



Ventilation Effectiveness Study (Phase II)

at

The Duke of York, Hounslow

2nd-3rd October 2003

Report by:

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These results are based upon the readings obtained between the 2nd - 3rd October 2003 and relate only to the data recorded on the dates when they were recorded.

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1. Executive Summary

A ventilation study was carried out at The Duke of York, Hounslow from the 2nd - 3rd October 2003. This study is a follow up to the original study carried out in April 2003.

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 off and on.

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 limitations 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 Duke of York Public House, Hounslow on the 2nd and 3rd October 2003. The Duke of York benefits from a ventilation system designed to provide 12 – 15 air changes per hour.

The back bar ventilation system comprised the following:

1 Vent Axia TX12 Fan – Extract

1 Vent Axia TX9 Fan – Extract

1 Vent Axia TX12 Fan – Supply

1 Vent Axia TX9 Fan – Supply

2 Air quality sensors and 2 Pub Controls

This is a simple ventilation arrangement that does not use any ductwork. The fans operate automatically on low speed and will switch to medium speed at the dictate of the air quality sensor. Manual boost for times of high occupancy is available on the pub controller.

The bar area is long, thin and open plan with no separate areas. Light meals are served at lunch times. The aim of this report is to quantify the effectiveness of the 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. For a brief period during the Friday evening, the ventilation was turned off.

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. Additionally, readings for some markers were taken in a customer area on a continuous basis.

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. The sampling device for the customer area was a Testo M450 IAQ Monitor.

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. Temperature and Relative humidity were also recorded. The rationale for this is as follows:

3.1 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/m³ (EH40 2000 Health and Safety Executive), however figures for traffic related airborne particles currently under review by DEFRA suggest annual exposure limits of a mean value of 0.04 - 0.05 mg/m³. This figure relates to “fresh air” rather than indoor air.

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.

3.2 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 CO₂ 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 CO₂ limit of 1000 ppm is recommended.

3.3 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). The advantages of ease of real-time recording and the existence of recognised occupational exposure standards for Carbon Monoxide 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).

3.4 Temperature and Relative Humidity

There are requirements under Health Safety legislation relating to the provision of a satisfactory thermal environment. Monitoring of these parameters satisfies two objectives, firstly to establish that in improving the air quality the ventilation is not having a negative impact on thermal comfort, and secondly to establish whether it is actually enhancing thermal comfort. Ideally temperatures should be maintained between 19 °C and 24 °C, and relative humidity between 40 and 70%, (CIBSE Guide A, 1999).

4. Results

4.1 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 2. These figures show that with the ventilation running the particulate level is generally limited to less than 0.5 mg/m³. Figure 2 shows that when the ventilation is out of service, the particulate levels rise over time, on this occasion to over 3.5 mg/m³, but when the ventilation is re-instated, the readings return very quickly to their earlier levels. For the levels recorded the time weighted average for any 8 hour period will be below 4 mg/m³. Occasional peaks will occur if smoke is blown directly at the monitoring instrument.

4.2 Carbon Dioxide

The results of the monitoring for CO₂ can be seen in Figures 3 and 4. These results indicate that CO₂ levels overnight fall to ambient levels in fresh air as would be expected. These figures show that with the ventilation running, the CO₂ levels are limited to less than 900 ppm. Figure 4 shows that when the ventilation is out of service, the CO₂ 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.

4.3 Carbon Monoxide

The results of the monitoring for CO can also be seen in figures 3 and 4. Figures 3 and 4 shows that the ventilation controls the rise in CO levels during the busy evening period to between 4 and 6 ppm. Figure 4 shows that when the ventilation is out of service, the CO levels rise over time, on this occasion to 14 ppm, but when the ventilation is re-instated, the readings return very quickly to their earlier levels.

4.4 Temperature and Relative Humidity

The results of the monitoring for temperature and relative humidity can be seen in figures 6 and 7. Temperature and relative humidity are reasonably constant during the monitoring period. The temperature is at the top of the acceptable range for comfort whilst relative humidity levels are satisfactory. During the period when the fans are off on the 3rd, there is a slight increase in temperature and humidity observed. If this increase in temperature were maintained the room would become uncomfortably warm.

