IAQ ASSESSMENT REPORT AT

[redacted]

[redacted]

11 April 2022
GAIR TECHNOLOGIES PTE LTD
BLk 80 Genting Lane #09-04, Singapore 349565

INTRODUCTION AND OBJECTIVES

[redacted]

Spot measurement was employed in this testing. This Indoor Air Quality Assessment was carried out without causing any inconvenience to the occupants.

The objective of this measurement is to measure the IAQ in the premise and evaluate the condition of the air quality in the designated sampling locations. This report summarizes our observations and findings. It should be noted that this study is based upon the limited information gathered during the execution of this project and it reflects our findings at the time and place inspected.

Parameters include temperature, air velocity, relative humidity, carbon dioxide, carbon monoxide, formaldehyde, total volatile organic compounds, respirable suspended particles, PM2.5 and total viable bacteria count. The test and audit are based on Singapore Standards 554:2016+A1:2021 Code of Practice for indoor air quality for air-conditioned buildings. The methods are complying on ISO/IEC 17025: 2017 and SAC-SINGLAS technical guides.

MATERIALS AND METHODS

Parameter	Acceptable Limit SS 554:2016 + A1:2021	Unit	Equipment details	Methods
1. Thermal Comfort Parameters				
Air (Ambient) Temperature	23 - 25	°C	PPM Touchscreen Unit	In-house Method NL-E-002-2014
Relative Humidity	<70[a] <65[b]	%		
Air Velocity (or Air Movement)	<0.30	m/s	E+E EE576-V2B1 Air Flow Meter	
2. Physical Parameters				
Respirable Suspended Particles (particles sampled with median cut-point of 4µm)**	50	µg/m^3	TSI DustTrak II 8532	In-house Method NL-E-003-2014
PM2.5**	37.5		Aeroqual PM10/PM2.5	
3. Chemical Parameters				
Carbon dioxide*	700 above outdoor	ppm	PPM Touchscreen Unit	In-house Method NL-E-003-2014
Carbon monoxide*	9			

Formaldehyde***	0.08		Formaldemeter HTV-m	
Total Volatile Organic Compounds (TVOC)*	1000	ppb	PPM Touchscreen Unit	
4. Microbiological Parameters				
Total viable Bacteria Count	1000	CFU/m^3	SAS SUPER ISO 180	In-house Method NL-E-004-2014

[a] For other buildings under peak and common part load conditions
[b] For buildings designed to SS553/ SS554 standard
* Denotes acceptable limit based on 8 hours exposure.
**Denotes acceptable limit based on 24 hours exposure.
***Denotes acceptable limit based on 30min exposure.

RESULTS

The results can be found in: Test Report Ref: [redacted] (Appendix I)

EVALUATION AND DISCUSSION

Temperature and Air Velocity

The temperature in 4 location exceeded the guideline of 23ºC to 25ºC.

The air velocity in all locations were within the recommended guideline of <0.30m/s.

Thermal comfort is often subjected to individual's preference. Different people prefer to stay in environment of different temperatures, depending on the physiological and external factors that they are exposed to. Opinions can be gathered from the staff on the comfort level. Some adjustment to the temperature can be done if the occupant prefers to work in a colder environment.

Air velocity may not have a direct influence over an occupant's perception on indoor environment as compared to temperature and humidity; it is synergistically related to thermal comfort and the overall performance of the ventilation system. For thermal comfort, higher air velocity can be maintain for higher room temperature and lower air velocity for lower room temperature.

As long as the occupants feel comfortable, no adjustment is needed.

Relative Humidity

The humidity level in 1 location exceeded the recommended guideline of <70%.

High humidity level often encourages the growth of microorganisms and aids in the release of formaldehyde into the atmosphere from materials containing formaldehyde.

Carbon Dioxide and Carbon Monoxide

The outdoor carbon dioxide level was 465ppm, therefore the indoor carbon dioxide guideline was 1165ppm (465+ 700ppm). The carbon dioxide level in 4 location exceeded the recommended guideline of < 1165 ppm.
The carbon monoxide level in all locations were within the guideline of 9ppm.

Carbon dioxide is a normal constituent of exhaled breath and humans are the main indoor source of carbon dioxide. Carbon dioxide level is commonly measured as a screening tool to evaluate whether adequate volumes of fresh outdoor air are being introduced into indoor environment. High human traffic or insufficient fresh air supply are the usual sources of carbon dioxide. For remedial actions, increase the fresh air supply by purging, increase ventilation and/ or recalculate the fresh air-exchange rate in the area.

