EFSG Design Guide 55.02

Thermal Comfort and Indoor Air Quality - Performance Brief

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1. INTRODUCTION

This Design Guide has been written to provide scope of provisions of systems and guidance for the design of the systems providing ventilation and air conditioning for typical teaching spaces, administration staff areas.

Specific solutions are suggested in order to provide a common standard across schools. The aim is for systems to be simple to use, robust and energy efficient in operation.

Above all, solutions should facilitate good learning outcomes and be flexible for future changes in internal fit out.

This guide is applicable to **new capital projects only**, which may include both new buildings and refurbishment components.

2. SCOPE OF PROVISIONS AND SYSTEMS

For all new capital projects, under the current NCC requirements, expected climate and weather patterns, and the government's intention to provide quality environments with energy efficient and sustainability systems and practices, the following systems are expected to be provided in order to satisfy these goals in a balanced manner:

1. Natural ventilation via windows or other openable means
2. Ceiling fans to assist indoor air movement in natural ventilation mode
3. Air conditioning and mechanical ventilation systems

These systems are provided to facilitate schools to be able to **rely on natural ventilation whenever appropriate** but have the ability to call on air conditioning and heating when such demands arise.

3. THERMAL COMFORT

3.1 Aim

To ensure that appropriate thermal comfort levels are achieved in learning spaces, administration and staff areas in new schools.

3.2 Performance Criteria

The following is required to demonstrate compliance:

- Learning spaces and libraries shall be provided with both natural and mechanical ventilation.
- Thermal modelling shall be undertaken to demonstrate that all applicable spaces have been designed to achieve a predicted mean vote (PMV) of +/- 1 for 95% of the floor area for not less than 98% of the occupied hours (refer to the current NCC code for reference PMV criteria).

3.3 Methodology

3.3.1 Thermal Comfort Modelling

Compliance shall be demonstrated by undertaking thermal modelling to demonstrate that the required PMV criteria will be achieved, in accordance with NCC Section J criteria. And any standards and documents referenced therein.

The following modelling conventions shall be followed:

1. Perimeter zones shall be defined as 'within 5m of any exterior wall'.(This does not specifically mean separate temperature control is required in these zones this is for PMV modelling purposes);
2. Each perimeter shall be accounted for independently (e.g. North, South, East and West);
3. Inter-zone partitions shall be accounted for;
4. All systems shall be assessed simultaneously;
5. Comfort predictions shall be measured at the midpoint of each zone at a height of between 0.8 and 1.5m above finished floor level (FFL) of each zone.

All inputs (e.g. building form, HVAC systems, shading, internal loads etc.) shall be clearly documented and justified.

3.3.2 Internal Heat Gains

The following conventions should be adopted when assessing internal heat gains:

1. People

Occupancy rates shall be based on the design occupancy for each space. Where the design occupancy is not known, the occupant density shall be based on figures from AS 1668.2 Table A1.

Learning space occupancies:

- Standard Classroom 30 Pro rata occupancy for smaller classrooms
- Library – Primary 40
- Library – High 50
- Laboratory 30

2. Lighting

Lighting gains shall be based on the lighting designers plans and relevant manufacturer's data.

Where relevant manufacturer's data is not available, lightings gains shall be based on the figures for Maximum illumination power density given in NCC/BCA Volume 1 Table J6.2a.

3. Equipment

Heat gain from electrically powered equipment will be based on the actual equipment to be used within the space and relevant manufacturer's data.

All assumptions and inputs relating to internal gains shall be clearly documented and justified.

3.3.3 External ambient design conditions

External design data shall be based on the most recent and accurate climatic data available from a recognised source e.g. AIRAH, ASHRAE the Bureau of Meteorological data, for the location of the proposed project. Designers must review the latest available data and make adjustments to the ambient design conditions were justified.

3.3.4 Schools calendar

The operating days is based on a typical school calendar obtained from the following weblink: https://education.nsw.gov.au/public-schools/going-to-a-public-school/calendars

4. INDOOR AIR QUALITY

4.1 Aim

To ensure that appropriate levels of indoor air quality (IAQ) are achieved in spaces under both natural ventilation mode and air conditioning mode.

4.2 Performance Criteria

The following is required to demonstrate compliance:

For natural ventilation provisions, these shall comply with the current NCC and relevant Australian standards. Ceiling fans shall be provided to further assist air movement.

