Ventilation

Key Problems

Natural ventilation is to be used wherever possible, and energy efficient mechanical ventilation used where needed.

Offices

The required ventilation rate is 10l/s per person, therefore 0.35m^3/s is required per floor of the office block.

Workshop

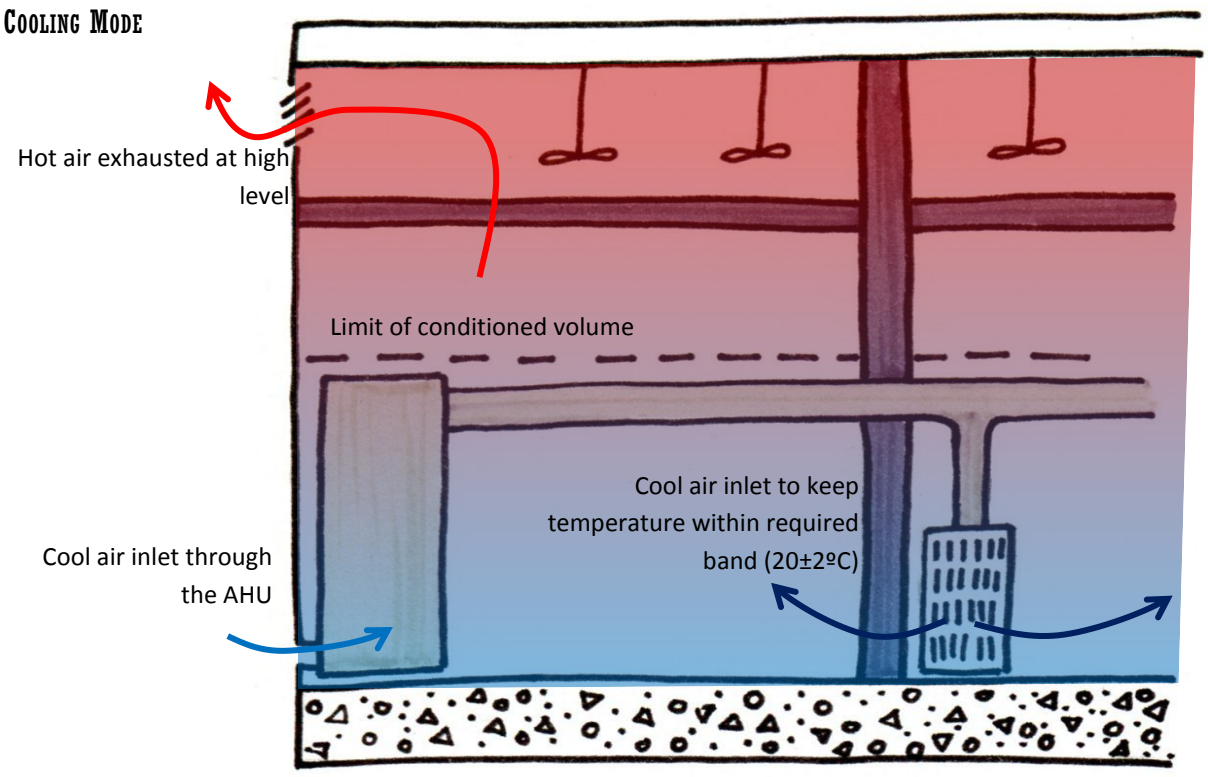
The need for ventilation in the workshop is driven by the need to remove the large heat gains generated by machinery. Assuming heat gains of 110W/m^2 the required rate of ventilation is 34.2m^3/s.

