Measuring Exposure to Second Hand Smoke:

Atmospheric monitoring and personal exposure measurements of hospitality workers in Liverpool

Diane Black, Helen Casstles, Ivan Gee, Andrew Hull, Glyn Mitchell, Andrew Easterbrook and Mark A. Bellis

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Monitoring Exposure to Second Hand Smoke: Atmospheric monitoring and personal exposure measurements of hospitality workers in Liverpool

Diane Black; Helen Casstles; Ivan Gee; Andrew Hull; Glyn Mitchell; Andrew Easterbrook.

1.0 Introduction

Occupational exposure to Second Hand Smoke (SHS) has been linked with several adverse health outcomes including lung cancer, cardiovascular disease and respiratory disease (ASH, 2005).

Research evidence has shown that workers in the hospitality industry particularly in bars are at a high risk of exposure to SHS (Bates et al., 2002 and Siegel & Skeer, 2003). Millions of employees are regularly exposed to SHS in their workplace. It is estimated that 1.3 million workers in the UK are exposed to SHS for at least 75% of their working time (Kauppinen et al., 2000) and at least one employee in the British hospitality industry dies from such exposure each week (Jamorozik, 2005).

The effect of SHS exposure is an ongoing issue in occupational settings, especially for the hospitality industry. At present the UK does not have an occupational exposure standard for SHS, although the Health and Safety at Work Act etc 1974 states that employers have to ensure, so far as reasonably practicable, the health, safety and welfare at work of all their employees (HMSO, 1974).

These high exposure rates associated with hospitality workers (particularly in bars and restaurants) constitute medical cause for establishing smoking policies for the restrictions and banning of smoking in the workplace (Quan, 1998). In the last few years, New York, Italy, Norway and the Republic of Ireland (Public Health (Tobacco) Acts 2002 and 2004) have introduced legislation, banning smoking in workplaces and enclosed public places.

In Liverpool, Smoke Free Liverpool was established in 2003 to take forward the objective of the Liverpool First for Health Strategic Partnership, to make Liverpool a Smoke Free City by 2008 (Smoke Free Liverpool, 2006). Although previous studies have assessed exposure to SHS (Carrington et al., 2003; Bates et al, 2002 and Cenko et al., 2004) such a study has not been carried out within the Liverpool area. This research measures constituents of SHS in the indoor environment of a sample of occupational premises (including bars, restaurants, night clubs and social clubs) in Liverpool and the associated personal exposure of workers within these premises.

1.1 Constituents of SHS

SHS consists of two phases, a particulate and a vapour phase. Some of the compounds released in SHS are within the particulate phase, some are in the vapour phase and others are distributed between the two.
1.2 Particulate phase of SHS

The most commonly used marker to highlight the particulate phase of SHS is respirable suspended particles (RSP) (EPA, 1992). Particulate matter is characterised by its size, in particular the particle’s diameter. Generally a distinction is made between PM\(_{10}\), “thoracic” particles 10 microns or less in diameter and PM\(_{2.5}\), “respirable” particles 2.5 microns or less in diameter. The greatest threat to health is from particles of 2.5 microns or less, as it is these particles which penetrate deep into the respiratory system into the gas exchange region of the lungs (Brunekreef and Holgate, 2002 and Pope, 2000) and may also carry carcinogens into the lungs (Pearce and Crowards, 1996).

Care must be taken when using RSP to determine exposure to SHS as particulates have a number of alternative sources including combustion by-products from cooking and heating and infiltration of particles from outdoor sources (Nelson et al., 1992). To reduce this possible overestimation, other tobacco specific measurements are needed to supplement the RSP measurements.

Tobacco specific derivatives of RSP, including UVPM (ultra-violet particulate matter) and FPM (fluorescent particulate matter), are often used to establish the contribution of tobacco particles to the total RSP (Douce et al., 2001). UVPM is a non-volatile tracer of particulate matter. It is a measure of the ultraviolet absorbance of the methanol extract of particulate matter at 325nm. FPM is a measure of the fluorescence of a methanol extract of particulate matter (Daisey, 1999). These methods however often also overestimate the contribution of SHS as they can include particles from other combustion sources.

Due to these quantification problems solanesol has been identified as a reliable marker for the particles present in SHS, in particular solanesol particulate matter (SolPM) (Tang et al., 1990). Solanesol is a tobacco specific alcohol present in the tobacco leaf (Johnston, 1959) and due to its large molecular weight is only present in the particulate phase of SHS and is easily detectable in air even at low concentrations of SHS (Tang et al., 1990).

1.3 Vapour phase of SHS

Measurement of the vapour phase of SHS is dominated by using the marker nicotine as it is tobacco specific and is released in vast quantities on smoking. The vapour phase of SHS is more detrimental to human health than the particulate phase as gas phase nicotine diffuses more rapidly in air than the particulate phase and will deposit more efficiently in the respiratory tract (Pankow et al., 1997).

Nicotine however has a high affinity for indoor surfaces, relative to other SHS constituents, which could lead to an underestimation of SHS exposures (Nelson et al., 1992). A common alternative marker to nicotine for vapour phase SHS is 3-Ethenylpyridine. This compound is formed by the pyrolysis of nicotine on the burning of tobacco (Nelson et al., 1992).
1.4 Personal exposure to SHS

The eventual human exposure to SHS is dependent on many factors including personal characteristics of the individual being exposed, for example age, gender and current state of health, activity level and breathing rate at the time of exposure (Haroun, 1997).

Personal exposure to SHS is commonly measured by the use of biomarkers. A biomarker quantifies the direct exposure of non-smokers to constituents contained in SHS (Haroun, 1997). Biomarkers refer to cellular, biochemical or molecular measures obtained from human tissue, cells or fluids that show human exposure to air contaminants (EPA, 1992).

Cotinine is a useful biomarker that provides a reliable measure of actual absorption by the body of SHS (Benner et al., 1989). Nicotine within SHS is absorbed into the blood stream and is metabolised (broken down) to cotinine in the liver; the cotinine is released into the blood stream and remains in the body for several days (Watts et al., 1990). The plateau levels of cotinine were found to be directly related to the nicotine intake with cotinine concentrations present in both plasma and saliva reaching a plateau after approximately four hours of exposure (Curvall et al, 1990).

Cotinine concentrations are commonly measured in subjects’ blood, urine and saliva (Leaderer and Hammond, 1991). Levels of cotinine in the body depend on the rate of metabolism of nicotine and the rate of elimination from the body (Benowitz et al., 1983). Saliva is more readily collectable than blood or urine and was the subject of Bates et al study in 2002 with the analysis concluding that those who worked in smoking areas had larger increases in cotinine concentrations than those workers who worked in smoke free places.