4.5 Monitoring in the Customer Areas

The instrumentation for this monitoring was located at a slightly higher position than the equipment behind the bar and hence slightly higher than the breathing zone in order to remain unobtrusive. The installed ventilation system is designed on the principle of mixing and therefore the height difference should not significantly influence the results.

The results of the monitoring for CO₂ and CO can be seen in figure 5. When compared with figure 4 it can be seen that the CO₂ levels are slightly higher in the customer area and the CO levels are significantly higher, reaching 25 ppm when the ventilation is off. This higher level in the customer area may be partly the result of the rear of bar air supply and partly the location of the smokers. When the ventilation is off it is entirely due to the location of the smokers.

The results of the monitoring for temperature and relative humidity can be seen in figure 8. As was the case behind the bar, temperature and relative humidity are reasonably constant during the monitoring period. The temperature is at the top of the acceptable range for comfort whilst relative humidity levels are satisfactory. During the period when the fans are off, there is a slight increase in temperature and humidity observed. If this increase in temperature were maintained the room would become uncomfortably warm.

5. Analysis of Results

5.1 2nd October 2003

The results from the 2nd October when the ventilation was running all evening show that contaminant levels are being controlled for the markers recorded. This is consistent with the findings from the first study.

5.2 3rd October 2003

The cigarette count for the period with the ventilation off was slightly higher than for the same period in the first study. The results show that the ventilation is still controlling the growth of contaminant levels for the markers recorded and that when the ventilation is turned off the levels steadily increase until the ventilation is re-instated. The rate of rise and the peak levels for Particulates and Carbon Monoxide are very similar to those in the first study as is the rapid rate of decay when the fans are re-started.

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, although the air quality behind the bar is better than at customer side of the bar where measurements were taken. This may be of concern where there is no segregation for smoking and non-smoking customers.

The similarity of results in the two studies increases confidence in the results in terms of their repeatability and hence reliability.

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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Figure 1 - Airborne Particulates Bar Side 2nd October (PM2.5) mg/m³

