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YOUR REF:

OUR REF: AC/ES/4463R/04


DATE: 30 June 2004


## AIR QUALITY ASSESSMENT FOR PERFECTAIRE REVITALISING SYSTEM

FOR PERFECTBRANDZ INTERNATIONAL PTE LTD  
12, HARPER ROAD, #06-00, LANDEX HOUSE,  
SINGAPORE 369677

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PERFECTAIRE SA



## 1.0 SUBJECT

Air Quality Assessment for PerfectAire Revitalising System was conducted by Environmental Services of Analytical Laboratories (S) Pte Ltd on 25 June 2004 for PerfectBrandz International Pte Ltd located at 12, Harper Road, #06-00, Landex House, Singapore 369677.

## 2.0 OBJECTIVE

The purpose of this study was to evaluate and assess the efficiency of the product namely PerfectAire Revitalising System filled with i-pur air purifying concentrate, blended with Perfect+ MicrobeShield formula.

The working principal of the product, PerfectAire Revitalising System is by means of "scrubbing effect" onto the incoming air which allows the mixture of botanical extracts and/or absorbed within the solution to disinfect bacteria, fungi, enveloped type viruses, malodours, nicotine smoke and other air contaminants through which the air is drawn into a funnel and sprayed for maximum contact between the air that is drawn in and the solution used (please refer to Appendix A for product details).

i-pur range of concentrates together with blends of essential oil and Perfect+ MicrobeShield formula also release a host of rejuvenating and soothing fragrances that provide physiological, psychological and therapeutical actions while improving the indoor air quality and ambience.

## 3.0 METHODOLOGY

### 3.1 Test Location

The "trial test" for all the air contaminants throughout the entire course of this study was carried out at PerfectBrandz International Pte Ltd's conference room of approx. 5.5m (length) x 3.5m (width) x 2.7m (height).

The conference room floor area is approx. 19.3m<sup>2</sup> (~208 ft<sup>2</sup>) whilst the room volume is approx. 52m<sup>3</sup> (~1836 ft<sup>3</sup>).

### 3.2 Test Methodology

#### a) Temperature and Relative Humidity

Temperature and Relative Humidity were measured using a portable TS-1 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<sub>2</sub>) 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 RAE VOCs Gas Detector fitted with Photoionization Detector (PID) for 1-minute interval over the desired sampling duration.

d) 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.

e) 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).

f) Nuisance Odour (as Ammonia)

Ammonia was collected with reference to NIOSH 6015 using silica gel treated with H<sub>2</sub>SO<sub>4</sub> 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 Visible Absorption Spectrophotometry (AS).

g) Nuisance Odour (as Mercaptans)

Mercaptans was measured using Gastec Detector Tube No. 70 (range 0.5 to 120 ppm) by drawing air through a Gastec pump with a volume of 100ml per pump stroke over 10 sampling strokes. The sample concentration was then read at the interface of the stained-to-unstained reagent (ie. yellow colour stain) of the Gastec Detector Tube.





#### 4.0 TEST RESULTS

All the respective test results obtained are tabulated below and reflect our findings on 25 June 2004.

Please refer to Pages 3 to 10 of this report.

#### 4.1 Carbon Monoxide (CO)

Cumulative Time (mins)	CO (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	0		
5	152		
30	49		
60	17	25	9 (8-hr) 35 (1-hr)
90	3		
120	1		
180	0		

**Remarks:** Carbon Monoxide (CO) was introduced into the indoor environment with Marlboro type cigarettes burning for the first 5 minutes of test duration.

