AIR QUALITY ASSESSMENT

FOR TAYLOR STANLEY MARKETING PTE LTD

71, TANNERY LANE

#-7-07, CITY INDUSTRIAL BUILDING

SINGAPORE 347807

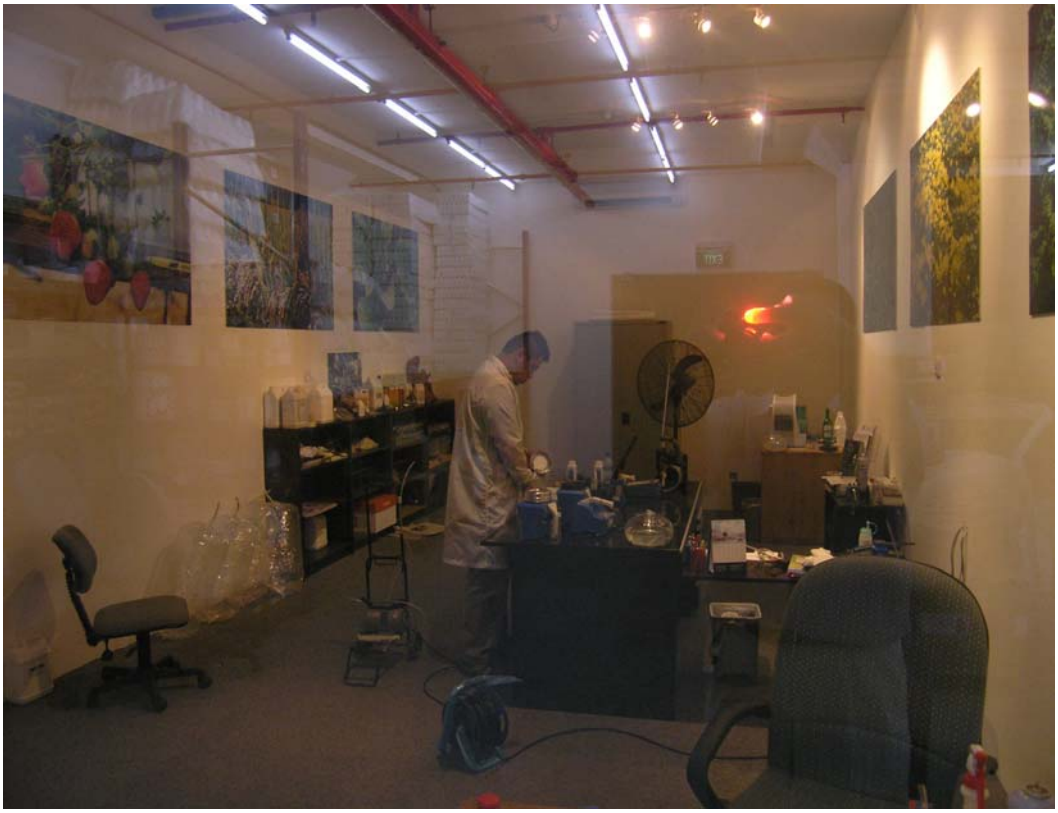
Date of Survey : 03 August 2005
Reported Date : 26 August 2005
Reference No. : ATS/IH/84/05KKL

Ko Kheng Leng
Environmental Engineer

Yao Kai Wen
General Manager

KITZ AIR REVITALISOR

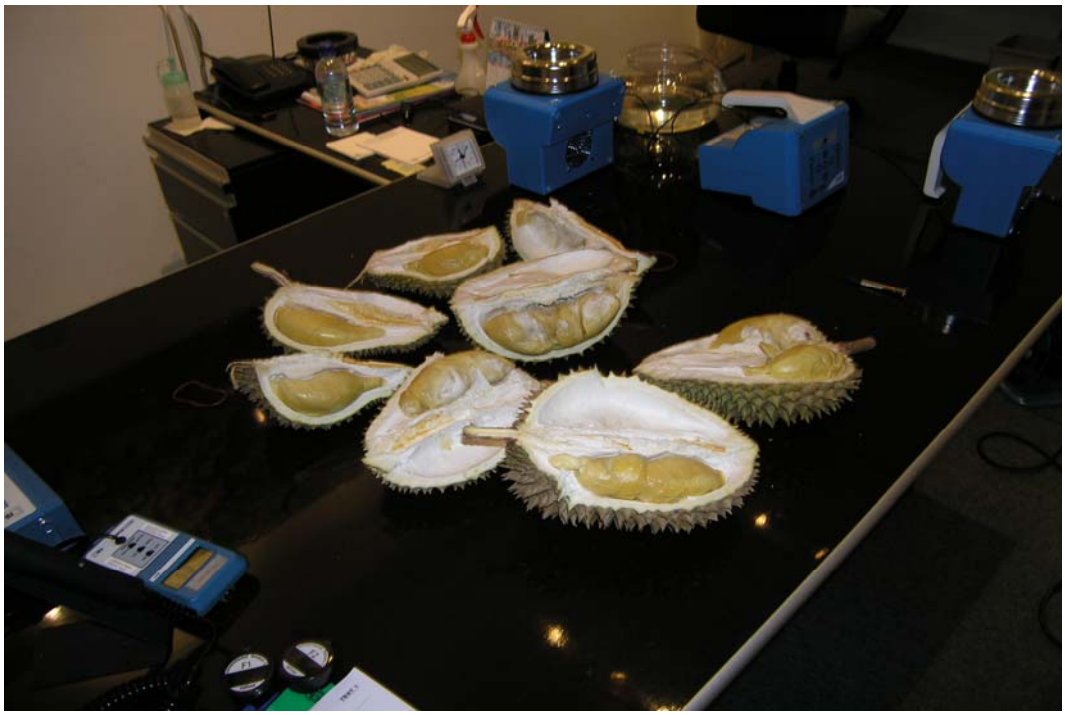
Test Location: Taylor Stanley's Conference Room measuring approx. 7.5m (length) x 4.26m (width) x 3.57m (height) whilst the room volume is approximately 119 m^3



Air Sampling Equipment for Formaldehyde

Burning of “Marlboro” cigarettes was to introduce Carbon Dioxide, Carbon Monoxide, Dust and Nicotine.

Grade “D-24” Durian Fruit was introduce Nuisance Odour.



Odour sample was collected by using 40L capacity Nalophan bags with air sampling pump.

Air Sampling for Total Bacterial & Fungal Counts

Air Sampling Equipment

1.0 SUBJECT

Air Quality Assessment for Kitz Air Revitalisor was conducted by ALS Technichem (S) Pte Ltd's Environmental Engineers on 03 August 2005 for Taylor Stanley Marketing Pte Ltd located at No. 71, Tannery Lane, #07-07, City Industrial Building, Singapore 347807.

2.0 OBJECTIVE

The purpose of this study was to evaluate and assess the efficiency of the product namely **Kitz** Air Revitalising System filled with Kitz Revitalising Concentrate, Kitz ARS – Lavender.

The working principle of the product, **Kitz** Air Revitalising System is by means of "scrubbing effect" which allows the botanical extracts in the solution to neutralise odour, bacteria, fungi and other air contaminants.

3.0 METHODOLOGY

3.1 Test Location

The assessment for all the air contaminants throughout the entire course of this study was carried out at Taylor Stanley's conference room size of approx. 7.5m (length) x 4.26m (width) x 3.57m (height) whilst the room volume is approximately 119 m^3. A total of 2 sets of Test were carried out during this assessment, consisting of with and without the Kitz Air Revitalisor.

3.2 Test Methodology

a) ***Temperature and Relative Humidity***

Temperature and Relative Humidity were measured using a portable TSI Q-TRAK IAQ Monitor fitted with the respective RTD and Capacitive sensors for 1-minute interval over the desired sampling duration.

b) ***Carbon Dioxide (CO_2) and Carbon Monoxide (CO)***

Carbon Dioxide and Carbon Monoxide were measured using a portable TSI Q-TRAK IAQ Monitor fitted with the respective non-dispersive infra-red sensors for 1-minute interval over the desired sampling duration.

c) ***Total Volatile Organic Compounds (TVOC)***

Total Volatile Organic Compounds was measured using a portable IAQRAE Gas Detector fitted with Photoionization Detector (PID) for 1-minute interval over the desired sampling duration.

d) ***Total Bacterial Count (TBC) and Total Fungal Count (TFC)***

A portable microbiological air sampler SAS Super 100 was used to collect indoor air particulates for microbial activity. Plate Count Agar for Total Bacterial Count was used as a sample medium for 2-minutes sampling period and was then incubated for 48 hours at 37^{o}C prior to microbial counts. Rose Bengal Agar was used for Total Fungal Count and was then incubated for 5 days at 25^{o}C prior to fungi counts.

e) ***Formaldehyde (HCHO)***

Formaldehyde was measured using a portable Environmental Sensor's Formaldehyde Meter for 1-minute interval over the desired sampling duration.

f) ***Respirable Suspended Particulates (RSP)***

Respirable Suspended Particulates was measured using a portable TSI DUST-TRAK Particle Monitor for 1-minute interval over the desired sampling duration.

g) ***Nicotine***

Nicotine was collected with reference to NIOSH 2544 using XAD-2 sorbent tube as a collection medium by drawing air through a calibrated air sampling pump with a flow rate of 1.0 l/min over the desired sampling duration. The sample was then analysed with Gas Chromatography – Mass Spectrometry (GC-MS).

h) ***Nuisance Odour***

Odour sample was collected by using air sampling pump with 40L capacity Nalophan bags with. The Odour analysis performs by Dynamic Olfactometer which conforms to European Standard for Olfactometry (EN 13725:2003). Results are expressed in Standard Odour Units per cubic metre, SOU/m^{3}.

i) ***Ozone***

Ozone was measured using a portable Environmental Sensor's Ozone Meter for 1-minute interval during the sampling regime.

j) ***Air Movement***

Air movement was measured using a portable TSI VelociCheck Air Velocity meter for 1-minute interval during the sampling regime.

