RENSAIR

rensair.com

Real-world trial confirms efficacy of Rensair hospital-grade air purifiers

INDEPENDENT TRIAL CONDUCTED BY

QCS

AIDED BY MONITORING FROM

AIRTHINGS | FOR BUSINESS

PARTICIPANTS

The participants in this independent, real-world indoor air quality trial were:

ORGANISER

OCS is an international facilities management company with 20,000 customers across the globe — from the UK and Ireland, to the Middle East and Asia Pacific.

More information:
ocs.com/uk

MONITORING

Airthings is a global technology company on a mission to ensure that people around the world take control of their air quality through simple, sustainable and accessible technology solutions.

More information:
airthings.com/business

AIR PURIFICATION

Rensair is a specialist in portable air purification, using HEPA filtration and germicidal UVC light to trap and destroy harmful particulate matter.

More information:
rensair.com

Rensair provided the air purifiers for this trial, which was conducted exclusively by OCS. The results were subsequently shared with Rensair for this write-up.

ABSTRACT

Real-world air purification trial confirms efficacy of Rensair units in removing fine particulate matter in a typical office environment.

Interest in air purification has grown steadily over the past decade, driven by the impact of rising outdoor air pollution on indoor air quality. Over the past 18 months, the Covid pandemic has accelerated demand for clean air as an infection control measure.

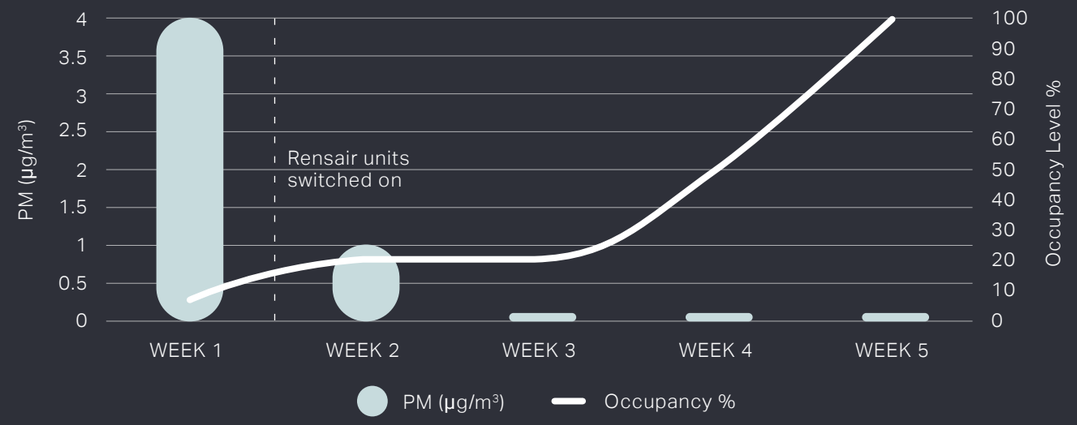
However, this has triggered an explosion of air cleaning products on the market. In the words of Dr. Marwa Zaatari – eminent Indoor Air Quality expert and Member of the Board Of Directors at U.S. Green Building Council – "it has created a marketplace that some liken to the 'wild west,' making it a challenge for most engineers and consultants to discern fact from fiction, let alone school district facilitators, administrators, and board members."

A select few manufacturers, like Rensair, have proof of efficacy from several respected scientific laboratories, including Eurofins and the Danish Technological Institute. However, to date most efficacy studies have been done in controlled environments and not in real-world settings.

This trial demonstrates the performance of Rensair's hospital-grade air purifier in a real-life office setting, with continuous air quality monitoring from an established, world-leading detection and measurement brand.

The result of this trial demonstrated that the air quality in the office was substantially better with the Rensair units switched on and almost 100% occupancy than with the Rensair units switched off and only 6% occupancy.

AVERAGE PM CONCENTRATION MEASURED AT CORRESPONDING OCCUPANCY LEVEL*



*Occupancy rates as provided by OCS.

OBJECTIVE

The purpose of the study was to determine the impact of Rensair's air purification units on indoor air quality within an occupied office environment.

LOCATION

The location was OCS' office in Cardiff, a typical industrial estate building with no HVAC system and windows only along one side of the building (i.e. there is no cross ventilation). The specific location was Caxton Place, Cardiff CF23 8HA, with an occupancy of 35 employees. The areas monitored as part of the trial total 251sqm (582 m^3).