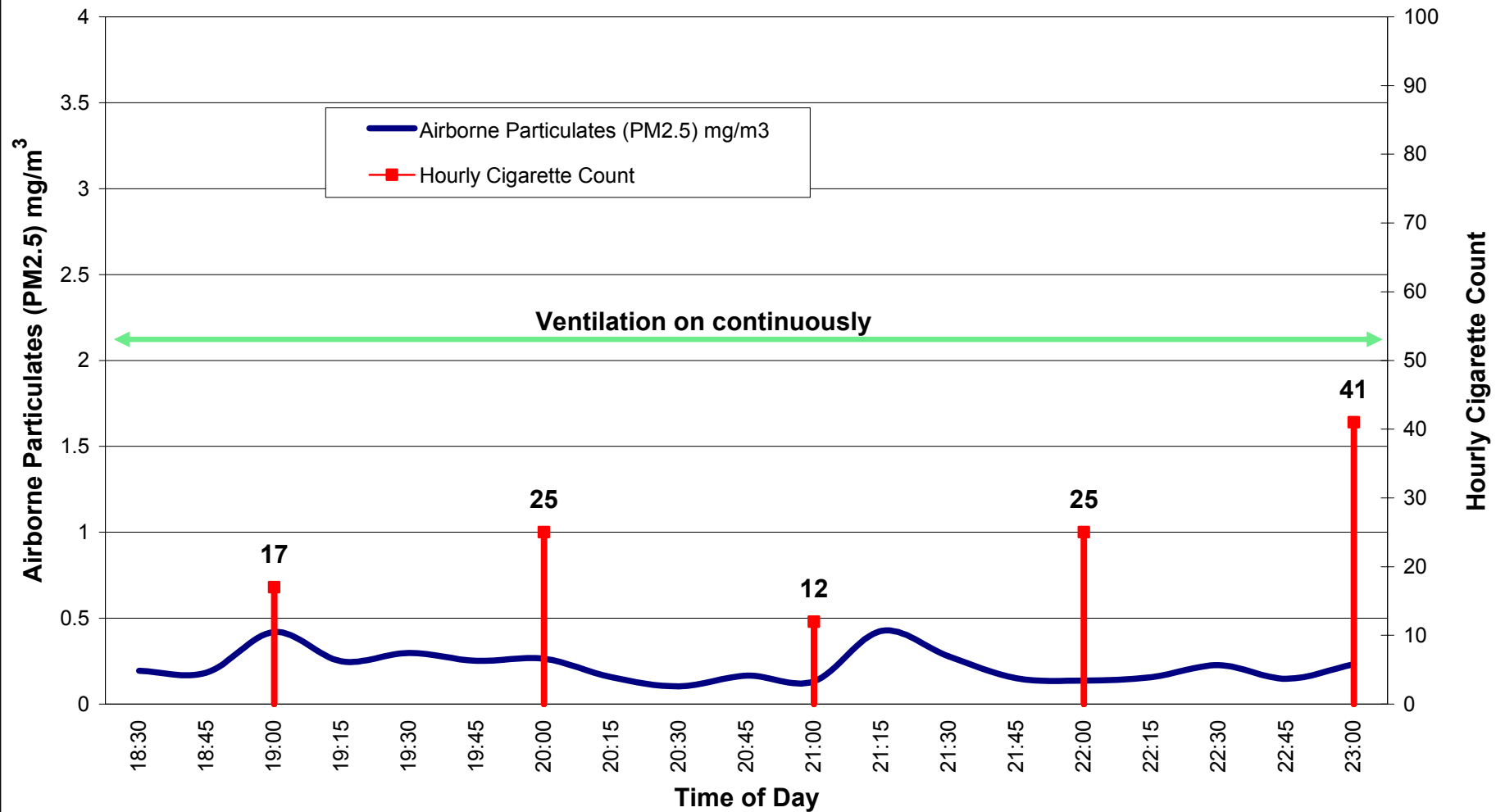


Figure 2 - Airborne Particulates Bar Side 3rd October (PM2.5) mg/m³