4.0 TEST RESULTS

All the respective test results obtained are tabulated below and reflect our findings on 03 August 2005.

Please refer to Pages 3 to 32 of this report.

Test Results

4.1 Background Condition

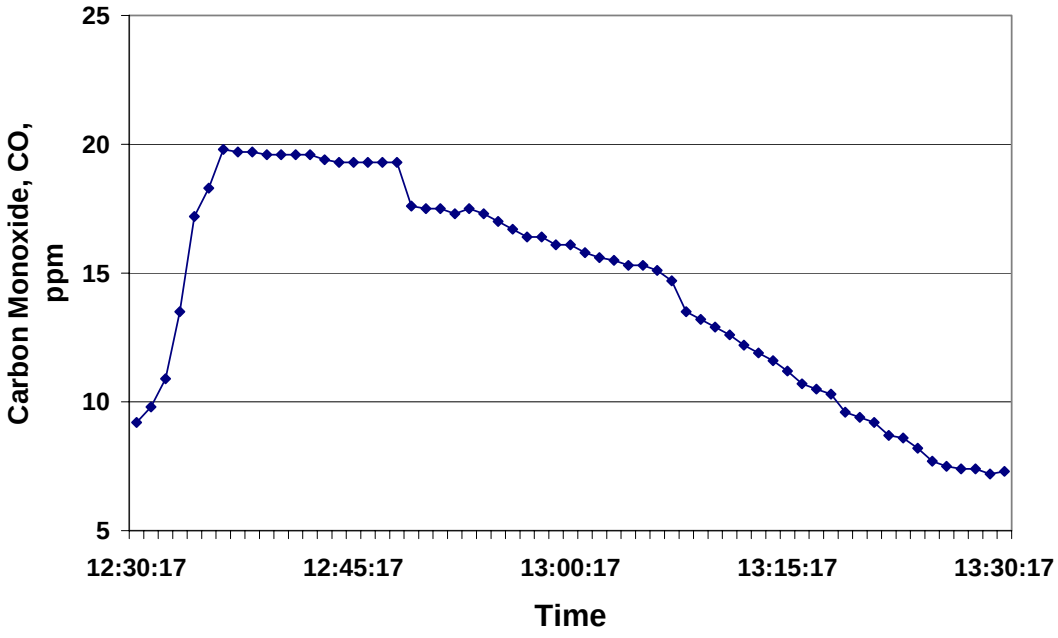
Time (mins)	CO (ppm)	CO2 (ppm)	RH (%)	Temp (^{O}C)	TVOCs (ppm)	RSP (mg/m^3)	Ozone (ppm)	Formaldehyde (ppm)	Bacteria (CFU/m^3)	Fungi (CFU/m^3)	Air Movement (m/s)	Nicotine mg/m^3	Nuisance Odour s.o.u./m^3
1100-1130	<1	1360	43	23.2	7.10	**0.15**	<1	0.44	230	105	0.18	ND(<0.1)	362
Singapore's IAQ Guidelines	**9**	**1000**	**≤ 70**	**22.5-25.5**	**3**	**0.15**	**0.05**	**0.10**	**500**	**500**	**≤ 0.25**	**NA**	**NA**
ASHARE's IAQ Guidelines	**9**	**1000**	**40-60**	**22-24**	**4**	**0.15**	**0.12**	**0.10**	**500**	**500**	**NA**	**NA**	**NA**

4.2 Carbon Monoxide (CO) without Kitz Air Revitalisor

Cumulative Time (mins)	CO (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	9.2	25	9 (8-hr) 35 (1-hr)
15	19.3		
30	16.1		
45	11.2		
60	6.9		

Remarks: ***Carbon Monoxide (CO) was introduced into the indoor environment by burning of Marlboro cigarettes.***

Graph of Carbon Monoxide Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)

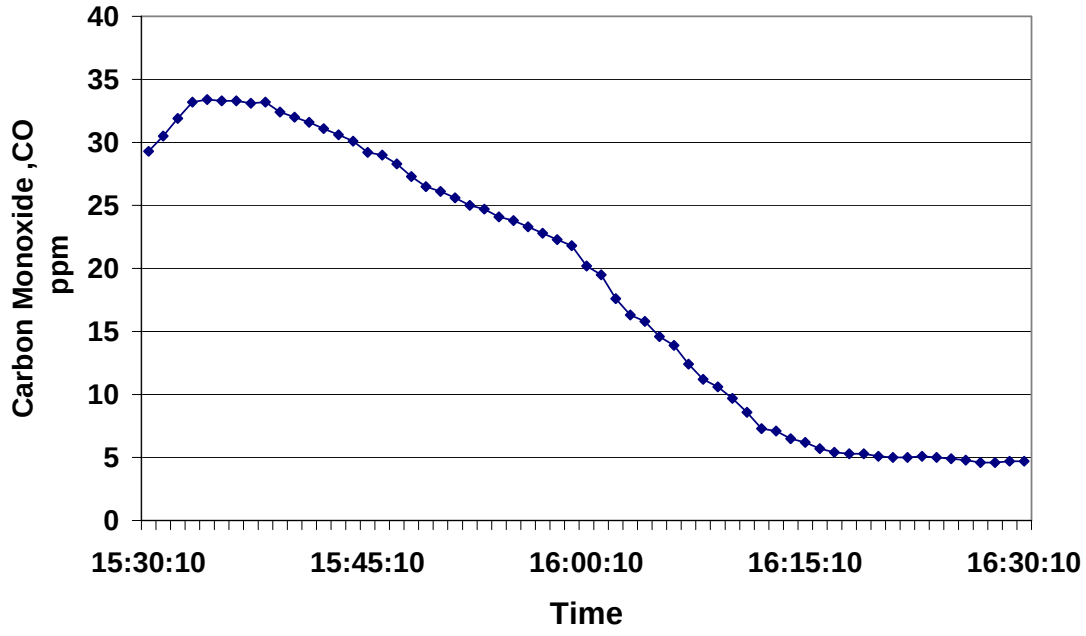


4.3 Carbon Monoxide (CO) with Kitz Air Revitalisor

Cumulative Time (mins)	CO (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	29.3	**25**	**9 (8-hr)** **35 (1-hr)**
15	29.2		
30	20.2		
45	6.2		
60	4.7		

Remarks: ***Carbon Monoxide (CO) was introduced into the indoor environment by burning of Marlboro cigarettes.***

Graph of Carbon Monoxide Concentration Versus Cumulative Time (With Kitz Air Revitalisor)

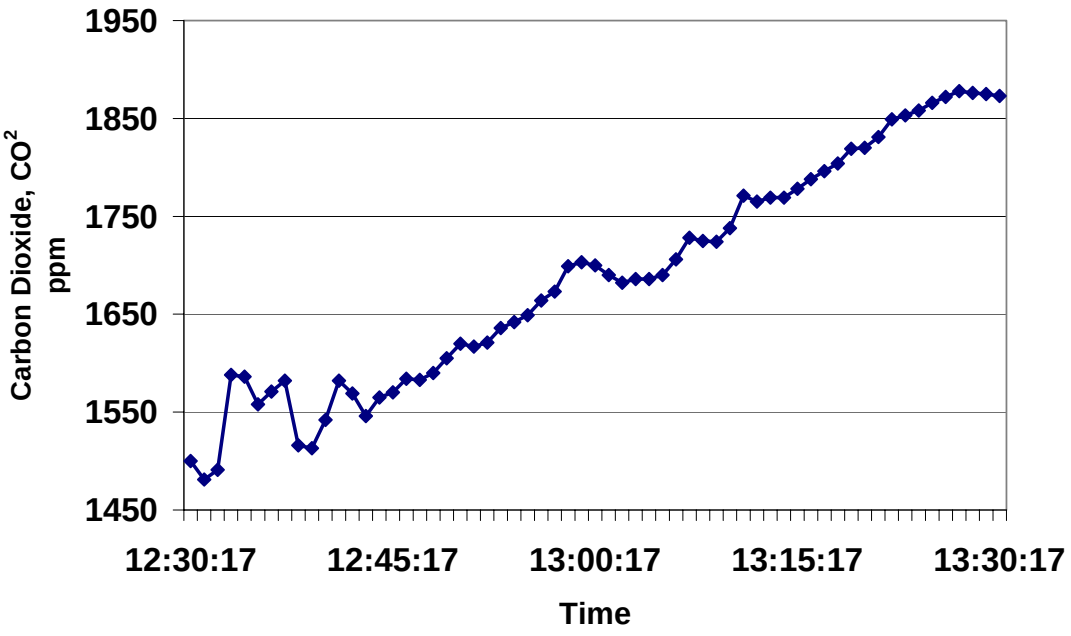


4.4 Carbon Dioxide without Kitz Air Revitalisor

Cumulative Time (mins)	CO_2 (ppm)	SIAQG (ppm)
0	1500	**1000**
15	1570	
30	1700	
45	1788	
60	1873	

