Ventilation Effectiveness Study

at

Jack Bailey's Public House, Wexford

for

The Vintners' Federation of Ireland, The Licensed Vintners' Association & The Irish Hotels Federation

Report by:

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1. Executive Summary

A ventilation study was carried out at the Jack Bailey's Public House, Wexford from Thursday 4th until Friday 5th September 2003. The building, loosely arranged as three rooms benefited from a high level supply and extract ventilation system providing 12-15 air changes per hour.

Levels of Carbon Dioxide, as an indicator of ventilation effectiveness, and Carbon Monoxide and airborne particulates, both constituents of environmental tobacco smoke, were recorded with the ventilation on and off.

The results indicate that with the ventilation on, there is substantial reduction in the levels of the contaminants being monitored.

In conducting the study a number of limitation were identified, and suggestions made to improve the reliability and robustness of any future studies.

2. Introduction

This report presents the findings of a ventilation effectiveness study carried out at the Jack Bailey's Public House, Wexford. Jack Bailey's benefits from a recently installed conventional (high level supply and extract) ventilation system designed to provide 12 – 15 air changes per hour.

Anecdotal evidence from customers and staff suggested that the new ventilation system produced conditions that were significantly better than before the refurbishment was carried out. One member of staff commented that they no longer had to change their clothes at the end of a shift because of the smell of tobacco smoke.

The aim of this report is to quantify the effectiveness of the new ventilation system using real time data recording of a sample of air quality and Environmental Tobacco Smoke markers.

3. Methodology

The monitoring was conducted on a Thursday and Friday as these days were identified as busy days of the week, so avoiding periods of decreased activity. (Particulate monitoring was continued into Saturday and Sunday to confirm this).

Continuous real-time monitoring was carried out to ensure that peak exposure conditions were captured and to measure baseline levels of markers during the overnight period of no occupancy. The sampling devices were located in the bar serving area at a height approximating to the breathing zone. In addition single point readings for some markers were taken in the customer areas during the busy periods.

The sampling devices used were the Dustrak Aerosol Monitor Model 8520 by TSI Inc, using the 2.5 μm inlet conditioner and a flow rate of 1.7 l/min, and the Q-Trak Plus IAQ Monitor Model 8554 by TSI Inc.

During the busy periods an hourly cigarette count was taken. Levels of Carbon Dioxide, Carbon Monoxide and Respirable Suspended Particles (PM 2.5) were recorded. The rationale for this is as follows:

3.1 Carbon Dioxide

Carbon Dioxide is produced wherever people are present in buildings, as a product of respiration. It is therefore usual to use Carbon Dioxide as an indication of the effectiveness of the ventilation system. For the purposes of this study it is important to establish that the ventilation is performing effectively. Levels of CO_2 are not likely to reach levels of health concern for a building in normal use, a figure of 12000 ppm is identified by the World Health Authority as the level of concern (BSRIA Technical Note 2/2002). For comfort level/odour dilution, a CO_2 limit of 1000 ppm is recommended.

3.2 Carbon Monoxide

Carbon Monoxide is a constituent of environmental tobacco smoke (ETS) but is sometimes considered unsuitable as an ETS marker, (as it has other sources). However, in this location and particularly in the evenings, it was considered that this would not be an issue, and that the advantages of ease of real-time recording and the existence of recognised occupational exposure standards outweighed this concern. Additionally any Carbon Monoxide from other sources will make the test conditions more onerous, not less. The long-term exposure limit (8 hour time weighted average) for carbon monoxide is 30 ppm (EH40/2000 Health and Safety Executive).

3.3 Respirable Suspended Particles (PM 2.5)

Respirable suspended particles (PM 2.5) are a constituent of environmental tobacco smoke and serve as a marker.

The long term exposure limit (8 hour time weighted average) for respirable particles is 4 mg/m^3 (EH40 2000 Health and Safety Executive), however figures for traffic related airborne particles currently under review by the Department of Food and Rural Affairs (DEFRA), suggest annual exposure limits of a mean value of 0.04 - 0.05 mg/m^3.

A number of other particle phase or vapour phase markers may be monitored when assessing ventilation performance in dealing with ETS, but to do so in this study would have extended the timescale and costs unacceptably. The aim of this study was to demonstrate the effectiveness of a ventilation system in dealing with ETS and by monitoring a solid, (PM 2.5), and a gaseous, (CO) constituent it is possible to indicate the likely effectiveness of the system for a wider range of constituents. Ultimately it is recommended that a more comprehensive study is undertaken to determine absolutely, the effectiveness of a ventilation system in dealing with ETS.