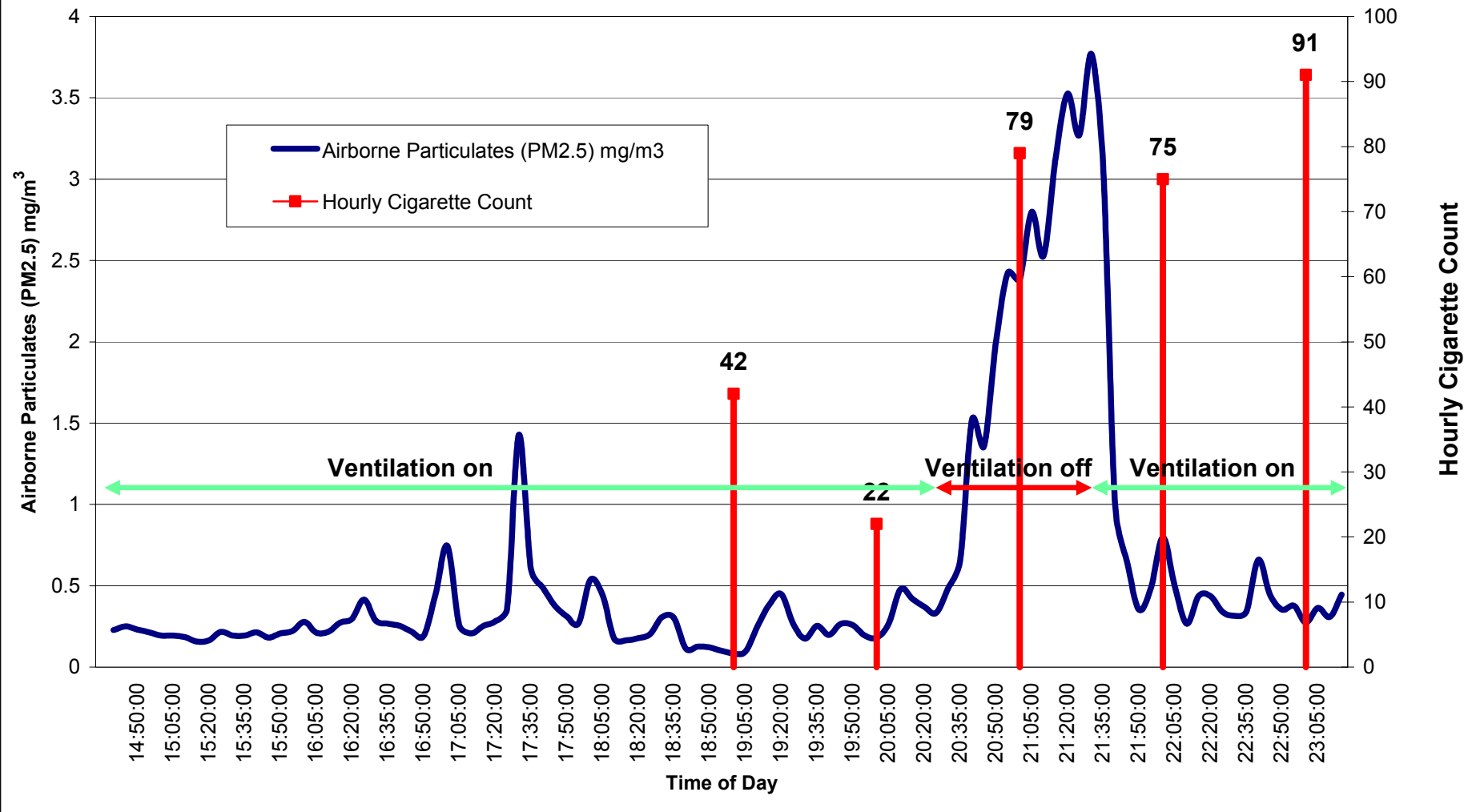


Figure 3 - Carbon Dioxide/Carbon Monoxide Bar Side 2nd October

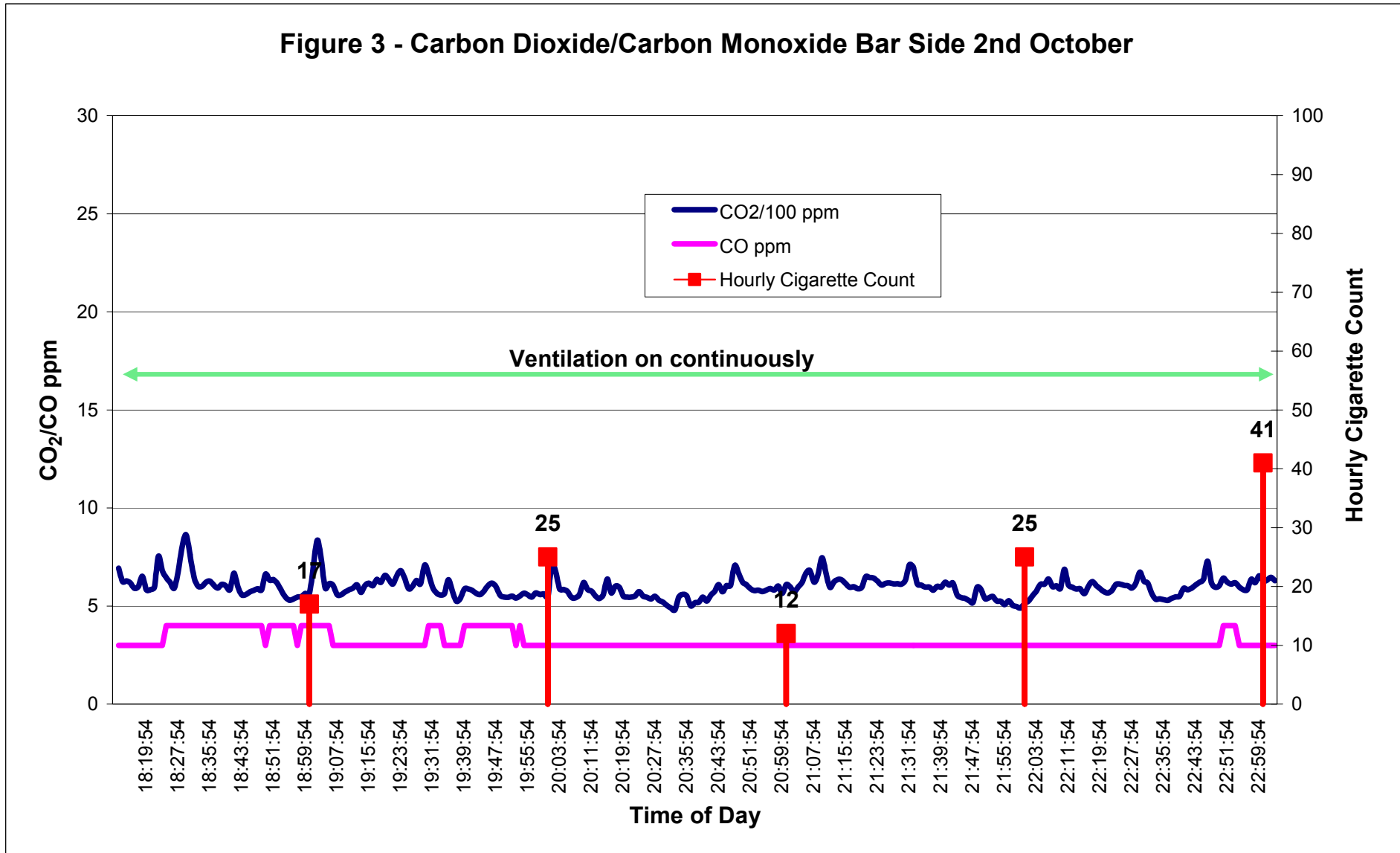