In addition to the measurement of constituents of SHS and the associated personal exposure of workers within these premises, this study will address the issue of exposure in relation to smoking restrictions and ventilation status within the premises tested. For the purpose of this study and for analysis the ventilation in premises was classified by four categories: natural ventilation, inlet/outlet ventilation, air conditioning/air cleaning or ducted ventilation.

This study builds on previous research on occupational exposure to SHS. In addition to measuring the personal exposure of hospitality workers via cotinine this study also pilots the use of passive samplers worn on the collar of hospitality workers during their shift to measure their personal exposure to the vapour phase constituents of SHS.
2.0 Aim and objectives

2.1 Aim

To examine risks to health of employees from exposure to SHS in various occupational settings; in particular within the hospitality industry.

2.2 Objectives

To measure the levels of constituent particles of SHS in the indoor environment from a sample of occupational premises within the Liverpool City Council area.

To measure the workers’ personal exposure to SHS by the use of the biomarker cotinine and personal monitors.

3.0 Methodology

Methodology 1- Indoor atmospheric monitoring
Methodology 2- Personal sampling

3.1 Methodology 1- Indoor atmospheric monitoring

Prior to the commencement of the study ethical approval was obtained from the Central Office for Research Ethics Committees (COREC), Liverpool Primary Care Trust.

A random sample of hospitality (licensed) premises in Liverpool was derived from the ‘Flare’ database held by the Environmental Health Department, Liverpool City Council.

The maximum number of premises to be sampled was determined by a power calculation with a required statistical power of 0.8 at 0.05 significance. The expected mean levels of atmospheric SHS levels in bars and offices were obtained from the literature (Siegel and Skeer, 2003) and used in conjunction with approximate variations to calculate a sample size of 64 hospitality premises and fourteen non-smoking occupational premises. (http://calculators.stat.ucla.edu/powercalc/)

Each of the premises selected was initially contacted by letter (appendix 1) outlining the proposed study and requesting their co-operation on a voluntary basis.

Of those premises initially approached, eight refused to take part in the study and three premises were either closed or under refurbishment. To achieve the recommended sample size further premises were randomly selected.

Those premises where the manager agreed to take part in the study were visited by Environmental Health staff to discuss the study and its implications. Consent was obtained from the manager/owner to carry out the testing within their premises (see appendix 2). A time for testing at each of the premises was agreed in advance with the management and was subject to the opening hours of the premises.
Prior to the study, training was given on the correct use of the monitors and the procedures necessary to collect valid samples, including the storing of samples prior to the transfer to the laboratory for analysis.

On the initial visit to the premises, a technical/design inspection (see appendix 3) was conducted to assess the layout of the premises and to identify the method of ventilation, if any, currently in use. The ventilation inlets and outlets were noted, showing the direction of airflow where possible, as this had implications for the positioning of the monitors.

The measurements of indoor SHS were completed on either a Friday or Saturday night (two premises per night) during the period June to October 2005 by Environmental Health staff from Liverpool City Council using validated equipment to standardised methods. A risk assessment was completed for the proposed research for staff exposure to SHS, noise and potential violence using a standard form from the Environmental Health Department, Liverpool City Council (see appendix 4). The risk to Environmental Health staff carrying out this research was deemed to be minimal; visiting premises out of hours is a normal occurrence for Environmental Health staff and appropriate control measures were observed.

A pilot study was competed prior to the start of the study to highlight any potential problems and to ensure the correct sampling procedures were followed.

At each venue an operational audit (see appendix 5) was carried out to determine the position of the monitors, note the number of staff on duty and record other relevant information.

The monitors (SKC Double Take Samplers) simultaneously measured the vapour and particulate phase of SHS over a four-hour period. The vapour phase constituents nicotine and 3-Ethylpyridine were collected using adsorbent tubes to BS 5202-18 (British Standards, 1997)(XAD-4 adsorbent tubes) and the particulate phase constituent, respirable suspended particles (RSP) were collected on a 37mm, 1µm pore size teflon filter by the use of a cyclone to ISO 15593 (British Standards, 2001). The airflow rate was monitored each hour throughout the sampling period and was kept at 2.2 litres per minute for the cyclone and 400ml per minute for the adsorbent tubes.

The SHS monitors were placed at two locations (sufficiently protected to prevent tampering) and the sample heads/inlets were positioned at head height, so far as was reasonably practicable for example on the back of bars rather than on the counters. This enabled continuous monitoring of the levels of both the particulate and vapour phase of SHS.

Each hour, the number of customers using the premises was recorded to allow the occupancy of the particular premises to be determined (Appendix 5).

At the end of the sampling period, the filter cassettes from the monitoring devices were closed with a storage clip, placed in a bag and labelled. The sorbent tubes were sealed with standard covers, placed in a bag and labelled. Both were placed in a cooler box filled with ice to allow transportation. As the testing took place at the weekend, the samples were stored in a freezer at or
below 0°C until Monday morning when the sample were transferred to the Environmental Health Department at Liverpool City Council in a cooler box. The samples were stored in a freezer until collected by the Health and Safety Laboratory for analysis on a fortnightly basis.

Analysis of the samples was carried out by the Health and Safety Laboratory using established sampling and analytical methods. For each particulate filter sample, the overall mass gain and the mass of each analyte was recorded. The samples were analysed using ultraviolet absorbing particulate matter (UVPM), fluorescing particulate matter (FPM) and solanesol related particulate matter (SoPM) methods. For each of the vapour sorbent tubes the mass of 3-Ethenylpyridine and nicotine was recorded. All of the measurements were converted into average concentrations (using the volumes obtained from the filters/sorbent tubes) in air for the four-hour period of monitoring in the premises being tested.

The hospitality premises were categorised by their current smoking policy (smoking throughout, separate designated smoking or non-smoking areas) and ventilation status to determine the effect on the SHS concentrations measured (natural ventilation, inlet/outlet ventilation, air conditioning/air leaning or ducted ventilation).

Indoor atmospheric monitoring of SHS was also conducted at four non-smoking venues to allow comparisons to be made with the measurements taken from the hospitality premises. The procedure for testing was the same as for the hospitality industry - with testing at appropriate times.

3.2 Methodology 2- Personal sampling

The personal exposure of the non-smoking employees to SHS was measured by using the biomarker cotinine. Nicotine from SHS is absorbed into the blood stream and is metabolised to cotinine in the liver.