METHODOLOGY AND TIMELINE

The duration of the trial was 5 weeks, from October 11 to November 14, 2021. Following automatic onsite calibration, the AirThings detection sensors were operational, allowing one week of 24x7 monitoring to collect baseline data for comparison. During this time, the office was running at 6% occupancy.

The AirThings sensors monitored:

- Fine particulate matter (PM 1, PM 2.5): micron per cubic metre (µg/m^3)[1]
- CO_2: parts per million (ppm)
- Humidity: percentage (%)
- Temperature: degrees Celsius (°C)
- VOCs: parts per billion (ppb)
- Pressure: millibar (mBar)

After week 1, the Rensair portable air purifier devices were unboxed, plugged in, and switched on to their default "Auto" LOW air flow setting. The 5 units were strategically positioned in 4 areas of the office to achieve the ventilation standard found in the latest World Health Organization (WHO) guidelines,[2] 'Roadmap to improve and ensure good indoor ventilation in the context of COVID-19'.

CONFIGURATION

The areas of the office included within the trial and their respective sizes and pre-Covid occupancy levels are recorded in the table opposite:

[1] PM2.5 and PM1 can be defined as the fraction of particles with an aerodynamic diameter smaller than 2.5 and 1 microns respectively. These include viruses and bacteria.

[2] https://www.who.int/publications/i/item/9789240021280

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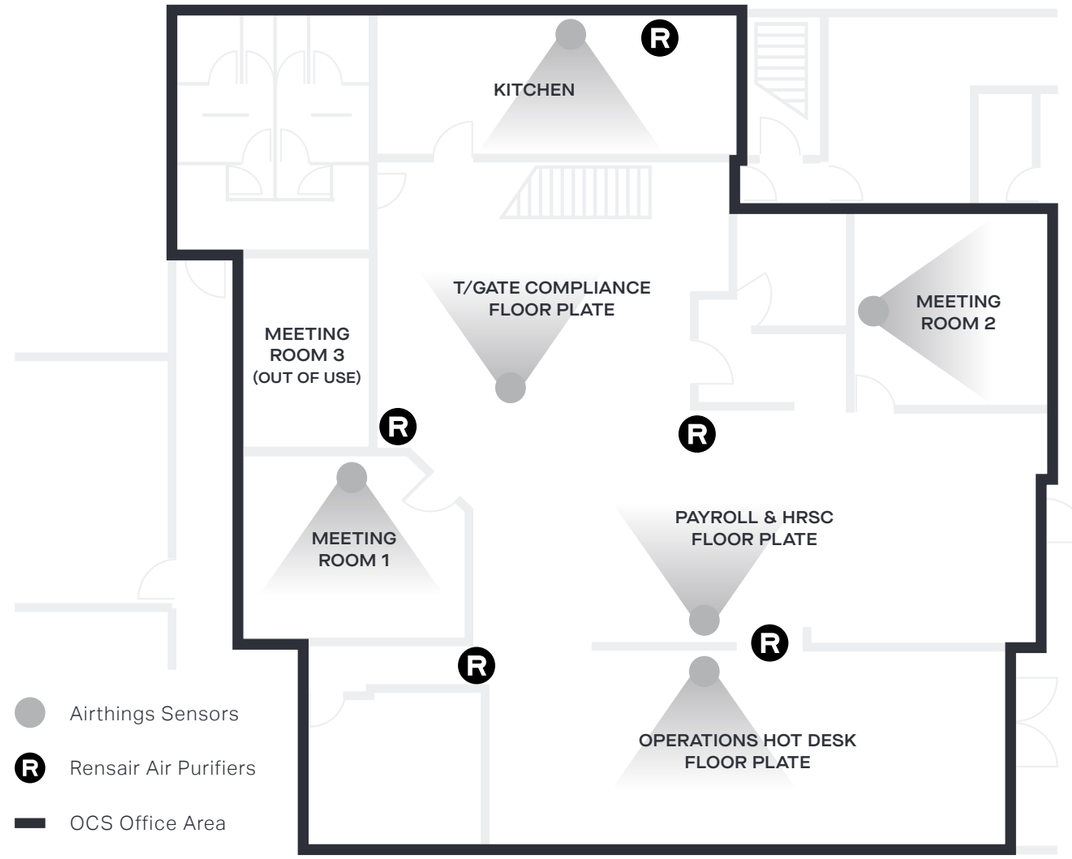
ROOM	DIMENSIONS (M)			AREA (M^2)	VOLUME (M^3)	NUMBER OF OCCUPANTS
	LENGTH	WIDTH	HEIGHT			
Operations	17.8	5.2	2.3	93	209	7
Payroll	14.2	5.8	2.5	82	205	16
T/gate Compliance	7.9	5.9	2.1	46	98	6
Kitchen	8.9	3.4	2.3	30	69	6

