MINISTRY OF EDUCATION
TE TĀHUHU O TE MĀTAURANGA

Improving Indoor Air Quality

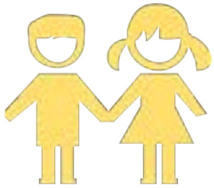
As part of a good physical learning environment

Bernie Cruise

AIVC Workshop 19 & 20 March 2018

BRANZ

In state schools…



We educate 788,000 young people.

There are 2,100 schools and 30,000 buildings.

We aim to be environmentally responsible.

We are the 2nd largest building owner in NZ. $24b value.

Traditional School Buildings

Avalon Block

Canterbury Block

Traditional School Buildings

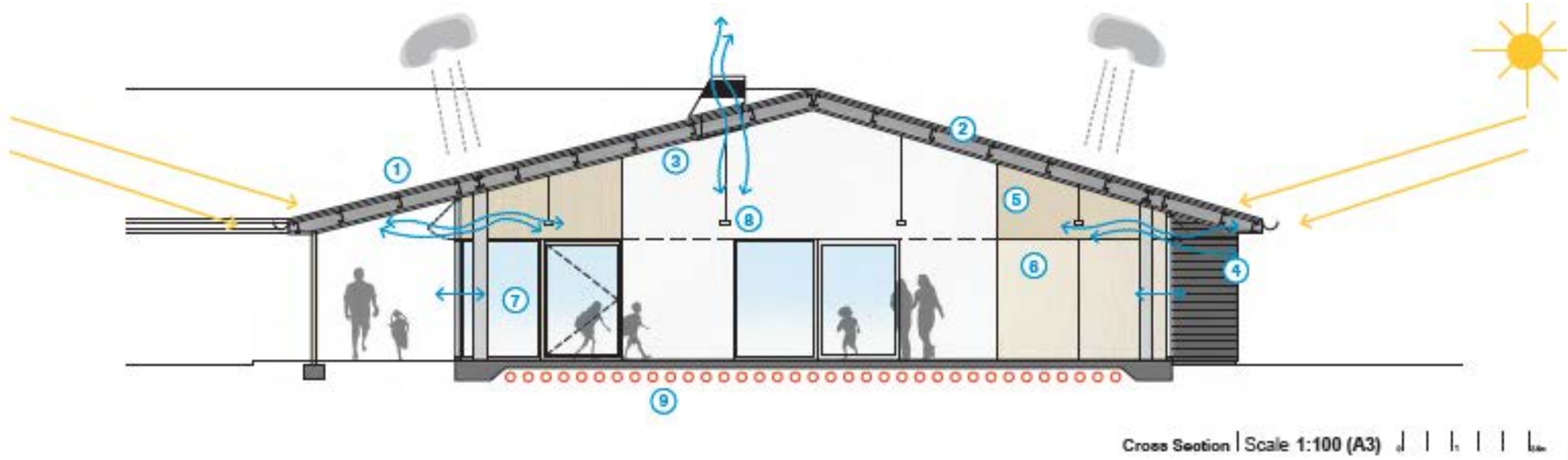
Nelson Block

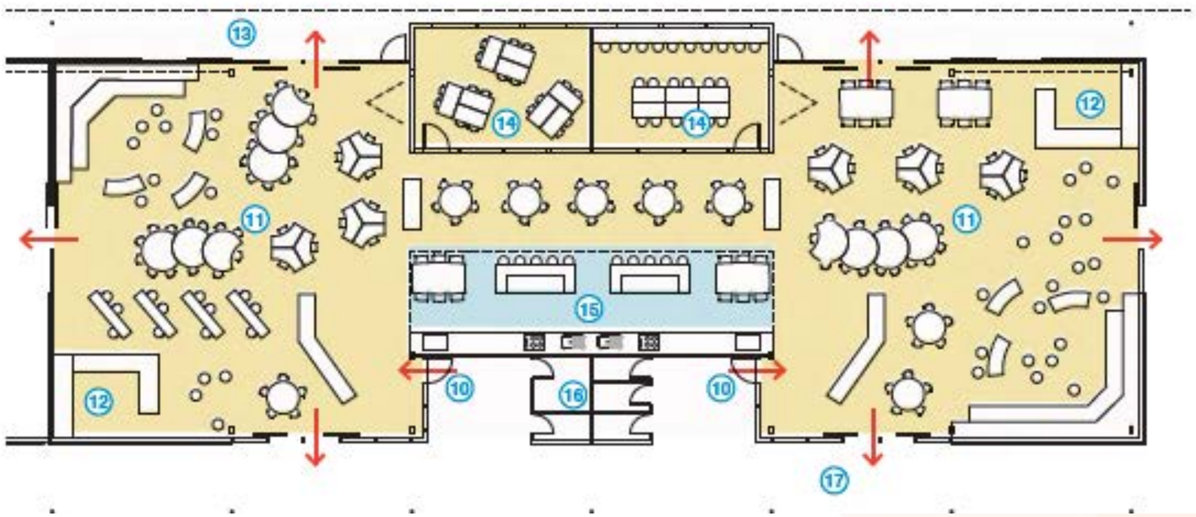
Formula Block