Atrium

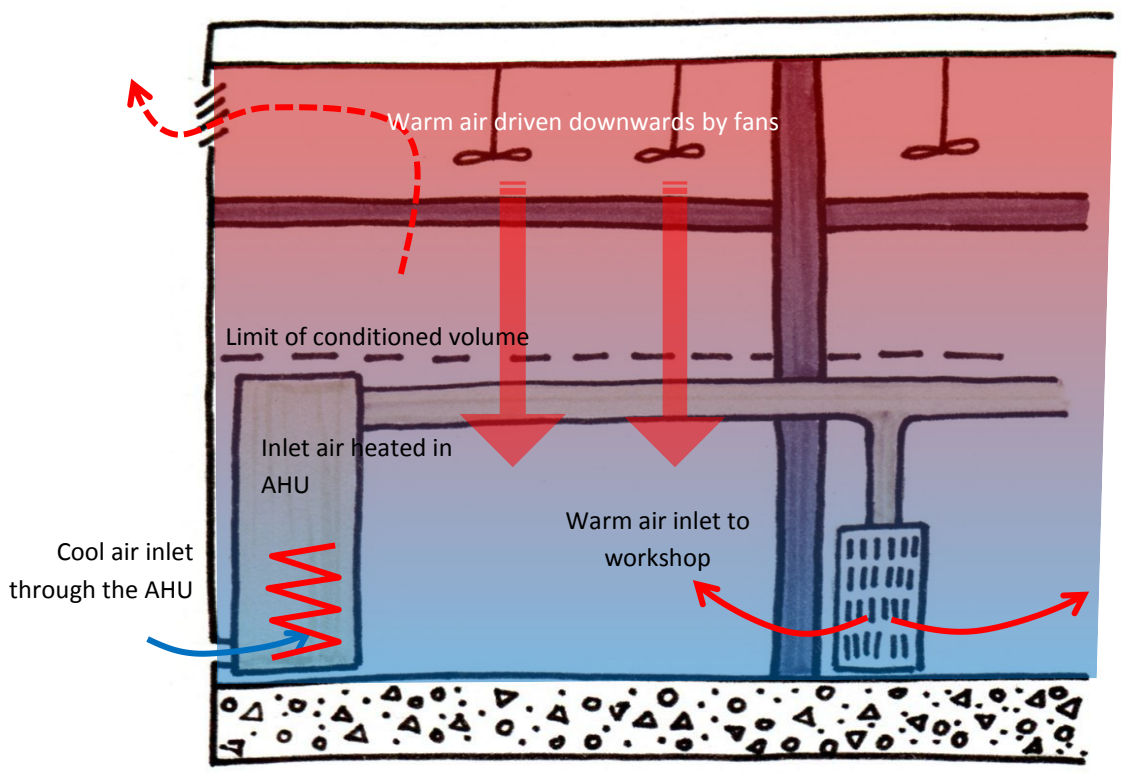
Ventilation is required to ensure adequate fresh air, especially when the atrium is used as an auditorium. The required rate of ventilation, based on an audience of 100 people, is 1m^3/s.