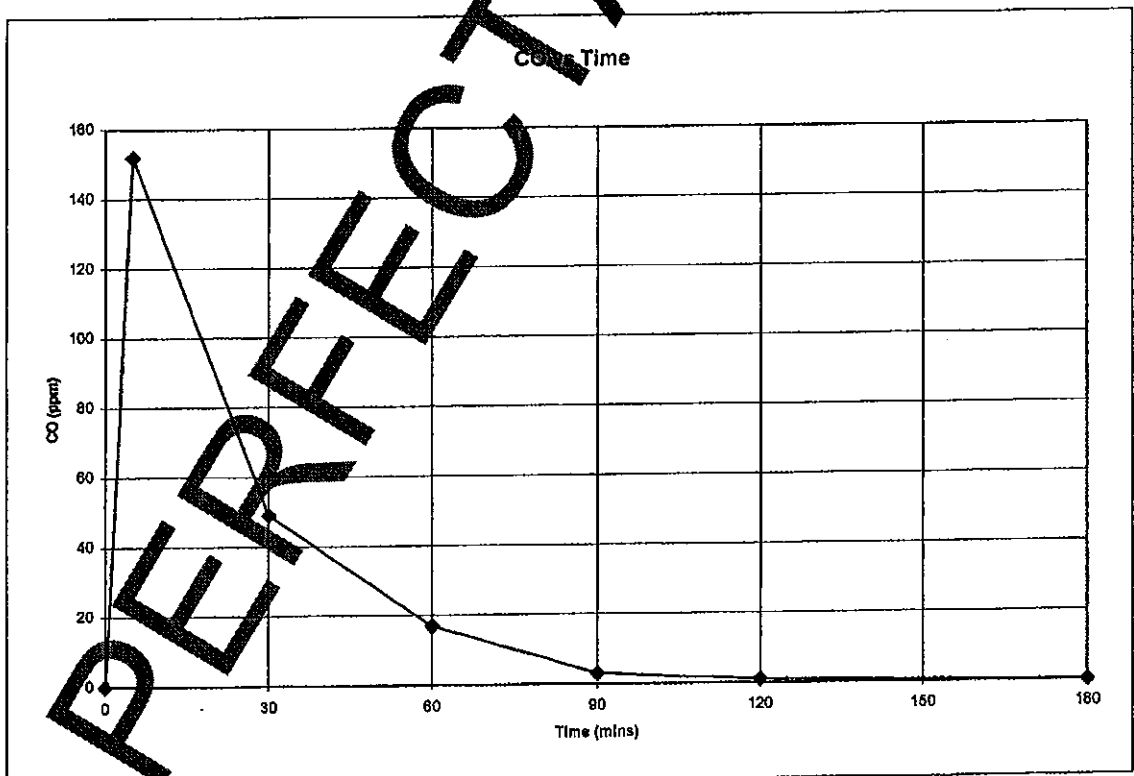


Figure 1: Graph of Carbon Monoxide Concentration versus Cumulative Time





#### 4.2 Nicotine

Cumulative Time (mins)	Nicotine (mg/m <sup>3</sup> )	OSHA / NIOSH / ACGIH (mg/m <sup>3</sup> )
0	0.000	0.5 (for reference purpose only)
5	0.601	
60	0.393	
120	0.034	
180	0.003	

**Remarks:** Nicotine was introduced into the indoor environment with Malboro type cigarettes burning for the first 5 minutes of test duration.

