Worker Health Protection

GETTING THE BALANCE RIGHT

Indoor Air Quality Survey

carried out on behalf of

Safewell Solutions / KSG Health Ltd

at their clients surgery

Main Street Medical Practice, 40 Main Street Bridgeton, Glasgow G40 1HA.

Surveyed: 5th November 2020

Issued: 25th November 2020

Job Number: WHPL 1082/20

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BOHS The Chartered Society for Worker Health Protection

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ROYAL SOCIETY OF CHEMISTRY

EXECUTIVE SUMMARY

Unlike directly legislated issues such as noise, hazardous substances and vibration, indoor air quality and related stressors associated with this subject, including some human factors, is not a black and white subject, especially when the current pandemic is factored in to the equation. However, this summary is aimed to at least give some guidance and interpretation to what was found and reported. It also allows a very favourable conclusion to be drawn around the performance of the Genano air purification system.

Prior to the actual site survey, anecdotal evidence supplied by the surgery staff suggested the Genano unit was very effective at odour minimisation particularly in the waiting area of the surgery. This was an early indication of the efficiency of the air cleaning filtration efficiency.

The findings from the survey show that there is a notable reduction in bacterial fractions in circulating aerosols both for total viable counts and the yeasts & mould concentrations from bacteria normally present in indoor air based on measurements when the Genano unit was not running compared with a period of just over 24 hours when it was running.

The office behind the reception occupied by staff was one location chosen slightly away from the waiting area and it shows it is less impacted by the Genano unit than the waiting area itself.

Overall, the air quality was generally good and the levels of Carbon Dioxide indicated sufficient fresh air change was being provided for the population in the building.

Air movement also indicated air was circulating but not to an excessive rate and outside pollutants were not a significant impact on the environment either.

INDOOR AIR QUALITY REPORT

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1. INTRODUCTION

Worker Health Protection Ltd was requested on behalf of Safewell Solutions Ltd and KSG Health Ltd to undertake an air quality study within a Glasgow Medical Practice to ascertain the air quality with a particular focus on the efficiency on an air purifier installed in the main waiting room of the practice.

Safewell SafeSpace™ is self-funding research into systems to suppress and measure airborne spread viruses and microbes. We are challenged by the twin imperatives of saving lives and livelihoods; offices remain empty and people work from home. This may be sustainable for some types of business but not all. For years we have ensured our clients breathe safe air when working in hazardous environments. Our breathing systems have been used offshore and onshore globally in multiple sectors and were recently used by a leading International company developing new ventilators.

Similarly, partnering company KSG Health Ltd focuses on the Genano Air Purification and Innovative solutions to remove airborne microbes of all sizes down to nanometer scale. The co-founders and co-directors of KSG Health Ltd, Mr Neville Spiers and Mr Jarmo Kesanto, have altogether 70+ years' experience in owning, developing and successfully running different sizes of businesses, in different industries, in UK and in other countries. Jarmo Kesanto has worked with the Genano business development team since 2008 and built up the base of the UK business, on behalf of Genano Ltd, the Finnish manufacturer and IPR owner.

Both Safewell Solutions Ltd and KSG Health Ltd believe that airborne Covid-19 transmission can be mitigated using a holistic risk-based approach to improve air quality and ventilation and create SafeSpaces™ in business. There is no such thing as zero risk but if we make the Invisible risks more visible, we can start to manage this pandemic in a completely logical and objective way.

This air quality study was carried out over two days between the 4th & 5th of November 2020 and the objectives of this survey work were:

1. To investigate potential pollutants that may cause specific health complaints or general health related work stressors. In particular those contained within circulating bioaerosols indicated by Total Viable Counts, Yeasts & Moulds, carbon dioxide, carbon monoxide, Oxides of Nitrogen, general nuisance dust and VOC's. Additionally, oxygen, air temperature (dry bulb) and relative humidity were measured.

2. To comment on the general air quality and perceived improvements offered by the air purifying device.

3. To comment on the ventilation performance.

This report summarises the work carried out during the visit.

