CONTROL OF ENVIRONMENTAL TOBACCO SMOKE

IN NEW ZEALAND BARS AND RESTAURANTS

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SUMMARY

Numerous studies have confirmed that inhalation of “second hand” or environmental tobacco smoke (ETS) is a threat to human health. ETS also creates significant nuisance from objectionable airborne odours and deposition of odours and tobacco smoke products onto surfaces, furnishings and clothing.

Existing New Zealand, Australian and ASHRAE (USA) ventilation standards are aimed at achieving average comfort criteria in places like restaurants, bars and smoking lounges. These standards are not based upon the effective elimination or control of the long-term health hazards associated with ETS.

In public restaurants and bars, the approaches to controlling ETS inhalation include:

1. **Allocating separate “Smoking and “Non Smoking” areas within the same open space**

   Although some dilution of ETS occurs, allowing smoking in an open area exposes all patrons and staff to the potential health threats and nuisance of tobacco smoke.

2. **Installing tobacco additional mechanical ventilation and smoke filtration equipment**

   Increasing dilution airflow beyond standard flowrates provides decreasing incremental improvements in ETS reduction. Further, increased ventilation air flowrates above existing standards prohibitively increases capital, operating and maintenance costs.

   Use of auxiliary filtration and mechanical ventilation systems provide only limited beneficial effects on control of the health and nuisance hazards of tobacco smoke. These systems are expensive to install, operate and maintain.

   Air filtration equipment only removes the visible airborne particulate fraction of ETS; the hazardous and invisible ETS gases and vapours remain unaffected. To ensure their reliability, ventilation and filtration systems require proper design, installation commissioning, and maintenance. In the field, maintenance often has proved problematic.

3. **Constructing physically segregated Smoking areas with an isolated mechanical ventilation system**

   Physically segregated smoking areas, with separate ventilation systems are a form of airborne hazard isolation. This approach will prevent the exposure of non-smoking patrons to the hazards and nuisance of ETS. The smoking area must be kept at sufficient negative pressure and the extraction system configured so that contaminated air from the smoking area cannot infiltrate the non-smoking area.

   Unless they are excluded from these areas, as is now recommended in British Columbia (Canada), restaurant staff in the separate smoking area will still be occupationally exposed to the ETS health threats. In fact, staff exposures may be worsened.

   The ventilation systems are complex and expensive to design, install and operate. In addition, there would be the costs and loss of floor space for the construction of segregated areas. To ensure effectiveness and reliability, the ventilation systems require proper design installation, commissioning, and adequate routine maintenance. In practice, this remains problematic.

4. **Banning smoking on the premises**

   Of the options listed, by eliminating the source, banning smoking in bars and restaurants:

   - Removes all threats to human health associated with ETS to both patrons and staff
   - Avoids the all the nuisance effects of ETS
   - Avoids the capital, operating and maintenance costs of additional ventilation and filtration systems and the need to construct costly segregated areas for ETS control by isolation
   - Avoids the inevitable real world failures and inefficiencies of ventilation and filtration systems intended for ETS control that are improperly designed or commissioned and/or poorly maintained.

Both in New Zealand, and internationally, the se of smoke filtration and/or mechanical ventilation equipment has been the approach emphasised by the some groups within the wider Hospitality Industry, usually with the strong support of the Tobacco Industry. However, this report supports the findings of other studies, all of which conclude that air filtration and/or mechanical ventilation equipment cannot effectively control ETS.

1.0 Background

Scope of this Report

This report is concerned with a discussion of the principles, practicalities and controversies regarding effective control of the health threats and nuisance from environmental tobacco smoke (ETS) in New Zealand bars and restaurants.

The bases for the information and opinions presented in this report include:

- Review of literature from New Zealand, Australia, North America and Europe regarding adverse health effects of environmental tobacco smoke and available ventilation standards and practices for control of ETS

- Review of current design approaches and equipment for ventilation and air filtration for ETS control

- Professional knowledge and 25 years experience in exposure risk assessments, Indoor Air Quality (IAQ) investigations, and in the design and evaluation of ventilation systems for effective control of airborne hazards.