All of the non-smoking employees working at the chosen premises were approached prior to the start of their work shift, given a brief explanation of the study and invited to take part in the personal monitoring element of the study on a voluntary basis.

The employees who volunteered were then screened to ascertain that they fulfilled the required criteria for the research, i.e. were a non-smoker, (should not have smoked for six months prior to the study) and on the day of the testing were working for at least four hours.

Consent was obtained (appendix 6) from volunteers that met the above criteria. The participants were given a fact sheet (see appendix 7) detailing the proposed study, what was expected of them and who they can contact for additional information.

The participants' age and sex was recorded. Participants were assigned a code, which was used to identify them for the duration of the study, thus assuring confidentiality.

The participants were asked a number of questions by Environmental Health staff (appendix 8) to ascertain their working history within the hospitality
industry to inform the sample. An increased health risk is associated with prolonged exposure to SHS.

A saliva specimen was taken (by means of an oral swab) using an Omni-SAL kit prior to participants starting their shift and a second sample after four hours at work. The participant was asked to take the saliva sample themselves by placing the sampling device (a plastic stick with an absorbent pad attached) under their tongue and to hold it there until the indicator turned blue, taking approximately three minutes.

The first sample taken indicated the subjects existing level of cotinine, and the second sample (taken after four hours) allowed personal exposure to SHS during that four hour period to be measured. Four hours was chosen to be the minimum time as previous research concluded that the cotinine concentrations present in both plasma and saliva reach a plateau after approximately four hours of exposure. The plateau levels of cotinine were found to be directly related to the nicotine intake (Curvall et al., 1990).

Once the participant had supplied the saliva sample, the sampling device was placed in a plastic tube containing a buffer solution, sealed and labelled with the participant’s code number. The samples were stored at room temperature and dispatched to the Health and Safety Laboratory by first class post within 24 hours.

The participants also wore a non-invasive adsorption badge (SKC 3M type 3500 passive samplers) ([http://www.skcinc.com/passive.asp](http://www.skcinc.com/passive.asp)) during their shift. The badge was pinned onto their clothes to measure their personal exposure to atmospheric SHS during their shift (vapour phase, 3-Ethenylpyridine a known marker of SHS).

At the end of the four-hour shift the badges were removed, placed in a bag, labelled and placed in a cooler box filled with ice to allow transportation. As the testing took place at the weekend the samples were stored in a freezer at or below 0°C by the Environmental Health staff completing the testing on the night until Monday morning when the samples were transferred to the Environmental Health Department at Liverpool City Council in a cooler box. The samples were stored in a freezer until collection by the Health and Safety Laboratory for analysis on a fortnightly basis.

The Health and Safety Laboratory carried out analysis on the saliva samples using two aliquots of the sample provided by the participants to allow the individual participants mean saliva cotinine concentration prior to and after four hours at work to be ascertained. The saliva samples were destroyed after analysis and were not used for any other purpose.

The mass of 3-Ethenylpyridine and nicotine was recorded from each personal sampling badge and the results converted into concentrations in air.

Personal monitoring was not completed in non-smoking venues as this was deemed unnecessary.
4.0 Limitations

Excluding the premises that refused to take part in the study could have introduced bias in the sample as it is possible that they could potentially have high levels of tobacco smoke present.

It was not practical to sample all the premises on the same night. With the sampling-taking place from June to October, i.e. during the summer months, the overall exposure to SHS may have been underestimated due to the windows/doors being left open.

Although set criteria were adhered to, as much as practicably possible, the position of the atmospheric monitors varied in each of the premises tested due to the different layouts. The design of premises, its smoking policy and ventilation status may have had an effect on the SHS marker concentrations measured.

The numbers present within the premises on the night of testing may not have been typical for example, due to weather conditions and special events. The classification of ventilation currently in operation at the premises was subjective as often it was difficult by observation to ascertain what systems were in place and if the systems were in working order. Furthermore staff were not always able to identify/confirm if ventilation systems were working.

The atmospheric monitors were positioned out of public view as much as practically possible; it was not however possible to observe the monitors over the full four hour testing period so tampering may have occurred.

A convenience sampling approach was adopted to measure the personal exposure of the employees working within the hospitality premises on the night of testing. By adopting this approach the results may not be statistically representative of all hospitality workers in Liverpool.

Inconsistencies in taking the saliva samples could have been introduced with each participant taking their own sample. To reduce this, participants were supervised by trained Environmental Health staff when taking their saliva sample.

The position of absorbent badges varied for each participant. Where possible set criteria for positioning of the badge was followed.

5.0 Results

For ease of comparison between the different types of hospitality venues, the concentrations of the following SHS markers were only considered in the analysis: Vapour (nicotine), 3-Ethenylpyridine (3-EP), respirable suspended particulates (RSP) and solanesol related particulate matter (SolPM). When the levels of SHS markers were below the level of quantification the concentration was concluded to be half that of the limit of quantification for the particular SHS marker (Baek et al., 1997).
5.1 SHS marker concentrations

The mean concentrations of the SHS markers, measured according to type of venue are shown in table 1. The mean concentrations of all the SHS markers are shown to be generally higher in bars and social clubs compared to the levels measured in restaurants. In particular there is a significant reduction in the concentration of tobacco specific markers SolPM and nicotine measured in restaurants compared to bars (the mean SolPM and nicotine concentrations measured in restaurants are found to be 25% and 20% respectively of that found in bars). This reduction is not as noticeable (only 40% reduction) when considering the mean RSP concentrations as restaurants could potentially have high levels of RSPs due to other sources including cooking. The levels of SHS markers found in social clubs are of the same order of magnitude of the levels found in bars.

The mean levels of the SHS markers measured are noticeably higher when compared with levels measured in the non-smoking venues (table 2 and figure 1). The box plots show that for bars there are many more venues with high levels of SHS markers.