4. Results

4.1 Carbon Dioxide

The results of the monitoring for CO_2 can be seen in Figures 2 and 4. These results indicate that CO_2 levels overnight fall to ambient levels in fresh air, (around 350 ppm), as would be expected. Figure 4 shows that the ventilation effectively controls the rise in CO_2 levels during the busy evening period, with a peak value of 706 ppm. Figure 2 shows that when the ventilation is out of service, the CO_2 levels rise over time, on this occasion to over 2000 ppm, but when the ventilation is re-instated, the readings return very quickly to their earlier levels, demonstrating the effectiveness of the ventilation system.

4.2 Carbon Monoxide

The results of the monitoring for CO can also be seen in figures 2 and 4. Again these results indicate that levels overnight fall to ambient levels in fresh air, 0 ppm. Figure 4 shows that the ventilation controls the rise in CO levels during the busy evening period to the extent that CO is not detected at a resolution of 0.1 ppm. Figure 2 shows that when the ventilation is out of service, the CO levels rise over time, on this occasion to 6.5 ppm, but when the ventilation is re-instated, the readings return very quickly to their earlier levels.

4.3 **Respirable Suspended Particles** (PM 2.5)

The results for the monitoring for respirable suspended particles (PM 2.5) can be seen in figures 1 and 3. These results show that particle levels overnight fall to values below 0.1 mg/m^3. Figure 3 shows that the ventilation controls the rise in particle levels to 1.3 mg/m^3. Figure 1 shows that when the ventilation is out of service, the particle levels rise, on this occasion to over 6 mg/m^3, but when the ventilation is re-instated, the readings return very quickly to their earlier levels.

4.4 Single point readings in the customer areas

During the test periods a portable CO/CO_2 meter was used to measure concentration levels in the customer areas. When the ventilation was off, the area furthest from the entrance doors experienced levels approximately 10% higher than in the bar serving area, but with the ventilation operating, levels were consistent throughout the building.

5. Analysis of Results

5.1 4th-5th September 2003

Although the original intention was to compare the results over the two evenings, the most striking results were obtained on the first evening when the ventilation was turned on towards the end of the evening. The hourly cigarette count indicated that between 10 pm and midnight, smoking levels were consistently high at over ninety for each hour. In the absence of ventilation the concentrations of all three recorded markers were rising steadily and when the ventilation was turned on a very steep exponential decay was observed, (Figures 1 and 2). The fact that the three recorded markers, both solid and gaseous, responded in the same way suggests that the ventilation would have the same impact on other constituents of ETS.

5.2 5th-6th September 2003

With the hourly cigarette count indicating similar rates of smoking in the middle part of the evening it is reasonable to make comparisons across the two evenings. The Carbon dioxide readings confirm that the ventilation system is working effectively. The bar staff, accustomed to controlling the ventilation rates for their own comfort, decided to turn the fans to full speed at 10 pm. The impact of this is shown in Figures 3 and 4.

6. Conclusions and Recommendations

This study clearly demonstrates the ability of the ventilation system in this building to limit and control the concentrations of the parameters under consideration.

The study has a number of limitations both in terms of the range of markers recorded and the duration of the test period. It does however support the argument for the development of a more comprehensive study to determine the parameters for an acceptable standard for ventilation systems in buildings where there is smoking in or near the building. It is recommended that the following issues be considered in any such study:

- Determination of an appropriate range of ETS markers to be measured
- Determination of an appropriate number of monitoring points
- Determination of an appropriate smoking regime to test against
- Determination of appropriate short term and long term exposure standards.

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for and on behalf of UGCS Ltd

These results are based upon the readings obtained between 4th-5th September 2003 and relate only to the data recorded on the dates when they were recorded.