2. VENTILATION OVERVIEW

Ventilation is the means by which fresh air is introduced to, and circulated throughout the workplace or building and by which vitiated or stale air is removed or diluted. Fresh air is clean air that has been drawn from a source outside the building and is not polluted by discharges from flues, exhaust ventilation systems and process outlets. In a pure, dry state it typically comprises: -

Oxygen	20.94% by volume
Carbon Dioxide	0.03% by volume (~300ppm)
Nitrogen and other inert gases	79.03% by volume

Fresh air is required for several reasons:

(a) for respiration, i.e. to provide oxygen and to dilute exhaled carbon dioxide;

(b) to dilute and remove airborne impurities created by the occupants of the room, for example body odour, tobacco smoke, exhaled aerosols;

(c) to remove excess heat and maintain comfortable conditions;

(d) to dilute other airborne impurities present in the room, for example, dust and fume etc., from work processes and machines, products of combustion from heaters and water heaters, traces of matter from the fabric of the room and its contents, cooking and other smells.

Respiration

A person's need for fresh air depends on his metabolism, or rate of activity. On average, 0.5 litres per second per person of fresh air will be required to provide sufficient oxygen for respiration but this can range from 0.15 litres per second at rest to 1.0 litre per second per person for heavy work. Approximately 2 litres per second per person will be required to dilute exhaled carbon dioxide to the occupational exposure limit, 0.5%.

Lack of oxygen and the presence of high concentrations of carbon dioxide can present an acute danger. However, they are only likely to occur in certain extreme situations, for example, when entering and working in confined spaces. In practice, other criteria need to be used when deciding on the appropriate ventilation rate.

Odour & Comfort

Air requirements for the dilution of personal odours depend largely on the space available per person, on personal cleanliness, and on personal sensitivity. Perception of odour varies and usually diminishes with time, as the sense of smell becomes fatigued. It is doubtful whether odour has any directly harmful effect. Odour is unlikely to be a problem at ventilation rates of 9 litres per second per person or more or where the air is filtered or "purified" in some other way.

Environmental Comfort

Personal comfort depends on the air temperature, radiant heat and, at higher temperatures, on humidity. The comfort of people in the workplace cannot be directly related to the ventilation rate. However, if comfort is to be maintained, ventilation is necessary to remove and dilute warm, humid air and to provide air movement. Some air movement is also necessary to provide a sense of 'freshness'. At normal room temperatures an air velocity of 0.1 to 0.15 metres per second (ms^{-1}) is recommended. Higher air velocities are likely to lead to complaints about draughts unless the temperature is high or the occupants are engaged in physically demanding work.

Medical research has shown a link between high humidity and respiratory allergic reactions. These are thought to be associated with the inhalation of fungal species or mites that thrive in elevated humidity levels at or above 60%. However due to such situations being less common and focused on individual susceptibility, it is not easy to regulate for such an occurrence. Though, given the test results, it would be useful to follow up on the latest evidence on fungal transmission etc.

Re-circulated Air

Mechanical ventilation and air conditioning systems often treat or condition the extracted air and then return it to the workroom. Treatment normally involves heating or cooling the air, filtering it and, in some cases, adjusting the humidity. Such treatment does not remove gases or very fine particles from the re-circulated air and these may accumulate. In extreme cases, impurities may build up to an unacceptable level. Even low concentrations of certain impurities can adversely affect the health of occupants, particularly if they have an allergenic effect. This is particularly true where a viral fraction attaches itself to a host aerosol or dust particle.

It is therefore important to distinguish between fresh and re-circulated air, and to ensure that the building or workplace has an adequate supply of fresh air either as make-up air into the ventilation system or from other sources such as doors and windows.

3. LEGAL REQUIREMENTS

The Health and Safety at Work Act 1974 gives general duties, under Section 2 and Section 4, to provide a safe place of work free of noxious fumes. In addition, the Workplace (Health, Safety and Welfare) Regulations give clear guidance on what is required in providing "wholesome air" and ventilation to a workplace. The Approved Code of Practice (ACOP) associated with the Workplace (Health, Safety and Welfare) Regulations makes the following points:

1 Enclosed workplaces should be sufficiently well ventilated so that stale air, and air which is hot and humid because of the processes or equipment in the workplace, is replaced at a reasonable rate.