<table>
<thead>
<tr>
<th>SHS marker</th>
<th>Bars (n=35)</th>
<th>Restaurants (n=9)</th>
<th>Social clubs (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>24.5 µg/m³</td>
<td>5.0 µg/m³</td>
<td>16.0 µg/m³</td>
</tr>
<tr>
<td></td>
<td>57.0 µg/m³</td>
<td>10.7 µg/m³</td>
<td>53.0 µg/m³</td>
</tr>
<tr>
<td>3-EP</td>
<td>6.4 µg/m³</td>
<td>2.1 µg/m³</td>
<td>3.6 µg/m³</td>
</tr>
<tr>
<td></td>
<td>20.6 µg/m³</td>
<td>7.4 µg/m³</td>
<td>10.8 µg/m³</td>
</tr>
<tr>
<td>RSP</td>
<td>172.9 µg/m³</td>
<td>107.8 µg/m³</td>
<td>133.2 µg/m³</td>
</tr>
<tr>
<td></td>
<td>405.0 µg/m³</td>
<td>290.0 µg/m³</td>
<td>305.0 µg/m³</td>
</tr>
<tr>
<td>SolPM</td>
<td>439 µg/m³</td>
<td>10.2 µg/m³</td>
<td>48.4 µg/m³</td>
</tr>
<tr>
<td></td>
<td>174.5 µg/m³</td>
<td>76.0 µg/m³</td>
<td>213.0 µg/m³</td>
</tr>
</tbody>
</table>

Table 1. Descriptive statistics for SHS markers categorised by type of venue.

<table>
<thead>
<tr>
<th>SHS marker</th>
<th>Non-smoking venues (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>1.5 µg/m³</td>
</tr>
<tr>
<td>3-EP</td>
<td>0.4 µg/m³</td>
</tr>
<tr>
<td>RSP</td>
<td>29.4 µg/m³</td>
</tr>
<tr>
<td>SolPM</td>
<td>1.5 µg/m³</td>
</tr>
</tbody>
</table>

Table 2. Descriptive statistics for the SHS markers in non-smoking venues
Figure 1. Boxplots to show the levels of each SHS marker categorised by type of venue (outliers removed)
Differences in the mean concentrations of all the tobacco specific SHS markers (Nicotine, 3-EP and SolPM) measured in bars compared to restaurants were found to be statistically significant when examined using a non-parametric Mann-Whitney test (p value<0.05). The results of the test are illustrated in table 3. There was no significance difference between the mean concentrations of RSP between bars and restaurants.

<table>
<thead>
<tr>
<th>SHS Marker</th>
<th>Mean Bars (µg/m^3)</th>
<th>Mean Restaurants (µg/m^3)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>24.5</td>
<td>5.0</td>
<td>-3.987</td>
<td>0.000</td>
</tr>
<tr>
<td>3-EP</td>
<td>6.4</td>
<td>2.1</td>
<td>-3.073</td>
<td>0.002</td>
</tr>
<tr>
<td>RSP</td>
<td>172.9</td>
<td>107.8</td>
<td>-2.169</td>
<td>0.30</td>
</tr>
<tr>
<td>SolPM</td>
<td>43.9</td>
<td>10.2</td>
<td>-2.250</td>
<td>0.024</td>
</tr>
</tbody>
</table>

Table 3. Results of significance tests comparing the mean levels of SHS markers in bars and restaurants (statistically significant results in bold).

Measurements of the above SHS markers were also completed in night clubs, in which relatively high levels of tobacco constituents were recorded. However due to the small sample size (n=3) these measurements have not been included in the analysis as they may not be typical.

5.2 Smoking Policy

Due to the larger sample size for bars the levels of SHS markers were considered by smoking policy. The bars were classified as either venues that allowed smoking throughout or venues with separate designated smoking and non-smoking areas. Table 4 shows the mean levels of the SHS markers detected in both kind of venue and figure 2 shows the range of concentrations measured.

<table>
<thead>
<tr>
<th>SHS marker</th>
<th>Smoking throughout (29)</th>
<th>Designated areas (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>Mean (µg/m^3)</td>
<td>Range (µg/m^3)</td>
</tr>
<tr>
<td>3-EP</td>
<td>6.1</td>
<td>20.6</td>
</tr>
<tr>
<td>RSP</td>
<td>178.6</td>
<td>405.0</td>
</tr>
<tr>
<td>SolPM</td>
<td>41.4</td>
<td>174.5</td>
</tr>
</tbody>
</table>

Table 4. Descriptive statistics for statistics for the SHS markers in bars categorised by smoking policy.
Figure 2. Boxplots to show the levels of each SHS marker categorised by smoking policy of bar (outliers removed).
The data suggests that for the tobacco specific markers (nicotine, 3-EP and SolPM) levels at the bar in premises with designated areas were higher than premises allowing smoking throughout. However these differences were not statistically significant. The results of the non-parametric Mann-Whitney test are illustrated in table 5.

<table>
<thead>
<tr>
<th>SHS Marker</th>
<th>Mean smoking throughout (µg/m^3)</th>
<th>Mean designated areas (µg/m^3)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>22.9</td>
<td>32.00</td>
<td>-1.576</td>
<td>0.115</td>
</tr>
<tr>
<td>3-EP</td>
<td>6.1</td>
<td>7.6</td>
<td>-1.183</td>
<td>0.237</td>
</tr>
<tr>
<td>RSP</td>
<td>178.6</td>
<td>145.4</td>
<td>-0.744</td>
<td>0.457</td>
</tr>
<tr>
<td>SolPM</td>
<td>41.4</td>
<td>56.2</td>
<td>-1.165</td>
<td>0.244</td>
</tr>
</tbody>
</table>

Table 5. Results of significance tests comparing the mean levels of SHS markers in bars with designated areas and bars that allow smoking throughout.

5.3 Ventilation status

The bars were categorised by the type of ventilation currently in use (natural ventilation, inlet/outlet ventilation, air conditioning/air cleaning or ducted ventilation). Table 6 shows the levels of SHS constituents dependent on the type of ventilation currently in use at the premises and figure 3 the range of SHS marker concentrations measured.

<table>
<thead>
<tr>
<th>SHS marker</th>
<th>Natural ventilation (12)</th>
<th>Inlet/outlet ventilation (4)</th>
<th>Air conditioning/Air cleaning (12)</th>
<th>Ducted ventilation (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>Mean (µg/m^3)</td>
<td>Range (µg/m^3)</td>
<td>Mean (µg/m^3)</td>
<td>Range (µg/m^3)</td>
</tr>
<tr>
<td>3-EP</td>
<td>24.9</td>
<td>55.5</td>
<td>25.2</td>
<td>47.0</td>
</tr>
<tr>
<td>RSP</td>
<td>5.7</td>
<td>12.2</td>
<td>6.6</td>
<td>12.0</td>
</tr>
<tr>
<td>SolPM</td>
<td>181.5</td>
<td>280.0</td>
<td>200.0</td>
<td>195.0</td>
</tr>
</tbody>
</table>

Table 6. Descriptive statistics for statistics for the SHS markers in bars categorised by ventilation status.
Figure 3. Boxplots to show the levels of each SHS marker categorised by ventilation (outliers removed).
The data indicates that there are lower mean RSP concentrations in bars with ducted ventilation but this is not apparent for tobacco specific markers (nicotine, 3-EP and SolPM). However there was found to be no significant difference in the mean SHS concentrations in bars that had natural ventilation compared with bars that had air conditioning or bars that had ducted ventilation (table 7&8).

