UoS Buildings Covid-19– Ventilation Systems

Contained within this paper is information and guidelines on how to control the risks of airborne diseases, such as Covid-19. These guidelines have been followed and undertaken by SEF Engineering Teams. All the available guidance from the authorities in ventilation, such as CIBSE, and the Government have been understood, rigorously applied and implemented. They are listed below:

- Before the start of term mechanical ventilation systems receive a pre-operation check of the plant.
- This has included replacement of filters; cleaning air handling units and supply fans and a physically checking that any dampers are in the correct position and functional.

Ventilation Systems air change calculations

As part of the ventilation requirements, the design process is based on the minimum supply flows to individual zones as well as the outdoor air requirements. In this process, the designer takes into account maximum occupancy in a room or zone and the ventilation is at its minimum supply or discharge airflow rates. SEF maintenance engineers have checked and validated all mechanical ventilation systems and they are operating as per their design requirements. If they were not operating at 100%, remedial work has already been undertaken to rectify these issues.

Determining the specification and design of a ventilation system for a building or room

When specifying a ventilation system, one of the most important considerations is the number of air changes per hour (also known as air change rate) needed to sufficiently ventilate the room. It is equally crucial to take into account the volume of outside air (fresh supply air) that the room requires. This can be calculated based on the number of people typically living or working in the space. These requirements can depend on a number of factors but the nature of the rooms' usage is a key place to start.

According to Ashrae, the American National Standards Institute, who are the ventilation authority in the USA and globally respected in their own right, the calculation for air changes is as follows, which is the same as is used in the UK and throughout the rest of the world "Air changes per hour (ACPH) is a measurement of air volume that is added to (or removed from) a room divided by the total volume of the room. Put simply, it measures how many times the air in the room is replaced. Higher ACPH values mean better ventilation." The formula is as follows:

ACPH = Q / Vol

Whereby:

- Q = Volumetric flow rate of fresh air from outside in cubic metres per hour (m^3/h)
- Vol = Space volume $L \times W \times H$ in cubic metres (m^3)

SEF have calculated the minimum air change rates for many buildings across campus, but in reality, for reasons outlined in the 2nd section of this paper, the calculations will be significantly higher. These figures below are conservative and represent the figure for the least well ventilated room in the building. Where rooms have A/C present, this has not been used to affect ACH, as the benefit of A/C is to alter temperature, not to exchange air.

Mechanical refers to mechanical ventilation and Natural refers to windows. For the mechanical readings, no windows were open and for the natural readings, only one window was open. If there is more than one window, the reading below can be multiplied by the number of windows. In the case of JMS, as the room is high up, with all 4 windows open, the ACH would have been 117.7. The results in the table below are from actual calibrated measurements:

Building	**Type of ventilation, mechanical or natural**	**Air changes per hour**
Shawcross	Mechanical	14.43
Silverstone	Mechanical	6.34
Chichester 1	Mechanical	14.56
Chichester 2	Mechanical	12.9
Medical Teaching School	Mechanical	7.6
Hastings	Natural	6.2
Arundel	Natural	8.9
Arts A	Natural	9.4
Chichester 3	Natural	7.8
Essex House	Natural	6.6
ACCA	Natural	6.69
Accelerator Building	Mechanical	11.12
Arts B	Mechanical	5.5
Arts C	Natural	5.33
Asa Briggs A1- A2	Mechanical	5.08
Ashdown House	Natural	9.6
Bramber	Mechanical	6.93
BSM Research	Mechanical	5.2
Clinical Imaging Sciences Centre (CISC)	Mechanical	11.52

CRPC	Mechanical	20.02
Education in Cancer (Shore-C)	Mechanical	5.74
Falmer House	Natural	6.2
Falmer Sports Complex	Mechanical	9.67
Freeman Building	Mechanical	20.03
Friston	Natural	12.47
Fulton	Natural	19.05
Genome Centre	Mechanical	12.34
Innovation Centre	Natural	11.71
John Clifford West	Natural	6.5
John Maynard Smith	Natural	29.43
Jubilee Building	Mechanical	66.66
Library	Natural	6.29
Meeting House	Natural	5.67
Pevensey 1	Mechanical	10.53
Pevensey 2	Natural	33.66
Pevensey 3	Natural	8.57
Research Centre (TFMRC)	Natural	7.2
Richmond	Mechanical	6.3
Sport Centre	Natural	18
Sussex House	Natural	11.52
Trafford Centre	Natural	6.3

The table shown is a representation of all buildings across the campus which vary in age, design and function and all ventilation systems, from entirely natural to a combination of mechanical and natural ventilation have been represented. All buildings have been surveyed and the ventilation systems within have been serviced and checked.

The buildings in the table are a mixture of mechanical and natural ventilation to provide a clear picture of how both perform. Wind speeds on the days when ACH were calculated (Thursday 10th September, Tuesday 22nd September and Wednesday 23rd September) was slight, ranging from 1.5-2.5 metres per second outside. The air flow speed inside, at the time of testing, was between 0.15- 0.40 and this level of air flow speed is hardly perceptible.
In the areas where I recorded the air changes with just mechanical ventilation in effect, with open windows as well as the mechanical ventilation working, the air exchange rates would dramatically increase, see Table 5.
All buildings had ventilation systems that worked as they should, even older systems. This is likely to be because minimum air exchange rates tended to be higher pre 1989 when new legislation came out. Post 1989, the guidance is based on a minimum ACH, whereas prior 1989, the guidance was to standard figure plus smoking was commonplace in buildings and this required much higher ACHs (of circa 30 changes per hour) than they do nowadays.