New Learning Environments

New Learning Environments

New Learning Environments





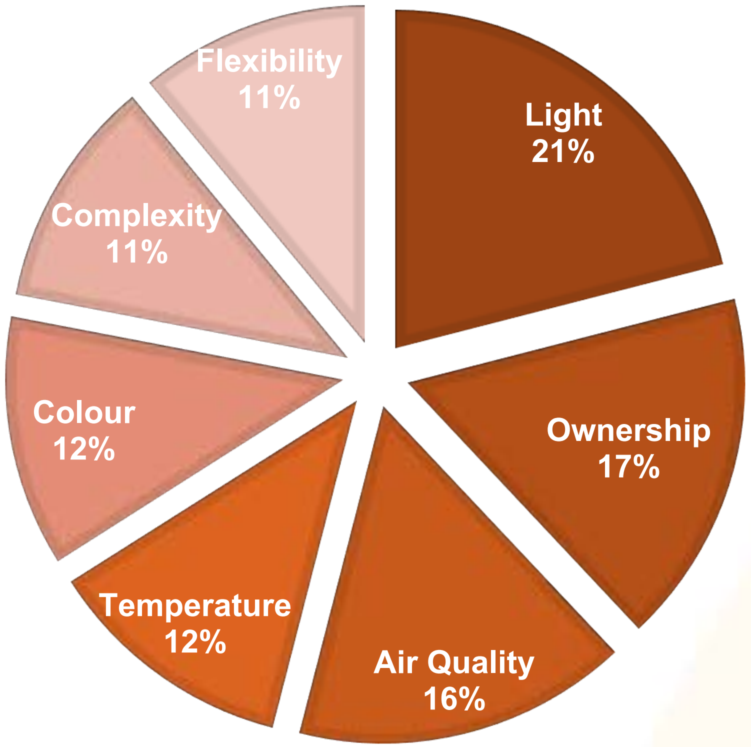
Primary School example

New Learning Environments

High School example

The Internal Environment

Design parameters can contribute to a 16% variation in academic progress



Relative contribution of key classroom design parameters to academic progress (Credit: derived from Barrett et al, 2015)

The connection between physical health, cognitive and mental well-being, and long-term academic achievement (Credit: derived from the Schools for Health Program, Harvard T.H. Chan School of Public Health).