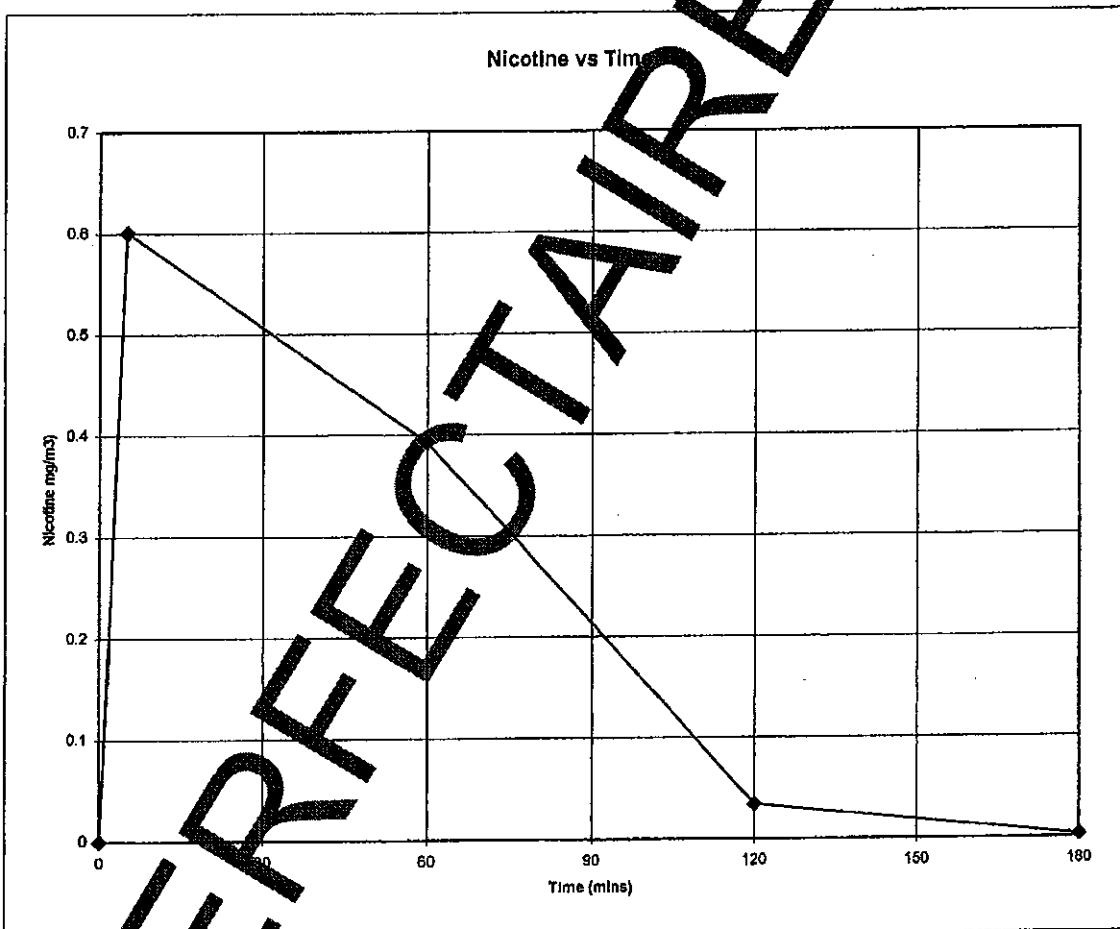


Figure 2: Graph of Nicotine (mg/m<sup>3</sup>) versus Cumulative Time





### 4.3 Respirable Suspended Particulates (RSP)

Cumulative Time (mins)	RSP (mg/m <sup>3</sup> )	MOM (PELTS) (mg/m <sup>3</sup> )	SIAQG (mg/m <sup>3</sup> )
0	0.08	10 (Nuisance Particulates)	0.15 (for reference purpose only)
5	50.1		
30	22.3		
60	6.4		
90	0.4		
120	0.11		
180	0.02		

**Remarks:** Respirable Suspended Particulates (RSP) was introduced into the indoor environment with Malboro type cigarettes burning for the first 5 minutes of test duration.

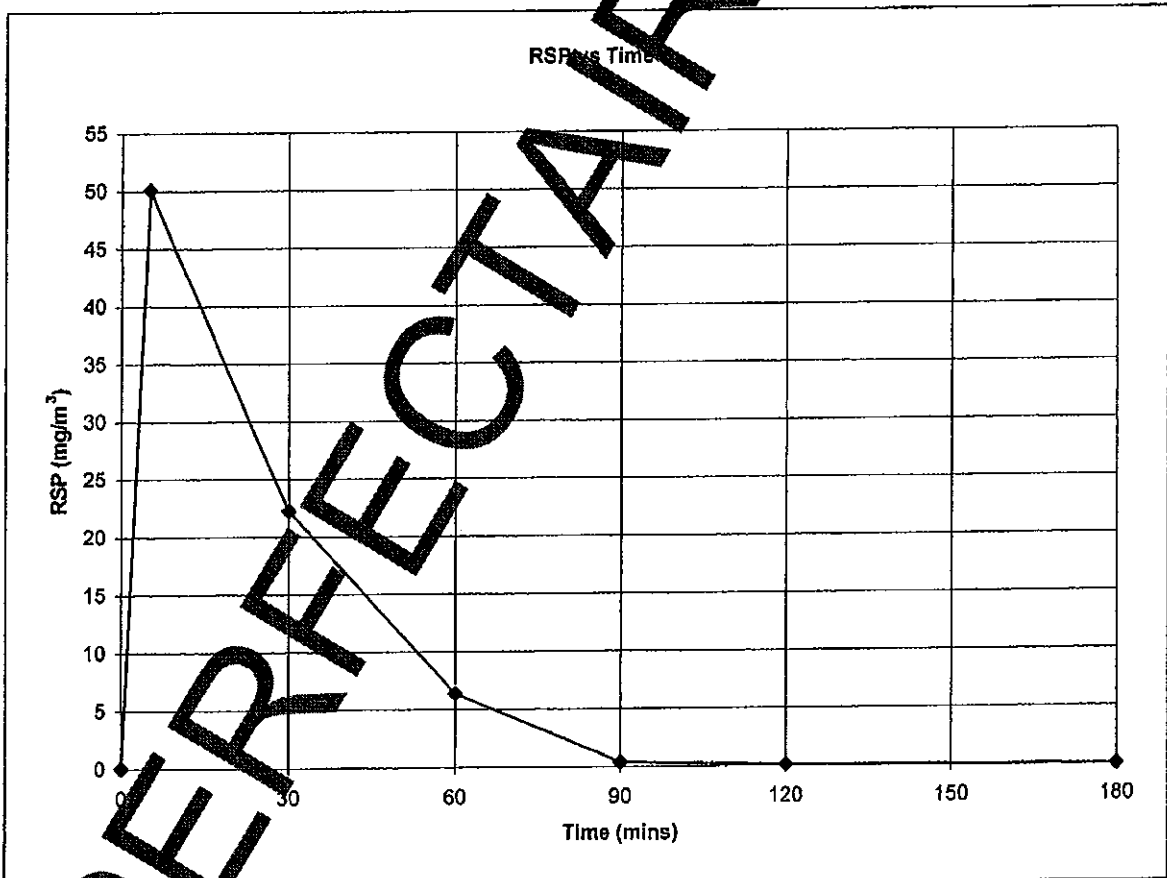


Figure 3: Graph of Respirable Suspended Particulates Concentration versus Cumulative Time





**4.4 Total Volatile Organic Compounds (TVOC) – Mixed Solution Comprised of Acetone, Thinner and Brandy (Gordon Blue)**

Cumulative Time (mins)	TVOC (ppm)	MOM (PELTS) (ppm)	SIAQG (ppm)
0	0	750 (for Acetone)	3 for reference purpose only
5	1138		
30	363		
60	102		
90	25		
120	8		
180	0		

**Remarks:** Total Volatile Organic Compounds (TVOC) was introduced into the indoor environment with evaporation of mixed solution comprised of acetone, thinner and brandy (Gordon Blue) for the first 5 minutes of test duration.

