SIKH GRAMMAR SCHOOL
SSDA
ENGINEERS ADVICE 01
MECHANICAL STRATEGY

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Author: Afroz Awan, David Arnott

Umow Lai NSW Pty Ltd
Consulting Engineers
L7, 657 Pacific Highway
St Leonards NSW 2065
PO Box 103 St Leonards
NSW 1585 Australia
T: +61 2 9431 9431
F: +61 2 9437 3120
ulsyd@umowlai.com.au
www.umowlai.com.au
Sydney Melbourne Brisbane

1. PROJECT BACKGROUND

The Sikh Grammar School is a new development at Tallawong Road in Rouse Hill. The campus comprises a series of buildings of varying usage and occupancies. This Engineers Advice explores the options for treating each space in terms of air-conditioning and ventilation.

It is important to the note that the campus is located in the North Western suburbs of Sydney with high temperatures when compared to the Sydney CBD. This was considered when developing strategies for the various buildings.

Furthermore, it is our understanding that the project will be built in a number of stages with timelines not yet known. As such, the proposed mechanical solution needs to be cognisant of this and be localised to each building rather than a campus wide centralised mechanical strategy.

2. PROPOSED MECHANICAL APPROACH

2.1. PRIMARY SCHOOL AND SECONDARY SCHOOL

Considering the high ambient design conditions of Rouse Hill, it is proposed that the school buildings be served via a *3-Stage Mixed Mode Ventilation System*. A Mixed Mode Ventilation design includes for natural ventilation during suitable ambient conditions, and has the added advantage of allowing the occupants to close the building up during cold and hot ambient conditions and utilise air-conditioning to serve the space. This approach maximises comfort whilst avoiding significant energy usage.

The three stage system is proposed as follows:

<u>Stage 1 – Natural Ventilation Mode</u>

The Primary and Secondary School buildings are arranged to have classrooms on the perimeter of the building and a corridor running through the spine of the building. This configuration is advantageous as under mild ambient conditions the space can be naturally ventilated by simply opening windows/louvres along the façade.

In order to achieve the best natural air movement, design strategies include:

- Maximise openable windows at facade – maximising openings provides the best opportunity for achieving natural air movement due to minimal restrictions

- Cross Flow Ventilation design – achieving openable facades on opposing or adjacent walls through considered building layout design will help facilitate cross flow ventilation which is the most effective way of introducing fresh air and removing used air from the space. We note that consideration will need to be given to the Acoustics associated with this solution
- Openings at different heights – by providing openable windows at both high and low level, the benefits of stratification can be realised by promoting air to enter at low level and exit the room at high level.

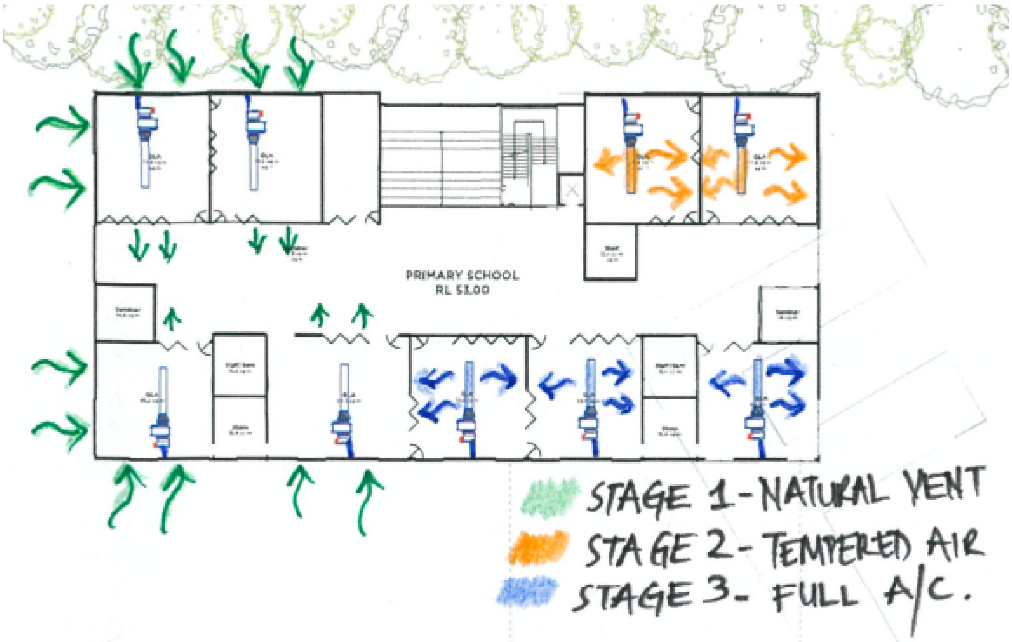

Figure 1 Mechanical Strategy depicted on Primary School Building

This mode may be further optimised by facilitating air movement within the space via ceiling fans within each room or fan assisted thermal chimneys within the corridor to drag air out of the classrooms.