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Designing Quality Learning Spaces (DQLS)

Indoor Air Quality and Thermal Comfort

Version 1.0, 2017

Overview

Indoor Air Quality and Thermal Comfort: Audience and Purpose

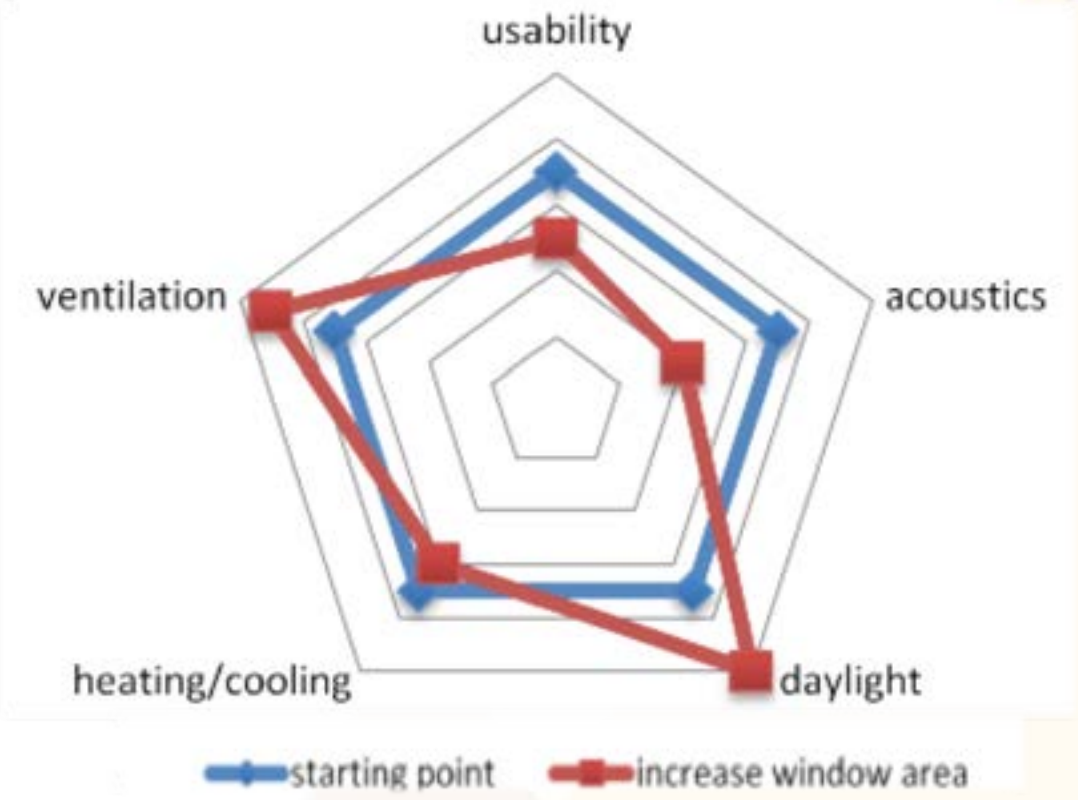
- The guideline is written for architects, designers and engineers
- It is used for new builds, redevelopments and building upgrades
- It addresses four key outcomes:
  - Indoor air quality (CO_2 and other pollutants)
  - Ventilation design (passive and mechanical)
  - Indoor thermal comfort
  - The ability for users to control their environment

Indoor Air Quality – Primary Strategies

- The primary strategies for creating good indoor air quality are:
  - Consider using passive design principles, where appropriate
  - Provide suitable ventilation with clean fresh air
  - Select building materials with low VOC content
  - Maintain a good cleaning programme
  - Use entry/exit mats to capture dust and dirt before they are brought into the building