Figure 4 - Carbon Dioxide/Carbon Monoxide Bar Side 3rd October

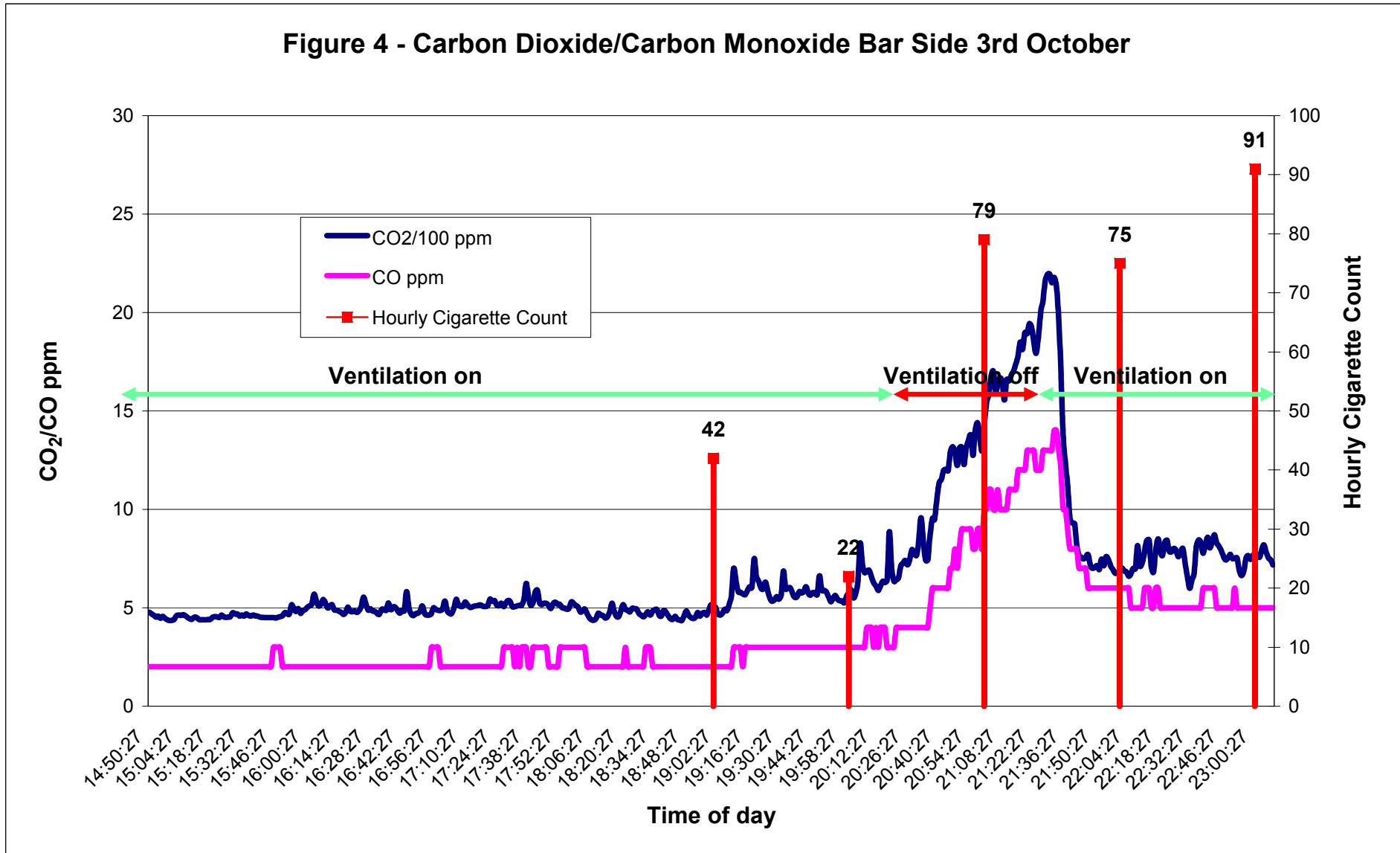