The floor plan below shows the positioning of the AirThings sensors (denoted by grey circles) and the Rensair air purifiers (denoted by the letter 'R') within the areas covered by the trial.

Note: although Airthings sensors are present in two of the meeting rooms, these areas are excluded from the trial data as no Rensair units were placed in these areas.



BACKGROUND - VENTILATION STANDARDS

After governmental health authorities recognised that Covid-19 was airborne, they and the WHO began to recommend an increase in ventilation within indoor spaces. The WHO now recommends achieving a ventilation rate of 10 litres of fresh air per person per second (l/p/s) – this is the same as the UK SAGE committee and CIBSE recommendations.

However, these recommended rates are a significant increase on current ventilation rates found in buildings. To achieve them will require a significant increase in ventilation standards.

Pre-pandemic, for example, the US ASHRAE building standard recommendations were to provide 3 to 5 l/p/s of fresh air. The new recommendations are 2-3 times that of the pre-Covid level. Similarly, European standards for offices range from 3-10 l/p/s for new buildings.

Many building AHUs provide ventilation rates nowhere close to 10 l/p/s, and a substantial number of older buildings offer no ventilation at all.

VENTILATION CHALLENGES

The WHO and many health authorities recognise that not everyone can provide or increase ventilation. Where ventilation is not possible, they have issued guidelines to 'clean and filter' indoor air using portable air purifiers.

Therefore, ventilation can be seen as:
Total Ventilation = Outside Air Ventilation + Air Purification. For example, if mechanical ventilation provides a fresh air change rate of 6 l/p/s, then delivering an additional air purification rate of 4 l/p/s would achieve the WHO and SAGE guidelines of 10 l/p/s. If no outside air is provided, then the entire 10 l/p/s should be provided by air purification.

Any air purifiers selected for the task must:

- Create effective air circulation to clean all the air in a room, rather than just around the machine itself.
- Use recognised technology with no toxic by-products - most governing bodies recommend avoiding units with 'additive technology' like plasma, ioniser or fogger systems, which add chemicals into the air and can give rise to toxic by-products.
- Have been rigorously tested by independent scientific laboratories to validate any manufacturer's air cleaning claims.

The WHO[1], CDC[2], SAGE[3] and other health authorities endorse 'subtractive' technologies, specifically HEPA filtration to trap and UVC light to destroy airborne particulate matter, without any harmful side effects.

[1] WHO: Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 https://www.who.int/publications/i/item/9789240021280

[2] CDC: Ventilation in Buildings, Summary of Recent Changes, Updates as of June 2, 2021 https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html#refphf

[3] SAGE: Potential application of air cleaning devices and personal decontamination to manage transmission of COVID-19, 4 November 2020 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/939173/S0867_EMG_Potential_application_of_air_cleaning_devices_and_personal_decontamination_to_manage_transmission_of_COVID-19.pdf

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AIR VOLUME CALCULATION

The WHO's recommended 10 litres per person per second (l/p/s) equates to 36 cubic metres per person per hour (m^3/p/h), which is the target air change requirement for this trial.

Calculations were made for each room to determine the number of air purifiers required to deliver the target air change rate.
The example below shows the calculation method for the Operations room:

CLIENT REQUIREMENT

Room Area	93	m^2
Room Volume	208	m^3
Occupancy	7	people
Purification Requirement	36	m^3 per person per hour
Total Room Purification Requirement	252	m^3 per hour

RENSAIR SOLUTION

Number of Units	1	
Fan Setting	Low	
Purification Delivered	300	m^3 per hour
Delivered Air Changes per Hour	1.4	
Time Between Air Changes	42	Minutes

The table below calculates the air purification requirement to achieve the WHO standards for each of the four designated spaces:

ROOM	AREA (M^2)	VOLUME (M^3)	OCCUPANTS	REQUIRED PURIFICATION		RENSAIR DELIVERED SOLUTION		
				M^3/HOUR	ACH	UNITS	M^3/HOUR	ACH
Operations	93	209	7	252	1.2	1	300	1.4
Payroll	82	205	16	576	2.8	2	600	2.9
T/gate Compliance	46	98	6	216	2.2	1	300	3.1
Kitchen	30	69	6	216	3.1	1	300	4.3

OCCUPANCY AND ENVIRONMENTAL INFLUENCES

Variables throughout the trial period included:
- Individual room occupancy levels
- Natural ventilation levels
- Wall mounted AC for heating and dehumidifying

These variables are acknowledged throughout the course of the trial in order to take into account any potential influence over the readings taken by the AirThings sensors,

Indoor Air Quality – Trial Results

Baseline results **WEEK 1: OCT 11-17: 6% OCCUPANCY**

The snapshot below shows the average baseline results during the first week of monitoring **without the Rensair air purifiers in operation**. The results are a composite of readings taken from all 4 sensors within the four monitored spaces: Operations, Payroll, T/gate Compliance and Kitchen.

During this period, there were only two people in the office (both in Payroll) on 3 out of 5 working days, equating to 6% occupancy. Some windows were periodically open. Of particular note were the PM1 and PM2.5 particulate levels, each reading an average of 4 µg/m³ throughout the week.

Average measurements during office working hours

- 550ppm CO_2
- 58% Humidity
- 4µg/m³ PM 1
- 19° Temp
- 125ppb VOC
- 4µg/m³ PM 2.5

Trial results **WEEK 2: OCT 18-24: 20% OCCUPANCY**

During this period, the first in which the 5 Rensair units were switched on to the "Auto" LOW air flow setting, there were 7 people in the office (6 in Payroll and 1 in Operations), equating to 20% occupancy. Some windows were periodically open.

Despite the increase in occupancy, there was a notable decrease in PM1 and PM2.5 particulate levels throughout the week, both of which reduced from 4 microns per cubic metre to just 1 micron per cubic metre. Taken in isolation, the PM levels within the occupied Payroll area also registered 1, meaning that they had no detrimental impact on the average data.

Average measurements during office working hours

- 485ppm CO_2
- 62% Humidity
- 1µg/m³ PM 1
- 19° Temp
- 103ppb VOC
- 1µg/m³ PM 2.5

WEEK 3: OCT 25-31: 20% OCCUPANCY

During this period, occupancy levels were the same as the previous week. Windows remained closed due to a drop in outside temperature, maintaining inside temperature at 19 °C. With no outdoor air particle ingress, PM levels reduced to zero.

Average measurements during office working hours

- 491ppm CO_2
- 62% Humidity
- 0µg/m³ PM 1
- 19° Temp
- 121ppb VOC
- 0µg/m³ PM 2.5

WEEK 4: NOV 1-7: 50% OCCUPANCY

During this period, occupancy rose to 18 members of staff (evenly distributed), equating to 50% occupancy. Windows were closed.

Despite the significant increase in occupancy, PM levels remained static at zero.

Not surprisingly, with higher occupancy and closed windows, CO_2 levels rose significantly. However, most guidance – such as that from the UK HSE – advises that ventilation needs to be addressed when CO_2 levels exceed 1,500ppm and the HSE's long-term exposure limit (8hr reference period) recommendation is 5,000ppm[1]. The Rensair units were not intended to influence CO_2.

Volatile Organic Compounds (VOCs) are a diverse group of chemicals that are commonly found in the air in homes and offices. Common sources of VOCs include paints (such as formaldehyde), lacquers, cleaning supplies, furnishings, office equipment, glues, alcohol, and human breath. This week, levels increased. The average Total VOC still fell within acceptable levels, below 250ppb, although the Kitchen area recorded a peak of 801ppb, suggesting that more ventilation is needed there. The Rensair unit is not designed to capture VOCs, although the filter has a carbon surround that will to some extent adsorb them.