2 The air, which is introduced should, as far as possible, be free of any impurity which is likely to be offensive or cause ill health. Air which is taken from the outside can normally be considered to be 'fresh', but air inlets for ventilation systems both natural and forced, should not be sited where they may draw in excessively contaminated air (for example close to a flue, an exhaust ventilation system outlet, or an area in which vehicles manoeuvre). Where necessary the inlet air should be filtered to remove particulate but in many cases where this is a natural source this is not possible.

3 The fresh air supply rate should not fall below 5 to 8 litres per second, per occupant and ideally be around 10. Factors to be considered include the floor area per person, the processes and equipment involved, and whether or not the work is strenuous.

Other regulations such as the Control of Substances Hazardous to Health Regulations will apply under some circumstances.

4. TEMPERATURE AND HUMIDITY

Legal guidance on temperature in the workplace is scant. The Workplace (Health, Safety and Welfare) Regulations tell us that 'during working hours, the temperature in all workplaces inside buildings shall be reasonable' and the associated code of practice gives us a normal minimum of 16° Celsius.

The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) give more information on temperatures and humidity in its publication ASHRAE 55-1992. ASHRAE recommends temperatures in the range 19.4 to 24.4^{o} C (67 to 76° F) in winter and 22.2 to 27.2^{o} C (72 to 81° F) in summer. However, they do point out that complaints may increase when temperatures rise above 23.3^{o} C (74° F).

Levels of relative humidity quoted by ASHRAE have an absolute lower limit of 30% but a normal lower band of 40% and an upper limit of 60%. Others extend the range of acceptable relative humidity to 70%.

5. VENTILATION AND AIR MOVEMENT

The use of mechanical ventilation allows more control than natural ventilation although some types of extract fan are affected by changes in wind speed and direction. Air movement within the workplace is influenced by the design and position of air inlet and extract openings, by temperature differences within the room or building, by the movement of people and equipment and by obstructions such as furniture and partitions. These influences are constantly changing and it is often difficult to predict airflow patterns. The same impact on air movement is achieved by devices that move the air such as those at ceiling heigh that can also heat the air or simple fans.

Air movement from inlets is directional, maintaining high velocities for a considerable distance, whereas air movement into openings is not directional, and so air velocities close to extract openings are generally low. The fast moving airstream from an inlet therefore has more influence on air movement in the room or workplace, entraining air and causing turbulence over a wide area. As previously mentioned, air velocities in the range 0.1 to 0.15 ms^{-1} are recommended for the comfort of people in the workplace.

6. MEASUREMENT METHODS

Various types of measurement were made in order to assess the quantity circulating in the waiting room and a side office

In order to evaluate air movement, visualisation was carried out using a Dräger, Airflow Tester which supported air quality determinations using a TSI Q-Trak Indoor Air Quality monitor, combustion analyser and a Casella Dust Analyser.

Reference to NIOSH Manual of Analytical Methods for bioaerosol sampling

Measurements of the concentration of contaminants in the air found nothing of significance for the other pollutants and a good efficiency for air cleaning regarding bioaerosols.

The air movement was acceptable.

Carbon Monoxide values were low as were associated traffic pollutants

Carbon Dioxide was generally around the expected values of 500ppm indicating good fresh air circulation from all sources.

7. AIR PURIFICATION

Air Purifiers allow circulating air to be "cleaned" in some way before being returned to the same environment. Ideally nano-size particles being filtered from the air allows submicron particles and aerosols that could harbour viruses to be dealt with efficiently. Additional elements to such devices including activated carbon and ionisation allows volatile organic compounds and microbes to be effectively controlled as well.

The application of nanotechnology allows a filter efficiency to be maintained down to as low as 0.003 µm.