Figure 5 - Carbon Dioxide/Carbon Monoxide Customer Side 3rd October

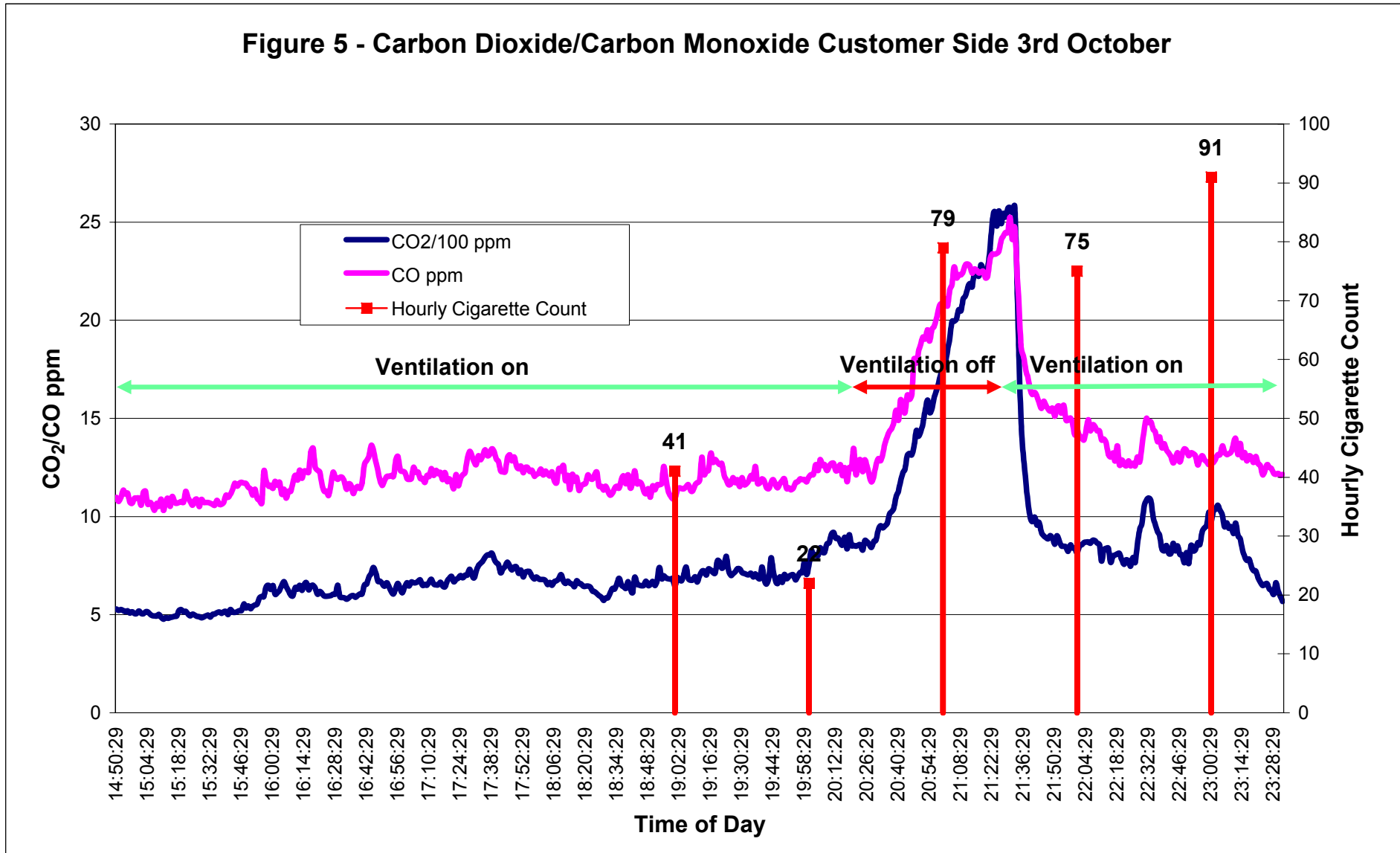


Figure 6 - Temperature/Relative