<table>
<thead>
<tr>
<th>SHS Marker</th>
<th>Mean natural ventilation (12) (µg/m³)</th>
<th>Mean air conditioning (12) (µg/m³)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>24.9</td>
<td>26.1</td>
<td>-0.462</td>
<td>0.644</td>
</tr>
<tr>
<td>3-EP</td>
<td>5.7</td>
<td>6.6</td>
<td>-0.607</td>
<td>0.544</td>
</tr>
<tr>
<td>RSP</td>
<td>181.5</td>
<td>155.8</td>
<td>-0.607</td>
<td>0.544</td>
</tr>
<tr>
<td>SolPM</td>
<td>43.5</td>
<td>41.0</td>
<td>-0.116</td>
<td>0.908</td>
</tr>
</tbody>
</table>

Table 7. Results of significance tests comparing the mean levels of SHS markers in bars with natural ventilation and bars that have air conditioning.

<table>
<thead>
<tr>
<th>SHS Marker</th>
<th>Mean natural ventilation (12) (µg/m³)</th>
<th>Mean ducted ventilation (7) (µg/m³)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>24.9</td>
<td>20.5</td>
<td>-0.592</td>
<td>0.554</td>
</tr>
<tr>
<td>3-EP</td>
<td>5.7</td>
<td>7.2</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>RSP</td>
<td>181.5</td>
<td>172.1</td>
<td>-0.211</td>
<td>0.833</td>
</tr>
<tr>
<td>SolPM</td>
<td>43.5</td>
<td>42.3</td>
<td>-0.085</td>
<td>0.932</td>
</tr>
</tbody>
</table>

Table 8. Results of significance tests comparing the mean levels of SHS markers in bars with natural ventilation and bars that have ducted ventilation.

5.4 Personal monitoring

In addition to the atmospheric monitors measuring the ambient levels of the SHS marker compounds within the various hospitality premises, passive samplers measured the associated personal exposure of the employees within these premises at the time of testing to the vapour phase of SHS.

Table 9 shows the mean levels of nicotine and 3-EP measured by the personal monitors. As with the atmospheric monitoring, the mean levels of these markers are found to be higher within the bars, social clubs and night clubs compared with the restaurants. In particular the mean nicotine levels in restaurants were found to be 20% of that found in the bars.

<table>
<thead>
<tr>
<th>Personal monitors-bars (60)</th>
<th>Personal monitors-Restaurants (20)</th>
<th>Personal monitors-social clubs (10)</th>
<th>Personal monitors-night clubs (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHS marker</td>
<td>Mean (µg/m³) Range (µg/m³)</td>
<td>Mean (µg/m³) Range (µg/m³)</td>
<td>Mean (µg/m³) Range (µg/m³)</td>
</tr>
<tr>
<td>Nicotine</td>
<td>18.0 54.0</td>
<td>3.8 11.6</td>
<td>12.3 45.8</td>
</tr>
<tr>
<td>3-EP</td>
<td>7.6 31.0</td>
<td>1.4 2.0</td>
<td>4.7 12.8</td>
</tr>
</tbody>
</table>

Table 9. Descriptive statistics for the SHS markers categorised by venue type.
Due to the large sample size, the mean SHS marker concentrations obtained from the personal badges worn by employees within bars were categorised by the smoking status of the venue the employee was working in at the time of testing. The results are illustrated in table 10 and figure 4.

<table>
<thead>
<tr>
<th>SHS marker</th>
<th>Smoking throughout (48)</th>
<th>Designated areas (12)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (µg/m³)</td>
<td>Range (µg/m³)</td>
</tr>
<tr>
<td>Nicotine</td>
<td>17.0</td>
<td>54.0</td>
</tr>
<tr>
<td>3-EP</td>
<td>7.2</td>
<td>31.0</td>
</tr>
</tbody>
</table>

Table 10. Descriptive statistics for the SHS markers measured by personal monitors categorised by smoking status

![Mean Vapour (nicotine, µgm⁻³)](image1)

![Mean 3-EP (µgm⁻³)](image2)

Figure 4. Boxplots to show the levels of each SHS marker measured by personal monitors categorised by smoking status of bar (outliers removed).

As also indicated by the atmospheric measurements (figure 1), it appears that employees working within bars categorised as having designated smoking and non-smoking areas are shown to have greater exposure to the tobacco specific SHS marker compounds nicotine and 3-EP, than employees working in bars that allow smoking throughout. This relationship has however not been shown to be statistically significant for either nicotine or 3-EP concentrations (table 11).
Table 11. Results of significance tests comparing the mean levels of personal exposure to SHS markers in bars with designated areas and bars that allow smoking throughout.

In addition the mean SHS marker concentrations obtained from the personal badges worn by employees within bars were categorised by the ventilation currently in operation at the venue the employee was working in at the time of testing. The results are illustrated in table 12 and figure 5.

<table>
<thead>
<tr>
<th>SHS Marker</th>
<th>Mean smoking throughout (µg/m³)</th>
<th>Mean designated areas (µg/m³)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>17.0</td>
<td>21.8</td>
<td>-1.323</td>
<td>0.186</td>
</tr>
<tr>
<td>3-EP</td>
<td>7.2</td>
<td>9.1</td>
<td>-0.853</td>
<td>0.394</td>
</tr>
</tbody>
</table>

Table 12. Descriptive statistics for the SHS markers measured by personal monitors categorised by ventilation currently in use.

<table>
<thead>
<tr>
<th>SHS marker</th>
<th>Natural ventilation (16)</th>
<th>Inlet/outlet ventilation (6)</th>
<th>Air conditioning/Air cleaning (25)</th>
<th>Ducted ventilation (13)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (µg/m³)</td>
<td>Range (µg/m³)</td>
<td>Mean (µg/m³)</td>
<td>Range (µg/m³)</td>
</tr>
<tr>
<td>Nicotine</td>
<td>12.1</td>
<td>35.0</td>
<td>13.4</td>
<td>26.5</td>
</tr>
<tr>
<td>3-EP</td>
<td>4.8</td>
<td>12.0</td>
<td>5.7</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Figure 5. Boxplots to show the levels of each SHS marker measured by personal monitors categorised by ventilation currently in use in the bar (outliers removed).
A significant difference was found when comparing the mean levels of 3-EP measured by the personal monitors in bars with natural ventilation compared to bars with air conditioning (table 13) and compared to the bars with ducted ventilation (table 14). However when considering the mean levels of nicotine measured by the personal monitors there was no significant difference.