Remarks: ***Carbon Monoxide (CO) was introduced into the indoor environment by burning of Marlboro cigarettes.***

Graph of Carbon Dioxide Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)

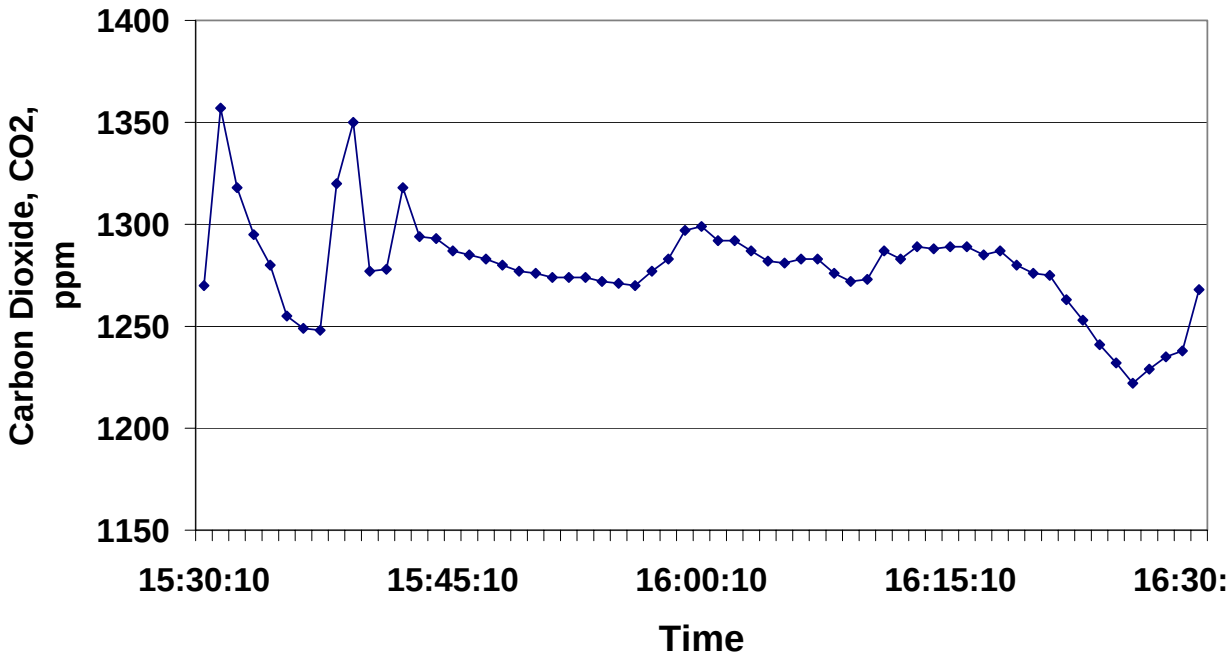


4.5 Carbon Dioxide with Kitz Air Revitalisor

Cumulative Time (mins)	CO_2 (ppm)	SIAQG (ppm)
0	1270	**1000**
15	1287	
30	1299	
45	1289	
60	1268	

Remarks: ***Carbon Monoxide (CO) was introduced into the indoor environment by burning of Marlboro cigarettes.***

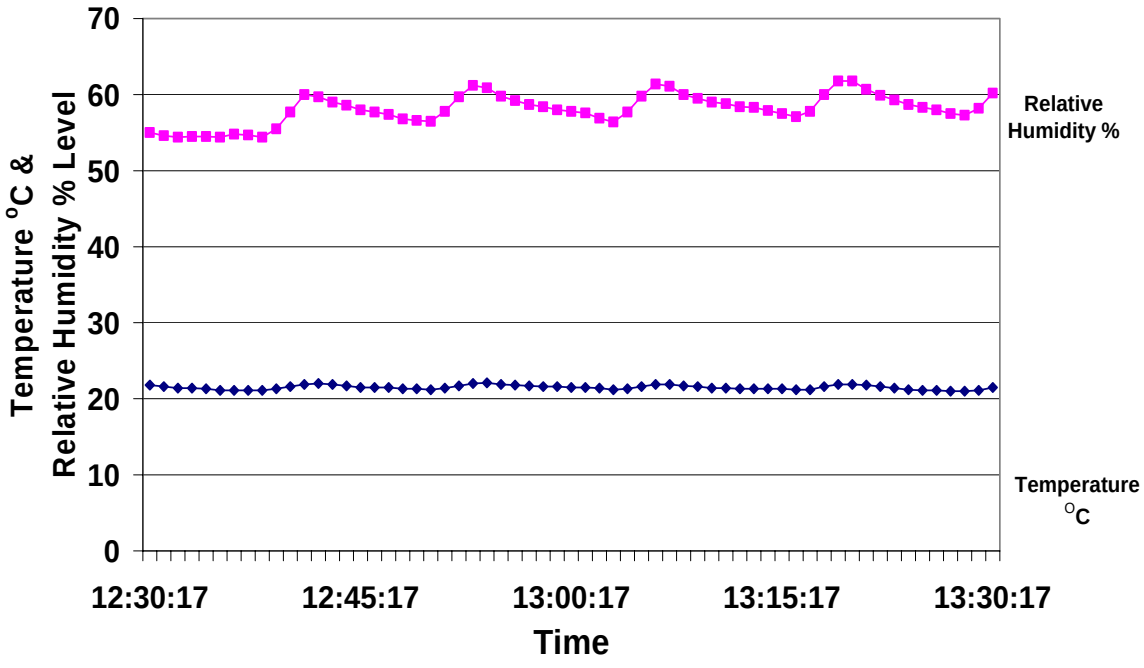
Graph of Carbon Dioxide Concentration Versus Cumulative Time (With Kitz Air Revitalisor)



4.6 Temperature and Relative Humidity Level without Kitz Air Revitalisor

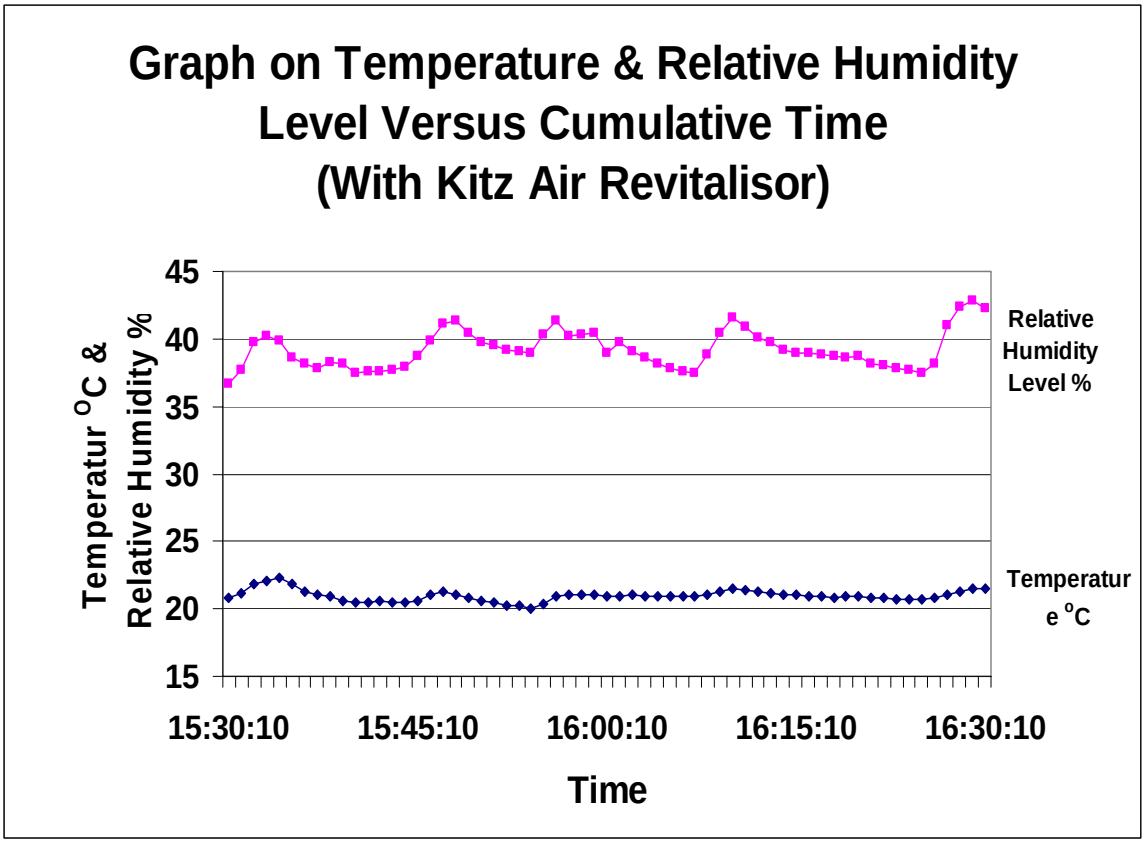
Cumulative Time (mins)	Temperature (°C)	SIAQG / ASHRAE (°C)	Relative Humidity (%)	SIAQG / ASHRAE (%)
0	21.8	22.5 - 25.5 / 22 - 24	33.2	≤ 70 / 40 - 60
15	21.5		36.5	
30	21.5		36.3	
45	21.3		36.2	
60	21.5		38.7	