Formaldehyde and Total Volatile Organic Compounds

The formaldehyde concentration in all locations were within the guideline of 0.08ppm.
The total volatile organic compounds (TVOCs) level in all locations were within the guideline of 1000ppb.

Formaldehyde is commonly found in adhesives used in furniture, carpets, etc. Exposure to formaldehyde and VOCs may cause headaches, fatigue and/ or irritation to the eyes, nose and throat to some people.

Respirable Suspended Particles and PM2.5

The respirable suspended particles in 4 locations were exceeded the guideline of 50μg/m^3.
The PM2.5 in all locations were within the guideline of 37.5μg/m^3.

High level of particulates can cause allergic reactions, such as dry eyes, contact lens problems, nose, throat, and skin irritation, coughing, sneezing, and respiratory difficulties.

Total Viable Bacteria Count*

The total viable bacteria count in all locations were within the guideline of 1000CFU/m^3.

Human occupants themselves are normal reservoirs of bacteria, increase human activities or volume would usually give rise to higher bacteria levels. Continue with the good housekeeping practices, cleaning and or maintaining good hygiene practices will generally keep the bacteria level low. Sufficient air-exchange rate will also remove pollutants and microorganisms in the area. Encouraging occupants to consume food in the appropriate areas would generally decrease the likelihoods of bacteria growth.

*Microorganisms are ubiquitous in indoor environment and do not necessarily constitute a health hazard. The concentration at which contamination becomes a threat to health is unknown and may vary greatly with each individual. Culture-based methods are suitable detection of culturable infection agents and allow species identification. Total viable bacterial count is a measure of the sanitary conditions of the premises and may not correlate with the presence of any specific pathogen.

RECOMMENDATION:

In general, at most of the locations tested, the IAQ parameters were within the guidelines. However, for certain locations, respirable suspended particles and carbon dioxide (CO_2) were exceeded the respective guidelines.

For the respirable suspended particles, please be noted the outdoor reading (59 ug/m3) was exceeded the guideline (50 ug/m3). The readings of these certain locations were at the same level (between 50 – 75 ug/m3). Therefore, the higher reading of the respirable suspended particles in these locations were probably due to the outdoor. One should monitor the situation closely, no remedial action is need at this stage.

In 4 locations, the CO_2 levels were exceeded the guideline (1165 ppm). The 4 locations are L1 P5 Peace (103) , L1 P6 Joy (104) , L2 Room (203) P1 Justice /fortitude , and L2 Room (201) P1 Hope / Pipty. All these 4 locations were classrooms, some activities were carrying on during the testing. High human traffic or insufficient fresh air supply are the usual sources of carbon dioxide. For remedial actions, one could consider to increase the fresh air supply by purging, increase ventilation in the area.

John Luo Jizhong
Director of Gair Technologies Pte Ltd

Appendix 1: IAQ test results (NLJ22/04002)

NUEVO LABORATORY

TEST RESULTS

Accredited Laboratory SAC - SINGLAS LA-2014-0583-F

Job Reference : [redacted]
Building / Area :

Sample Number	Site ID	Location	Parameters									
			Air Temperature (degC)	Relative Humidity (%)	Air Velocity (m/s)	Carbon dioxide (ppm)	Carbon monoxide (ppm)	Formaldehyde (ppm)	Total Volatile Organic Compounds (ppb)	Respirable Suspended Particles (µg/m3)	PM 2.5 (µg/m3)	Total Viable Bacteria Count (CFU/m3)
SS554 : 2016 Guideline			23 - 25	**<70% or <65%	<0.30	*700 above outdoor	9	0.08	1000	50	37.5	1000
Sampling Date :	4.4.22											
2201326	BK1	L1 Outdoor	29.0	65.3	0.16	465	1.3	0.04	153	59	13	-
2201327	BK2	L1 General office	24.9	60.1	0.20	758	1.3	0.06	192	**64**	14	260
2201328	BK3	L1 P5 Peace (103)	25.0	61.5	0.05	**1222**	1.2	0.07	428	31	7	230
2201329	BK4	L1 P6 Joy (104)	25.9	66.5	0.20	**1293**	1.4	0.08	301	38	9	140
2201330	BK5	L3 Learning Space	24.3	58.1	0.06	472	1.5	0.01	111	**54**	14	130
2201331	BK6	L3 Band Room	26.1	68.8	0.15	522	1.2	0.02	113	43	10	420
2201332	BK7	L3 Room 302	24.6	62.1	0.20	799	1.5	0.04	144	47	11	660
2201333	BK8	L3 Room 304	24.2	54.7	0.06	625	1.2	0.08	138	32	7	180
2201334	BK9	L2 Staff Room	25.0	68.9	0.21	617	1.3	0.04	148	47	10	320
2201335	BK10	L2 Room 203 P1 Justice /fortitude	25.1	**71.2**	0.11	**1177**	1.3	0.04	283	**55**	13	310
2201336	Bk11	L2 Room 201 P1 Hope / Pipty	25.5	67.1	0.04	**1210**	1.3	0.04	220	**73**	17	770