Indoor Air Quality and Thermal Comfort: An integrated approach

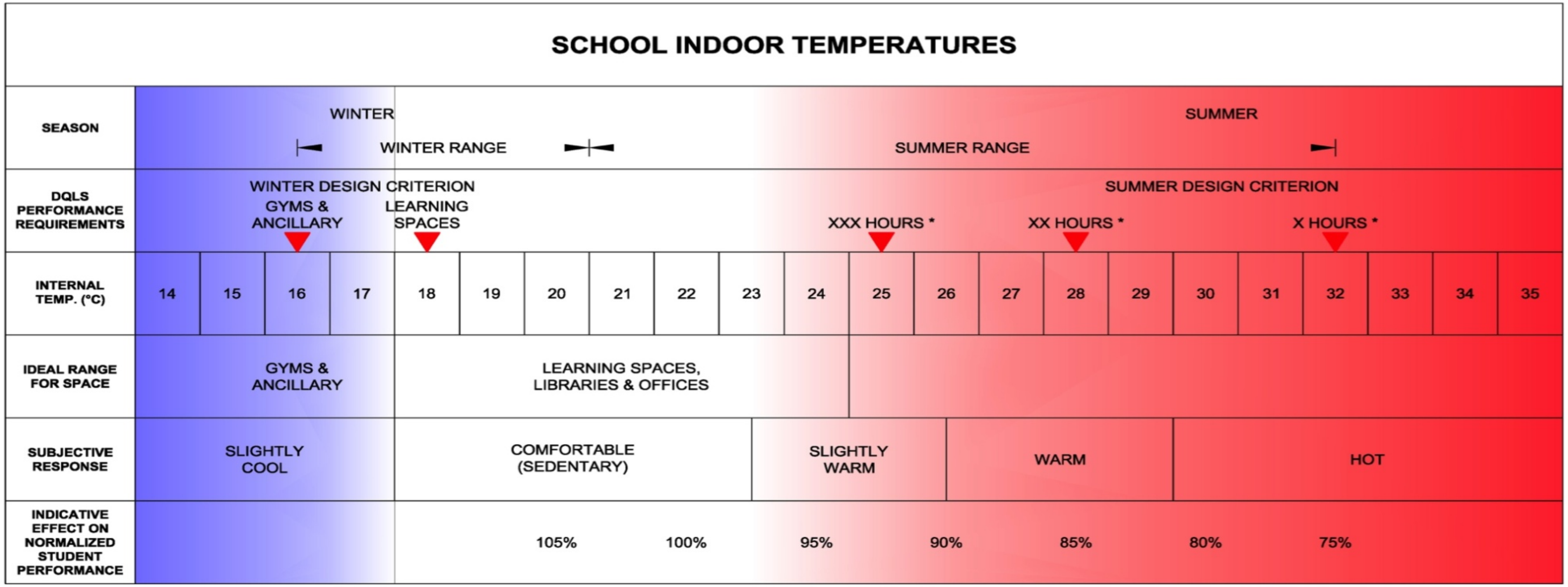
- Taking a holistic and integrated approach to building design
- The different design attributes can greatly influence acoustics, ventilation, daylight, heating and cooling, and most importantly, building usability
- Changes to one design aspect can impact other areas



IAQ&TC - Key measurables

- Indoor air quality and pollutant minimisation
  - CO_2 average should not exceed 1500ppm
  - CO_2 max peak concentration 3000ppm
  - Purge CO_2 to 1000ppm within 10min
- Ventilation design strategies
  - Natural (passive), mixed mode, mechanical
- Temperature control
  - Minimum temperature 18°C
  - Maximum temperature 25°C (with maximum hours above 25°C and 28°C)
- New insulation requirements (minimum 'R-values')
- Life cycle costing – minimum life expectancy figures (using Treasury model)

Temperature Control



- Chart shows a comparison of perceived comfort levels and temperature over summer and winter seasons. It also indicates the threshold for overheating, with markers to show reference points for maximum hours of heat exposure.
- Overheating starts to occur where internal temperatures rise above 25°C

Maximum Temperature by Climate Zone

Climate Zone	Sub Zone Towns/Cities		No. of Hours above	
			25°C	28°C
North Island 1 - Warm	Northern North Island	Kaitaia Whangarei Auckland	250	50
North Island 2A - Cool	Central North Island	Hamilton Rotorua	150	10
	South West North Island	New Plymouth Whanganui Palmerston North Wellington	150	10
North Island 2B - Warm	Eastern North Island	Gisborne Napier Hastings Masterton	250	60
North Island 3A - Cool	Central North Island	Taupo	150	10
South Island 3B - Warm	Northern South Island	Nelson Blenheim	150	20
South Island 3C - Cold	Western South Island	Westport Hokitika Greymouth	50	10
	Eastern South Island	Kaikoura Christchurch Timaru	150	40
	Inland South Island	Wanaka Queenstown Alexandra	50	10
	Southern South Island	Dunedin Invercargill	20	10