2.0 Introduction

2.1 Health and Nuisance Risks of ETS

Numerous medical studies and scientific findings have confirmed that inhalation of “second hand” or environmental tobacco smoke (ETS) has been directly implicated as a chronic threat to human health. The subject is covered in detail in many other sources and will not be covered in depth here. Briefly, these identified health effects include:

In adults, ETS exposure:

- Is a human lung carcinogen
- Exacerbates some existing medical conditions, eg, asthma, emphysema, cardiopulmonary system diseases

In children ETS exposure:

- Irritates the upper respiratory tract and is associated with a small but significant reduction in lung function.
- Increases the risk of lower respiratory tract infections such as bronchitis and pneumonia
- Is a risk factor for development of new cases of asthma and increases the frequency of episodes and severity of symptoms in existing asthma sufferers
- Increases the prevalence of middle ear disease

In addition, ETS creates significant nuisance from the standpoint of:

- Acute eye, nose and throat irritation
- Objectionable odours
- Deposition of tobacco smoke products onto surfaces and furnishings
- Absorption of tobacco smoke odours onto persons and their clothing

Chemical Constituents of ETS

Tobacco smoke is composed of thousands of chemical components in the form of airborne particulates, gases and vapours. The major ETS components are listed in Table 3.1.

Table 3.1 Major Hazardous Chemical Components of Tobacco Smoke Average ETS Yields from 50 Top Selling US Brands	
Chemical Substance	**Yield (micrograms/cigarette)**
Particulate Substances	
Respirable Suspended Particulates (RSP)	13,700
Solanesol	410
Scopoletin	18.2
Catechol	11.2
Gaseous Substances	
Carbon Monoxide	55,100
Total Hydrocarbons	27,800
Total Volatile Organic Compounds	19,100
Isoprene	6,200
Ammonia	4,100
Acetaldehyde	2,500
Nitric Oxide	1,650
Nicotine	1,590
Formaldehyde	1,330
Acetonitrile	1,140
Acetone	1,070
Toluene	500
1,3 Butadiene	370
3-Ethenylpyridine	333
Xylenes	298
Benzene	280
Limonene	269
Pyridine	218
Nitrogen Dioxide	198
3-Picoline	125
Styrene	94
Ethylbenzene	80
2-Picoline	75
Myosmine	49
3-Ehtypyridine	44
4-Picoline	40
1,2,3-Trimethylbenzene	33
n-Propylbenzene	9
Isopropyl benzene	5

Source: Martin, et al, 1997 (from, *Design for Smoking Area, Part 1 and Part 2*, Nelson et al [R J Reynolds Tobacco Company], ASHRAE Transactions, July 1998)

Particulates are solid or liquid substances that are small and light enough to remain suspended in air for a time. Of primary concern from a health standpoint, ETS particulates are of respirable size, termed Respirable Suspended Particles (RSP). These very small airborne particles have a higher probability of penetrating deep into the lungs, where they may stay a long time and are more likely to cause acute or chronic health effects. One ETS-RSP component of special note is Benz-a-pyrene, a known human carcinogen.

Gaseous pollutants include inorganic combustion gases, and various polar and non-polar gases and vapours of organic chemicals. Many of the individual substances in ETS are known to have specific harmful effects on human health. These effects include: irritation, nervous system damage, mutations, birth defects, specific organ systems damage and cancer.

Details on the toxigenic risk of ETS constituents can be found in an ESR report to the New Zealand Ministry of Health (*The Chemical Constituents in Cigarettes and Cigarette Smoke: Priorities for Harm Reduction*, Fowles, *et a*l, March AE 2000). This report also suggests that one volatile organic component of ETS, 1,3 Butadiene, poses the greatest specific carcinogenic hazard.

3.0 Indoor Air Quality Ventilation Standards

A number of ventilation standards exist that provide recommended ventilation requirements for indoor environments, including restaurants, bars and smoking lounges. These standards are:

- American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) 62-1989
- New Zealand Standard (NZS) 4303 (essentially similar to ASHRAE 62-1989)
- Australian Standard (AS) 1668.2

Taken from the present NZS 4303 and AS 1668.2, the recommended minimum ventilation rates to meet the acceptability criteria for bars, restaurants and smoking lounges are listed in Table 3.1 below.

Table 3.1
Recommended Ventilation Rates

Location	Minimum flowrate (litres/sec) per occupant	
	NZS 4303/ASHRAE 62-'89	AS 1668.2
Bars and cocktail lounges	15 ("Supplementary smoke removal equipment may be required."	20
Restaurants (Dining Rooms)	10	15
Smoking lounges	30 ("Normally supplied by transfer air, local mechanical exhaust; with no recirculation recommended."	25

Particular points to note regarding NZS 4303 / ASHRAE 62-1989:

- "Recirculation is not recommended" for smoking lounges; to recirculate the ETS-laden air would defeat the purpose of having an extraction system. The smoking lounge is to be kept at a negative pressure with respect to surrounding spaces to prevent the exfiltration of ETS-laden air.