Graph of Temperature and Relative Humidity Level Versus Cumulative Time (Without Kitz Air Revitalisor)



4.7 Temperature and Relative Humidity Level with Kitz Air Revitalisor

Cumulative Time (mins)	Temperature (°C)	SIAQG / ASHRAE (°C)	Relative Humidity (%)	SIAQG / ASHRAE (%)
0	20.8	**22.5 - 25.5 / 22 - 24**	36.7	**≤ 70 / 40 - 60**
15	20.6		38.7	
30	20.9		40.4	
45	21.0		38.9	
60	21.5		42.3	

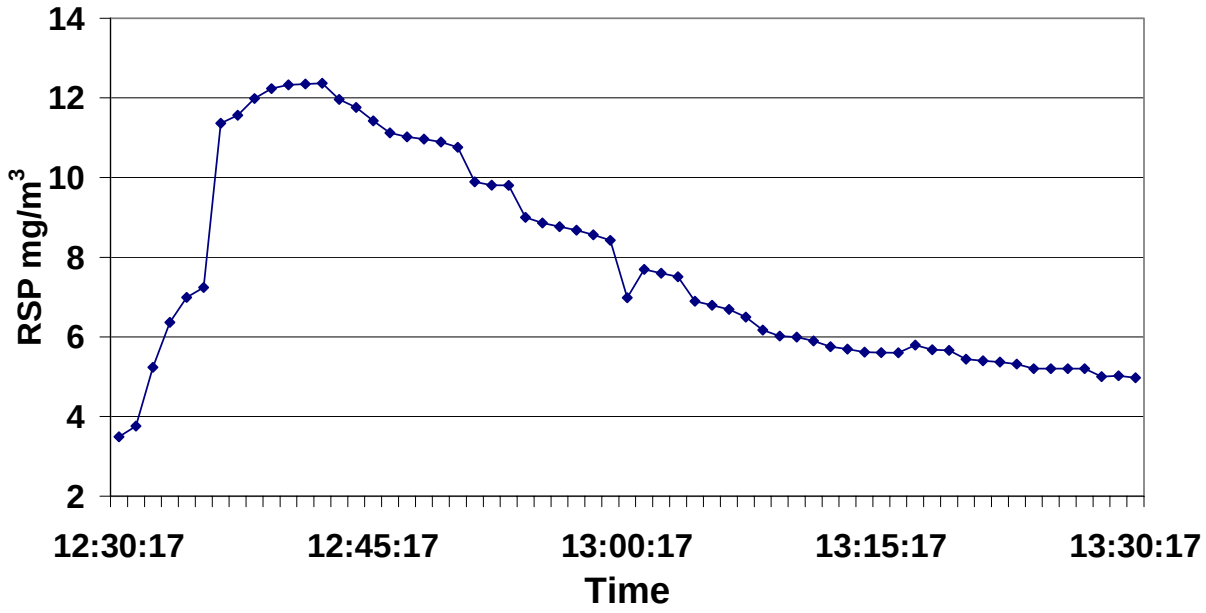


4.8 Respirable Suspended Particulates (RSP) without Kitz Air Revitalisor

Cumulative Time (mins)	RSP (mg/m^3)	MOM (PELTS) (mg/m^3)	SIAQG (mg/m^3)
0	3.49	**10 (Nuisance Particulates)**	**0.15 (for reference purpose only)**
15	11.87		
30	7.87		
45	5.60		
60	4.98		

Remarks: ***Respirable Suspended Particulates (RSP) was introduced into the indoor environment with burning of Marlboro cigarettes.***

Graph of Respirable Suspended Particulates (RSP) Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)

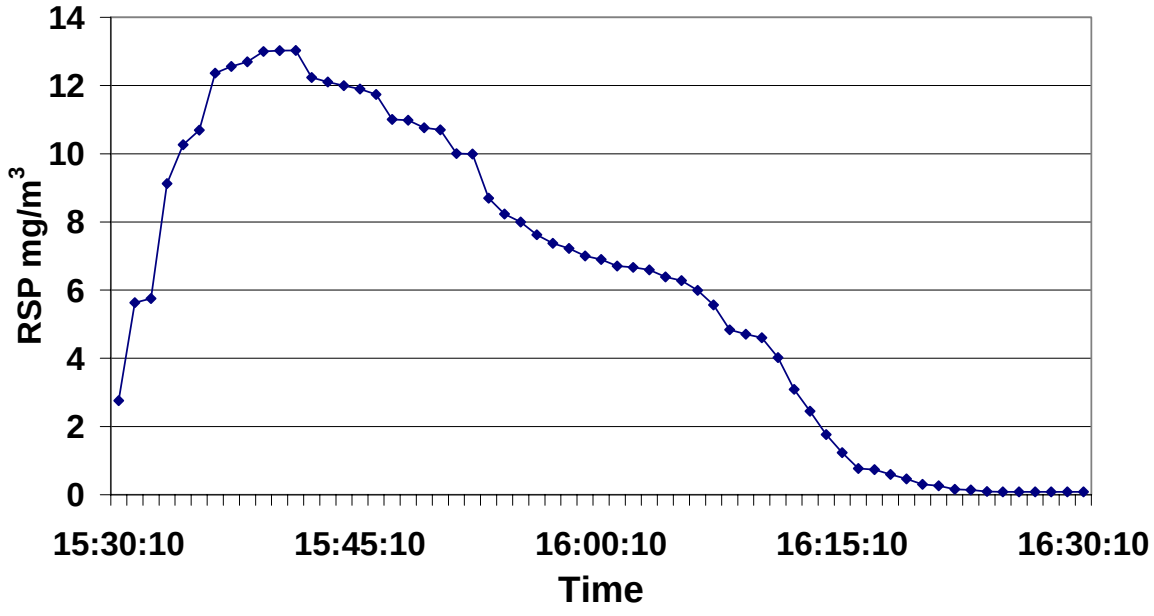


4.9 Respirable Suspended Particulates (RSP) with Kitz Air Revitalisor

Cumulative Time (mins)	RSP (mg/m^3)	MOM (PELTS) (mg/m^3)	SIAQG (mg/m^3)
0	2.76	**10 (Nuisance Particulates)**	**0.15 (for reference purpose only)**
15	11.88		
30	6.90		
45	1.24		
60	0.09		

Remarks: ***Respirable Suspended Particulates (RSP) was introduced into the indoor environment with burning of Malboro cigarettes.***

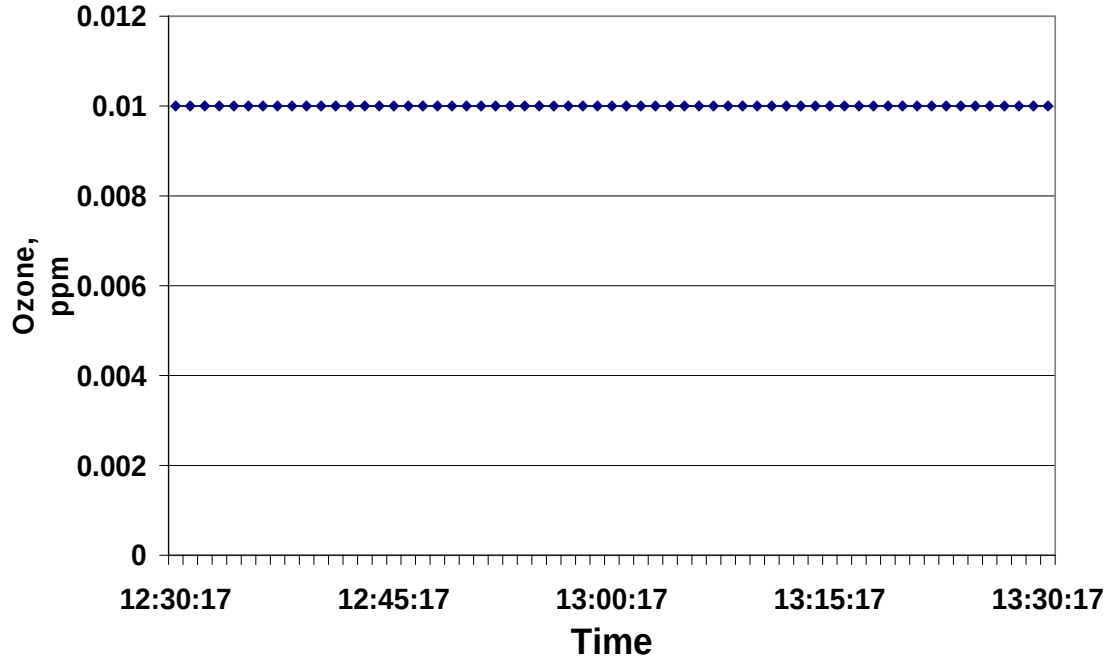
Graph of Respirable Suspended Particulates (RSP) Concentration Versus Cumulative Time (With Kitz Air Revitalisor)