For mechanical ventilation provision as part of the air conditioning systems:

1. Outdoor air ventilation rates are in accordance with the requirements of AS 1668.2.

   Classrooms serving persons up to 16 years of age 12 l/s per person.

   Classrooms serving persons over 16 years of age 10 l/s per person.
2. Mechanical ventilation systems shall be designed to provide adequate access for maintenance and cleaning.
3. Mechanical ventilation systems shall be linked to CO2 sensors to provide demand controlled ventilation if and when required by BCA.
4. Ventilation systems are designed to maintain an average daily CO_2 concentration as per the latest NCC code, to ensure that maximum concentration does not exceed 1,500ppm for more than 20 consecutive minutes in each day. A CO2 sensor and indicating light shall be provided.
5. The required outdoor air ventilation rates and CO_2 concentrations shall be maintained when windows and other ventilations opening are open.
6. Ventilation systems shall be designed to minimise the entry of outdoor pollutants through ensuring that the ventilation system design is in accordance with the relevant parts of AS 1668.2. and ASHRAE Standard 62.1.
7. Where local sources of pollutants are present e.g. photocopiers, minimum exhaust ventilation flow rates should be provided in accordance with AS1668.2: Table B1.

5. TYPICAL AIR CONDITIONING SYSTEMS

Recommended learning space mechanical systems to be Variable refrigerant ducted fan coil unit with direct ducted outside air. Conditioning of adjoining withdrawal rooms to be supplied from learning space fan coil unit where possible. (TBC by SINSW)