- The recommended fresh airflow rate of 10 l/s per occupant for a restaurant where smoking is allowed is the same as for a non-smoking office area.
- For Bars and Cocktail Lounges, the 15 l/s per occupant fresh air is to be augmented by "Supplementary smoke removal equipment."

In effect, the last point above equates to the need for more fresh air. This would either be actual fresh air, termed "make up air" to replace smoke-laden air extracted from the space (typically near the ceiling), or in limited - *particulate removal only* - "fresh air equivalents" from use of air filtration systems. (See discussion on air cleaning devices in Section 4.0 below.)

All the ventilation standards cited allow for smoking in hospitality areas. These consensus standards were not intended to address the use of ventilation or air cleaning devices as an effective means to eliminate or control the potential long-term health threats from ETS. Instead, these standards were designed to meet subjective "Acceptance Criteria" as expressed by the comfort and/or lack of acute irritation from ETS in approximately 80% of an average test population. Importantly, neither ASHRAE 62-1989 nor NZS 4303 states the allowable number of active smokers in relation to non-smokers in a bar or restaurant upon which the "acceptability criteria" are based.

In 1999, ASHRAE drafted and issued a revised standard, ASHRAE 62-1999, which was based on tobacco smoke-free environments. The Philip Morris Company launched a legal appeal to prevent the promulgation of the revised ASHRAE standard.

4.0 ETS Control Methodologies

4.1 Generic Control of Airborne Health and Nuisance Hazards

Generic methods for control of airborne hazards are well established. These concepts apply to any airborne environmental hazard in an indoor area that may affect either public or occupational health. In the case of ETS, both risks apply. The public health risk applies to patrons who occasionally frequent bars and restaurants. The greater health risks from ETS exposures are to hospitality industry employees who are repeatedly exposed to ETS in the course of their normal work. In this regard, in a number of countries, unions and organisations representing Resort, Hospitality and Casino workers have listed ETS as a major occupational health risk, and are lobbying for banning smoking in their workplaces.

The accepted hierarchy of control approaches for airborne contaminants include:

1. Eliminate the source
2. Substitute a less hazardous material
3. Minimise exposure by engineering controls (eg, enclosures, isolation, ventilation systems)
4. Require use of personal protective equipment to minimise exposures (eg, wear gas masks)

Of the above items, items 2 and 4 can be eliminated, as neither is applicable to control of ETS in bars and restaurants. Of the remaining items, only *Elimination of the source* or *Minimisation of exposure* by engineering controls remains for practical consideration.

It is an established principle of hazard control, and common sense, that elimination of the source of the hazard is often the most effective, most cost-effective and most reliable means of controlling the airborne hazard. Where certain substances must be used, as in commercial applications in industry, allowable exposure standards based upon healthy adult workforce populations are used as exposure guidelines. Even in these cases, because of varying susceptibilities and to minimise risks, the requirement is to reduce all hazardous exposures to the lowest practicable level. In New Zealand, the exposure guidelines are termed Workplace Exposure Standards (WES). To ensure that risks to workers are minimised, the control hierarchy listed above, ie, Elimination, Isolation, etc, is the standard approach taken.

While the model of workplace assessment and control has some applicability to control of ETS, certain aspects are problematic. One important item is that it is improper to use Workplace Exposure Standards as a means of assessing health risks to the general public. The public includes the young, infirm, elderly and other susceptible groups of persons. Unfortunately, this inappropriate stance was taken in a paper presented by Joe Robertson of Healthy Buildings International (HBI) Pty Ltd (*Indoor Air Quality and the Hospitality Industry*, HANZ Conference, Queenstown, 1966). In addition, the paper presented incomplete and biased information concerning airborne hazards and the practical effectiveness of ventilation and air filtration system to effectively control ETS hazards.

4.2 Control Approaches for ETS

In public restaurants and bars, the approaches to controlling ETS include:

- Allocating separate “Smoking and “Non Smoking” areas within the same general space
- Installing additional tobacco smoke filtration and/or mechanical ventilation equipment
- Constructing physically segregated Smoking areas with an isolated mechanical ventilation system for smoking areas
- Banning smoking on the premises

4.2.1 Allocating Separate “Smoking and “Non Smoking” Areas within the Same Space

Although some dilution of ETS will occur, allowing smoking in an open area exposes all patrons and staff to the potential health threats and nuisance of tobacco smoke.