Humidity Bar Side 2nd October

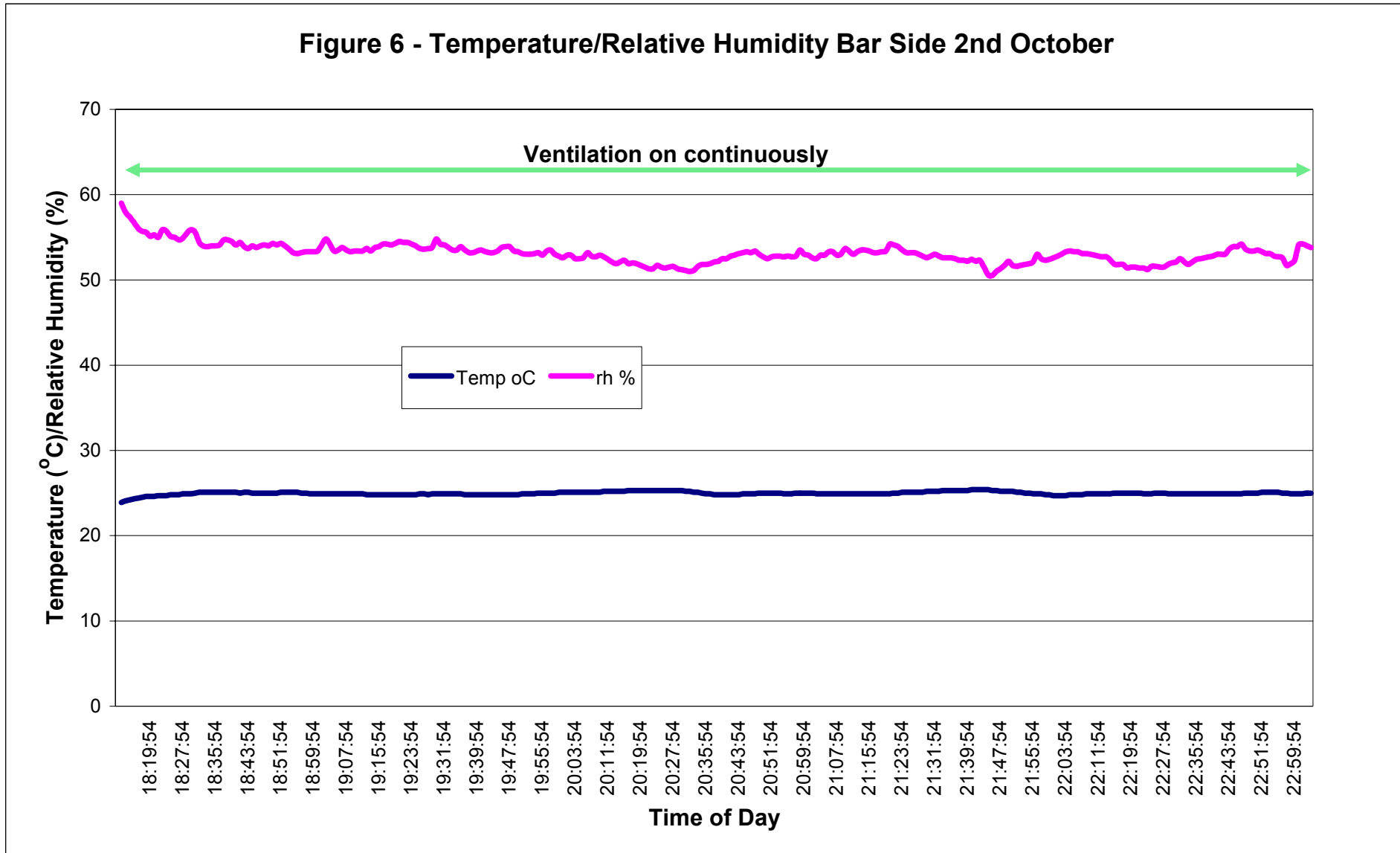


Figure 7 - Temperature/Relative Humidity Bar Side 3rd October 2003