4.10 Ozone Concentration without Kitz Air Revitalisor

Cumulative Time (mins)	RSP (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	0.01	**0.1 (STEL)**	**0.01 (for reference purpose only)**
15	0.01		
30	0.01		
45	0.01		
60	0.01		

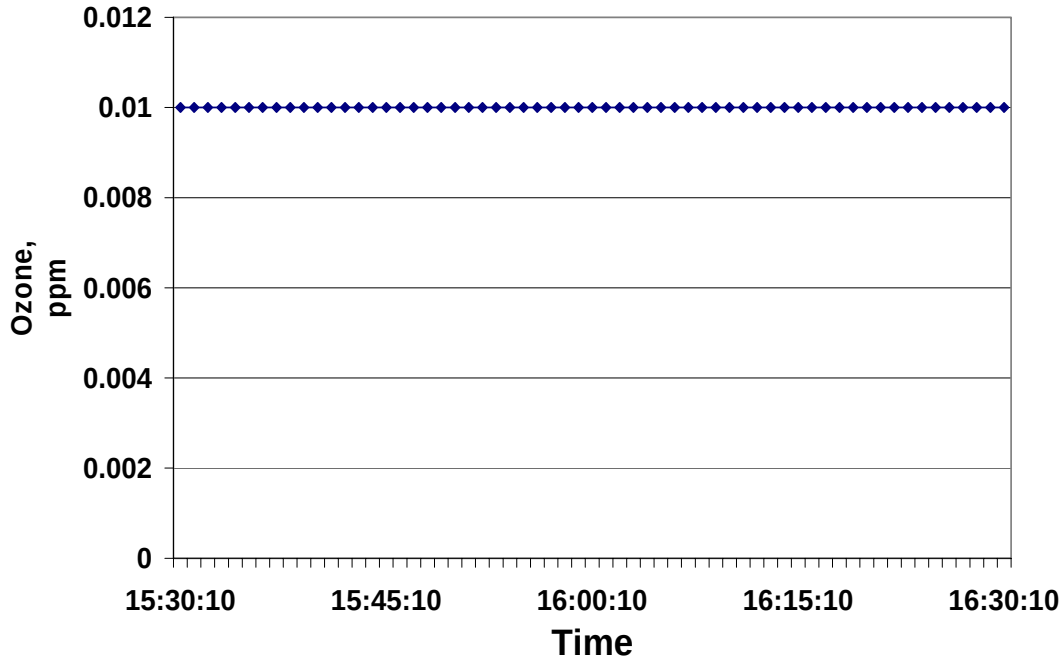
Graph of Ozone Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)



4.11 Ozone Concentration with Kitz Air Revitalisor

Cumulative Time (mins)	Ozone (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	0.01	**0.1 (STEL)**	**0.01 (for reference purpose only)**
15	0.01		
30	0.01		
45	0.01		
60	0.01		

Graph of Ozone Concentration Versus Cumulative Time (With Kitz Air Revitalisor)

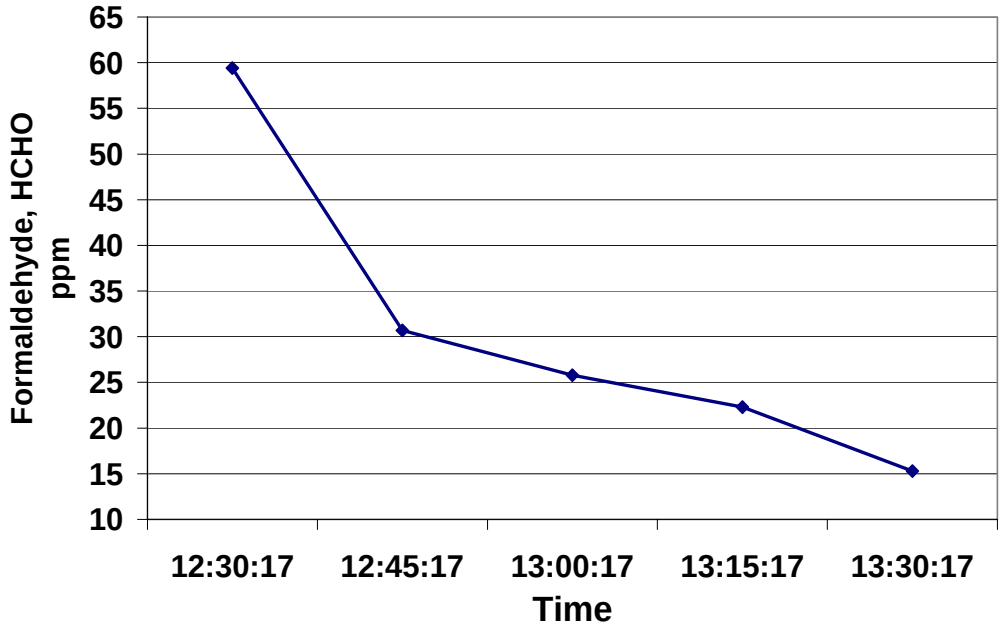


4.12 Formaldehyde (HCHO) without Kitz Air Revitalisor

Cumulative Time (mins)	HCHO (ppm)	MOM (PELTS) (ppm)
0	59.7	**0.3 (STEL)**
15	30.7	
30	25.8	
45	22.3	
60	15.3	

Remarks: ***Formaldehyde (HCHO) was introduced into the indoor environment with evaporation of formaldehyde solution.***

Graph of Formaldehyde Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)

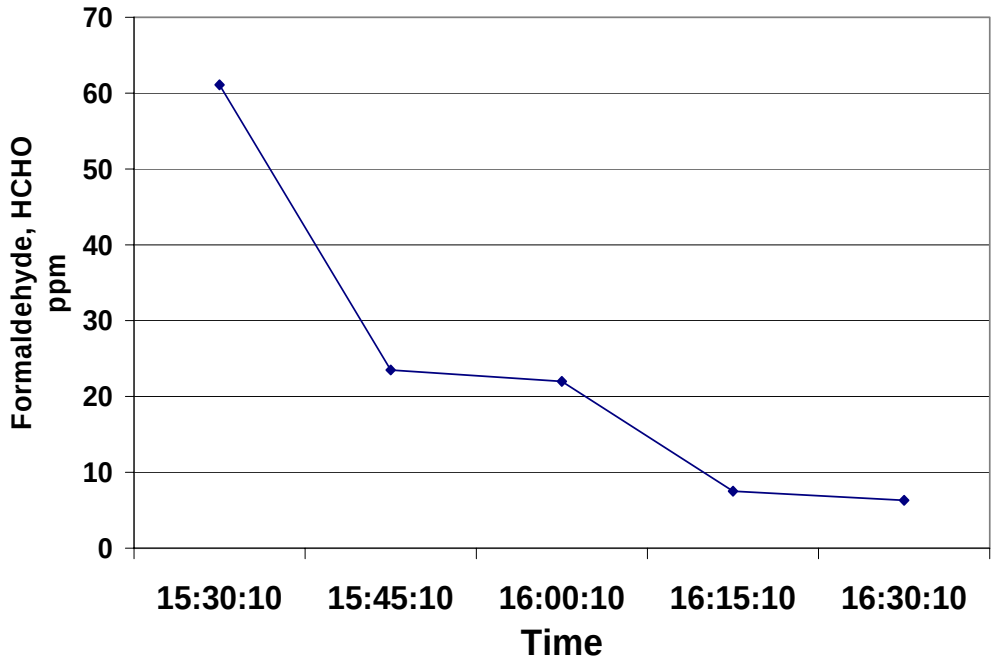


4.13 Formaldehyde (HCHO) With Kitz Air Revitalisor

Cumulative Time (mins)	HCHO (ppm)	MOM (PELTS) (ppm)
0	61.1	**0.3 (STEL)**
15	23.5	
30	22.0	
45	7.5	
60	6.3	

Remarks: ***Formaldehyde (HCHO) was introduced into the indoor environment with evaporation of formaldehyde solution.***

Graph on Formaldehyde Concentration Versus Cumulative Time (With Kitz Air Revitalisor)