This is one approach supported by the Tobacco Industry under their so called “accommodation” and “tolerance” programmes that have been rolled out in campaigns against attempts to ban smoking in restaurants and bars in several countries, eg, Australia, USA and Switzerland.

4.2.2 Use of Mechanical Ventilation and/or Air Filtration Equipment

Ventilation systems

Ventilation systems are comprised of two main approaches: dilution ventilation and exhaust or extraction ventilation.

The capital, operating and maintenance costs for standard ventilation systems are significant costs to the hospitality business. The reliability of ventilation systems to maintain even their limited level of ETS control is another problem. Other studies, and the author’s experience, suggest that ventilation system maintenance is an often-overlooked item in businesses, including the hospitality industry

Dilution Ventilation

The ventilation systems for bars and of restaurants are based on dilution ventilation. Dilution ventilation systems move large quantities of fresh air through a space to mix with and dilute any airborne contaminants present in the space. It can be achieved by opening windows and doors, but in most indoor situations, it is done via mechanical ventilation systems, often termed HVAC (heating, ventilating and air conditioning) systems.

There are practical limits to the extent dilution ventilation can reduce airborne pollutants from ETS. Costs for moving and heating or cooling large volumes of replacement air are significant. Further, to ensure whatever effectiveness does exist, all ventilation system components including air filtration devices require proper design, installation commissioning, and maintenance. Experience has shown that in practice poor maintenance is common.

Displacement Ventilation

Displacement ventilation is a specialised form of dilution ventilation that has been discussed as a possible means to improve ETS control in hospitality settings. Displacement ventilation has been used successfully in certain types of industrial facilities.

This approach is based upon releasing cool fresh air with minimum turbulence low into a high-ceilinged room. The intent is for the mass flow of fresh cool air to “displace” the warm contaminated air upwards with very little mixing towards the ceiling, where it can be extracted. This contrasts with the normal ventilation design that relies on turbulent mixing and dilution to reduce the concentration of air contaminants in a space.

Displacement ventilation does work in certain industrial settings. Typically, these involve, hot processes, tall narrow open cross section buildings, minimal factors affecting air turbulence and worker positions are kept away from the sources of airborne contamination. Hospitality settings often have the wrong physical configuration, the temperature gradients between fresh and contaminated air are small, and the sources of turbulent air mixing and deflection of smooth airflow are numerous. Importantly, persons are also near the sources of air contamination, eg, cigarette smoke. Thus, the application of displacement ventilation designs to control of ETS in hospitality settings is at present an academic discussion.

Exhaust or Extraction Systems

Exhaust or extraction ventilation draws away the contaminated air. The exhaust system may be designed to provide “local ” or “area” exhaust. Extraction is usually most effective if located very near the source to “capture” the contaminated air before it can spread. A typical local extraction system would be the exhaust hoods required in a restaurant kitchen above cooking appliances. Designs have been considered for locally extracted ashtrays to capture ETS nearer the source, but these are impractical for most commercial applications.

Some limited benefit in ETS reduction in bars and restaurants can be achieved by providing area extraction ventilation in high roof/ceiling areas, where warm smoke-laden air tends to accumulate. However, area extraction does not selectively extract only the smoke, but the smoke/air mixture. In addition, general air extraction at the ceiling does not have a significant localised effect: it does little good for a person sitting adjacent to smokers.

4.2.2 Air Filtration Systems

Besides increased ventilation rates, ETS control approaches may also rely on use of air filtration equipment. As mentioned above, ventilation rates significantly in excess of current standard requirements are not economically practical, as the cost-benefit of additional dilution ventilation follows the “law of diminishing returns”.

As will be shown, the use of air cleaning devices for ETS control cannot assure adequate indoor air quality, particularly where significant sources are present and standard ventilation rates remain inadequate. Most importantly, air filtration will only reduce the visible airborne particulates from ETS. This reduction in visible smoke particles makes the air look cleaner, providing a basis for the subjective reports of “clear air” from use of filtration devices for ETS control. Unfortunately, the hazardous and invisible gas and vapour components of ETS are not affected by air filtration.