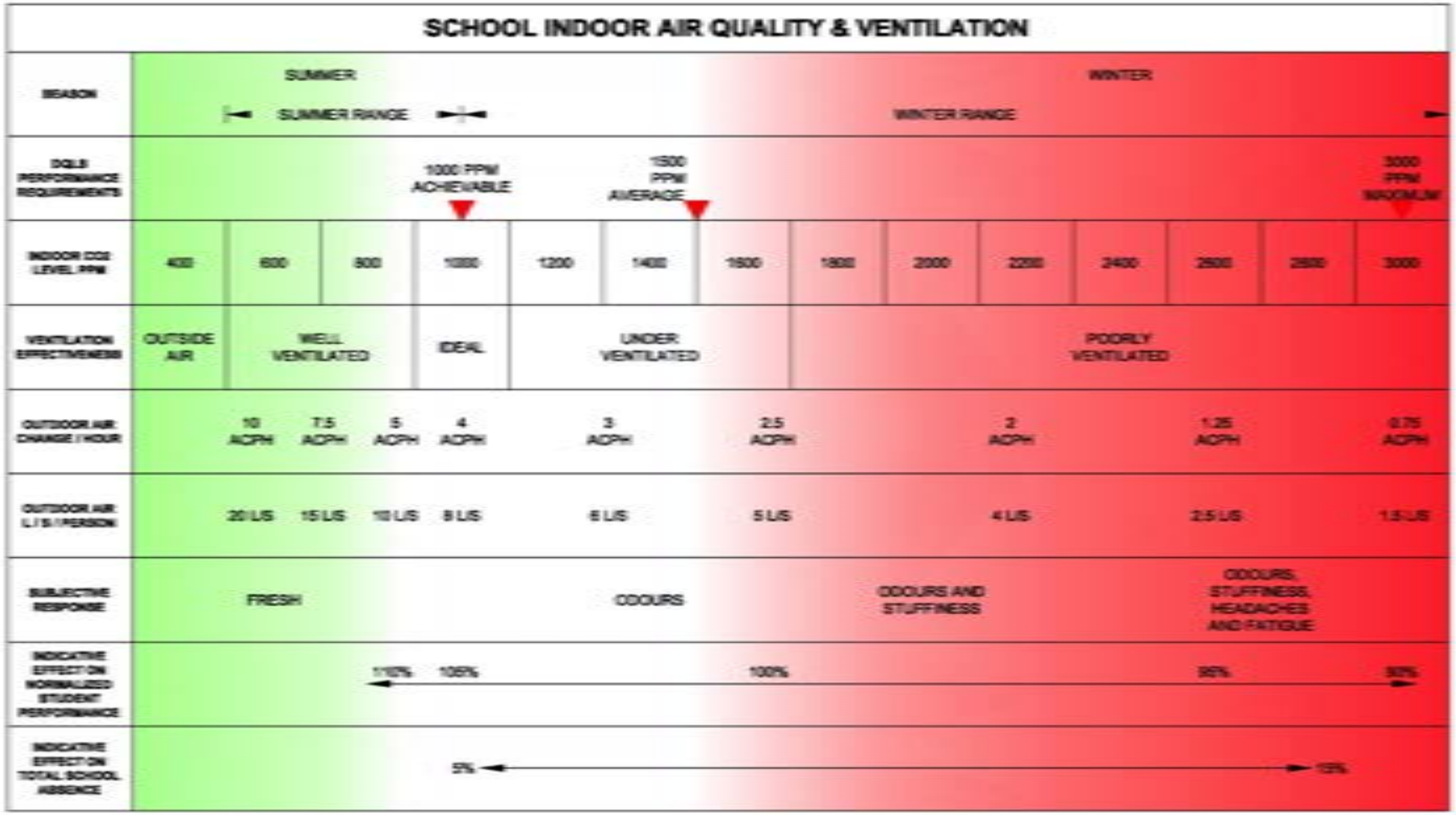
The table shows the maximum number of hours for summer that the internal temperature can exceed the 25°C and 28°C thresholds. The difference in hours between regions accounts for regional climate variation.