<u>Stage 2 – 'Tempered Air' Mode</u>

Air tempering is a means of delivering air to the space at an elevated supply air temperature when compared to an airconditioned solution. The result being that the internal temperature range will be higher than a conventional A/C system (e.g. 24-26°C as opposed to 21-24°C). During moderate ambient conditions, it is proposed that the students have the ability to run the air-conditioning system (Stage 3 system discussed later) in 'tempered air mode' whereby the system is running at partial capacity.

The tempered air solution delivers comfort to the space through the same mechanical equipment (VRF condensers and indoor ducted fan coil units per room) with reduced energy usage when compared to a conventional air-conditioned system hence offering energy savings.

<u>Stage 3 – Air-conditioning Mode</u>

During peak summer conditions the students will have the ability to close the louvres/windows in the classroom to stop the hot air from entering the building. The air-conditioning system can then be run in complete air-conditioning mode. Reed switches on the louvre/window arrangement shall be proposed so that full air-conditioning mode can only be achieved when the windows are closed.

A Variable Refrigerant Flow (VRF) system is proposed to air condition the building. This system shall provide air conditioning to the selected spaces via local fan coil units in the ceiling space. This system features a reverse cycle functionality with heat recovery meaning different spaces can be cooled and heated simultaneously and efficiently as the by-products of cooling and heating can be used to transfer energy where it is required.

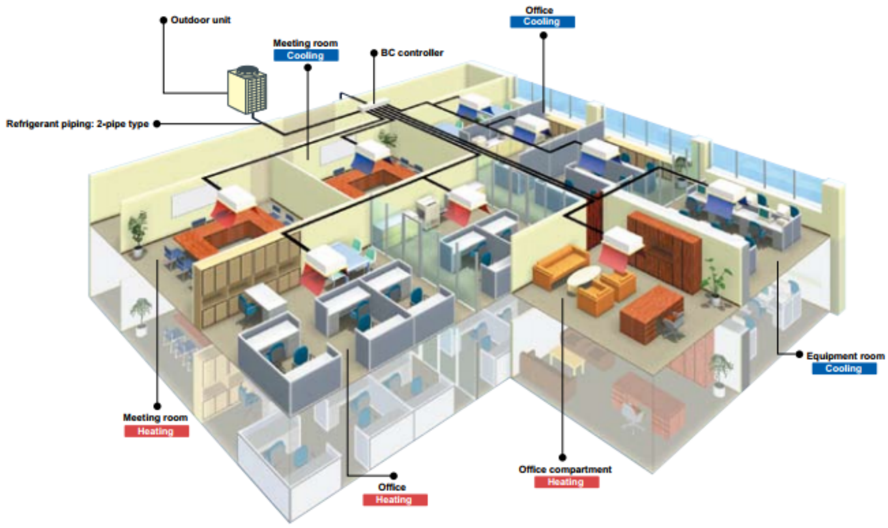

Figure 2: Example of VRF system installed in a building

Controls Strategy

A visual light indication system could be used to indicate that external conditions are high-low and advising occupants to close windows to activate the A/C to provide cooling or heating. Although the indicator panel suggest the mode, the occupants have control over which mode to be in.

2.2. EARLY LEARNING CENTRE

It is our understanding that in Stage 1 the Early Learning Centre (ELC) will be the Primary School building. Once the Primary School has been built, this building will then be converted to an ELC.

It is proposed that this building be served in a similar manner to the Primary and Secondary school building via a 3 stage mixed mode ventilation system.

2.3. LIBRARY BUILDING

The Library and Staff Lounge areas are proposed to be served via a ducted VRF air-conditioning system. This space could act as a refuge under peak conditions. As such, it is proposed to fully condition this space via an AC system dedicated to this building alone.

It is proposed that this building is tightly sealed to optimise the operation of the air conditioning and minimise undesired leakage. Furthermore, during optimum ambient conditions (when the outdoor air temperature is less than the return air temperature) the fan coil units within the space shall be used to provide fresh air as a means of providing ‘free cooling’ – Economy Cycle. This has the added benefit of improved indoor air quality and increased productivity.