Average measurements during office working hours

- 671ppm CO_2
- 48% Humidity
- 0µg/m³ PM 1
- 19° Temp
- 232ppb VOC
- 0µg/m³ PM 2.5

[1] HSE: General hazards of Carbon Dioxide https://www.hse.gov.uk/carboncapture/carbondioxide.htm

WEEK 5: NOV 8-14: 98% OCCUPANCY

During this period, staff numbers returned to almost full capacity with a headcount of 34, equating to 98% occupancy. Windows were closed. Given the drop in temperature, the wall mounted AC units were switched on whilst staff were on site and set for the heating function only.

Even with occupancy at almost 100%, particle levels remained at zero. CO_2 levels increased further, indicating a lack of ventilation and highlighting the need for air purification as an infection control measure.

Average measurements during office working hours

- 802ppm CO_2
- 47% Humidity
- 0µg/m³ PM 1
- 24° Temp
- 275ppb VOC
- 0µg/m³ PM 2.5

One additional point to note is that, as air is heated in winter with minimal ventilation, the relative humidity in the office decreases. The levels within this trial remained within the guidelines (between 40% and 60%) but, with continuous heating and high occupancy, it is possible that they would decrease further over time.

The Centers for Disease Control and Prevention found that, with humidity at 23%, 70–77% of flu virus particles could still cause an infection one hour after a person coughed.

When humidity was raised to 43%, the percentage of infectious particles was reduced to 14%.

Air purifiers can help to remove virus particles that are more transmissible with lower levels of humidity in the office.[1]

[1] Source: High Humidity Leads to Loss of Infectious Influenza Virus from Simulated Coughs https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0057485

NOISE LEVELS

The air purifiers were operated on the “Auto” LOW air flow setting to avoid noise disruption. This generates only 45dBA of an even white noise, equivalent to the recommended white noise level limit for an infant sleep machine.

On a Sound Pressure Level (SPL) metre, 45dBA sits between ‘quiet whisper’ and ’quiet home’.

"Here at OCS we are always striving to be at the forefront of innovation in responding to our clients' needs. Working with AirThings and Rensair, we are bringing to the market a joined-up solution to deliver real time data and cleaner air to the workplace. The benefits stretch far beyond the current pandemic and into the future as we change the way we see and interact with our workplaces.”

Craig Parrish, Senior Technical Services Manager, OCS Group

“By taking full control of your indoor air quality, you can better mitigate the risk of infection. A healthy workforce means a healthy business.”

Jonas Storåkers, Sales Director, Airthings

“With many wild claims flooding the air purifier market, it’s essential to have independent validation, both from respected laboratories and from credible real-world trials.”

Frederik Hendriksen, Co-founder, Rensair

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CONCLUSIONS

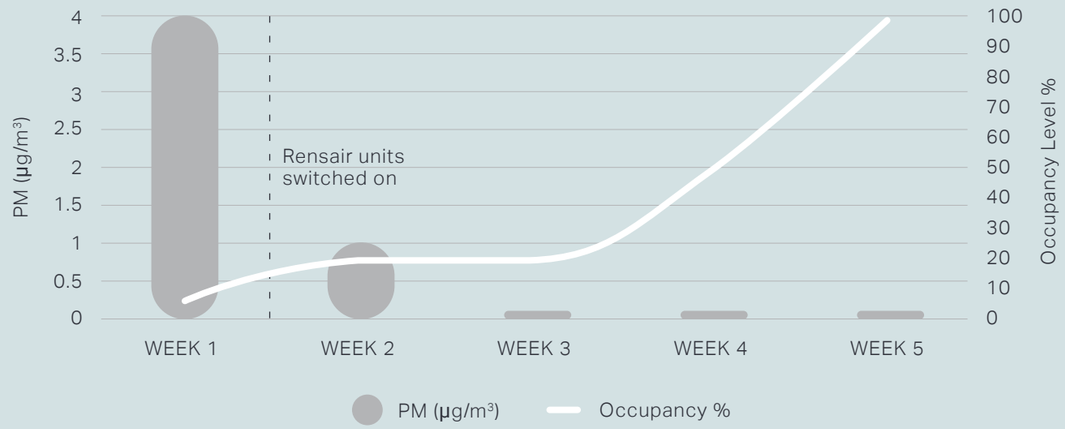
The data from the trial clearly demonstrates that, in a real life setting, Rensair air purifiers are highly effective in reducing levels of fine PM1 and PM2.5 particulate matter to minimal traces or zero. This is due to a combination of HEPA filtration with powerful air circulation, achieving 300m^3 per hour on the low setting. As occupancy increased over the period of the trial, the units continued to keep the particle count level at zero, thereby providing highly effective infection control against seasonal viruses, bacteria and Covid-19.