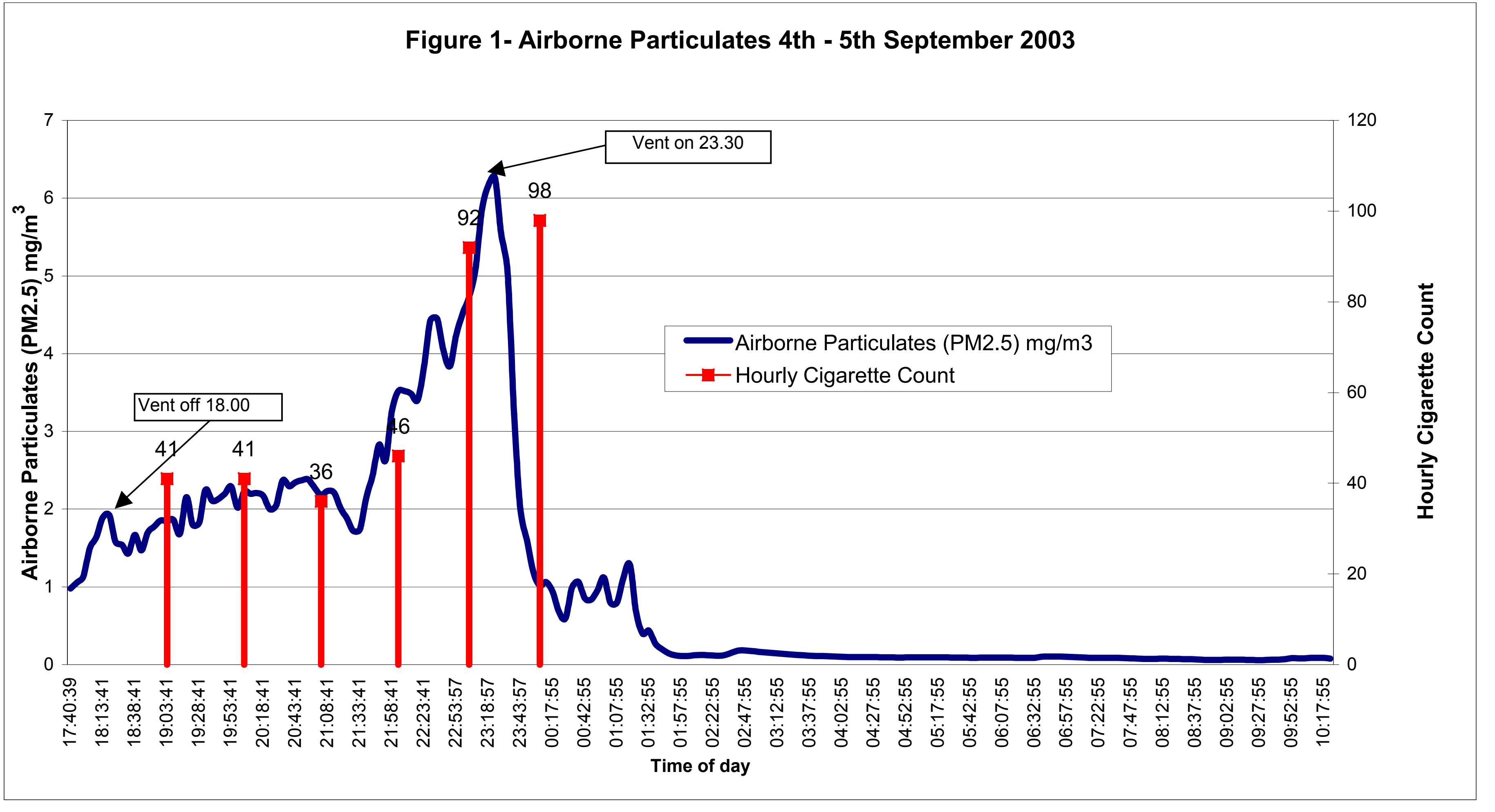
Figure 1- Airborne Particulates 4th - 5th September 2003
Airborne Particulates (PM2.5) mg/m3
Hourly Cigarette Count
Time of day
Vent on 23.30
Vent off 18.00
41
41
36
46
92
98
Airborne Particulates (PM2.5) mg/m3
Hourly Cigarette Count
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120
17:40:39
18:13:41
18:38:41
19:03:41
19:28:41
19:53:41
20:18:41
20:43:41
21:08:41
21:33:41
21:58:41
22:23:41
22:53:57
23:18:57
23:43:57
00:17:55
00:42:55
01:07:55
01:32:55
01:57:55
02:22:55
02:47:55
03:12:55
03:37:55
04:02:55
04:27:55
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09:52:55
10:17:55