<table>
<thead>
<tr>
<th>SHS Marker</th>
<th>Mean natural ventilation (12) (µg/m³)</th>
<th>Mean air conditioning (12) (µg/m³)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>12.1</td>
<td>16.8</td>
<td>-1.485</td>
<td>0.137</td>
</tr>
<tr>
<td>3-EP</td>
<td>4.8</td>
<td>7.7</td>
<td>-2.855</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Table 13. Results of significance tests comparing the mean levels of SHS markers from personal monitors in bars with natural ventilation and bars that have air conditioning.

<table>
<thead>
<tr>
<th>SHS Marker</th>
<th>Mean natural ventilation (12) (µg/m³)</th>
<th>Mean Ducted ventilation (13) (µg/m³)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>12.1</td>
<td>29.5</td>
<td>-1.505</td>
<td>0.132</td>
</tr>
<tr>
<td>3-EP</td>
<td>4.8</td>
<td>11.7</td>
<td>-2.468</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Table 14. Results of significance tests comparing the mean levels of SHS markers from personal monitors in bars with natural ventilation and bars that have ducted ventilation.

5.5 Cotinine results

On analysis of the cotinine concentrations there appeared to be no clear pattern in the results obtained. This could be possibly due to problems with the analytical methods used, the storage and transportation of the samples or inconsistencies in the sampling procedure.

6.0 Discussion

This study provides a snapshot of SHS levels within a number of hospitality premises in Liverpool on a particular night of testing, therefore the ability to generalise the results is limited.

However, high levels of all the SHS marker compounds were found in a number of bars, restaurants and social clubs compared to the non-smoking venues tested. In particular the tobacco specific compounds (SolPM, nicotine) were found to be noticeably higher in bars in comparison to restaurants. This could be explained by increased numbers of smokers in bars or by the culture that is apparent in restaurants, with many smokers only lighting up after their meal or between courses rather than smoking during the whole evening as in a pub.

For the tobacco specific SHS markers (nicotine, 3-EP and SolPM), the mean levels are shown to be higher (or very similar) in the venues that have
separate designated smoking and non-smoking areas compared to those that allow smoking throughout. This would appear to be contradictory but can be explained by considering the layout in most bars with designated areas (figure 7). In general these venues have a small non-smoking area directly in front of the bar, with the majority of smokers congregating next to this in the smoking area, increasing exposure to SHS at the bar with the non-smoking area furthest from the bar. Nicotine is less mobile (Carrington et al., 2003) than the particulate phase therefore it tends to stay in the smoking area, increasing the exposure to SHS to staff working at the bar.

![Diagram](image)

Figure 7. Typical layout of pub with designated smoking and non-smoking areas.

The levels of SHS markers found within the hospitality premises in Liverpool are comparable with levels measured in previous research studies. Carrington et al., 2003 found that SHS marker concentrations were higher in smoking areas compared to non-smoking areas in a sample of pubs in Greater Manchester and Cenko et al., 2004 showed the average concentrations of nicotine and particulates were higher in smoking areas compared to dining areas, with approximately a twofold reduction of SHS within non-smoking areas.

In addition employees were found to be exposed to high levels of SHS during their shift within hospitality premises that allowed some degree of smoking compared to venues that were smoke free. This was found to be true for venues that allowed smoking throughout and venues that had separate designated smoking and non-smoking areas. This is in agreement with the link highlighted by Bates et al in 2002 between SHS exposure and smoking policy in the workplace. Analysis concluded that the hospitality workers who completed their shift in premises in which smoking was allowed throughout had more significant increases in cotinine (a marker for SHS exposure) than for those who worked in smoke free work places.

When the bars were classified by the type of ventilation currently in use at the premises there was found to be no significant difference in the SHS marker concentrations within the bars that had natural ventilation and those that had either air conditioning or ducted ventilation. This result suggests that the types of ventilation system currently in use in bars are not adequate for the removal of SHS.

Previous studies have shown that unenclosed non-smoking areas had higher SHS concentrations than non-smoking areas that were separately enclosed from smoking-permitted areas (Cenko et al., 2004). This was again
highlighted in a study by Mulcahy published in 2001 conducted in Ireland. It was concluded that not only were bar ventilation systems unable to maintain SHS at low levels but it was so out of control that extremely high levels of Carbon Monoxide were found in two out of 14 bars tested (Mulcahy, 2001).

At the onset of this research study the Government White Paper, Choosing Health 2004, proposed a staged approach for the implementation of a smoking ban in enclosed public places and workplaces by 2008. This strategy exempted non-food serving premises, which would leave a large number of employees still exposed to SHS. However after a recent vote by MPs in relation to the proposals outlined in the white paper, smoke free legislation, banning smoking in all workplaces and public places is set to be introduced in the UK in 2007.

This comprehensive smoke free legislation will protect all workers from the harmful effects of SHS and will create the right environment to encourage people to quit, reducing the current smoking prevalence. Levels of RSP have been shown to decrease substantially in western New York hospitality venues after the implementation of the smoking law that requires almost all workplaces and public places to be smoke free, thus suggesting that improvements can be made within months of policy implementation (Travers et al., 2004). Previous studies carried out in New York (MMWR, 2004) and Italy (Giuseppe., et al., 2005) have shown significant reductions in SHS concentrations in hospitality venues after smoking legislation.

Reductions in salivary cotinine levels of bar workers (reduction of 80%) have been shown in the Republic of Ireland since the introduction of the comprehensive smoke free laws (Public Health (Tobacco) Acts 2002 and 2004) covering all indoor workplaces including bars and restaurants offering non-smoking bar workers significant protection from exposure to SHS (Allwright et al., 2005). This was also supported in a recent study (Mulcahy et al., 2005) which assessed the SHS exposure to hotel workers. Significant reductions in saliva cotinine concentrations (70%) were observed following the smoking ban.

7.0 Conclusions & Recommendations

This study quantifies the atmospheric levels of SHS in hospitality premises in Liverpool and the associated personal exposure of the employees within these premises. High levels of all the SHS marker compounds were found in a number of bars, restaurants and social clubs compared to the non-smoking venues tested. Previous research studies (Repace, 2000) have shown that even at very low levels, SHS poses a threat to the health of all hospitality workers.