Minimum Thermal Resistance Requirements - Targeted by Climate Zone

- Table shows the minimum Ministry insulation requirements (R-value) per climate zone.
- The difference in insulation requirements between regions accounts for regional climate variation.

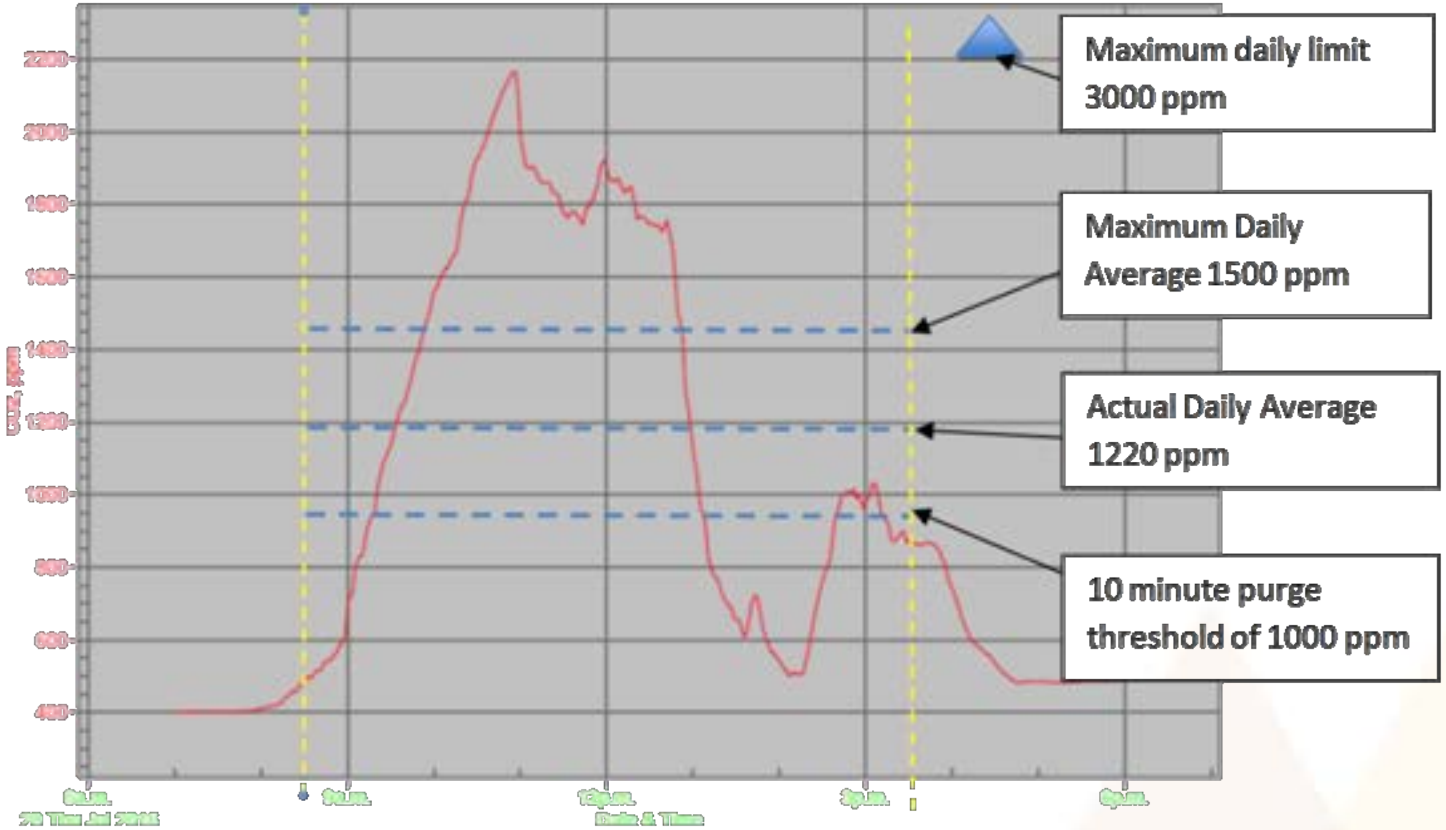
Climate zone	Sub zone	Town/City	Building component	Ministry insulation requirements*
North Island 1 - Warm	Northern North Island	Kaitaia Whangarei Auckland	Roof	R 3.4
			Wall	R 2.2
			Floor	R 1.3
			Windows	R 0.15 (single glazing)
North Island 2A - Cool	Central North Island	Hamilton Rotorua	Roof	R 3.4
			Wall	R 2.2
			Floor	R 1.3
			Windows	R 0.26 (IGU)
	South West North Island	New Plymouth Whanganui Palmerston North Wellington	Roof	R 3.4
			Wall	R 2.2
			Floor	R 1.3
			Windows	R 0.26 (IGU)
North Island 2B - Warm	Eastern North Island	Gisborne Napier Masterton	Roof	R 3.4
			Wall	R 2.2
			Floor	R 1.3
			Windows	R 0.15 (single)
North Island 3A - Cool	Central North Island	Taupo	Roof	R 3.6
			Wall	R 2.6
			Floor	R 1.9
			Windows	R 0.26 (IGU)
South Island 3B - Warm	Northern South Island	Nelson Blenheim	Roof	R 3.6
			Wall	R 2.6
			Floor	R 1.9
			Windows	R 0.26 (IGU)
South Island 3C - Cold	Western South Island	Westport Hokitika Greymouth	Roof	R 3.6
			Wall	R 2.6
			Floor	R 1.9
			Windows	R 0.26 (IGU)
	Eastern South Island	Kaikoura Christchurch Timaru	Roof	R 3.6
			Wall	R 2.6
			Floor	R 1.9
			Windows	R 0.26 (IGU)
	Inland South Island	Wanaka Queenstown Alexandra	Roof	R 3.6
			Wall	R 2.6
			Floor	R 1.9
			Windows	R 0.26 (IGU)
	Southern South Island	Dunedin Invercargill	Roof	R 3.6
			Wall	R 2.6
			Floor	R 1.9
			Windows	R 0.26 (IGU)