Workshop

Cooling Mode



Heating Mode



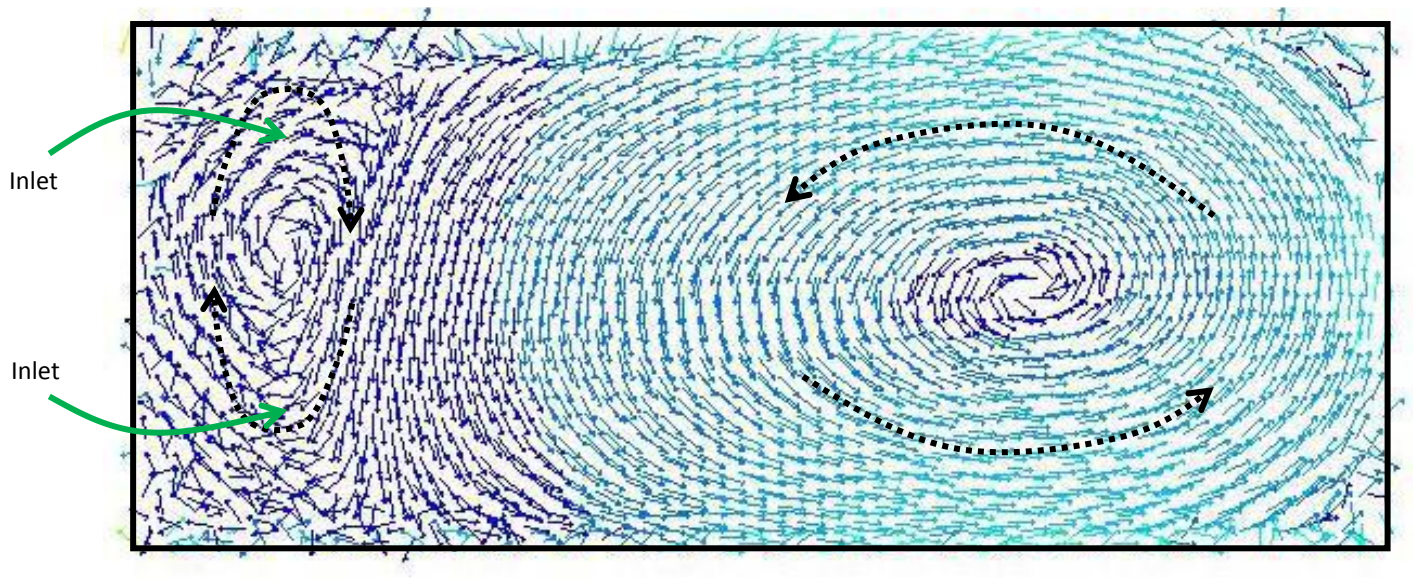
Offices

A shallow plan office block has been adopted, with the office depth being 9.4m, which is less than 2.5x floor to ceiling height.

Analysis of the three potential driving forces have been made, with the worst case found to be single sided buoyancy driven flow. The opening area required is found to be 0.7m^2 per floor, or 0.05m^2 per window. The opening area required for purge ventilation is 0.2m^2.

Double hung windows have been adopted to maximise the effective opening area, in addition to the opportunity to utilise high and low level openings.

Analysis using CFD suggests that high and low level inlets create two distinct pockets of circulation, as illustrated below. Although the height difference between the two openings is limited, buoyancy effects ensure that hot air is ventilated from the upper opening leading to improved occupant comfort.



Workshop

The need for ventilation in the workshop is driven by the large heat gains generated by machinery. Due to the large volume and requirement for close temperature control a displacement ventilation system has been adopted.

Assuming conservative heat gains of 110W/m^2, the required rate of ventilation is found to be 34.2m^3/s, which is supplied to the workshop by 6 AHUs and 40 bin diffusers. The free standing diffusers are located immediately adjacent to columns, reducing the loss of usable floor space.

The main ducts are required to be 1000mm in diameter, with branch ducts of 650mm diameter. Accounting for losses in the system, due to friction and fittings, the pumping pressure required is 32Pa.

There are two key modes of operation for ventilation in the workshop, namely when heating or when cooling is required. The general concepts behind these modes are illustrated in the diagrams.