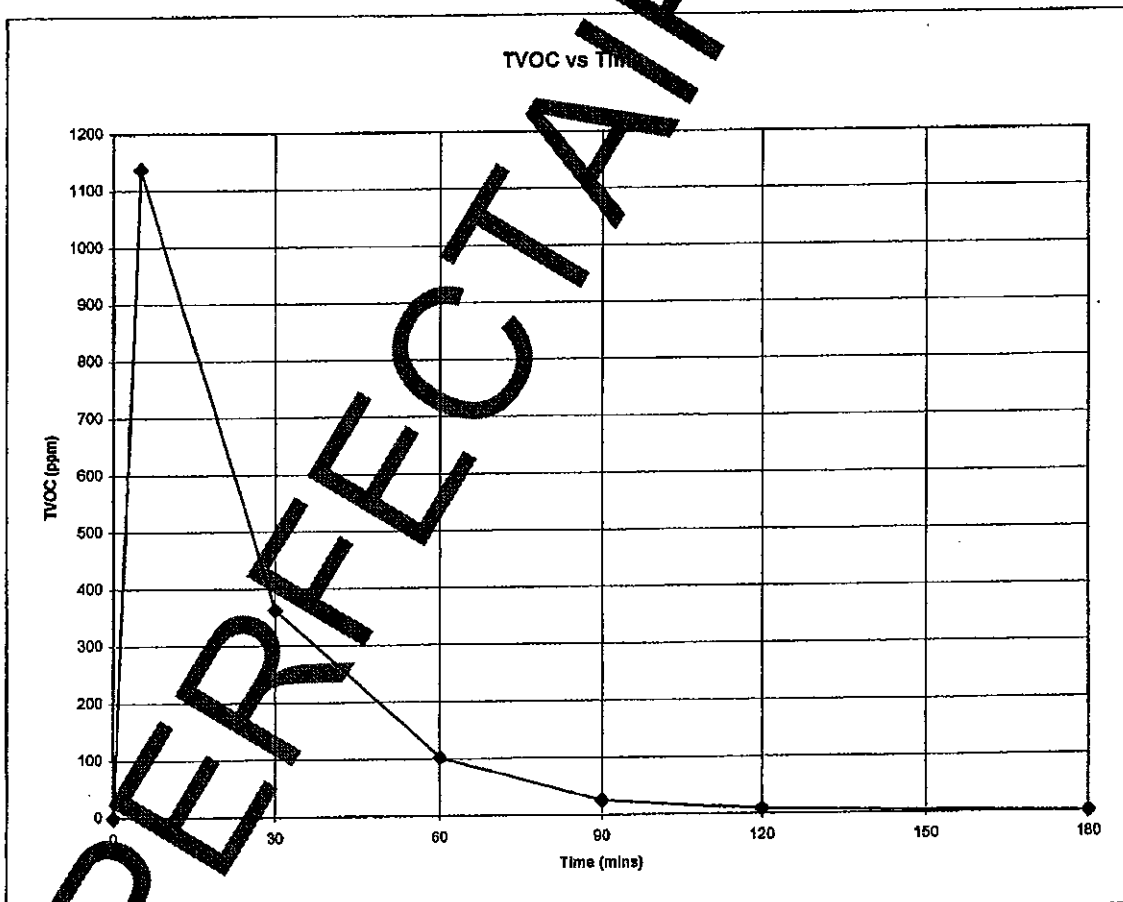


Figure 4.4 Graph of Total Volatile Organic Compounds Concentration versus Cumulative Time





#### 4.5 Nuisance Odour (as Ammonia)

Cumulative Time (mins)	Nuisance Odour (as Ammonia) (mg/m <sup>3</sup> )
0	0
5	39
60	4
120	0
180	0.01

**Remarks:** Nuisance Odour (as Ammonia) was introduced into the indoor environment with evaporation of ammonia solution for the first 5 minutes of test duration.