Clearly, the technology exists from submarines and aerospace systems to clean, regenerate and recirculate high quality breathing air. However, these systems are hugely impractical for everyday use. As will be seen below, practical commercial air cleaning devices cannot assure adequate health-based air quality control of ETS in bars and restaurants. This is particularly true where significant numbers of smokers are present, and the NZS 4303 based (or similar) levels of dilution ventilation are supplied.

Air Cleaning Devices (Source, US EPA)

Particulate removal versus gas and vapour absorption

This discussion addresses only airborne ETS particulate removal. Few air cleaners are intended to remove any airborne gaseous agents. Systems usually using activated charcoal are commercially available for trace odour control. These air cleaners are expensive, have very limited sorbent capacity, require rigorous maintenance and sorbent replacement, and are not effective for control of quantity and types of gaseous components present in ETS. ETS contains a very broad range of inorganic and organic (polar and non-polar) gases and vapours (See Table 3.1.) No practical sorbent is able to effectively and reliably capture them all. For all of these reasons, effective gas and vapour removal air cleaning systems are unavailable for ETS control in bars and restaurants.

Particulate filtration

The typical air filters installed in heating and air-conditioning (HVAC) systems are simple mechanical air filters. This basic HVAC system air filtering may be augmented by using higher efficiency filters. An alternative to upgrading the HVAC filters is to use portable or auxiliary air cleaners. These air cleaners generally rely on filtration for the removal of airborne particulates, and often are enhanced by electrostatic or ionisation methods.

HVAC System Filters

HVAC filters are typically installed in air-conditioning units, fan coil units, and centralised HVAC systems. HVAC filter efficiency for particle removal is assessed by standard test methods described in ASHRAE Standard 52-76. In these tests, the filters are measured for the percentage removal of a standardised airborne dust. Of note, the ASHRAE test methods have been found by US EPA to underestimate the actual particle removing efficiency for very small particulates like those in ETS.

Typical older New Zealand HVAC systems use 10-20% filters. Some newer installations may use 40-60 % filters, but this is less common. Thus, the HVAC filters used in New Zealand HVAC systems are not effective at reducing at ETS particulates. As mentioned, the gaseous ETS components remain unaffected by HVAC filtration.

Auxiliary Air Cleaning Devices

There are several types of auxiliary air cleaners on the market. These include: mechanical filters, electronic air cleaners, ion generators and combination or “hybrid” units. Mechanical filters are not unlike the HVAC filters discussed above, and will not be covered further.

The performance of auxiliary air cleaners in removing airborne particulates from indoor air depends on:

1. Airflow rate through the device
2. Efficiency of particle capture by the filter
3. Concentration and particle size of the airborne particulates
4. Reduced filter efficiency, internal air by-pass of the filter, and/or reduced air flowrate as the filter resistance increases with filter loading
5. External air short circuiting, ie, whether or not the just-filtered air recycles into the unit, instead of drawing in contaminated room air
6. The placement of the ring device in the space and the general air circulation in the room also affect filtration performance.

Electronic air cleaners use an electrical field to trap charged particles. In most electronic air cleaner units, the incoming particles are electrostatically charged by an electrical discharge from wires or needles before the collection process. Electronic air cleaners use either electrostatic precipitators or static electricity charged-media filters. In electrostatic precipitators, particles are attracted to and collected on a series of electrically charged flat plates. In charged-media filter devices, the particles are collected on the filter fibres.

Ion generators also use static electricity to remove particles from indoor air. These small portable units act by electrostatically charging (or “ionising”) the airborne particles as they pass through the device. The charged particles are in turn removed from the air by being drawn to surfaces in the room.

Some newer auxiliary air cleaners combine an ion generator with fan-powered filters. Of the available portable air cleaners for airborne particulate removal, these combination or hybrid units have been found to be the most effective type of auxiliary air cleaning device.

Installation and Maintenance of Air Cleaning Devices

To ensure maximum benefit, the manufacturers’ requirements must be followed. These include: proper placement, an adequate and accessible power supply, and the need for access during use, cleaning, and maintenance. After installation, specified operating and maintenance procedures must be followed. This includes regular cleaning, replacement parts, and new filters. In high use areas, these required maintenance intervals and part servicing are more frequent.

Besides the initial purchase price, costs for auxiliary air cleaning devices include: operating costs and maintenance. In general, the best units with high airflow rates and high particle removal efficiencies, are also the most costly to purchase and maintain.