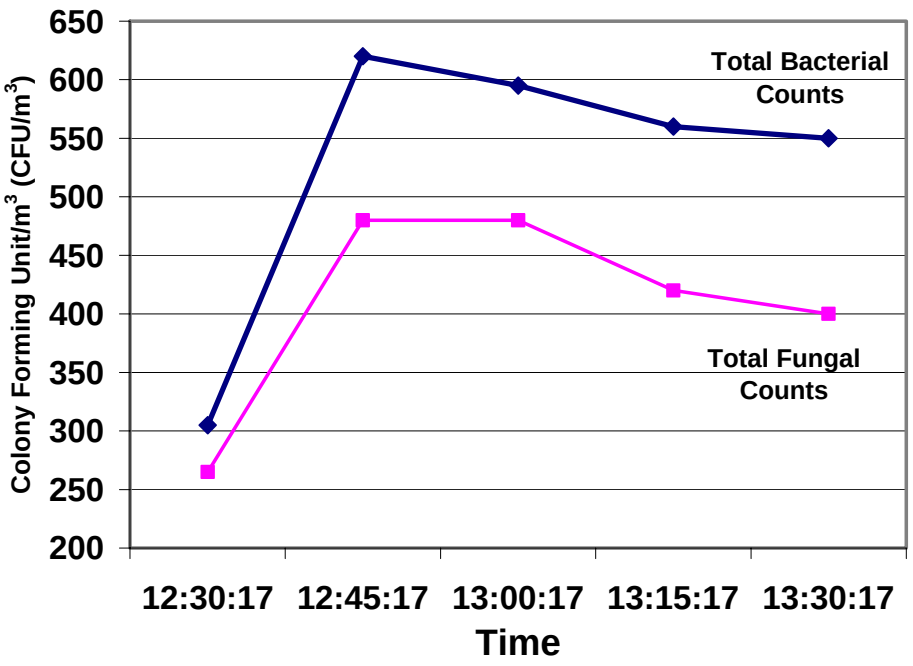


4.14 Total Bacterial Count (TBC) and Total Fungal Count (TFC) without Kitz Air Revitalisor

Cumulative Time (mins)	TBC (CFU/m³)	TFC (CFU/m³)	SIAQG (CFU/m³)
0	305	265	TBC: 500 TFC: 500
15	620	480	
30	595	480	
45	560	420	
60	550	400	

Remarks: ***Both Bacteria and Fungi were introduced into the indoor environment with common airborne bacteria and fungi cultures media.***

Graph on Total Bacterial & Fungal Counts Versus Cumulative Time (Without Kitz Air Revitalisor)

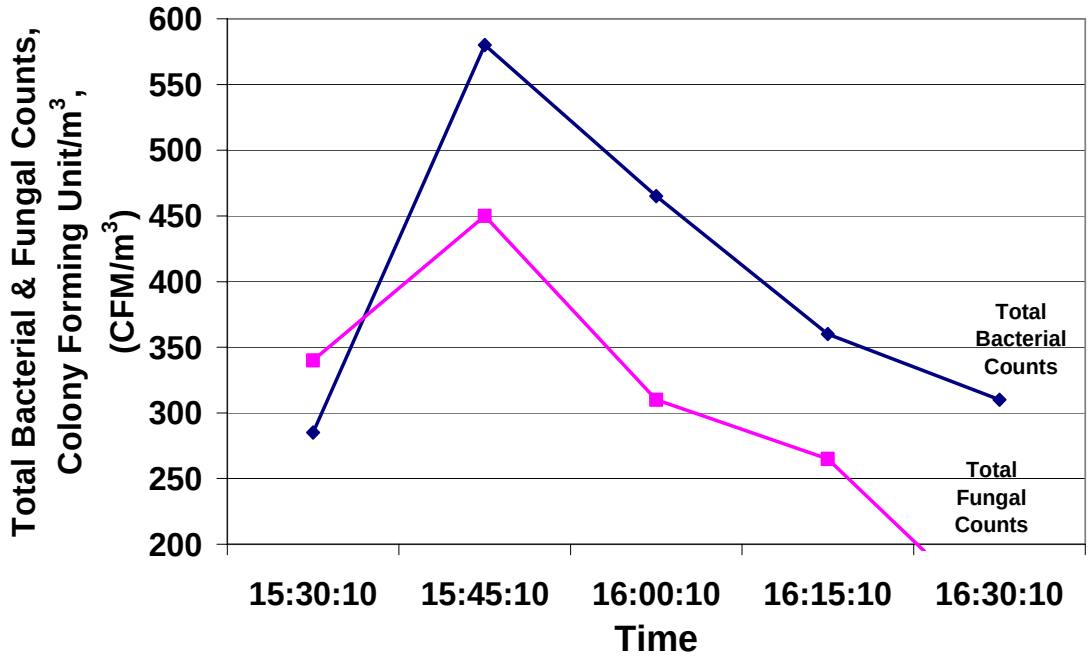


4.15 Total Bacterial Count (TBC) and Total Fungal Count (TFC) with Kitz Air Revitalisor

Cumulative Time (mins)	TBC (CFU/m³)	TFC (CFU/m³)	SIAQG (CFU/m³)
0	285	340	**TBC: 500 TFC: 500**
15	580	450	
30	465	310	
45	360	265	
60	310	140	

Remarks: ***Both Bacteria and Fungi were introduced into the indoor environment with common airborne bacteria and fungi cultures media.***

Graph on Total Bacterial and Fungal Counts Versus Cumulative Time (With Kitz Air Revitalisor)

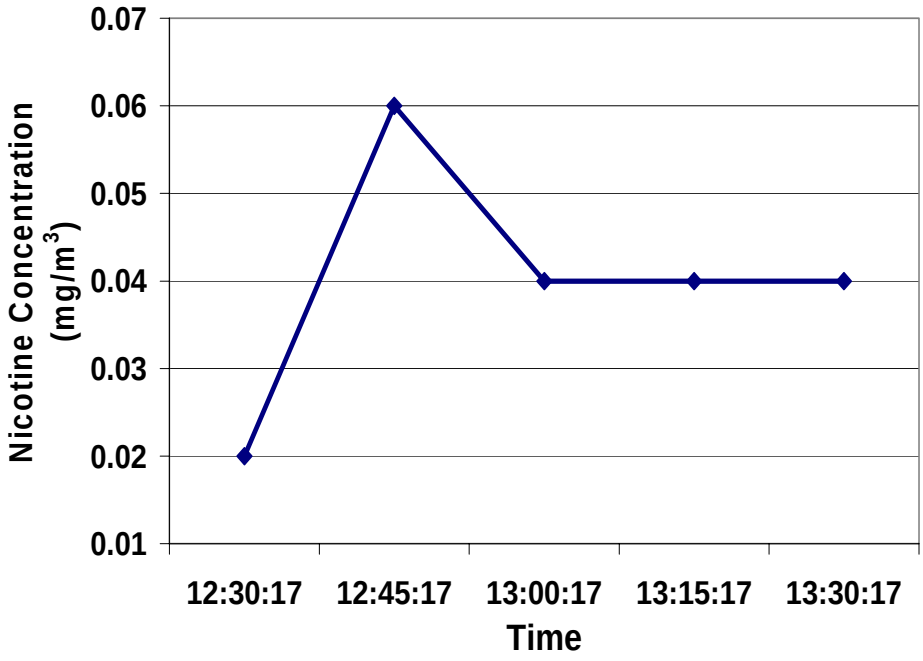


4.16 Nicotine Concentration without Kitz Air Revitalisor

Cumulative Time (mins)	Nicotine (mg/m^3)	OSHA / NIOSH / ACGIH (mg/m^3)
0	0.02	**0.5 (for reference purpose only)**
15	0.06	
30	0.04	
45	0.04	
60	0.04	

Remarks: ***Nicotine was introduced into the indoor environment by burning of Marlboro cigarettes.***

Graph on Nicotine Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)

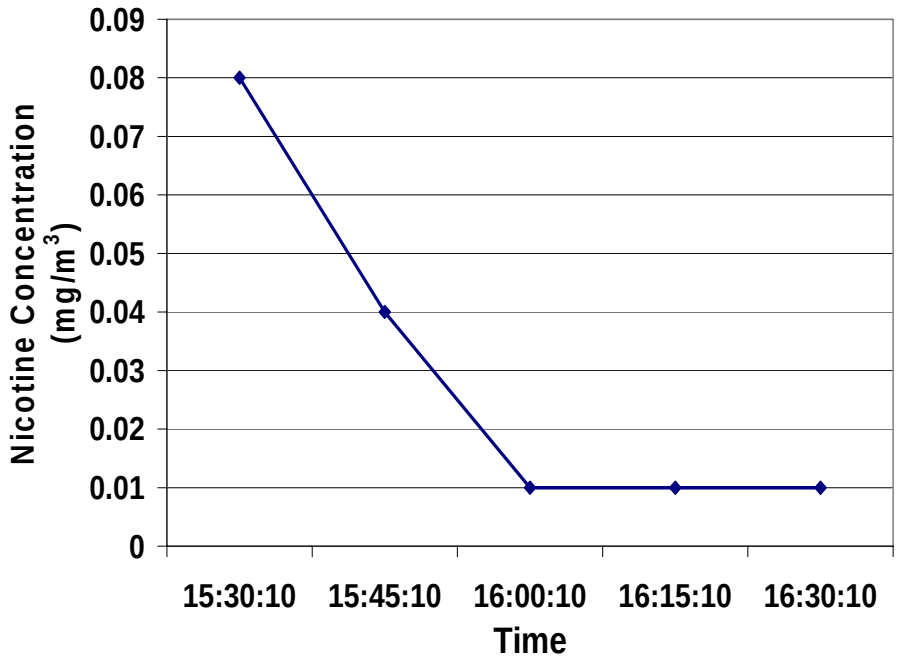


4.17 Nicotine Concentration with Kitz Air Revitalisor

Cumulative Time (mins)	Nicotine (mg/m^3)	OSHA / NIOSH / ACGIH (mg/m^3)
0	0.08	**0.5 (for reference purpose only)**
15	0.04	
30	0.01	
45	0.01	
60	0.01	

Remarks: ***Nicotine was introduced into the indoor environment by burning of Marlboro cigarettes.***

Graph on Nicotine Concentration Versus Cumulative Time (With Kitz Air Revitalisor)