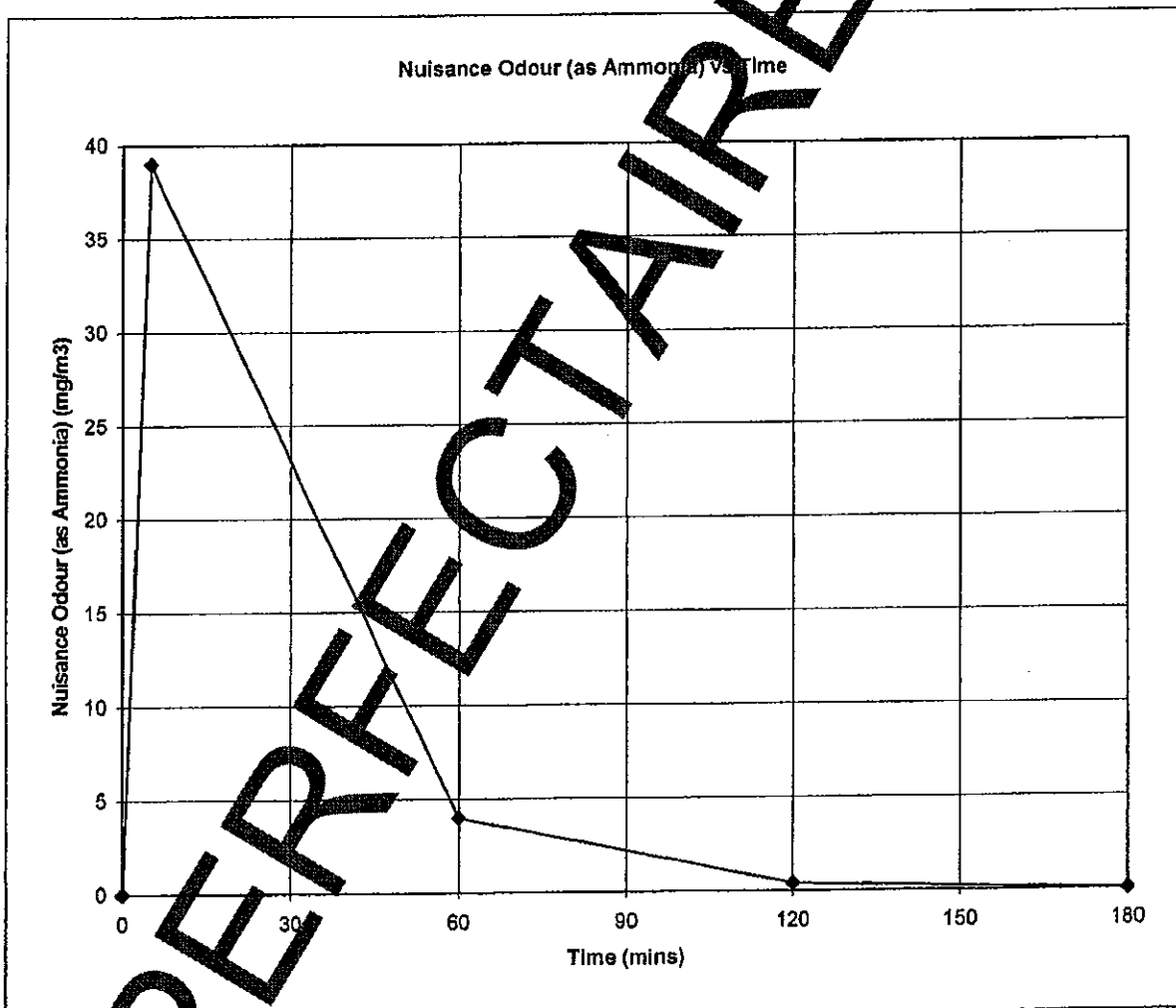


Figure 1 Graph of Nuisance Odour (as Ammonia) Concentration versus Cumulative Time







**4.6 Nuisance Odour (as Mercaptans)**

Cumulative Time (mins)	Nuisance Odour (as Mercaptans) (ppm)
0	0
5	15
60	8
120	4
180	0.5

**Remarks:** Nuisance Odour (as Mercaptans) was introduced into the indoor environment with Durian Fruit for the first 5 minutes of test duration.