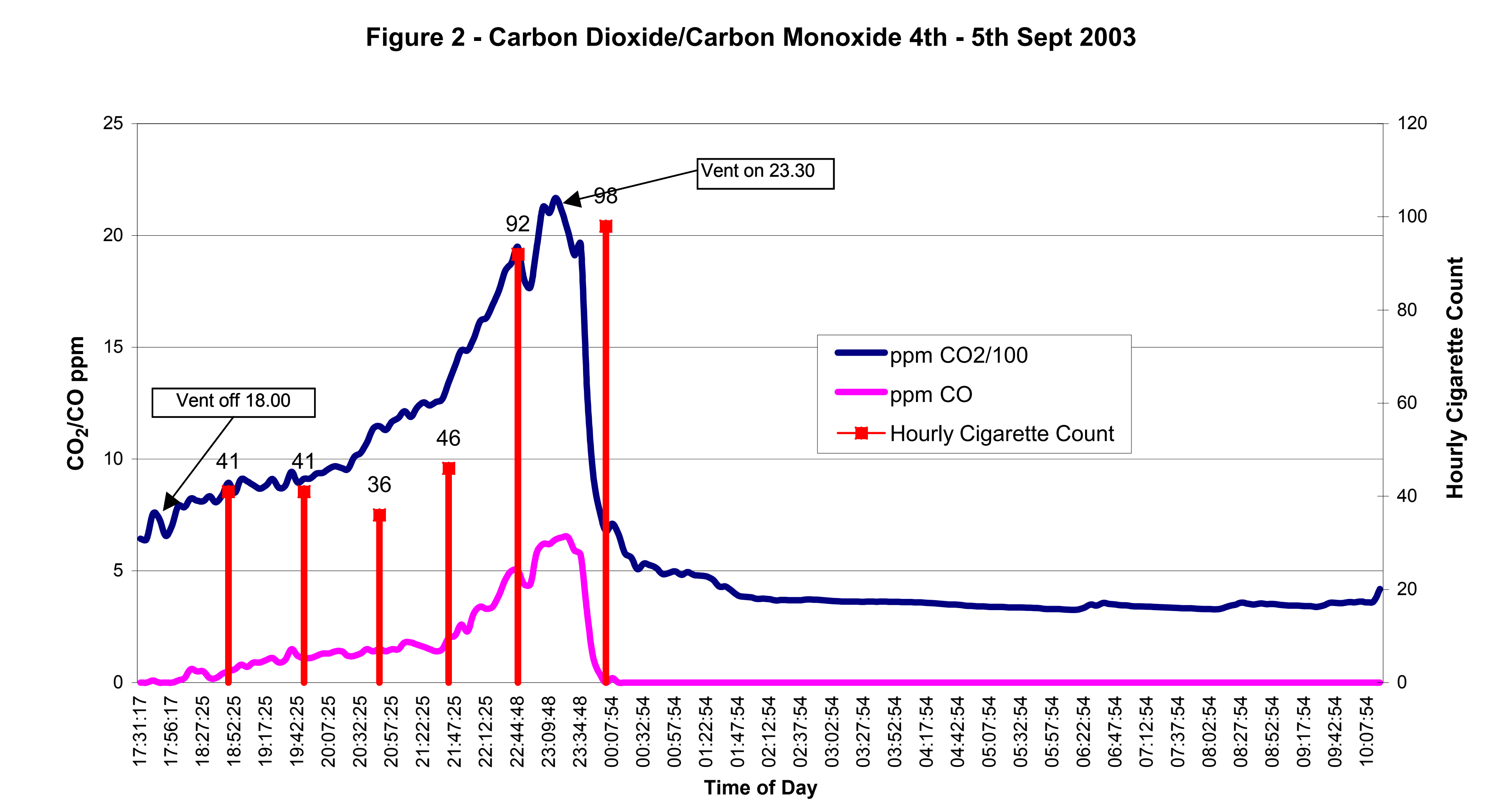