Indoor Air Quality – CO_2 Levels



- Chart shows a comparison of the relative CO_2 levels, with ventilation rates, occupant perception, equivalent air changes, indicative student performance and effect on absences over summer and winter seasons.

Indoor Air Quality – CO_2 Measuring (pre-IAQ&TC release)

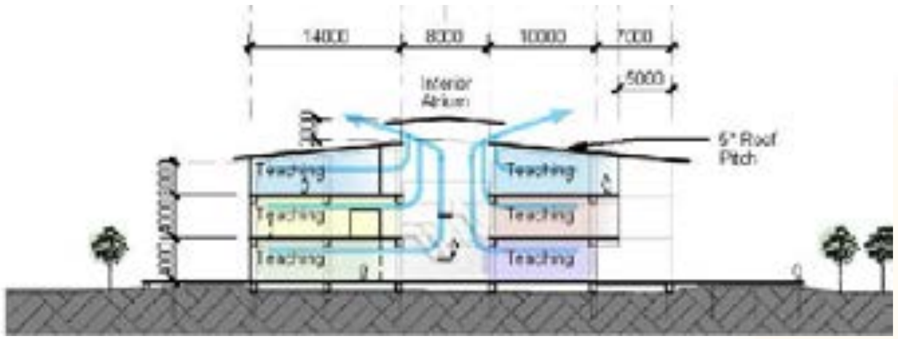


- Chart shows an example of measured carbon dioxide concentrations (ppm) for a naturally ventilated flexible learning space in Auckland during a winter's day.