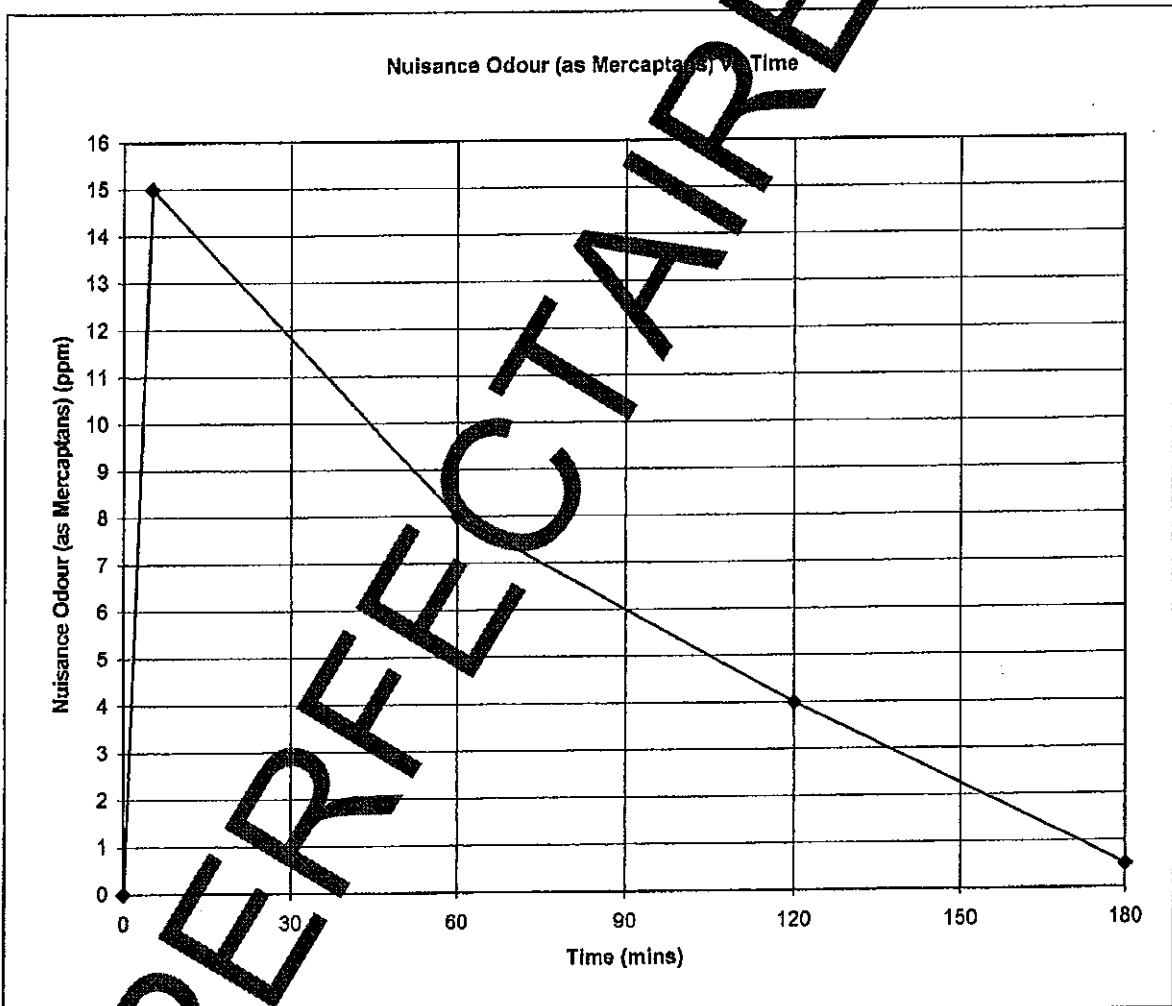


Figure 6: Graph of Nuisance Odour (as Mercaptans) Concentration versus Cumulative Time





#### 4.7 Carbon Dioxide (CO<sub>2</sub>)

Cumulative Time (mins)	CO <sub>2</sub> (ppm)	SIAQG (ppm)
0	678	1000
5	669	
30	662	
60	681	
90	674	
120	690	
180	684	

**Remarks:** Carbon Dioxide concentration remained relatively constant as baseline condition of the conference room throughout the entire test duration (for reference purpose only).