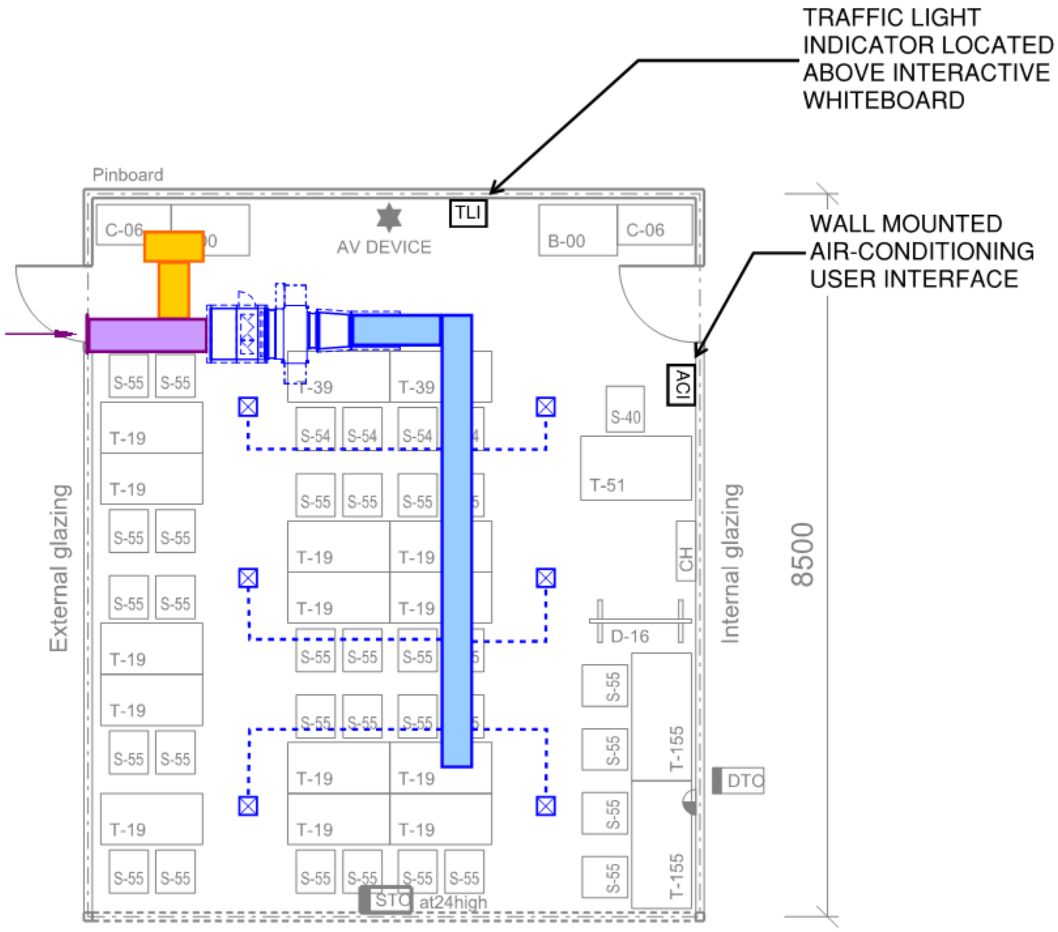

Figure 1 Typical Learning Space mechanical systems

Where the outside air load exceeds the operational parameters of VRF systems the use of energy recovery ventilators is to be explored by the design engineer. The assessment of the viability of energy recovery ventilators is to be reviewed in line with the methodologies outlined in WOL/Alternative proposals section below. This is most likely to only occur in climate zones with extreme summer and winter temperatures.

6. TYPICAL COOLING AND HEATING INFRASTRUCTURE SYSTEMS

Recommended typical systems as outlined in the table below:

School Type	Air Conditioning System	Ventilation	Design Considerations
Cooling system capacity below 900kW	Centralised ducted VRF	Ducted O/A	Refrigerant Charge Energy Recovery Ventilator requirements due to climate zone
Cooling system above 900 kW in a single building	Centralised ducted VRF or Chilled/heated Water System	Ducted O/A	Refrigerant Charge Energy Recovery Ventilator requirements due to climate zone Centralised Energy Recovery ventilator to be considere Chilled water system should be considered

Table 1 System specification based on typical load

Note: The design engineer must undertake detailed assessment in line with the methodologies outlined in WOL/Alternative proposals sections below

6.1 Methodology for Thermal Modelling and WOL/Alternative Proposals

All air-conditioned spaces must be designed to meet the thermal comfort, indoor air quality and associated acoustic performance criteria. Air conditioning and ventilation systems must be appropriately sized to achieve thermal comfort and indoor air quality guidelines.

Energy modelling is required for all air-conditioned spaces, including but not limited to libraries and learning spaces. Modelling Methodology to be in line with NCC2019 Section J modelling requirements for the Proposed Building. The following modelling inputs must be used and referenced in the Energy Modelling report.

Climate: External Design data must be sourced from a recognised source. This may be from the Bureau of meteorology, or a modelling weather file such as TRY and RMY. The choice of data must be justified

Lighting: Based on the lighting designer's plans

Building Geometry: Per the architectural plans. All internal zones and partitions must be accounted for.

Building Fabric and glazing: Per the proposed building materials.

Population: Occupancy rates will be for the design occupancy of each space.

Equipment: To be estimated and justified based on the anticipated loads in the space

Mechanical Systems: to be modelled as a dynamic, detailed system. Zoning for the analysis must match the mechanical system and account for perimeter effects as a separate zone.

Modelling Program: To be a BESTEST validated modelling program.

Alternative proposals must be assessed by way of a whole of life costing or life cycle costing in accordance with AS/NZS 4536 life cycle costing guidance. Whole of life cost analysis is to be comprehensively detailed with assumptions & sources of information documented. Analysis documentation to formatted as per AS/NZS 4536 clause 4.5 and presented to client for review. See AS/NZS 4536:1999 Appendix E for examples.

Whole of life cost to be calculated for an operational period of 30 years, any equipment replacement cost in this period is to be accounted for.

7. NATURAL VENTILATION DESIGN

7.1 Natural ventilation systems

The choice and configuration of windows and other opening types within a natural ventilation scheme can have a significant impact on building performance and occupant comfort. Collaboration between the client and design team will be necessary to ensure an appropriate design solution is developed in the relation to the natural ventilation design strategy.

Natural ventilation can be achieved through the use of one or a hybrid of the following solutions:

- Opening windows or louvres (can be manual, automated, or a combination of both) opening dampers (can be manual, automated, or a combination of both)
- Roof stacks (these can be manual or automated)
- Manual control provides the opportunity for energy-efficiency education in the classroom, but automatic controls (such as interlocks) are likely to save energy.

7.2 Strategies for natural ventilation

Designers should refer to CIBSE AM10 for guidance on natural ventilation design.

Single-sided ventilation that relies solely on openings on one side of the room has a limiting depth for effective ventilation of typically 5.5m or 2 times the room height. Separating the openings sufficiently vertically can increase the effective depth to 2.5 times the room height.