Although this study provides a snapshot of SHS levels within hospitality premises in Liverpool, the data obtained adds to the evidence base, supporting the proposed smoking ban in England due to take affect in 2007.

The results from this study will be disseminated within an academic framework to inform further policy as smoke free legislation is inconsistent across Europe.
As a follow up to this study it is recommended that a similar research study is completed in Liverpool post ban to assess the true reduction in SHS concentrations as a consequence of the smoking restrictions.

Acknowledgements

Colleagues from the Environmental Health Department Liverpool City Council in particular Brian Mosses and Rob Faulkner.

Colleagues from the Health and Safety Laboratory.
8.0 References


Appendices
9.1 Appendix 1-letter to hospitality premises

Environmental Health & Trading Standards
Liverpool City Council
1st Floor, Kingsway House
Hatton Garden
Liverpool
L69 3YD

Dear Smoke Free Liverpool

Smoke Free Liverpool has been in existence since 2003. Its aim is to take forward the objective of the Liverpool First for Health Strategic Partnership to make Liverpool a smoke free city by 2008.

The success of the smoke free policies in New York and Ireland have given momentum to the current work in Liverpool.

In support of the smoke free objectives Liverpool City Council will be carrying out a joint research project with the Centre for Public Health at Liverpool John Moores University within the next few months.

The aim of the proposed research is to measure the levels of second hand smoke within various occupational premises across Liverpool to identify the potential health risks to hospitality workers.

The research will involve monitoring the indoor air quality in a variety of occupational settings across Liverpool. The air quality will be assessed by measuring the levels of particulates (dust from tobacco smoke) and nicotine within the premises using appropriate monitors.

Your premises have been randomly chosen as one of the non-hospitality test sites proposed for this study.

At the time of testing, your employees working within the premises will be asked if they wish to participate in personal monitoring to assess their personal exposure levels to second hand smoke. This would involve taking two saliva samples prior to and after four hours at work and the wearing of an absorbance badge for four hours. This is completely voluntary and will only take a few minutes.

This study is merely for research. The results obtained will be anonymised and held in confidence. Should high levels of nicotine or particulates be found within your premises advice will be given on ways to reduce these levels.
A member of staff from the Environmental Health Department, Liverpool City Council will be contacting you shortly to arrange a visit to your premises to discuss the study and its implications.

Should you have any concerns concerning the proposed research please contact Glyn Mitchell on 0151 225 3964 or Brian Mosses on 0151 225 4736.

Kind Regards

Mr Andrew Hull
Director of Environmental Health & Trading Standards
Title of project/procedure: Occupational Exposure To Environmental Tobacco Smoke: assessment of ambient levels of environmental tobacco smoke in occupational premises in Liverpool and the associated personal exposure of workers’ within these premises.

Name of Premises

I, ................................................................. Position............................................

(Subjects full name)*

agree to take part in the above named project/procedure, the details of which have been fully explained to me.

Signed............................................................ Date .................................................

(Subject)

I, ..................................................................................................................certify that the
details of this

(Investigators full name)*

project/procedure have been fully explained to the subject named above and have been understood by him/her.

Signed............................................................ Date .................................................

(Investigator)

I, ..................................................................................................................certify that the
details of this

(Witness full name)

project/procedure have been fully explained to the subject named above and have been understood by him/her.

Signed............................................................ Date .................................................

(Witness)

NB The witness must be an independent third party.

* Please print in block capitals
Technical/Design Inspection (to be completed on first visit to the premises)

Name of business:…………………………………………………………………………………

Type of business:………………………………………………………………………………

Address:…………………………………………………………………………………………

Contact: Name…………………… Telephone number……………………………………

Visit

Date of initial visit:…………………Time…………………………………………………

Operators:……………………………..and…………………………………………………

Ventilation (if any)

Description (e.g. air conditioning, ducting from roof, natural ventilation etc…)
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Positions (intake, extraction, internally, etc..)
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Possible interference (kitchens, naked flames, heaters, smoke generator)
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Health and safety observations
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Briefly describe the layout of the business (use blank sheet for diagram)
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
Name of business………………………………………………………………………...
### A

<table>
<thead>
<tr>
<th>Group</th>
<th>Team</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution</td>
<td>Enforcement (Environmental Health &amp; Trading Standards)</td>
<td>Various</td>
</tr>
</tbody>
</table>

**Date:** 26.11.2004.  
**Reference:** Review  
**Assessor:** Glyn Mitchell  
**Manager:** Mike Kennedy

### B

**Assessment of risk for:**

**OFFICERS CARRYING OUT EXTERNAL MONITORING**  
(Licensed premises)

### C

<table>
<thead>
<tr>
<th>List Hazards Here</th>
<th>List Groups of People at risk</th>
<th>List Existing Controls</th>
<th>Priority</th>
</tr>
</thead>
</table>
| 1. Possibility of violent / abusive incident occurring whilst on inspection of licensed premises. | Enforcement Officers          | Officers do not work alone  
Safe Code of Practice  
Licensee or nominated person in charge always to accompany officers around premises | Low.     |
| 2. Pre Inspection of Bar Areas                                     |                               | Safe Code of Practice  
Ensure handrails adequate for descent  
Ensure appropriate lighting is in place  
Ensure area clean and free of obstacles  
Liaise with licensee to identify any possible hazards.  
Use torch, check stair treads | Medium   |
Conditions of license reference broken glass, spillage and keeping areas clean upheld. | Medium   |
<table>
<thead>
<tr>
<th>C</th>
<th>List Hazards Here</th>
<th>List Groups of people at risk</th>
<th>List Existing Controls</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exposure to second Hand Tobacco Smoke</td>
<td>All Staff</td>
<td>Exposure Time limited to minimum</td>
<td>High</td>
</tr>
</tbody>
</table>

Risk Priority: 
High: Accident likely with possibility of serious injury or loss
Medium: Possibility of accident occurring causing minor injury or loss
Low: Accident unlikely with control measures in place

E | Cross Reference

**Emergency Procedures**

**Monitoring Procedures**

**Specific Legislation**

**HSE & Other Guidance**

<table>
<thead>
<tr>
<th>D</th>
<th>Controls</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>E</th>
<th>To be completed by manager</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Additional controls required</th>
<th>Action to be taken</th>
<th>By whom</th>
<th>Comp. Date</th>
<th>Task Completed (Signed &amp; Dated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support and counseling be made available after any incident may have occurred</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous monitoring of licensed premises and good liaison with police to identify possible future hotspots within this area.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controls</td>
<td>To be completed by manager</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------</td>
<td></td>
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<tr>
<td></td>
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<table>
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<tr>
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<th>Action to be taken</th>
<th>By whom</th>
<th>Comp. Date</th>
<th>Task Completed (Signed &amp; Dated)</th>
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<tbody>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Copies:**