Potential problems with use of auxiliary air cleaning devices (Source, US EPA)

Production or re-dispersal of air contaminants

Air filtration units may produce additional airborne contaminants or re-disperse existing volatile components of ETS. Both precipitators and ion generator devices may produce significant quantities of Ozone (O^3) as a by-product of their operation. Ozone production is enhanced by improper installation and inadequate cleaning and maintenance. Ozone is a chemically reactive and very irritating form of oxygen. (Normal oxygen in the air is O_2.) Ozone is a strong pulmonary irritant and is one of the hazardous components of photochemical smog.

The release or by-pass of fine airborne particulate material by electronic air cleaners has also been reported. Some of these particles would then tend to collect on adjacent surfaces by electrostatic attraction.

Inability to remove ETS odours

Studies have shown that although a number of air cleaners reduce the levels of visible airborne ETS particulates, the ETS odours remained. This is because the air cleaning devices did not remove the gaseous ETS components. Additionally, as mentioned above, some gaseous ETS products contained in the ETS particulate fraction collected on the filters are subsequently re-emitted into the air.

Potential adverse pulmonary effects of electrostatically charged ETS articulates

There is a possible risk from the air cleaners that incorporate air ionisation. Experiments have shown that a greater rate of particle deposition occurs in the lungs when the airborne respirable particulates are electrostatically charged. Therefore, the use of ion generator type air cleaners may not reduce the actual biological risk from ETS particulates as much as the gross particle reduction numbers might suggest.

Surface Soiling by Particle Deposition

Ion generator type devices not only collect particles on the filters, they also cause them to be deposited on surfaces near the unit and throughout the space. This results in some soiling of walls and other surfaces, especially if the filter is clogged or bypassed.

Cleaning and Maintenance Problems

As with the cleaning and maintenance of normal HVAC systems in bars and restaurants, the real world prognosis for the ongoing reliability of regular cleaning and maintenance programmes for auxiliary air cleaning devices is not assured.

Standards for Auxiliary Air Cleaners

Standards for portable air cleaners focus only on airborne particulate removal. In Australia and New Zealand, there is no accepted method for rating or comparing the performance of air-cleaning devices. However, a USA industry standard was developed by the Association of Home Appliance Manufacturers (AHAM), Chicago, Illinois, USA. It is based upon the American National Standards Institute (ANSI) recommended standard for airborne particulate removal and has been reviewed by the US Environmental Protection Agency (EPA).

Under AHAM, the standard operational unit for portable air-cleaning devices is termed the "Clean Air Delivery Rate" (CADR). The CADR is the product of the unit's particulate removal efficiency times its air flowrate. In essence, an air cleaning unit with a CADR of 150 is supposed to have the equivalent effect on airborne particulate reduction as would introducing 150 cfm (70 litres/second) of fresh air.

Actual CADR numbers are determined by tests of new units to reduce known concentrations of airborne particulates under standardised laboratory conditions in an enclosed room. AHAM certification lists three CADR numbers. These values apply to the removal of tobacco smoke (ETS) particulates, Plant Pollen, and a standard airborne Dust.

The manufacturer's CADR values represent performance that can be expected during the first few days of use. Subsequent air cleaning performance may degrade performance, largely due to reduced filtration efficiency, internal air by-pass and/or reduced air flowrate as the filter loading increases.

The air cleaning devices are more effective for ETS particulate reduction if the source of the particulate, in this case smoking, is intermittent. The air cleaners are not as effective on continuous sources, for example, if a number of people are smoking more or less continuously in an area.

Again, it is important to note that the CADR values apply only to reduction in the particulate portion of ETS. Thus, the concept of the CADR equivalence to an equal quantity of fresh dilution air does not take into account the fact that these devices have no affect on reducing the hazardous gaseous components of ETS.

The Aironic^{tm} AE 2000 Air Cleaner

The air filtration device being encouraged for use by the Hospitality Association of New Zealand (HANZ) is the *Aironic^{tm} AE 2000*, manufactured by the Aironic Pty Ltd, Artarmon, NSW, Australia. The device is a hybrid ionic/powered air filtration unit. Based on the AHAM particulate removal test, the *Aironic^{tm} AE 2000* unit has been shown to be effective for its intended design and use, that is, the reduction of airborne particulate levels.

Table 4.1 below, lists the performance of an *Aironic^{tm} AE 2000* unit on high-speed setting, based upon the AHAM test protocol. The CADR values would be lower on one of the reduced fan speed settings.