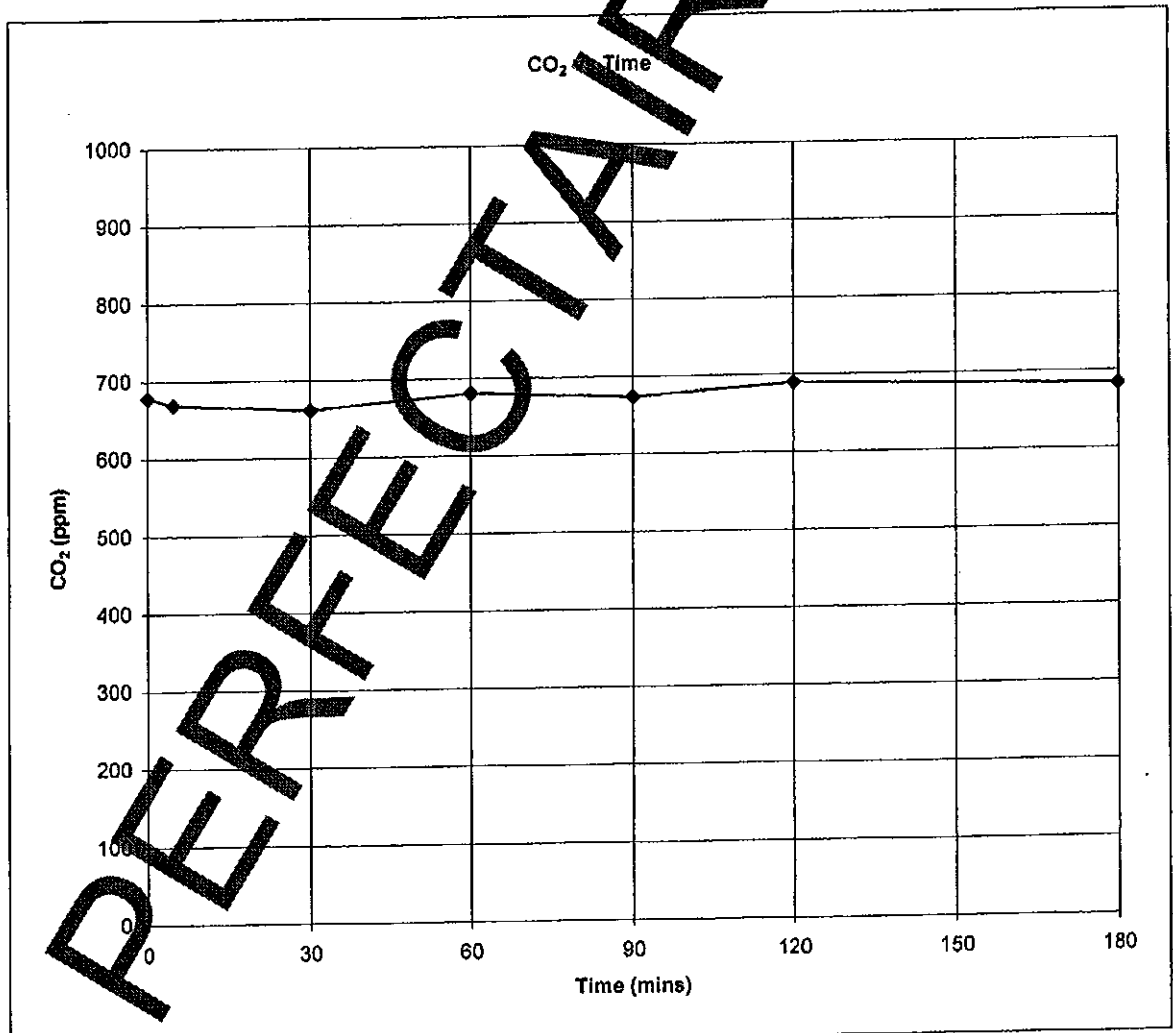


Figure 7: Graph of Carbon Dioxide Concentration versus Cumulative Time





#### 4.8 Temperature and Relative Humidity

Cumulative Time (mins)	Temperature (°C)	SIAQG / ASHRAE (°C)	Relative Humidity (%)	SIAQG / ASHRAE (%)
0	22.3	22.5 - 25.5 / 22 - 24	49.5	< 70 / 40 - 60
5	22.4		50.7	
30	22.5		51.5	
60	22.4		50.8	
90	22.3		52.1	
120	22.4		49.9	
180	22.3		51.1	

**Remarks:** Both Temperature remained relatively constant as baseline condition of the conference room throughout the entire test duration (for reference purpose only).