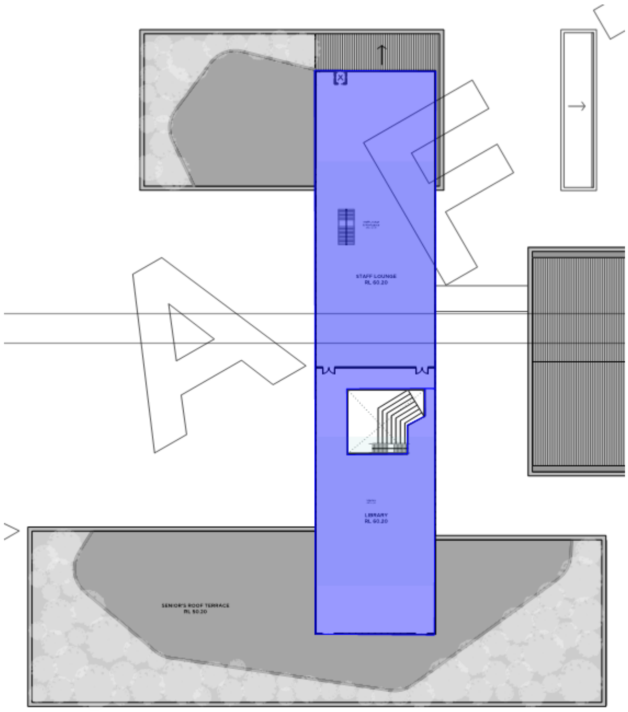

Figure 3 Proposed area of air-conditioning for Library

Note that considering the narrow geometry of the building, this building would also lend it self to a similar solution to that proposed for the Primary and Secondary Building. If natural ventilation is desired for this building, it can be considered.

2.4. BOARDING HOUSE

2.4.1. Option 1 – Natural Ventilation coupled with Heating

Under this option the boarding house is proposed to be naturally ventilated through openable windows along the façade. Ducted toilet exhaust shall be supplied to each dorm room which will facilitate air movement within the space. Each dorm room is also proposed to include a wall mounted hydronic radiant panel heater for winter heating. Makeup air for the toilet exhaust will be introduced into the building via a louvre in the corridor and door grilles on the dorm room and toilet doors.

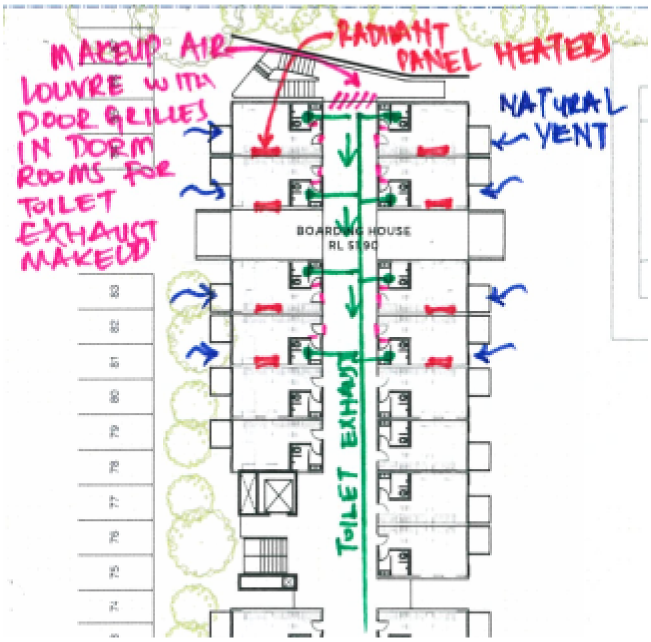

Figure 4 Mechanical Strategy depicted for the Boarding Facility

Under peak ambient conditions, students could reside within the ‘air-conditioned refuge’ if desired. In this building this refuge space is proposed to be the Dining and Lounge area on Level 0.

2.4.2. Option 2 – Passive House Strategy

Passive House is a design standard which aims to achieve excellent levels of thermal comfort and indoor air quality with minimal energy requirements. There are five key principles of Passive House and to deliver robust outcomes **all** five must be incorporated, with a meticulous attention to detail given to each throughout the entirety of the design and construction process. As such, the pursuit of Passive House should not be undertaken unless a full commitment can be given by the client, design team and contactor. It should also be noted that Passive House principles will result in additional capital cost. The below information provides some high-level advice on this strategy and further advice can be provided if an appetite exists to explore this option in more detail.