Table 4.1
Airborne Particulate Removal for the *Aironic^{tm} AE 2000* Unit
Clean Air Delivery Rate (CADR) and Room Size

Test Particulate	**ETS**	Pollen	Dust
CADR* - cfm (litres/second)	**130 cfm (61 l/s)**	170 cfm (80 l/s)	175 cfm (82 l/s)

Source, Aironic Pty Ltd

*Rounded values within standard deviation of test

The CADR for ETS particulates is lowest compared to the CADR values for airborne pollen and dust. This is likely to be related to the average smaller particle size of ETS particulates.

The required range fresh air flowrates to control ETS particulates to acceptable levels is 30 to 120 litres/second per active cigarette smoker to achieve comfort-based acceptability criteria. (See Section 5.0) Given the basis of the AHAM standard, and assuming some dilution in the space and standard air flow dilution, the CADR data from Table 4.1 above suggests that a single *Aironic^{tm} AE 2000* unit would only be sufficient to control the ETS particulates produced by very few active smokers. Further, unless the smokers were located very close to the units, the limited benefits of the air filtration would be further reduced. In addition, like any similar air filtration unit, the *Aironic^{tm} AE 2000* has no effect on the hazardous gas and vapour components of ETS.

4.2.4 Constructing Physically Segregated Smoking Areas with Isolated Mechanical Ventilation Systems

An effective means to isolate ETS hazards can be achieved by creating physically segregated smoking areas in restaurants. This is reportedly one mandated approach taken in the Australian Capitol Territory and other places, like British Columbia, Canada. Segregation however, is an expensive and relatively complex proposition, entailing construction of separate smoking areas with independent ventilation systems. In addition, hospitality staff who must enter or work within the isolated smoking areas are likely to be at greater risk from ETS hazards because the ETS levels would be concentrated.

The ventilation systems would need to be separate from the ventilation systems serving the non-smoking areas. The smoking area ventilation system would need to create a significant negative pressure with respect to occupied non-smoking areas to prevent the migration of smoke laden air into them, even when entry doors are opened.

Although non-smoking patrons would be protected by a properly designed and maintained isolated smoking area, the creation of segregated smoking areas would still result in routine occupational exposures of restaurant and bar staff to the health risks from ETS. This increased occupational risk to employees remains a serious weakness of the segregated smoking area approach. In British Columbia, ETS is considered a significant occupational health risk by the governmental authority that is the equivalent of NZ OSH. The issue of ETS exposure in isolated smoking spaces has been addressed by precluding staff from being assigned to work inside these areas while they are occupied by active smokers. Staff may only enter after the enclosure has been empty for a specified period to allow the ETS to dissipate.

Finally, the practical issues of upkeep and maintenance of the separate dedicated ventilation systems for the smoking enclosures remains a critical factor in preventing the spread of ETS into non-smoking areas. Again, the level of effort for maintenance becomes an expensive operational cost. In the field, poor maintenance of ventilation systems is a common finding.

4.2.5 Banning smoking on the premises

Of the ETS control options listed, by eliminating the source of the ETS contaminants, only banning smoking:

- Removes the threats to human health from ETS exposure
- Avoids the nuisance effects of ETS exposure

- Avoids the capital, operating and maintenance costs of installing and operating specialised ventilation and filtration systems
- Avoids the inevitable real world failures and inefficiencies in the design, operation and maintenance of ventilation and air filtration systems

The downsides to banning smoking in bars and restaurants are primarily related to:

- The concerns of individual smokers who feel their freedoms and enjoyment are maligned
- The Hospitality Industry fears of potential for lost patronage from the approximately 23% of the New Zealand population that continue to smoke

5.0 Discussion

5.1 ETS Ventilation Acceptability Criteria

Published data from tobacco company scientists have shown that the actual volume of fresh dilution air required per cigarette to achieve 80% acceptability criteria, based on ETS Respiratory Smoke Particulates (RSP) alone is very large (Leader and Cain, 1983; Walker, et al, 1997; in: Nelson, et al, 1998). From laboratory test chamber studies:

- The dilution air volume range for non-smoker acceptability is 78 - 120 cubic metres of fresh air per smoked cigarette
- The dilution air volume range for smoker acceptability is 30-40 cubic metres of fresh air per smoked cigarette.