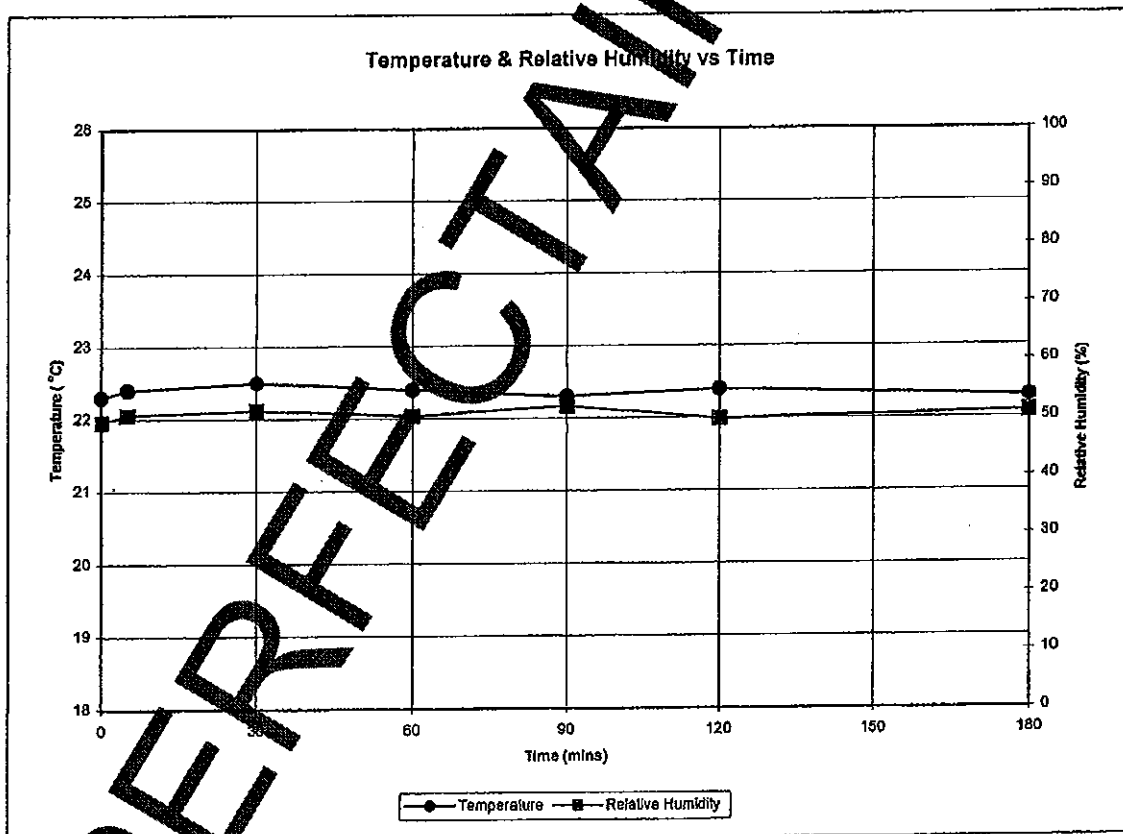


Figure 8: Graph of Temperature & Relative Humidity Level versus Cumulative Time





## 5.0 CONCLUSION

In general, all the results obtained were within their respective Singapore's Ministry of Manpower (MOM)'s "Permissible Exposure Levels of Toxic Substances (PELTS)", National Environment Agency (NEA)'s "Guidelines for Good IAQ in Office Premises" and ASHRAE's IAQ Guidelines as well as other established international organisations such as OSHA, NIOSH and ACGIH.

In conclusion, the overall Air Quality Assessment showed that the PerfectAire Revitalising System filled with i-pur air purifying concentrate can be considered as "acceptable" and "efficient" by means of "scrubbing effect" onto the incoming air which allows the mixture of botanical extracts with Perfect+ MicrobeShield formula and/or absorbed within the solution to disinfect bacteria, fungi, enveloped type viruses, malodours, nicotine smoke and other air contaminants based on the findings of the "trial test" in this study.

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.

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## 6.0 ABBREVIATIONS GUIDE

AIHA	American Industrial Hygiene Association, US
ACGIH	American Conference of Governmental Industrial Hygienists, US
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers, US
CFU	Colony Forming Units
CO <sub>2</sub>	Carbon Dioxide
CO	Carbon Monoxide
NEA	National Environment Agency, Singapore
HCHO	Formaldehyde
IAQ	Indoor Air Quality
MOM	Ministry of Manpower, Singapore
mg/m <sup>3</sup>	milligram per cubic metre
NPAAQS	National Primary Ambient Air Quality Standards
NIOSH	National Institute for Occupational Health and Safety, US
OSHA	Occupational Safety and Health Administration, US
O <sub>3</sub>	Ozone
PELTS	Permissible Exposure Levels of Toxic Substances
ppm	Parts per million
RH	Relative Humidity
RSP	Respirable Suspended Particulates
SIAQG	Singapore Indoor Air Quality Guidelines
STEL	Short Term Exposure Level
T	Temperature
TVOC	Total Volatile Organic Compounds
USEPA	United States Environmental Protection Agency, US





## 7.0 REFERENCES

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

NIOSH, "Manual of Analytical Methods", Fourth Edition, January 1998.

MOM, "The Factories (Permissible Exposure Levels of Toxic Substances) Order 1996", Ministry of Manpower, Singapore.

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

NEA, "Pollution Control Reports, 2000 - 2003", National Environment Agency, Singapore

PERFECTAIR (S) PTE LTD





## AIR QUALITY STANDARDS

Parameter	Air Quality Standard	Organisation	Health Hazards
Carbon Monoxide	35 ppm/40,000 µg/m <sup>3</sup> as 1 hour average 9 ppm/10,000 µg/m <sup>3</sup> 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 <sup>3</sup>	ASHRAE SIAQG	headache, sensation of shortage of breath, discomfort effects
Total Volatile Organic Compounds	4 ppm/5 mg/m <sup>3</sup> for total VOCs 3 ppm	AIHA SIAQG	acute bronchitis, humidifier fever, allergies, skin irritation
Ozone	0.12ppm/235 µg/m <sup>3</sup> as 1 hour average 0.05 ppm/100 µg/m <sup>3</sup> 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/m <sup>3</sup> as 24 hour average 50 µg/m <sup>3</sup> as annual mean 0.15 mg/m <sup>3</sup> 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/m <sup>3</sup>	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/m <sup>3</sup> as a maximum value	AIHA SIAQG	infections, pontiac fever, legionnaire disease
Fungus	500 CFU/m <sup>3</sup> as a maximum value	AIHA SIAQG	stimulate the outbreak of asthma
Air Movement	0.25 m/s	SIAQG	physical discomfort, stuffy, headache