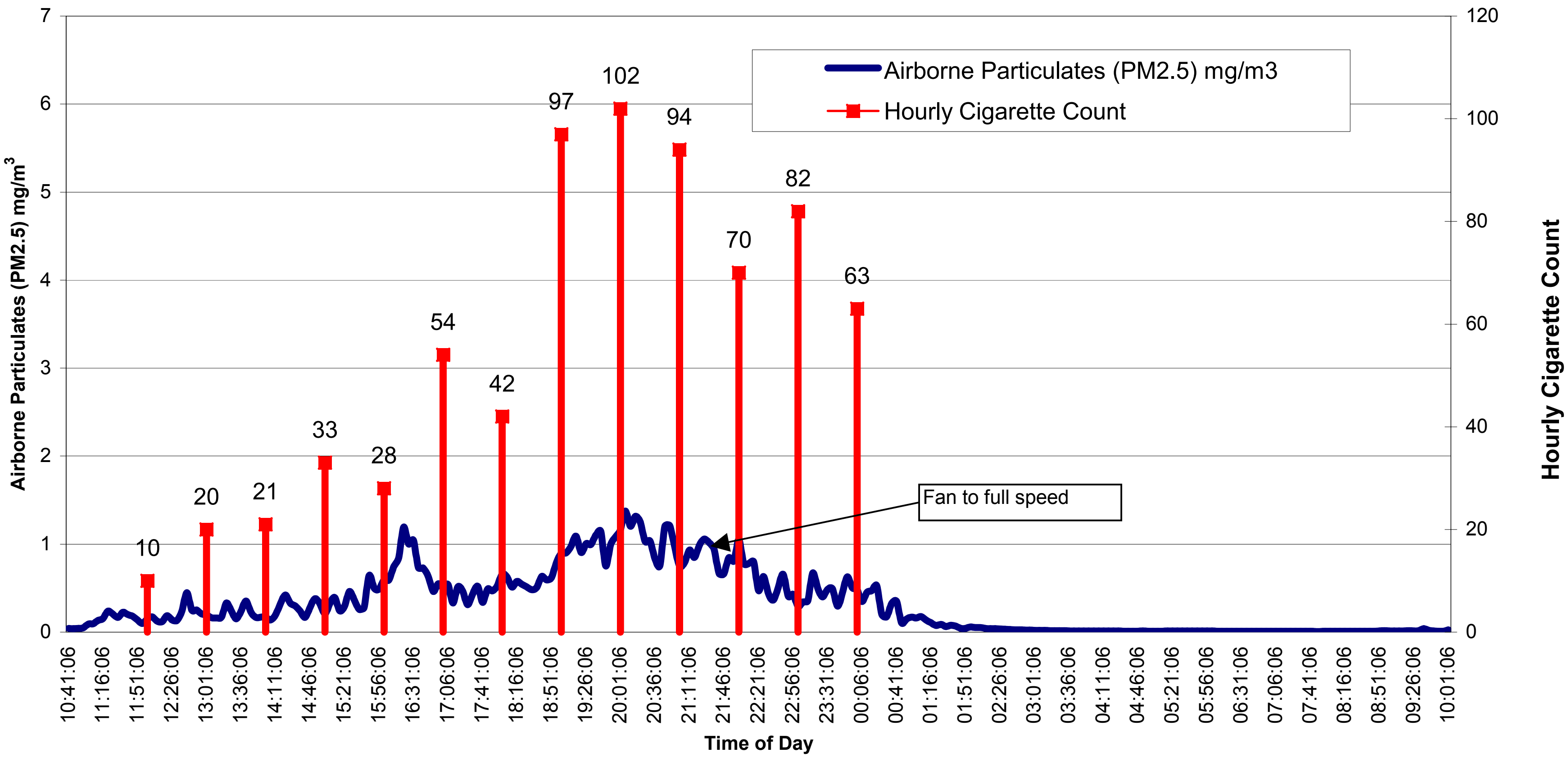


