1.0 Introduction

Airconstruct H.V.A.C. is an airconditioning contracting company established in Mackay in 2001. We are members of the Airconditioning and Mechanical Contractors Association and the Managing Director, David Jones is a member of the Australian Institute of Refrigeration Airconditioning and Heating with 25 years full time industry experience.

2.0 Methodology and Equipment

The indoor air quality at [redacted] Shopping Centre was assessed for each of the following parameters:

- Carbon dioxide
- Carbon monoxide
- Temperature
- Humidity
- Inspirable and respirable particulates.

Static air testing was conducted on carbon monoxide, carbon dioxide and inspirable and respirable particulates for four individual 30 minute periods at each of the fifteen (15) air conditioner plants that make up [redacted] Shopping Centre's ventilation systems. All measurements were taken during operating hours at the return air inlet of each air conditioner unit, with multiple measurements (4) taken at each location.

The equipment used in this air quality assessment was calibrated prior to use, and their calibration records can be found in Appendix A.

The Q-Trak Indoor Air Quality Monitor was used to measure temperature, relative humidity, carbon dioxide and carbon monoxide levels. Temperature is expressed in degrees Celsius, Relative Humidity is expressed as a percentage, and both Carbon Dioxide and Dioxide levels are expressed as parts per million (ppm).

The Dust Trak 8520 Aerosol and Dust Monitor was used to measure levels of both respirable and inspirable particulates. The monitor is capable of determining particulate size, and so can determine between these two types of particulates of interest. Particulate levels are expressed as milligrams per cubic metre of air (mg/m^3).

3.0 Exposure Levels

Numerous publications and standards make recommendations on indoor air quality and exposure levels, and recognize that indoor air quality levels outside of these recommendations are likely to affect the comfort, and potentially the health of building occupants. The standards used by the following organizations have been used as guidelines to generate this report, and further details of these standards may be found in Section 7 below (References).

- NHMRC – National Health and Medical Research Council
- BOMA – Building Owners and managers Association
- Worksafe Australia
- International Standards Organization
- Safework Australia

3.1 Temperature

The ISO Standard ISO 7730 – 1984 recommends a range of acceptable temperatures for summer or winter to ensure indoor air quality and comfort of workers and patrons. In summer, it is recommended that air temperatures be maintained between 22°C and 26°C, while temperature recommendations for winter range between 20°C and 24°C.

3.2 Relative Humidity

The ISO Standard ISO 7730 – 1984 also recommends that the relative humidity in the workplace should range between 35% and 65%.

3.3 Carbon Monoxide

Carbon monoxide is an odorless, colorless and toxic gas. At low levels, carbon monoxide exposure may cause headaches, fatigue, dizziness and disorientation, but at higher levels, or at longer-term exposures, carbon monoxide poisoning may be fatal. As such, it is essential that levels of this gas be closely monitored in indoor environments. The NHMRC recommends that levels of carbon monoxide in indoor environments do not exceed 9 ppm (parts per million).

Sources of carbon monoxide may arise from poorly vented or poorly maintained combustion equipment such as boilers, furnaces, or generators. Carbon monoxide may also be present due to build up of vehicle emissions and cigarette smoke.

3.4 Carbon Dioxide

Carbon dioxide is also an odourless, colourless and toxic gas. Low concentrations may make individuals feels drowsy, while moderate concentrations produce similar health effects to carbon monoxide. At high concentrations, carbon dioxide exposure may cause unconsciousness and death. Thus, the Building Owners and Managers Association recommends that carbon dioxide concentrations be maintained below 800 ppm.

Man-made sources of carbon dioxide include combustion of fossil fuels and waste incineration. However, human respiration also produces carbon dioxide. When people exhale, the concentrate carbon dioxide in their breath is diluted upon mixing with ventilated air, but over time, or with inadequate ventilation, carbon dioxide levels may rise to that which may cause health impairment.

3.5 Inspirable Particulates

Inspirable particulates are airborne particles that may be breathed into a person's airways and may cause hazardous health effects. They are generally less than 10 microns in diameter. Safework Australia standard NOHSC 3008 recommends that levels of inspirable particulates be maintained below $10mg/m^3$.

Sources of inspirable particulates include cigarette smoke, vehicle emissions, industrial emissions, fires and dust (including fungal spores, bacteria and pollen).

3.6 Respirable Particulates

Respirable particulates are defined as particles that are of a size that are small enough (less than 2.5 microns) to be inhaled deep into the lungs (as far as the alveoli), where there are few defense mechanisms to clear them from the lungs. This may potentially result in illness or tissue damage. The smallest particles may even be absorbed into the blood to cause further detrimental health effects. Worksafe Australia recommends that levels of respirable particulates be maintained below $3mg/m^3$.