8. OCCUPATIONAL EXPOSURE LIMITS

Workplace Exposure Limits (WELs) are occupational exposure limits (OELs) set under COSHH, in order to help protect the health of workers. WELs are concentrations of hazardous substances in the air, averaged over a specified period of time referred to as a time-weighted average (TWA). Two time periods are used: long term (8 hours) and short term (15 minutes). Short-term exposure limits (STELs) are set to help prevent effects, such as eye irritation, which may occur following exposure for a few minutes.

There was nothing of significance applicable on this occasion.

9. RESULTS

The indoor air quality elements covered by this study indicated a good overall provision of fresh air from several sources and by purifying the air, an ability to improve factors such as odour and even bioaerosol hosts for bacteria and viruses was demonstrated as well.

The following results were recorded without the air purifier running:

Location	Temp, ^0C	Air Flow ms-1	%RH	CO ppm	CO2 ppm	O2 %	TVC's	Yeasts / Moulds	VOC's. ppm	Comments
		0.1 –0.15 typical	40 – 60 typically with 70 as a maximum	3 max, 30 limit	300 – 500 Typical range 800 IAQ	>20%	Guide only to be below 1000cfu/m^3	Guide only to be below 500cfu/m^3	OEL 100ppm	
Waiting Room										
Seating area, left	18.0	0.12	64	<1	640	20.8	285	415	<1	
Seating area, right	18.5	0.10	65	<1	650	20.8	240	520	<1	
Reception desk	19.4	0.10	65	<1	640	20.8	320	385	<1	
Office Behind Reception										
By door	20.1	0.10	58	<1	590	20.8	190	205	<1	

The following results were recorded with the air purifier running for 24 hours:

Location	Temp, ^0C	Air Flow ms-1	%RH	CO ppm	CO2 ppm	O2 %	TVC's	Yeasts / Moulds	VOC's. ppm	Comments
		0.2 –0.15 typical	40 – 60 typically with 70 as a maximum	3 max, 30 limit	300 – 500 Typical range 800 IAQ	>20%	Guide only to be below 1000cfu/m^3	Guide only to be below 500cfu/m^3	OEL 100ppm	
Waiting Room										
Seating area, left	18.9	0.12	67	<1	610	20.8	16	26	<1	
Seating area, right	19.2	0.11	62	<1	600	20.8	18	32	<1	
Reception desk	19.5	0.12	63	<1	570	20.8	24	28	<1	
Office Behind Reception										
By door	20.8	0.10	59	<1	540	20.8	80	65	<1	

Note: ppm = parts per million in air ms-1 = metres per second or air movement
cfu = colony forming units for TVC's, Yeasts & Moulds. M^3 = cubic metres of air sampled.

10. CONCLUSIONS

The findings tabulated above show that there are no significant air quality issues under normal conditions. However, as there is an increasing body of science suggesting the risk of airborne transmission of a range of infections including viruses is more significant than first thought.

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the strain of coronavirus that causes coronavirus disease 2019 that we all have come to know as COVID-19. Airborne transmission relies on this virus being attached to a host that can provide substance and this is provided where such a host is an aerosol or moist particulate.

The latest research suggests that COVID-19 aerodynamic particle size relating to airborne transmission is between 0.06 & 0.14μm and with the air purifier systems installed with the surgery waiting room providing filtration efficiency down to as low as 0.003μ then this seems to clearly enhance the control strategy for a front line service such as a doctors surgery. This view is further supported by the staff comments on odour reduction as well which is another benefit of such a control measure.

The yeasts & moulds results show a reduction well above a factor of 10 which is better than most commonly used respiratory filtration devices for personal protection. It is likely that the concentration would continue to fall with time the longer the unit was operating but with a detection limit of 20cfu/m^3 the performance is already impressive.

11. REFERENCES

- The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) ASHRAE 55-1992, as amended.
- The Chartered Institute of Building Services Engineers (CIBSE) Guide, Volume A: Design Data .
- The Control of Substances Hazardous to Health Regulations.
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- Environmental Health Perspective 1986; 65: 351-361. *Indirect health effects of relative humidity in indoor environments*
- NIOSH – Sampling and characterisation of bioaerosols