Ventilation Strategies

The three main design strategies

- Naturally ventilated (passive)
- Mixed natural/mechanical ventilation
- Mechanically ventilated



Passive ventilation approach guidelines

- Trickle vents in windows
- 7.5% - 10% of floor area opening windows (excluding doors) as a start point (Building Code is 5%)
- Consider building orientation and vent locations
- CO_2 and temperature monitoring/ feedback is now required

Examples of Passive Ventilation used in new school buildings

Roof mounted wind catchers

Opening high level windows

High and low level openings

Cross ventilation and ceiling mounted fans

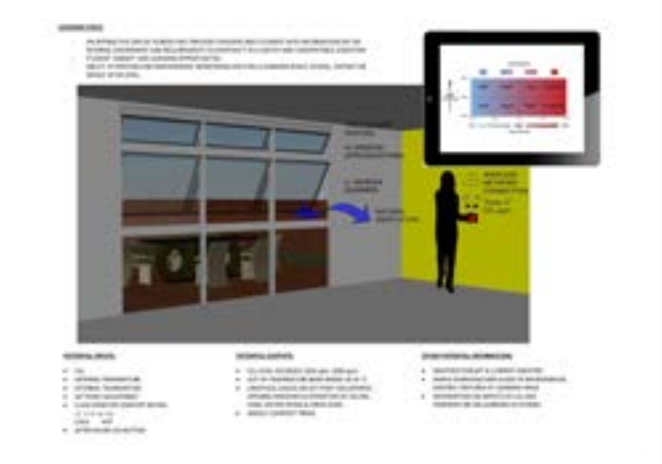
Teacher/Student Monitoring and Control of Internal Environment

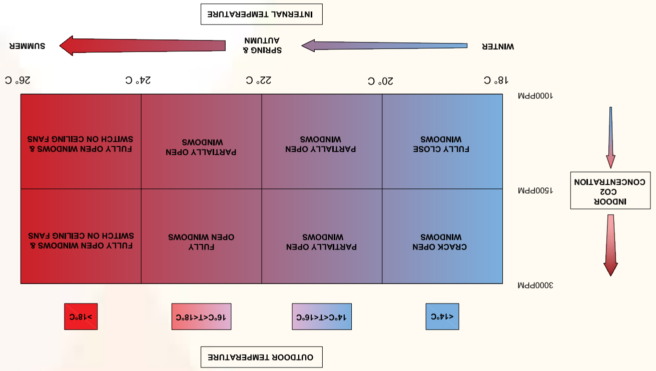
IAQ&TC requirements

- Provide CO_2 and Temperature Monitors in a central location within each learning space
- Provide a ‘User Guide’ next to the monitors

User Monitoring and Control of Environmental Conditions

- New provision - the Ministry has not required monitors to be available for occupants before.
- This will enable occupants to adjust the internal environment by deciding to open windows or doors.
- This provision is specifically for naturally ventilated spaces, as it should already be integrated with HVAC systems.
- not all interventions need to be high tech – knowing the temp or CO_2 is elevated can lead to a user opening a window.





Indoor Air Quality: Some Challenges

- Humidity > Condensation
- closed windows in winter (using radiators, underfloor heating, heat pumps etc)
- Acoustic challenges from external noise – closed windows
- Funding. Costly/complex mechanical ventilation systems
- Environmental pollution entering classrooms – esp. urban, inner city schools
- Balancing automated [sometimes complex or expensive] design interventions against educating, and placing expectations on, occupants

Indoor Air Quality - Summary

- CO_2 and humidity within buildings can vary greatly, and can be influenced many factors, including: design, the environment and user behavior
- Mandatory IAQ requirements aim to ensure learning environments are adequately ventilated, in an achievable way.
- Simple interventions can be used to improve air quality, without jumping to high tech solutions, through supporting user engagement and awareness
- Environmental factors, bespoke designs, and other Ministry requirements, can pose challenges that require an integrated approach from design teams

Feedback & Questions?

We **shape** an **education** system that delivers **equitable** and **excellent outcomes**

He mea **tārai** e mātou te **mātauranga** kia **rangatira** ai, kia **mana taurite** ai ōna **huanga**

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