu	Sat	Sun
00:00–01:00	1	1	1	1	4	4	4	4	5	5	5	5
01:00–02:00	1	1	1	1	4	4	4	4	5	5	5	5
02:00–03:00	1	1	1	1	4	4	4	4	5	5	5	5
03:00–04:00	1	1	1	1	4	4	4	4	5	5	5	5
04:00–05:00	1	1	1	1	4	4	4	4	5	5	5	5
05:00–06:00	1	1	1	1	4	4	4	4	5	5	5	5
06:00–07:00	1	1	1	1	4	4	4	4	5	5	5	5
07:00–08:00	1	1	1	1	4	4	4	4	5	5	5	5
08:00–09:00	2	2	2	1	9	9	9	4	5	5	5	5
09:00–10:00	11	11	11	2	11	11	11	9	11	11	11	5
10:00–11:00	11	11	11	11	11	11	11	11	11	11	11	11
11:00–12:00	11	11	11	11	11	11	11	11	11	11	11	11
12:00–13:00	11	11	11	11	11	11	11	11	11	11	11	11

Time	Bags and luggage — Lighting and equipment load (W/m²)				Banks and other financial, government or administrative services — Lighting and equipment load (W/m²)				Communication, electronics and games — Lighting and equipment load (W/m²)			
	Mon–Wed, Fri	Thu	Sat	Sun	Mon–Wed, Fri	Thu	Sat	Sun	Mon–Wed, Fri	Thu	Sat	Sun
13:00–14:00	11	11	11	11	11	11	11	11	11	11	11	11
14:00–15:00	11	11	11	11	11	11	11	11	11	11	11	11
15:00–16:00	11	11	11	11	11	11	11	11	11	11	11	11
16:00–17:00	11	11	11	8	11	11	11	9	11	11	11	10
17:00–18:00	9.5	11	8	1	10	11	9	4	10.5	11	10	5
18:00–19:00	4.5	11	1	1	6.5	11	4	4	7.5	11	5	5
19:00–20:00	1	11	1	1	4	11	4	4	5	11	5	5
20:00–21:00	1	11	1	1	4	11	4	4	5	11	5	5
21:00–22:00	1	8	1	1	4	9	4	4	5	10	5	5
22:00–23:00	1	1	1	1	4	4	4	4	5	5	5	5
23:00–24:00	1	1	1	1	4	4	4	4	5	5	5	5

A.14.5 Vertical transport

For retail stores, only the energy for the lifts and escalators solely for use by customers and staff of the rated premises should be included.

Lift energy may be calculated using one of the following methods in order of priority:

c) *Method 1*: ISO 25745-2, *Energy performance of lifts, escalators and moving walks — Part 2: Energy calculation and classification for lifts (elevators)*.

d) *Method 2*: GBCA, *Energy Consumption and Greenhouse Gas Emissions Calculator Guide*.

> **Note:** When using Method 2, it should be demonstrated where it is impractical or unsuitable to use Method 1.

A.14.6 Infiltration

Infiltration schedules for modelling should be based on the typology of the retail store. The infiltration is significant and depends on multiple factors, such as the retail store's location type, door size, opening frequency and outdoor temperature.

The manner in which the model has been divided into thermal zones will also impact infiltration. Zones near the perimeter will have higher infiltration rates compared to zones located in the interior.

The infiltration may be calculated using one of the following methods in order of priority:

1. The preferred method of modelling should involve simulating openings based on wind direction and speed, i.e. using air network method or similar.

2. A simplified empirical methodology such as described in *PNNL-20026 Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings* is appropriate for this application, or the **Estimator** may use detailed infiltration modelling considering wind direction and speed, i.e. using air network method or similar.

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