Figure 2 - Carbon Dioxide/Carbon Monoxide 4th - 5th Sept 2003
Vent on 23.30
Vent off 18.00
41
41
36
46
92
98
ppm CO2/100
ppm CO
Hourly Cigarette Count
CO2/CO ppm
Hourly Cigarette Count
Time of Day
0
5
10
15
20
25
0
20
40
60
80
100
120
17:31:17
17:56:17
18:27:25
18:52:25
19:17:25
19:42:25
20:07:25
20:32:25
20:57:25
21:22:25
21:47:25
22:12:25
22:44:48
23:09:48
23:34:48
00:07:54
00:32:54
00:57:54
01:22:54
01:47:54
02:12:54
02:37:54
03:02:54
03:27:54
03:52:54
04:17:54
04:42:54
05:07:54
05:32:54
05:57:54
06:22:54
06:47:54
07:12:54
07:37:54
08:02:54
08:27:54
08:52:54
09:17:54
09:42:54
10:07:54

Figure 3 - Airborne Particulates 5th - 6th September 2003



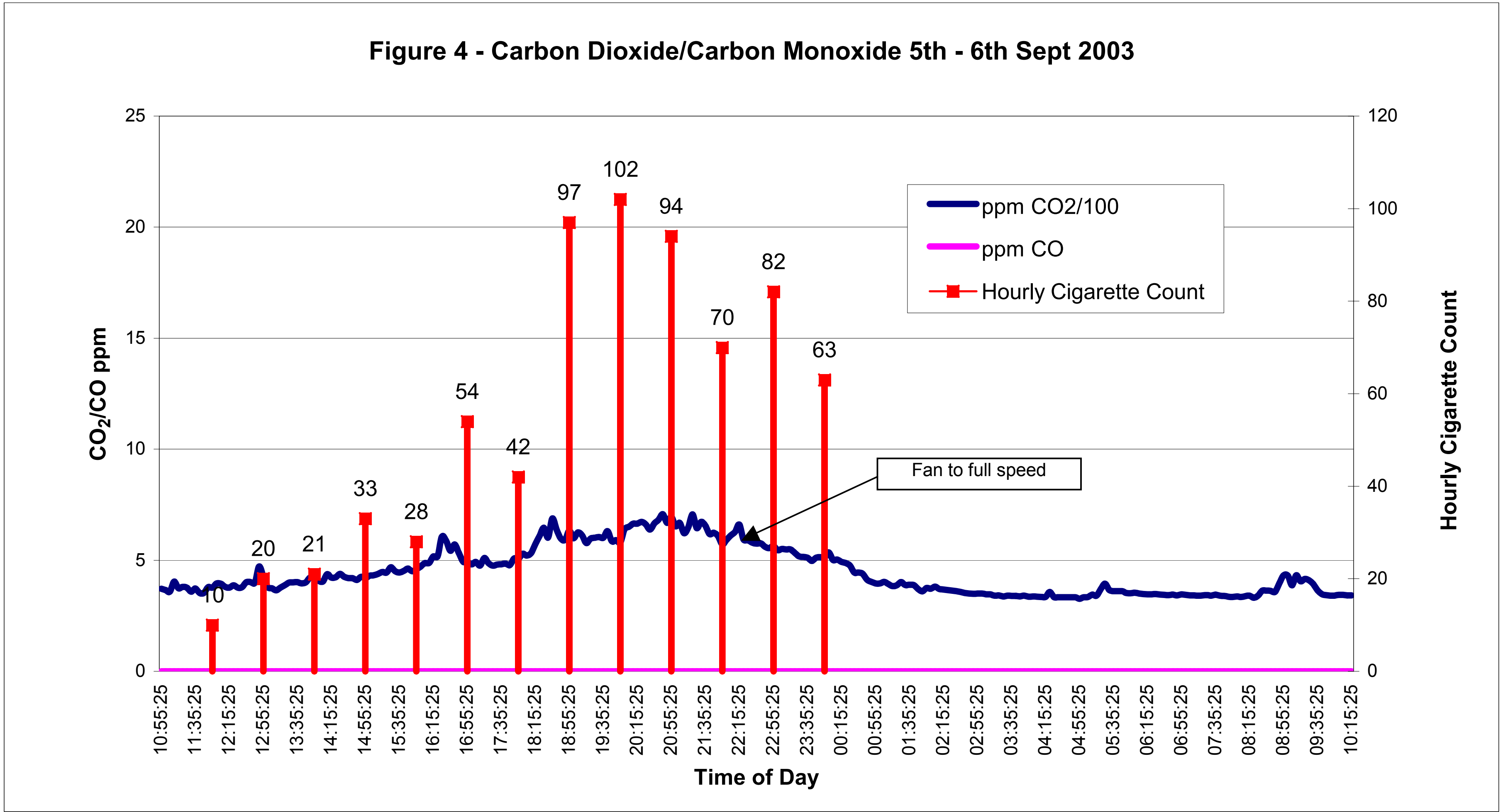


Figure 4 - Carbon Dioxide/Carbon Monoxide 5th - 6th Sept 2003
25
20
15
10
5
0
120
100
80
60
40
20
0
CO_2/CO ppm
Hourly Cigarette Count
ppm CO2/100
ppm CO
Hourly Cigarette Count
Fan to full speed
10
20
21
33
28
54
42
97
102
94
70
82
63
10:55:25
11:35:25
12:15:25
12:55:25
13:35:25
14:15:25
14:55:25
15:35:25
16:15:25
16:55:25
17:35:25
18:15:25
18:55:25
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20:15:25
20:55:25
21:35:25
22:15:25
22:55:25
23:35:25
00:15:25
00:55:25
01:35:25
02:15:25
02:55:25
03:35:25
04:15:25
04:55:25
05:35:25
06:15:25
06:55:25
07:35:25
08:15:25
08:55:25
09:35:25
10:15:25
Time of Day