The World Health Organization[1] describes PM as a “common proxy indicator for air pollution” and says that it “affects more people than any other pollutant”. Small particulate pollution has health impacts even at very low concentrations and no threshold has been identified below which no damage to health is observed.

Therefore, the WHO’s guideline aims to achieve the lowest concentrations of PM possible.

Based on theory, the Rensair unit’s HEPA filtration achieves 99.99% efficacy at the size that COVID-19 particles are typically transmitted as airborne aerosols ie. sub 0.1 micron. In practice, in a laboratory test by the Danish Technological Institute to determine Rensair’s performance in reducing the concentration of surrogate Covid-19 particles in the air, a particle reduction rate of 99.98% was recorded in 15 minutes and above 99.99% in 30 minutes. This real-time trial provides evidence that the laboratory findings translate into real-world efficacy in a typical, occupied office setting.

AVERAGE PM CONCENTRATION MEASURED AT CORRESPONDING OCCUPANCY LEVEL*

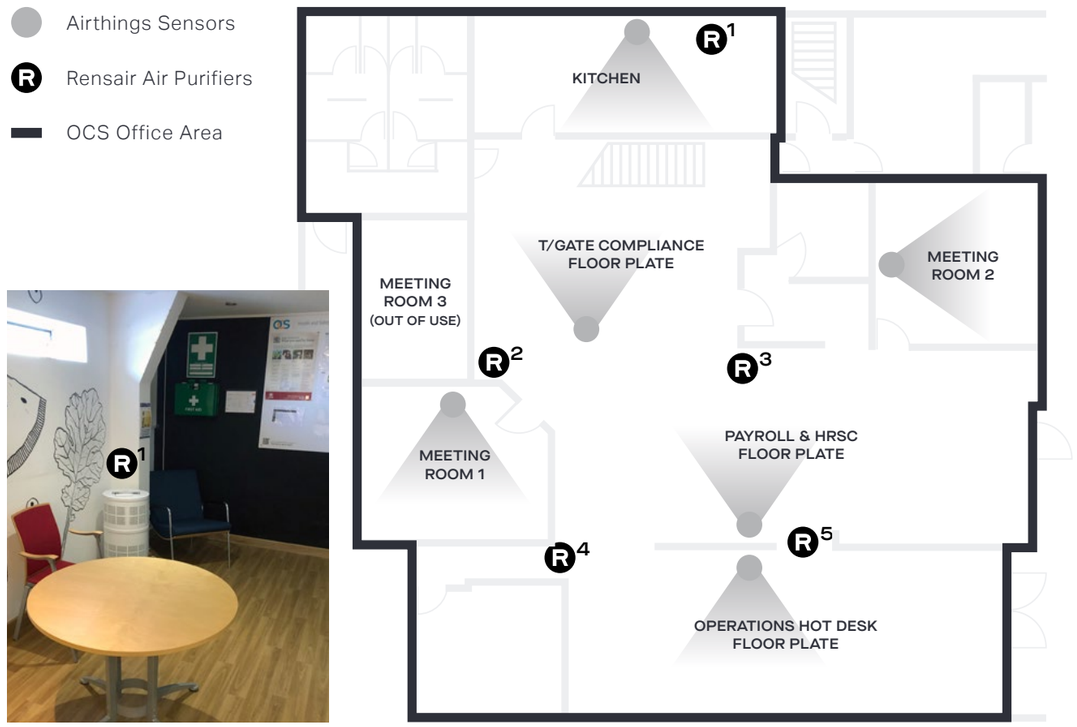


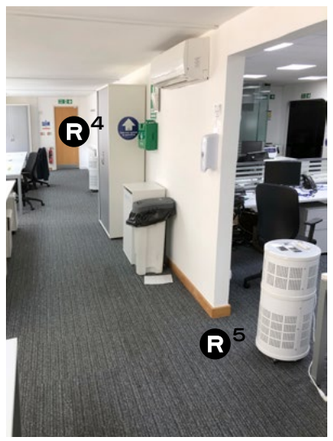
*Occupancy rates as provided by OCS.

[1] https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

APPENDIX

Images of the trial space.





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