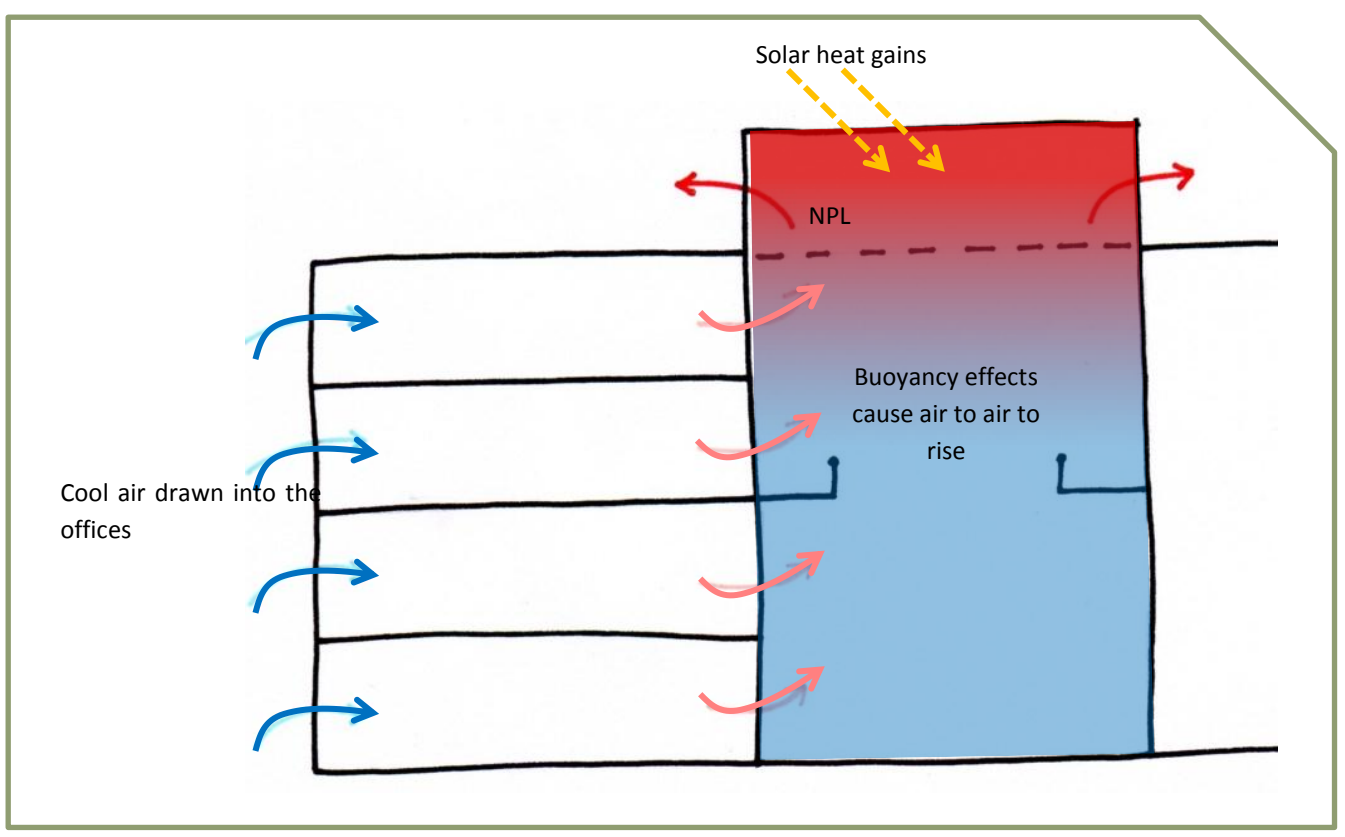
Atrium

Ventilation in the atrium is driven by the stack effect, with fresh air inlets at the ground level. Air is also drawn through the offices into the atrium.

The outlet area required is 1.843m^2 with an inlet area of 0.673m^2, to deliver a ventilation rate of 1m^3/s.

This method is adopted in the Green Office in Leeds, which uses a glazed atrium to connect two office blocks together. As proposed for the NAMRC, ventilation in the atrium is driven by the stack effect, which is effective for providing fresh air.

It should be noted that whilst solar heat gains are beneficial in increasing the effectiveness of stack ventilation, since they warm air; excessive heat gains should be prevented as the air flow rate is inadequate to create cooling.



Key Benefits

The key benefits offered by the systems proposed for the NAMRC are summarised as follows:

Offices

- Natural ventilation means that there is no energy demand from the ventilation system
- Openable windows allow user control, which in turn leads to greater tolerance of internal conditions
- Cross ventilation can be used in those offices connected to the atrium

Atrium

- Buoyancy driven ventilation leads to acceptable internal conditions at the low occupied level
- This system requires no further energy input, and is beneficial to the offices connected to the atrium
- The Neutral Pressure Level has been carefully considered to ensure that hot air is not re-circulated into the upper floors of the office block

Workshop

- Displacement ventilation means that only the occupied zone is serviced, leading to significant energy savings
- Bin diffusers allow penetration of fresh air throughout the workshop, allowing close control over temperature (as required by the client brief)
- System easily adapts to the need for heating in the workshop
- System allows the workshop to be isolated from the atrium, and therefore the offices, which prevents aerosols generated in the workshop from being transmitted throughout the building

Solutions

Natural ventilation has been adopted where possible in the NAMRC, with success ensured through careful consideration of the building form. Although the required internal floor area for the workshop means that a shallow plan cannot be adopted, elsewhere in the building a shallow plan has been adopted.

Natural ventilation is successful in the office due to the minimised depth, with double hung windows adopted to allow hot air to be ventilated at high level.

Ventilation in the atrium is driven by the stack effect, with careful consideration of the Neutral Pressure Level to ensure that hot air is not recirculated into the upper office floors.

Due to the large heat gains in the workshop, natural ventilation is not a feasible option. Displacement ventilation offers the best option, allowing only the lowest occupied portion of the workshop to be serviced. This offers large energy savings, which is important for a sustainable building such as the NAMRC.