<u>Passive House Principles</u>

Passive House has a specific focus on a high-performance thermal envelope, the avoidance of thermal bridging and high levels of airtightness coupled with controlled mechanical ventilation with heat recovery (MVHR).

Typically, insulation levels and glazing specification within Passive House are increased beyond minimum standard levels when compared to the Section J requirements. Airtightness is rarely addressed in any form within the Australian construction market.

The intension of pursuing Passive House principles is to provide an informal structure for good passive design, which requires early consideration of the architectural form and design to achieve the maximum outcome with regards to building services impact and occupant impact. While certain passive design principles are well understood, others such as thermal bridging, air tightness and MVHR are not. Addressing all of these items is a measure for addressing build quality and can act as a strong driver for improved performance across a number of metrics such as occupant comfort, acoustic quality and energy efficiency.

Comprehensive Shading Strategy

To complement and enhance this approach a comprehensive shading strategy is required to reduce passive solar gains (direct and diffuse) such that internal temperature rises are mitigated as far as practically possible. A well-design shading system can also increase the period that natural ventilation is viable, reducing the need for air conditioning. Solar loads represent the largest contributing factor to a buildings thermal performance and therefore developing an appropriate shading strategy is critical.

Diminished Highly Variable Thermal Energy

As can be seen by the below pie chart loads attributed to solar gains, fabric and infiltration can equate to as much as 84% of the total. Therefore, if we can mitigate highly variable thermal energy as much as possible – with a combination of Passive House principles and a comprehensive shading strategy – we can greatly limit the need for mechanical cooling and enable a MVHR system to operate effectively.

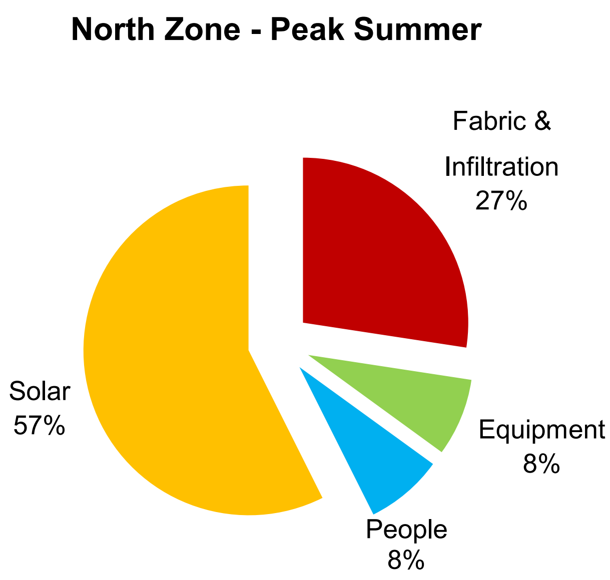

Figure 5 Load distribution chart

Recommended Targets

Tables 1, 2 and 3 provide a summary of the minimum Section J requirements and the recommended targets for the Sikh Grammar School, for air tightness, building fabric and glazing elements respectively, should a Passive House approach be pursued

Table 1 *Air tightness*

Element	*Minimum Section J NCC 2016 Requirement*	*Target Performance*
Air tightness	Nil	**1 $m^3/hr.m^2$ at 50 Pa**

Building Fabric Total R-value Targets

Fabric Element	*Minimum Section J NCC 2016 Requirement*	*Target Performance*
External Walls	R_T2.8	**R_T3.5**
Internal Wall*	R_T1.8	**R_T2.0**
Roof/Ceiling	R_T3.2	**R_T5.0**
Suspended Floor	R_T2.0	**R_T2.0**
Concrete Slab on Ground	Not Required	**Not Proposed**

**Separating conditioned from non-conditioned spaces.*

Table 2 *Glazing Performance Targets*

Glazing Parameter	*Minimum Section J NCC 2016 Requirement*	*Target Performance*
Glass U-value	DTS*	**≤ 2.5 W/m²K**
Glass SHGC	DTS*	**~ 0.40**
Glass to façade ratio	-	**40%**

**Deemed-to-Satisfy performance determined using the Glazing Calculators.*

Please note that the above values are preliminary only and energy modelling is essential to optimise specifications in context of climate and accurately quantify performance of different façade solutions. Furthermore, to ensure desired airtightness outcomes are achieved, verification of as-built performance completed through physical "blower door" testing would be required.

Mechanical Design Considerations

If the Passive House principles mentioned previously are incorporated, under this option the mechanical strategy would be as summarised under Option 1 with the exception of the following:

- No louvres in the façade so that air tightness can be achieved
- Energy Recovery Ventilator whereby the energy is being recovered from toilet exhaust be ducted out the building to pre-treat the outside air that will be ducted into the corridors. This air will be a mean to provide air movement within the space and makeup air for the toilet exhaust
- Similar to the first option, the windows will be openable however once shut, the building will become air tight. Furthermore, windows will be required to be closed on hot summer days.