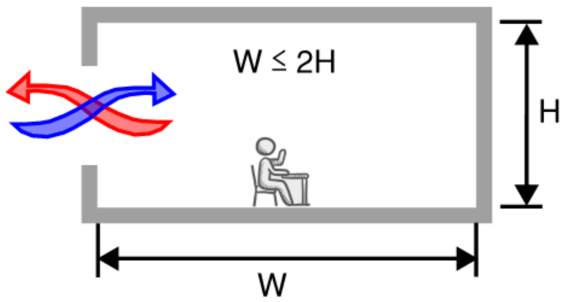

Figure 2 Single Sided Single Opening

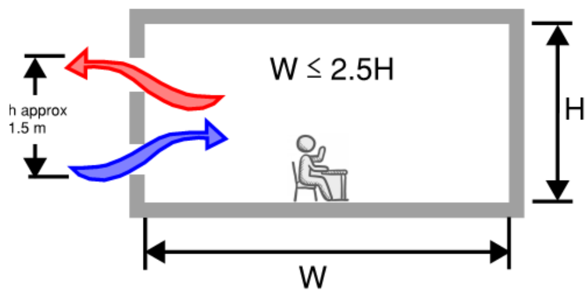

Figure 3 Single sided double opening

Cross-ventilation occurs when there are ventilation openings on both sides of a space. Across the space there is a reduction in air quality as the air picks up local pollutants and heat, limiting the effective depth for ventilation to typically 15m or 5 times the room height.

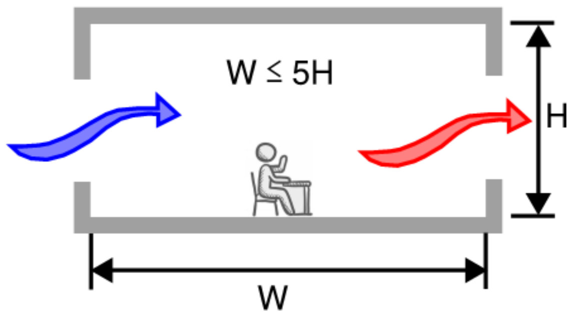

Figure 4 Cross ventilation

7.3 Ventilation opening calculations

The calculation methods for natural ventilation must be based on the effective openable area. 'Effective area' is defined as the product of the discharge coefficient and free (measurable) area.

The structural opening shall not be used for the openable areas calculations. Window or louvre manufacturers should confirm the effective area of the ventilation opening.

Obstructions to the flow of air (eg deep external sills and recesses), blinds, flyscreens and bush fire mesh must be taken into account, as these will have the effect of reducing the airflow through the opening.

8. ACOUSTIC REQUIREMENTS

8.1 Aim

To ensure that HVAC systems are designed to achieve appropriate levels of acoustic comfort in permanent learning spaces and libraries.

8.2 Performance criteria for air-conditioned spaces

The following is required to demonstrate compliance:

Area	**Recommended Internal Noise Level, dBLAeq**
Arts and Craft Studios	45
Computer Room Teaching	45
Laboratories Teaching	40
Libraries – General Staff administration areas	45
Libraries – Reading Areas	45
Open Plan Teaching Areas	40
Study Rooms	45
Teaching Spaces - Hearing Impaired	30
Teaching Spaces – Primary and Secondary Schools	40

Table 2 Internal noise level criteria

HVAC systems shall be designed in accordance with the recommended internal noise levels noted in table 1. The noise levels are the result from the cumulative contribution of traffic noise (via the façade) PLUS the building air-conditioning /ventilation systems.

8.3 Methodology and guidance

The noise measurement and documentation must be provided by a qualified acoustic consultant and in accordance with AS/NZS 2107. Noise measurement must account for all internal and external noise including noise arising from building services equipment, noise emission from outdoor sources such as traffic, and (where known) noise from industrial process. Occupancy noise is excluded.

Compliance shall be demonstrated through measurement, and the measurements shall be conducted in at least 10% of the spaces in the nominated area. The selection of representative spaces must be justified within the Submission Template and must consider how the spaces are considered to be the most conservative with respect to both internal, and external noise sources.

The range of measurement locations shall be representative of all spaces available within the nominated area. All relevant building systems must be in operation at the time of measurement. Projects less than 500m2 Gross Floor Area (GFA) must account for measurements conducted in at least 95% of spaces within the nominated area.