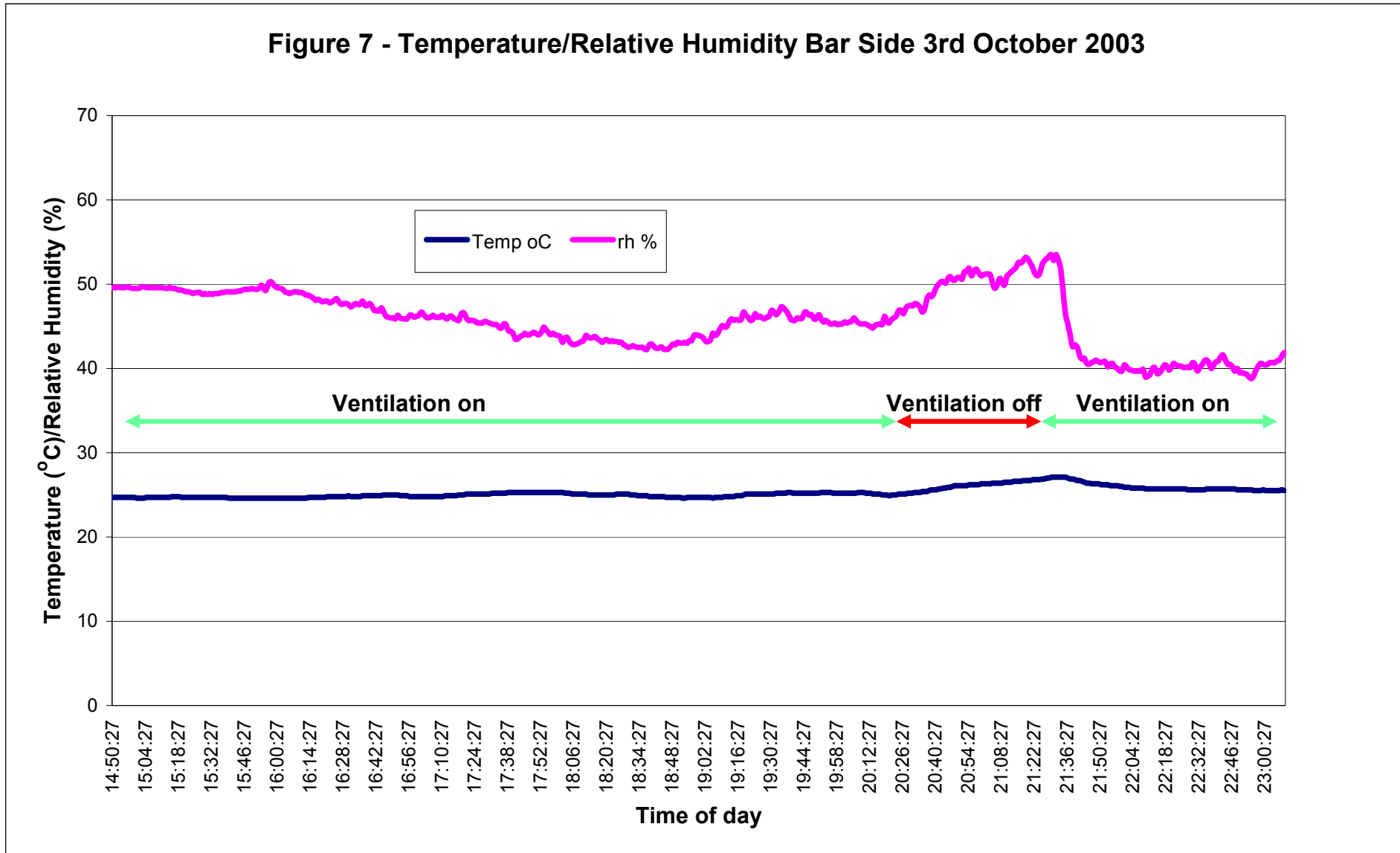


Figure 8 - Temperature/Relative Humidity Customer Side 3rd October