Sources of respirable particulates tend to be due to the include cigarette smoke, vehicle emissions, industrial emissions, fires and dust (including fungal spores, bacteria and pollen). Assessment of indoor airborne particles indicates the filtration efficiency of air conditioning systems.

3.7 Results

The following tables are the results of the tests performed during the afternoon while Airconstruct staff were on site.

3.8 Temperature

R/A of	Time	Temp °C	Time	Temp °C	Time	Temp °C	Time	Temp °C
AC 1	13:00	24.6	13:30	24.7	14:00	24.6	14:30	24.9
AC 2	13:10	23.9	13:40	23.8	14:10	23.9	14:40	23.7
AC 3	12:30	24.6	13:00	24.2	13:30	24.6	14:00	24.5
AC 4	13:25	20.8	13.40	21.0	13:55	20.8	14:25	21.1
AC 5	13:55	23.5	14.25	23.7	14:55	23.5	15:25	23.6
AC 6	14:00	23.5	14:30	23.6	15:00	23.5	15:30	23.7
AC 7	13:50	22.6	14:20	22.3	14:50	22.6	15:20	22.4
AC 8	14:45	22.5	15:15	22.8	15:45	22.5	16:15	22.4
AC 9	14:20	23.8	14:50	23.7	15:20	23.8	15:50	23.9
AC 10	14:30	23.2	15:00	23.4	15:30	23.6	16:00	23.8
AC 11	12.45	24.6	13:15	23.9	13:45	24.3	14:15	23.8
AC 12	14.25	23.5	14:55	23.6	15:25	23.5	15:55	23.7
AC 13	14:45	23.5	15:15	23.5	15:45	23.5	16:14	23.8
AC 14	15:15	23.5	15:45	23.4	16:15	23.6	16:45	23.5
Ac 15	15:45	23.5	16:15	22.9	16:45	23.1	17:15	22.9

3.9 Relative Humidity

R/A of	Time	R.H. %	Time	R.H. %	Time	R.H. %	Time	R.H. %
AC 1	13:00	42.7	13:30	44.5	14:00	46.8	14:30	46.5
AC 2	13:10	47.4	13:40	47.5	14:10	47.4	14:40	47.5
AC 3	12:30	42.9	13:00	42.7	13:30	42.7	14:00	42.7
AC 4	13:25	55.9	13.40	55.8	13:55	55.5	14:25	55.7
AC 5	13:55	51.4	14.25	51.5	14:55	51.4	15:25	51.4
AC 6	14:00	56.8	14:30	56.8	15:00	56.8	15:30	56.8
AC 7	13:50	51.3	14:20	51.7	14:50	51.7	15:20	51.8
AC 8	14:45	56.6	15:15	56.7	15:45	55.9	16:15	55.9
AC 9	14:20	61.7	14:50	61.6	15:20	61.7	15:50	61.8
AC 10	14:30	55.6	15:00	54.9	15:30	55.8	16:00	56.0
AC 11	12.45	42.9	13:15	42.7	13:45	46.8	14:15	42.9

AC 12	14.25	56.8	14:55	56.8	15:25	56.8	15:55	57.5
AC 13	14:45	56.9	15:15	56.8	15:45	56.8	16:14	57.8
AC 14	15:15	56.8	15:45	56.8	16:15	56.8	16:45	56.9
AC15	15:45	57.1	16:15	56.9	16:45	56.8	17:15	56.8

3.10 Carbon Monoxide

R/A of	Time	C.M.P.P.M.	Time	C.M.P.P.M.	Time	C.M.P.P.M.
AC 1	13:00	24.6	13:30	24.7	14:00	24.6
AC 2	13:10	23.9	13:40	23.8	14:10	23.9
AC 3	12:30	24.6	13:00	24.2	13:30	24.6
AC 4	13:25	20.8	13.40	21.0	13:55	20.8
AC 5	13:55	23.5	14.25	23.7	14:55	23.5
AC 6	14:00	23.5	14:30	23.6	15:00	23.5
AC 7	13:50	22.6	14:20	22.3	14:50	22.6
AC 8	14:45	22.5	15:15	22.8	15:45	22.5
AC 9	14:20	23.8	14:50	23.7	15:20	23.8
AC 10	14:30	23.2	15:00	23.4	15:30	23.6
AC 11	12.45	24.6	13:15	23.9	13:45	24.3
AC 12	14.25	23.5	14:55	23.6	15:25	23.5
AC 13	14:45	23.5	15:15	23.5	15:45	23.5
AC 14	15:15	23.5	15:45	23.4	16:15	23.6
Ac 15	15:45	23.5	16:15	22.9	16:45	23.1