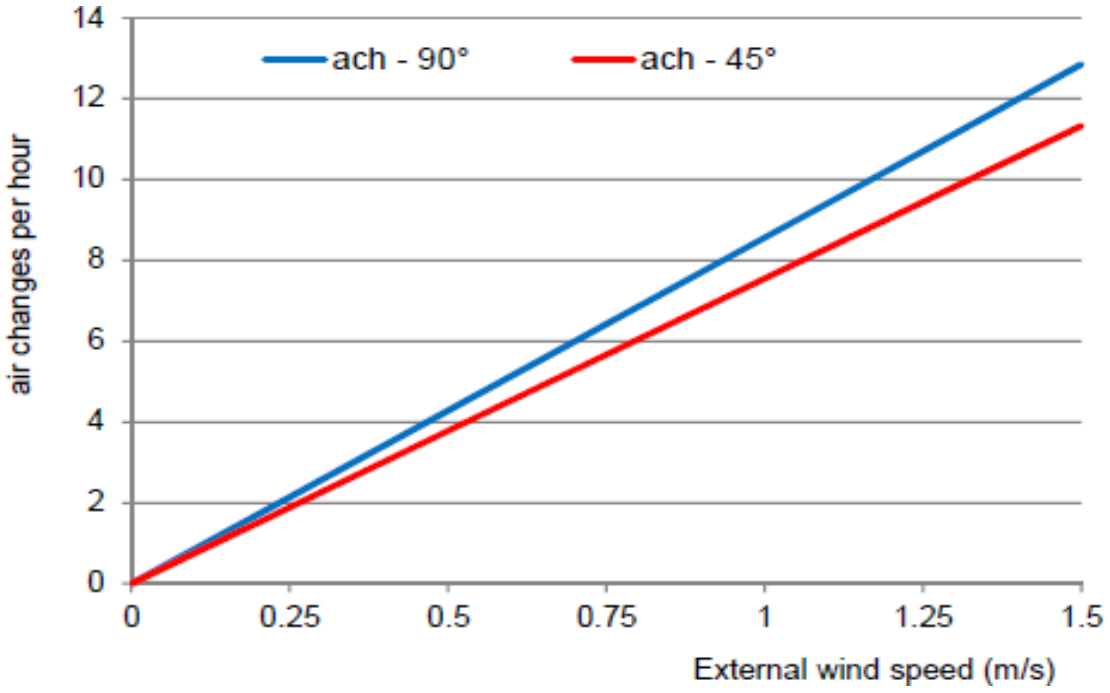
Natural ventilation

The formulae in CIBSE Guide A can be used to estimate the natural airflow rates for simple building layouts, as seen in the following table:

	Wind @ 90°	Wind @ 45°	Stack effect
Airflow rate (m^3/s)	1.61	1.42	0.84
Air changes per hour (ach)	12.8	11.3	6.7
l/s/person	107	94	56

Table 5 Natural ventilation air flow rates using formula in CIBSE Guide A

The table below (Table 5) taken directly from CIBSE Guide A, shows how wind speed, hitting a building at either 45 or 90 degrees, creates sufficient air changes. The wind speed required is actually very low, a speed of just 1 metre per second will provide around 8 air changes per hour in a room. Average wind speed in the UK is 8.4 knots or 4.32 m/s, so this is a clear indicator of the potential for natural ventilation.



This demonstrates how effective natural ventilation via open windows is. CIBSE have made assumptions for the calculations, for instance "a coefficient of discharge (Cd) of 0.61 is adopted based on cl 4.6.1 of CIBSE Guide A to take into account the pressure drop through a sharp edged opening, such as a window. The resulting air flow rates are shown in Table 5."

In office buildings it is generally necessary to calculate air changes for one typical interior zone, and in the case of this campus, we have chosen the rooms with the lowest ventilation rates. No other calculations are required, even if the building has 1,000 zones.

Building Management System (BMS)

A BMS is a computer-based control system installed in buildings that control and monitor the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems.

How we control risk:

- Operational checks of the BMS are completed to ensure that there are no faults on the system.
- If faults are detected these are attended to promptly using our in-house teams or specialist contractor support network.

Other Mechanical Systems

There will be other mechanical systems within the workspace and the risks are varied and many.

How we control risk:

- Checks and testing are carried out on any gas detection systems.
- Checks on gas boilers and water heaters for correct operation along with auxiliary equipment are carried out.
- Checks are carried out on the operation of chiller plant and auxiliary equipment.
- Checks are carried out on F-Gas systems and that the logbook is up to date for all equipment.
- Checks are carried out on all gas Certification to ensure that it is up to date.
- Checks are carried out on the operation of all air conditioning equipment.
- Checks are carried out on the operation of compressed air systems.

Reference

HSE ACoP - Workplace (Health, Safety and Welfare) Regulations 1992 – Reg. 6 Ventilation

HSE Guidance - Air conditioning and ventilation during the coronavirus outbreak – 2020

CIBSE COVID-19 Ventilation Guidance – v.2 May 2020

Natural ventilation in non-domestic buildings, CIBSE Applications Manual AM10 - 2005