It ought to be noted that under natural ventilation mode, the external noise level is not under control of the project design team or the school, thus the indoor sound levels are only applicable in the design of air conditioning systems and when they are in operation with windows/openings closed.

For projects close to major noise sources (such as railway lines, major road, or airports etc.), designs incorporating elaborate windows/natural openings which seek to attenuate such major noise levels may lead to cost prohibitive designs and elements, which may also be inhibitive to good natural air flow movement, thus reducing the effectiveness of the natural ventilation intended. For these projects the design team should undertake a thorough briefing process with the school to arrive at solutions, which are pragmatic and economically viable.

9. SYSTEMS CONTROL AND OPERATION

9.1 Aim

The aim of the proposed control and operation is to facilitate:

- Operation of the air conditioning and mechanical ventilation systems to deliver appropriate thermal environment and indoor air quality. Convenient use and automation requiring minimal intervention of school staff;
- Optimisation of energy usage;
- Monitoring of room and ambient air properties; and
- Providing visual feedback to students regarding air quality and energy usage.

9.2 Methodology and guidance

9.2.1 Systems

Control and operation of the air conditioning and ventilation in each learning space and library will be provided via:

The inbuilt air conditioning unit controls to control temperature. A programmable controller for each learning space to manage the starting, stopping and status indication of the systems, implementing the operating function outlined below.

Room temperature measurement will be used to limit the operation of the outdoor air fan during higher indoor conditions.

Enthalpy measurement will be used to determine favourable ambient conditions.

Dedicate space temperature sensors, shall be provided for each Homebase and General Learning Space. This will prevent control system conflicts which can arise where there is separate control of thermal comfort and ventilation systems.

9.2.2 Control Panels

MCB's shall be provided in the dedicated cupboards tool lockable and labelled with the source of supply.

9.2.3 Sensor locations

In each learning space and library, adjacent to the student seating area. As a result of vandalism, mounted at a height of 1500mm, protected with a welded perforated stainless steel sheet cover.

User Interface Panel: locate panel adjacent to room entries and to the new ceiling fan controlle, mounted at a height of 1500mm.

9.2.4 User Interface

SINSW will develop a proprietary software product which will integrate with the students and teachers portable devices and/or interactive whiteboards to provide a traffic light type visual indicator on these devices to indicate the suitability or otherwise of weather conditions for natural ventilation.

Or,

Provide user access for operation of the systems via a Local Control Point incorporating:

- Pushbutton. Green, Blue and Yellow mode indication lights.
- Mount lights and pushbutton on a brushed stainless-steel fascia plate (detailed below), flush mounted in wall elements. Where flush mounting is not achievable, surface mount using a stainless-steel mounting block.
- Engrave the panel as follows: Panel Title : "Air Conditioning & Ventilation" Pushbutton : "Push to Start or Stop AC" Blue Light : "Air conditioning operating" Green Light : "Outdoor conditions favorable. Open windows instead of AC"

9.2.5 Remote Controllers

Utilise wired remote controllers for all air conditioning systems. Users of the learning spaces and libraries are not to have access to proprietary air conditioner remote controllers. Controllers are to be located:

Within MCPs where they are located inside the learning space. Where MCPs are centralised outside the space served, locate remote controllers adjacent to the fan coil unit at high level, concealed in a plastic enclosure with non-transparent screw fixed cover.

9.2.6 Operation

<u>Temperature sensors</u>

Start the air conditioning system when the Start or Stop AC pushbutton is pressed. Once operating via the pushbutton, stop the system:

On expiry of an adjustable run on timer function (initially set to 2 hours), or when the pushbutton is pressed again within the run on time above. Where multiple units serve a space, start all units within that space and operate the units in parallel.

<u>Temperature Control</u>

Automatic via the AC manufacturers integrated air conditioning system controls to manage cooling and heating operation and maintain room temperature.

Room operating temperature range of: - Cooling : 24°C and 25.5°C; - Heating : 19.5°C and 21°C.

<u>Indication</u>

A/C Operation: Illuminate the blue mode indication light whenever the air conditioning system is operating. Turn off the light whenever the air conditioning system is not operating.

Outdoor Conditions: Illuminate the green mode indication light whenever the outdoor air temperature and humidity is within the following range (adjustable) 18°C – 24°C and below 70% RH. Turn off the light whenever conditions are outside this range.