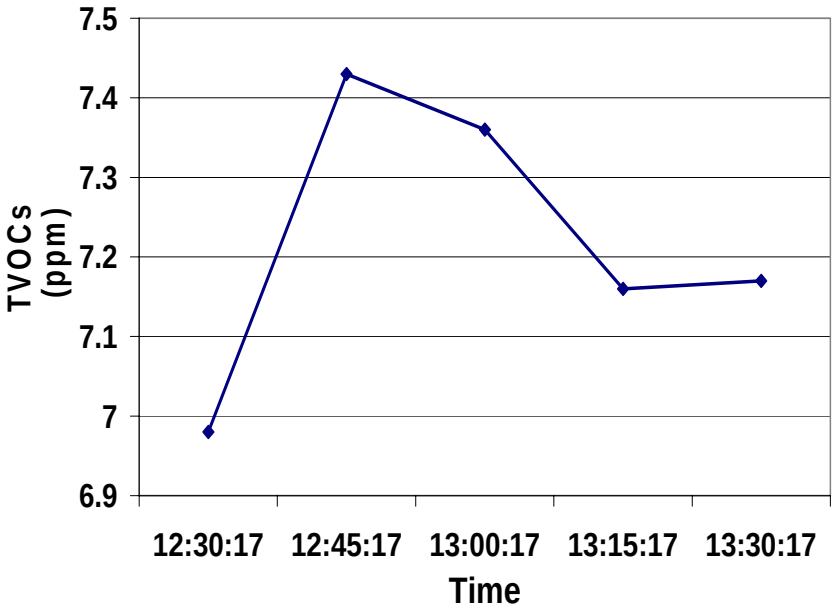


4.18 Total Volatile Organic Compounds (TVOC) without Kitz Air Revitalisor

Cumulative Time (mins)	TVOC (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	6.98	**750 (for Acetone)**	**3 (for reference purpose only)**
15	7.43		
30	7.36		
45	7.16		
60	7.17		

Remarks: ***Total Volatile Organic Compounds (TVOC) was introduced into the indoor environment with evaporation of acetone solution.***

Graph on Total Volatile Organic Compunds Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)

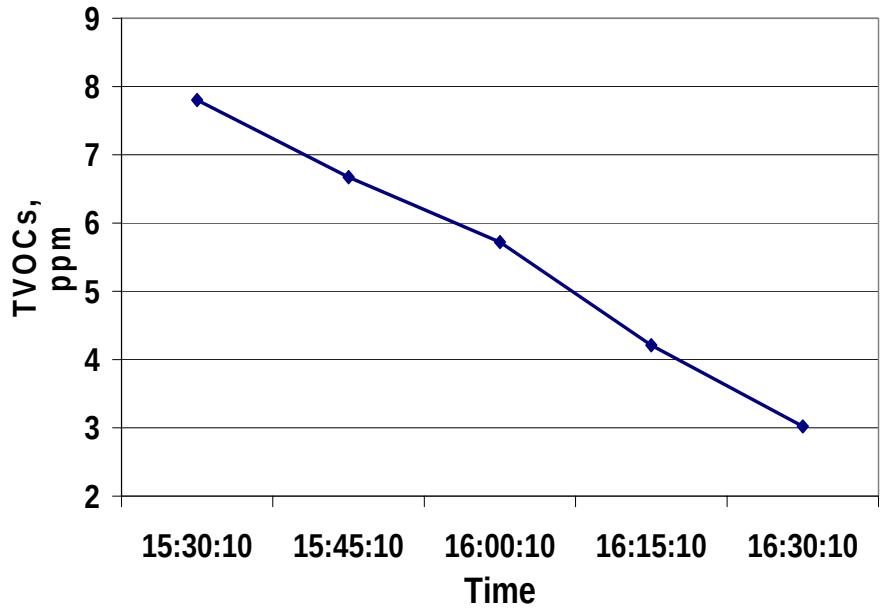


4.19 Total Volatile Organic Compounds (TVOC) with Kitz Air Revitalisor

Cumulative Time (mins)	TVOC (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	7.80	**750 (for Acetone)**	**3 (for reference purpose only)**
15	6.67		
30	5.57		
45	4.21		
60	3.02		

Remarks: ***Total Volatile Organic Compounds (TVOC) was introduced into the indoor environment with evaporation of acetone solution.***

Graph on Total Volatile Organic Compounds Concentration Versus Cumulative Time (With Kitz Air Revitalisor)

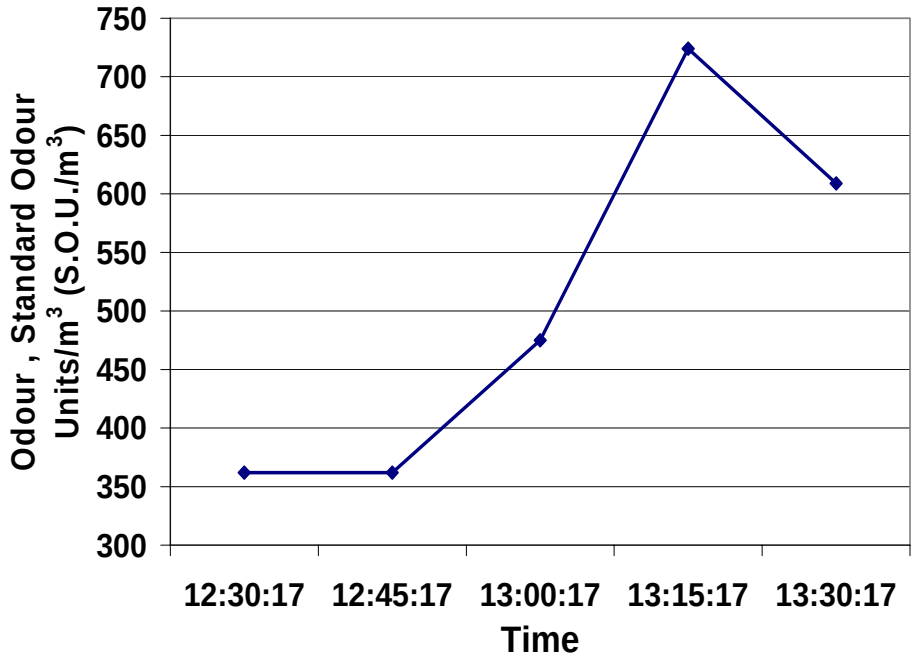


4.20 Nuisance Odour without Kitz Air Revitalisor

Cumulative Time (mins)	Nuisance Odour (s.o.u./m^3)
0	362
15	362
30	475
45	724
60	609

Remarks: ***Nuisance Odour was introduced into the indoor environment with D24Durian Fruit.***

Graph on Nuisane Odour Concentration Versus Cumulative Time (Without Kitz Air Revitalisor)

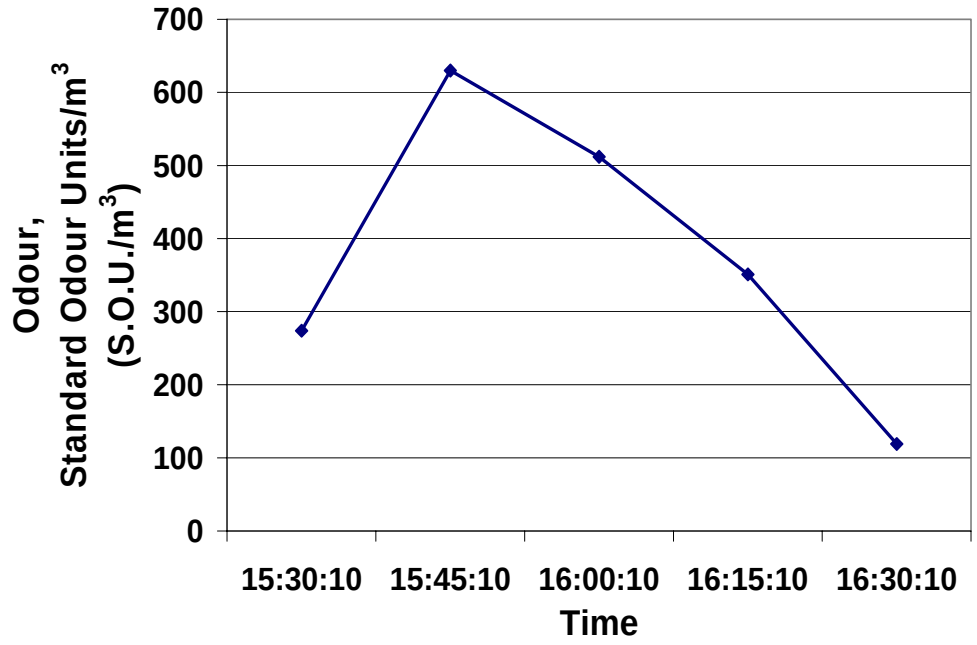


4.21 Nuisance Odour with Kitz Air Revitalisor

Cumulative Time (mins)	Nuisance Odour (s.o.u./m^3)
0	274
15	630
30	512
45	351
60	119

Remarks: ***Nuisance Odour was introduced into the indoor environment with D24Durian Fruit.***