Luo Jizhong
Director

*The indoor carbon dioxide guideline is 1165ppm (465+700ppm).
**RH Guideline: <70% for existing building, <65% for buildings built to SS553/SS554 standard.

Appendix II: ES programme for Indoor Air Quality (IAQ) test & audit

Indoor Air Quality (IAQ)

Premises Managers are required to hire an accredited laboratory to carry out IAQ audit* of air-conditioned rooms within the premises every 3 yearly. If any renovations were are carried out, there is a need to put in the requirement for contractors to utilise low formaldehyde emitting materials. The premises manager is required to engage an accredited laboratory to conduct post renovation IAQ audit for formaldehyde and Total Volatile Compounds (TVOC) parameters prior to occupation. In case of non-compliance, the premises manager should follow up to identify the cause of poor IAQ and rectify the situation accordingly, e.g. remove/substitute source of contaminant, increase ventilation, use air cleaning equipment to remove pollutants etc.

Please see below for a sample of IAQ records to be kept.

**Audit based on Singapore Standards 554:2016+A1:2021 Code of Practice for indoor air quality for air-conditioned buildings for recommended chemical, particulate matter and microbiological parameters.*

Routine IAQ Audit (for air-conditioned spaces)

An IAQ audit to be conducted once every 3 years minimally.

Please file the IAQ audit reports, remedial measures taken (if any) for audit purposes.

Name of accredited laboratory / 3rd party auditor*:* ***GAIR TECHNOLOGIES PTE LTD****.*

Frequency of routine IAQ audit	*Routine IAQ audit once every 3 years for entire premises*
Date of IAQ audit:	*4 April 2022*
Date of last IAQ audit	-

Summary of IAQ audit findings

Areas	**Findings**	**Remedial measures taken**
L1 P5 Peace (103)	*CO_2 exceeded the guideline*	Increase the fresh air supply by purging, increase ventilation in the area.

, L1 P6 Joy (104) ,	*CO_2 exceeded the guideline SS554:2016+A1:2021 limits*	Increase the fresh air supply by purging, increase ventilation in the area.
L2 Room 203 P1 Justice /fortitude ,.	*CO_2 exceeded the guideline*	Increase the fresh air supply by purging, increase ventilation in the area
L2 Room 201 P1 Hope / Pipty	*CO_2 exceeded the guideline*	Increase the fresh air supply by purging, increase ventilation in the area
Renovation Works (if major renovation work is carried out)		
Major renovation work should be undertaken in a way that minimises contamination to indoor environment. ***An IAQ audit to be conducted prior to occupation.*** *Please file the contract/procurement records, IAQ audit reports, remedial measures taken (if any) for audit purposes*		
Pre-renovation		
I declare the following:		
(√) "Low Volatile Organic Compounds (VOC), low formaldehyde emitting building materials" were used for major renovation works (such as adhesives, paints, wall and ceiling finishes, floorings and carpentry works).		
(√) Measures were taken to isolate areas under renovation from any occupied zones.		
Duration of renovation	*No major renovation has been conducted*	
Post-renovation IAQ Audit (for air-conditioned spaces)		
Name of accredited laboratory / 3rd party auditor*: 123 Good IAQ Pte. Ltd.*		
Date of IAQ audit	*e.g. 15 February 2023*	
Summary of IAQ audit findings		

Areas	Findings	Remedial measures taken
e.g. main foyer	*Formaldehyde levels exceeded SS554:2016+A1:2021 limit*	*Items that emit formaldehyde were removed.* *To follow up with another round of IAQ test on 22 February 2023.*
(√) The IAQ assessment report has been properly documented.		
Endorsed by: _____ Date: Name and signature of Environmental Control Coordinator _____ Date: Name and signature of Premises Manager		