3.11 Carbon Dioxide

R/A of	Time	Temp ^{o}C	Relative Humidity %	Carbon Monoxide ppm	Carbon Dioxide ppm	Inhalable Particulate mg/m^3
AC 1	13:00	24.6	42.7	<0.1	678	0.013
AC 2	13:10	23.9	47.4	<0.1	642	0.010
AC 3	13:00	24.6	42.7	<0.1	678	0.013
AC 4	13:25	20.8	55.9	0.2	727	0.013
AC 5	13:55	23.5	51.4	0.1	706	0.008
AC 6	14:00	23.5	56.8	<0.1	642	0.008
AC 7	13:50	22.6	51.3	0.1	739	0.017
AC 8	14:45	22.5	56.6	<0.1	618	0.011
AC 9	14:20	23.8	61.7	<0.1	624	0.010
AC 10	14:30	23.4	55.6	<0.1	550	0.006
AC 11	12.45	24.6	42.7	<0.1	678	0.013
AC 12	14.25	23.5	56.8	<0.1	668	0.012

AC 13	14:45	23.5	56.8	<0.1	654	0.009
AC 14	15:15	23.5	56.8	<0.1	697	0.009
Ac 15	15:45	23.5	56.8	<0.1	686	0.009

3.11 Inspirable Particulates

R/A of	Time	Temp °C	Relative Humidity %	Carbon Monoxide ppm	Carbon Dioxide ppm	Inhalable Particulate mg/m³
AC 1	13:00	24.6	42.7	<0.1	678	0.013
AC 2	13:10	23.9	47.4	<0.1	642	0.010
AC 3	13:00	24.6	42.7	<0.1	678	0.013
AC 4	13:25	20.8	55.9	0.2	727	0.013
AC 5	13:55	23.5	51.4	0.1	706	0.008
AC 6	14:00	23.5	56.8	<0.1	642	0.008
AC 7	13:50	22.6	51.3	0.1	739	0.017
AC 8	14:45	22.5	56.6	<0.1	618	0.011
AC 9	14:20	23.8	61.7	<0.1	624	0.010
AC 10	14:30	23.4	55.6	<0.1	550	0.006
AC 11	12.45	24.6	42.7	<0.1	678	0.013
AC 12	14.25	23.5	56.8	<0.1	668	0.012
AC 13	14:45	23.5	56.8	<0.1	654	0.009
AC 14	15:15	23.5	56.8	<0.1	697	0.009
Ac 15	15:45	23.5	56.8	<0.1	686	0.009

3.12 Respirable Particulates

R/A of	Time	Temp °C	Relative Humidity %	Carbon Monoxide ppm	Carbon Dioxide ppm	Inhalable Particulate mg/m³
AC 1	13:00	24.6	42.7	<0.1	678	0.013
AC 2	13:10	23.9	47.4	<0.1	642	0.010
AC 3	13:00	24.6	42.7	<0.1	678	0.013
AC 4	13:25	20.8	55.9	0.2	727	0.013
AC 5	13:55	23.5	51.4	0.1	706	0.008
AC 6	14:00	23.5	56.8	<0.1	642	0.008
AC 7	13:50	22.6	51.3	0.1	739	0.017
AC 8	14:45	22.5	56.6	<0.1	618	0.011
AC 9	14:20	23.8	61.7	<0.1	624	0.010
AC 10	14:30	23.4	55.6	<0.1	550	0.006
AC 11	12.45	24.6	42.7	<0.1	678	0.013
AC 12	14.25	23.5	56.8	<0.1	668	0.012
AC 13	14:45	23.5	56.8	<0.1	654	0.009
AC 14	15:15	23.5	56.8	<0.1	697	0.009
Ac 15	15:45	23.5	56.8	<0.1	686	0.009

4.0 Discussion

- Discuss how the units performed overall
- Discuss outlier readings – single events related to outside events or are one or more of the units consistently out of range?

5.0 Conclusions

- Make recommendations based on conclusions

6.0 References

- Worksafe Australia National Exposure Standards, "Exposure Standards for Atmospheric Contaminants in the Occupational Environment" Third Edition, May 1995
- Building Owners and Managers Association of Australia Guidelines, "Managing Indoor Air Quality", 1994
- Australian Standard 1668.2, "The Use of Mechanical Ventilation and Air Conditioning in Buildings, Part 2 Mechanical Ventilations for Acceptable Indoor Air Quality", 1991
- National Health and Medical Research Council, "Interim National Indoor Air Quality Goals"
- Safework Australia "Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment", NOHSC 3008, (1995) 3rd Edition

Appendix A – Calibration Information For Equipment Used in Monitoring Indoor Air Quality