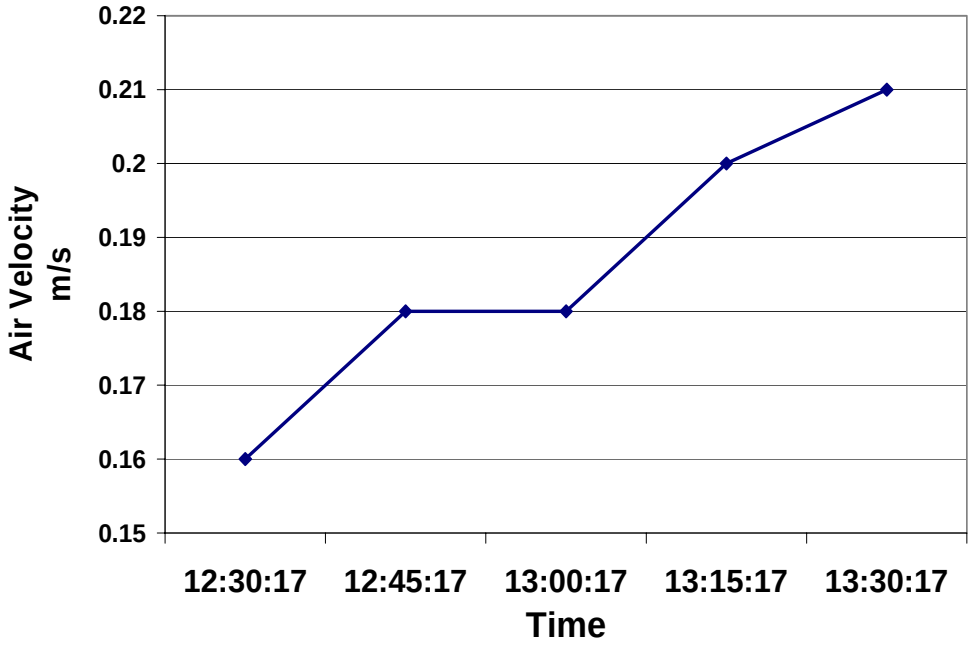
Graph on Odour Concentration Versus Cumulative Time (With Kitz Air Revitalisor)



4.22 Air Velocity without Kitz Air Revitalisor

Cumulative Time (mins)	Air Velocity (m/s)	SIAQG (ppm)
0	0.16	**≤ 0.25 (for reference purpose only)**
15	0.18	
30	0.18	
45	0.20	
60	0.21	

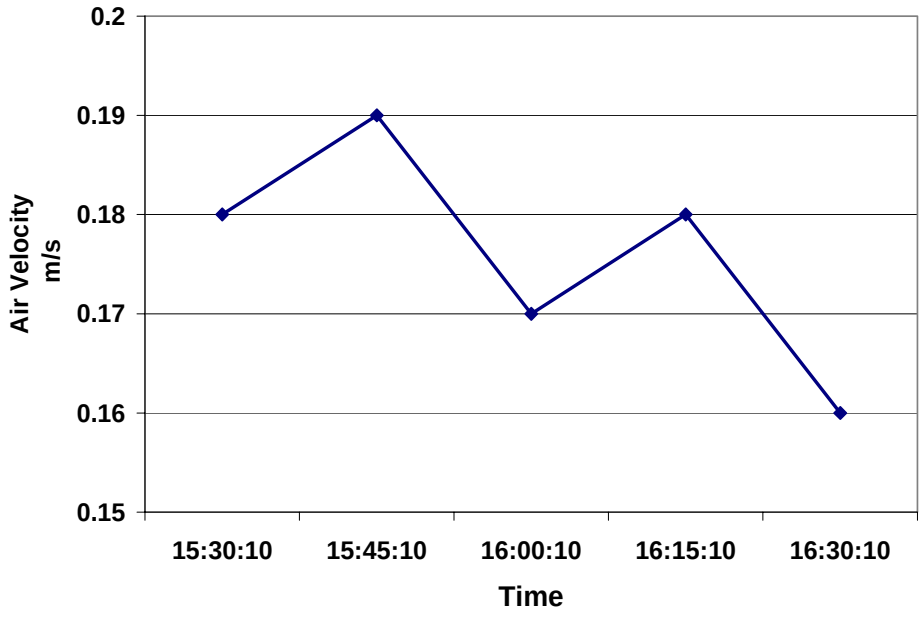
Graph on Air Movement Versus Cumulative Time (Without Kitz Air Revitalisor)



4.23 Air Velocity without Kitz Air Revitalisor

Cumulative Time (mins)	Air Velocity (m/s)	SIAQG (ppm)
0	0.18	**≤ 0.25 (for reference purpose only)**
15	0.19	
30	0.17	
45	0.18	
60	0.16	

Graph on Air Movement Versus Cumulative Time (With Kitz Air Revitalisor)



5.0 CONCLUSION

In general, most of the results obtained showed a significant improvement to the Indoor Air Quality.

It should be noted that this study is based upon limited information gathered during the execution of this project and reflects our findings at the date/time and location monitored.

6.0 ABBREVIATIONS GUIDE

SIAQG	Singapore Indoor Air Quality Guidelines
AIHA	American Industrial Hygiene Association
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
MOM	Ministry of Manpower, Singapore
NPAAQS	National Primary Ambient Air Quality Standards
PELTS	Permissible Exposure Levels of Toxic Substances
IAQ	Indoor Air Quality
CO_2	Carbon Dioxide
CFU	Colony Forming Units
mg/m^3	milligram per cubic metre
ppm	Parts per million

7.0 REFERENCES

ASHRAE, 'Ventilation for Acceptable Indoor Air Quality', ASHRAE Standard 62-1989, The Society, Atlanta, GA, 1989.

Hines, A., Ghosh, T., Loyalka, S., Warder, R. Indoor Air Quality and Control. PTR Prentic Hall, New Jersey, 1993.

National Environment Agency, Singapore, Guidelines for Good Indoor Air Quality in Office Premises, Institute of Environmental Epidemiology, Ministry of the Environment, Singapore, 1996.

TABLE 1

AIR QUALITY STANDARDS

Parameter	Air Quality Standard	Organisation	Health Hazards
Carbon monoxide	35 ppm/40,000 μg/m³ as 1 hour average 9 ppm/10,000 μg/m³ as 8 hour average	USEPA NPAAQS SIAQG	dizziness, loss of memory, fatigue, headaches, loss of muscular control
Carbon dioxide	Ventilation rate/air exchange rate to achieve carbon dioxide level below 1,000 ppm / 1800 mg/m^3	ASHRAE SIAQG	headache, sensation of shortage of breath, discomfort effects
Total volatile organic compounds	4 ppm/5 mg/m³ for total VOCs 3 ppm	AIHA SIAQG	acute bronchitis, humidifier fever, allergies, skin irritation
Ozone	120 ppb/235 μg/m³ as 1 hour average 0.05 ppm/100 μg/m³ as 8 hour average	USEPA NPAAQS ASHRAE SIAQG	0.1 ppm eye irritation 0.15 ppm increase asthmatic effect, bronchitis, bronchopneumonia, abscesses of lung & lung tumours
Respirable Suspended Particulates	150 μg/m³ as 24 hour average 50 μg/m³ as annual mean 150 μg/m³ as 24 hour average	USEPA NPAAQS SIAQG	eye, nose irritation, cough, sneezing, asthmatic effects
Formaldehyde	0.4 ppm for indoor exposure 0.1 ppm / 120 μg/m³	ASHRAE SIAQG	carcinogenic, miscellaneous hypersensitivity fatigue
Temperature	22°C - 24°C 22.5°C - 25.5°C	ASHRAE SIAQG	discomfort, difficulty in concentration, fatigue, sleepiness
Relative Humidity	40% - 60 % ≤ 70%	ASHRAE SIAQG	discomfort, stuffy, headache, dry throat, skin discomfort, eye discomfort (contact lens wearer)
Bacteria	500 CFU/m³ as a maximum value	AIHA SIAQG	infections, Pontiac fever, legionnaire disease
Fungus	500 CFU/m³ as a maximum value	AIHA SIAQG	stimulate the outbreak of asthma
Air Movement	≤ 0.25 m/s	SIAQG	physical discomfort, stuffy, headache

Odour Analysis

The quantity or the concentration of an air sample is measured by number of dilutions with odour-free air required to render it barely detectable by an odour observer. Odour concentration is typically expressed in terms of odour units per cubic metre of odour free air (ou/m3). This is the amount of odour necessary to contaminate 1m3 of clean, odour-free air to the threshold level of the observer. Odour measurement involves diluting the odourous air sample with clean deodorized air and presenting the diluted air mixture to a group odour observer, who have been slected and calibrated against a standard reference gas, for determining the odour thresholds.

Methodology

Air Sampling
Odorous air sample was collected using a portable Teflon Air Pump with Nalophan (polyethyleneterephthalate) sampling bag. The air samples shall be analysed within 24 hours upon sampling.

Odour Analysis

Odour concentration was measured using a Dynamic Olfactometer that conforms to the European standard for Olfactometry (EN 13725:2003). Air samples were presented using the “binary forced-choice method” to a panel of odour observers who had been selected based on a known sensitivity to the reference odorant n-butanol. All odour analysis shall be carried out in an odour quality room specially designed for odour assessment. Results of odour concentration were expressed in standard odour units per m^3, (sou/ m^3).