Manager x 1 (to ensure that Risk Assessment is shared with staff & relevant TU Safety Reps)

<table>
<thead>
<tr>
<th>Assessment Review Date: November 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signed:</td>
</tr>
<tr>
<td>Name (IN BLOCKS):</td>
</tr>
<tr>
<td>Date:</td>
</tr>
</tbody>
</table>
9.5 Appendix 5-Operational inspection

Operational inspection

Name of business:……………………………………………………………………

Type of business:……………………………………………………………………

Address:………………………………………………………………………………

Contact: Name………………………… Telephone number……………………

Hours of business……………………………………………………………………

Licensed for (numbers)………………………………………………………………

Smoking policy………………………………………………………………………

Date of monitoring:…………………………………………………………………

Time of monitoring:………………To………………………………………………

Operators names:………………and………………………………………………

Position of detector (e.g. on post, by optics)……………………………………

Approx measurements (Height, distances)……………………………………

Weather on day of testing…………………………………………………………...

Number of staff on duty

Bar persons:…………………………
Glass collectors:…………………..
Waiters/waitresses………………
Other personnel…………………..
Typical shift patterns……………………………………………………………………

Customers

Hourly head counts:-

<table>
<thead>
<tr>
<th></th>
<th>Number of customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour 1</td>
<td></td>
</tr>
<tr>
<td>Hour 2</td>
<td></td>
</tr>
<tr>
<td>Hour 3</td>
<td></td>
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FORM OF CONSENT TO TAKE PART AS A SUBJECT IN A MAJOR PROCEDURE OR RESEARCH PROJECT

Title of project/procedure: Occupational Exposure To Environmental Tobacco Smoke: assessment of ambient levels of environmental tobacco smoke in occupational premises in Liverpool and the associated personal exposure of workers within these premises.

I, ............................................................................................................................ agree to take part in (Subjects full name)*
the above named project/procedure, the details of which have been fully explained to me and described in writing.

Signed..........................................................................  Date ...............................................................
(Subject)

I, ............................................................................................................................ certify that the details of this (Investigators full name)*
project/procedure have been fully explained and described in writing to the subject named above and have been understood by him/her.

Signed..........................................................................  Date ...............................................................
(Investigator)

I, ............................................................................................................................ certify that the details of this (Witness full name)
project/procedure have been fully explained and described in writing to the subject named above and have been understood by him/her.

Signed..........................................................................  Date ...............................................................
(Witness)

NB The witness must be an independent third party.
* Please print in block capitals
What is the purpose of the study?

Past research has demonstrated that hospitality workers suffer high occupational exposures to second hand smoke (passive smoking) during their working shift.

Liverpool City Council is carrying out a joint research project with the Centre of Public Health at Liverpool John Moores University to measure the levels of second hand smoke exposure among hospitality workers in Liverpool.

Why have the premises I work in been chosen?

Hospitality premises have been chosen at random from a database held by the Environmental Health Department Liverpool City Council.

Will everybody working at the premises be asked to take part?

All staff working at the premises at the time of testing will be asked to take part in the study. The participants will be asked to sign a consent form. There is no obligation to take part.

If you meet the criteria you will then be asked a number of questions to assess your present and past working status within the hospitality industry.

Will personal details be taken?

Personal details including age and sex will be taken. These details will remain confidential at all times.

How will my personal exposure to second hand tobacco smoke be measured?

Prior to starting your work shift and after four hours at work a saliva sample will be taken. You will be asked to place an absorbent pad attached to a plastic stick under your tongue for a approximately a minute. The absorbent stick will then be placed in a plastic sampling tube which will be labelled and stored appropriately before being transferred to the laboratory for analysis.

By taking a saliva sample the amount of nicotine that you have presently in your body can be measured. This measure of nicotine gives an indication of your level of exposure to second hand smoke. Your exposure to second hand smoke during your work shift can therefore be measured by using the level of nicotine prior to and after your work shift.
During your work shift you will also be asked to wear a non-invasive personal badge on your shirt/top. The badge contains a tube that will measure the second hand smoke in your environment.

What will happen to my saliva samples?

The saliva samples that you give will be analysed at the Health and Safety Laboratory in Sheffield. The samples will be destroyed after analysis and will not be used for any other purpose.

How long will I be required to be away from my job?

The whole process will take approximately fifteen minutes (ten minutes prior to you starting your work shift and 5 minutes after you have completed four hours at work).

Will I have access to my personal results?

Yes. 3 months after the completion of the study your personal results will be available from the Environmental Health Department, Liverpool City Council, Hatton Garden, Liverpool. Please contact Glyn Mitchell on 0151 225 3964 or Brian Moses on 0151 225 4736

At the time of testing you will be given a participant code by a member of the Environmental Health Department. When telephoning for your personal results you will only need to give this code.

Benefits of taking part in the study

By taking part in the study you will be contributing to the development of the evidence base in Liverpool with respect to second hand smoke.

Additional Information

If you require more information or have any questions regarding the study please don’t hesitate to contact Glyn Mitchell at the Environmental Health Department, Liverpool City Council on 0151 225 3964 or Brian Moses on 0151 225 4736

Please Note: All participants have the right to withdraw from the project/study at any time without reason.

Thank you for reading this

Participant code__________________
Personal Exposure to second hand smoke

Screening

Premises:__________ Smoker □ Non-Smoker □ Male □ Female □

If non-smoker, How long have you been a non-smoker?

Less than 6 months □ Greater than 6 months □ Never smoked □

Will you be working for four or more hours tonight? Yes □ No □

Personal Details

Participant code__________

Age __________ Male □ Female □

Time that participant started their shift________________________

Workplace/employment history

1. How long have you been in your present employment?
   
   Years__________ Months__________ Less than one-month □

2. How many hours a week do you work within these premises?

   Hours______________

3. What proportion of your time do you spend doing….

   Bar work________ collecting glasses_______ serving food ________

   Cleaning________ other__________________ (please specify)

4. In the past 5 years how long have worked in the hospitality industry?

   Year__________ Months________________

Previous Second hand smoke exposure

1. Do you live in a household where at least one person smokes? Yes □ No □