KENELEC SCIENTIFIC PTY LTD
CALIBRATION LABORATORY

CALIBRATION CERTIFICATE

Form KF 157Rev B

Certificate Number	**2682**	**Date of Test 27 November 2009**
CLIENT	**Airconstruct HVAC Pty Ltd** **8 Carlyle Street** **Mackay QLD 4740**	
Contact:	**David Jones**	
Test Method	**Kenelec test method LABP 1**	
Client Instrument details	**TSI DustTrak Model 8520** **Serial No. 23099**	
Condition as received	*As left*	
Environmental Conditions	Ambient Temp. Humidity Barometric Pressure	26.0°C 48.0%RH 747.0mmHg

Signed _____
Mark Williams
Laboratory Manager

Page 1 - Cover Sheet
Page 2 - Calibration after adjustment

Path: F:\Calibration\Certificates\2009\2682-8520-23099-11-09.doc

Kenelec Scientific
KENELEC SCIENTIFIC PTY LTD ABN 88 064 373 717
23 redland drive mitcham vic 3132
T 1300 73 2233 F 1300 73 2244
info@kenelec.com.au www.kenelec.com.au

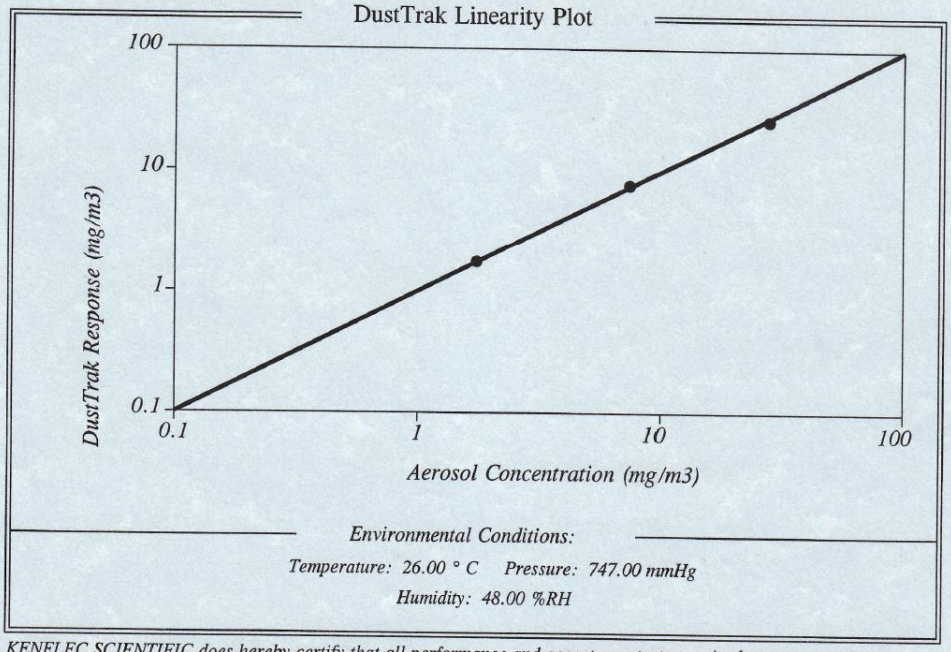
Form KF 157 Rev B

CERTIFICATE OF CALIBRATION AND TESTING

Model 8520 TSI Serial No. 23099

Description DustTrak

Calibration Standard Aerosol Calibration Bench #1



KENELEC SCIENTIFIC does hereby certify that all performance and acceptance tests required were successfully conducted according to required specifications. All test and calibration data supplied by KENELEC SCIENTIFIC has been obtained using respirable mass standard ISO 12103-1 A1 Ultra Fine Test Dust. Prior to calibration the instrument was cleaned and the flow rate was adjusted to 1.70 l/min.

Applicable Test Report	Report Number	Date Last Verified	Date Due
DC Voltage	8786	24-04-09	24-04-10
Barometric Pressure	RGA20148-2	21-04-09	21-04-10

Calibrated by

☐ Final Function Check

27/11/2009 Calibration Date

Kenelec Scientific

KENELEC SCIENTIFIC PTY LTD ABN 88 064 373 717 | 23 redland drive mitcham vic 3132 | T 1300 73 2233 F 1300 73 2244 | info@kenelec.com.au www.kenelec.com.au

- Use either the summer or winter tables, depending on the season air quality is measured in
    - Insert 1 or 2 tables under the results heading

- I recommend using the summary table only if there are outlier readings in the first table – that way you can see if the outlier was due to extremely high outdoor temperature, or due to a rush on a sale or a bushfire outside etc, or some anomaly that made a single reading fall outside of the recommended range, or if one of the unit is consistently under-performing
    - Discuss if you feel the outliers are due to external environmental factors or the performance of individual units