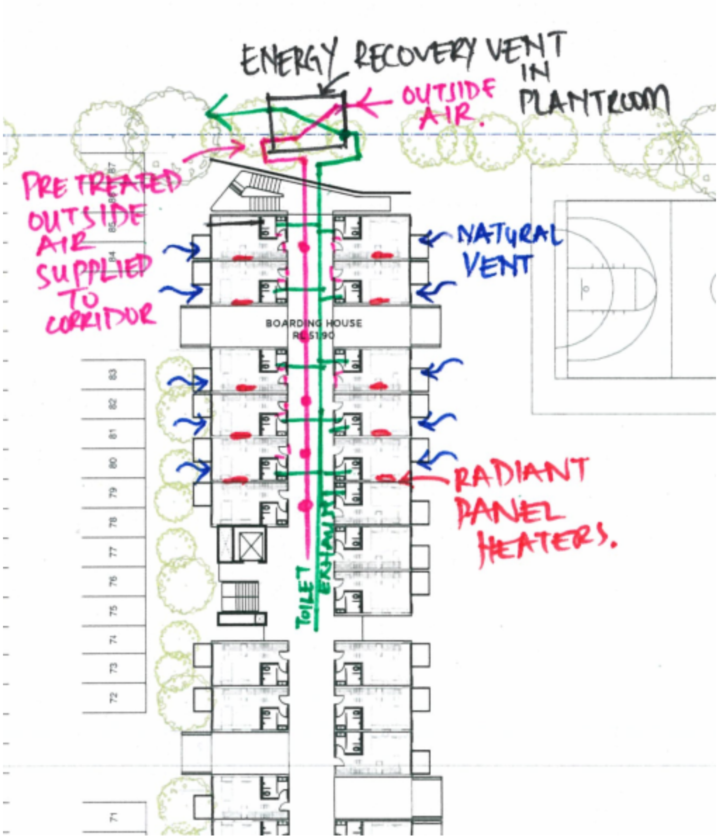

Figure 6 Passive House Mechanical Strategy depicted for the Boarding Facility

2.5. GURDWARA/ LANGAR BUILDING

This building comprises of a series of spaces which will all be discussed separately below.

<u>Ground Floor – Langar</u>

This space is expected to be densely occupied. As such, it is proposed that this building be airconditioned via roof mounted DX packaged unit. Depending on the occupancy densities, DX units may also require air-to-air heat recovery to save energy.

This system shall integrate Economy Cycle, whereby under suitable conditions outside air is introduced to the space without active cooling to provide space cooling. This strategy aims to reduce energy consumption and has the added benefit of improving Indoor Air Quality.

The commercial kitchen will include a dedicated kitchen exhaust system.

Figure 7: Example of rooftop packaged air-conditioning system

<u>Ground Floor – Entry & Admin</u>

This space comprises of Office and Meeting Room areas as well as a Retail space. It is also expected that when required the occupants within the Langar could spill into this space or use it as a Foyer for gathering. The space is also proposed to be conditioned in a similar manner to the Langar with the possible added dimension of localised ceiling mounted split Fan Coil Unit for meeting rooms and retail.

<u>Level 2 – Gurdwara</u>

Again, this space is expected to be densely populated and lends itself to the same air-conditioning solution as the Langar discussed earlier.

<u>Level 2 - School Hall</u>

It is our understanding that this space will not only serve as a School Hall during school hours but can be doubled as a space where occupants from the Gurdwara spill into when it is highly populated.

There is a desire of the client to have the ability to naturally ventilate the school hall. This can be achieved via the installation of low-level louvres supplemented by roof mounted turbine ventilators complete with dampers. The dampers can be closed when the space is being air conditioned.

There is a possibility that the stage may require smoke exhaust due to its size – awaiting BCA report. In this scenario, the low-level louvres can act as the makeup air for the smoke exhaust and the roof turbine ventilators may be replaced by large fans.

The hall will also have the ability to be air-conditioned in a similar manner to the Langar, that is, with Rooftop DX Packaged units complete with Economy Cycle. We note that if there is likely to be an instance where the Gurdwara is being airconditioned and the School Hall is being used in Natural Ventilation mode at the same time, specific consideration will need to be given to the partition dividing the two spaces so that Section J compliance is achieved.