Given an average of about 5 minutes smoking time per cigarette (from field observation data), and assuming good air mixing in the space, this equates to:

- For non-smoker acceptability, a range of 260 to 400 litres/second fresh air per active cigarette smoker
- For smoker acceptability a range of required fresh air flowrates of 100 to 130 litres/second per active cigarette smoker

Note that these airflow quantities do not consider the gas and vapour constituents of ETS. These air flowrates are well in excess of the minimum (eg, NZS 4303, ASHRAE 62-1989, AS 1668.2) guidelines for bars, restaurants and smoking lounges. (See Table 3.1) “Normalisation” of the ventilation values above for linkage to standard ventilation rates has been done by tobacco company scientists. Their assumptions include:

- Individuals are less responsive to ETS in real world settings than in laboratory tests
- Only 1.25 cigarettes per hour are smoked in an office or restaurant
- Only 2 cigarettes per hour are smoked in a bar
- Only 3 cigarettes per hour are smoked in a smoking lounge
- Only 27% of persons are smokers in an office, bar or restaurant
- 100% of people in smoking lounges are smokers
- The space volumes are 2750-4240 cubic feet (78-120 cubic metres) for an office, bar or restaurant, and 880-1410 cubic feet (25-40 cubic metres) for a smoking lounge
- Ventilation rates follow ASHRAE 62-1989

These assumptions appear overly biased in favour of an outcome supporting the Tobacco Industry's avowed adherence to existing ventilation standards that allow smoking in public spaces. In addition, these findings and assumptions address only comfort criteria; they do not address adequate control of the health risks of ETS.

The Tobacco Industry based ETS RSP particulate acceptability values are based at a concentration of hundreds of micrograms per cubic meter of air. This compares poorly with the ASHRAE suggested total RSP guideline of a maximum of 50 micrograms per cubic metre of air from all sources.

Similarly, a study of acceptable ETS exposure and carcinogenic risk was done. The risk assessment criteria were similar to those used in US regulations for environmental carcinogens in air, drinking water or food. The study suggested an average daily exposure ETS RSP of 0.75 micrograms/cubic metre of air. (Repace and Lowrey, 1985)

These findings suggest that the per-cigarette-based acceptance criteria-based ventilation rates are realistic requirements. Ventilation criteria should be based upon the acceptability criteria of the persons most affected by ETS, notably non-smokers. Ventilation flowrates required to obtain an acceptable health risk from ETS in indoor air where smokers and non-smokers share a space were estimated at over 1000 air changes per hour. Like the per cigarette acceptability data, these airflow rates are an order of magnitude above current ventilation standards. To achieve these sorts of air flowrates would be prohibitively expensive. (Broadbent and Wesley, 1996).

5.2 Results of Other Studies on Ventilation and ETS Control

A number of other reports and investigators came to similar conclusions as those expressed in this report.

- A New South Wales Task Force studying passive smoking found that normal ventilation rates were not effective or efficient at controlling ETS. Dilution ventilation alone was found to take excessively long to clear smoke from a space, even after smoking had ceased. At a ratio of one smoker to four non-smokers, even in segregated smoking area, the amount of ETS generated was too great for the ventilation system to reduce ETS to an acceptable level. Their recommendation was that banning smoking was the best and most cost effective step. (NSW Passive Smoking Task Force Report 1997)

- A West Australian Task force on passive smoking in public places found that the majority of air conditioning systems investigated complied with design and standards, but were not suitable for controlling levels of ETS. The investigators also found that inadequate maintenance of HVAC systems was common. (Report of West Australian Task Force on Smoking in Public Places, October 1997)

- A comprehensive study by Broadbent and Wesley from Australia had findings similar to those expressed in this report. They found that in open plan areas, air mixing and turbulence mixed and spread the ETS into non-smoking areas. Their study also questioned the effectiveness, reliability and maintainability of air cleaning devices for ETS particulate control. They also noted that ETS gases and vapours remain unaffected by these devices, and that the devices themselves could create or re-emit pollutants and be a source of noise. (*Ventilation issues and risks from exposure to environmental tobacco smoke [ETS],* Broadbent and Wesley, August 1996)

5.3 Position of the New Zealand Hospitality Industry on ETS control

Internationally, the Hospitality Industry, usually with the support of the Tobacco Industry, has taken the position that control of ETS in restaurants is best accomplished by ventilation and air filtration devices. The same process has been apparent in Australia and New Zealand. The Hospitality Association of New Zealand (HANZ) in a recently produced glossy publication ("*A Breath of Fresh Air"*) provides examples of allegedly successful use of ventilation and air ionisation/filtration devices in a number of bars and restaurants throughout the country. No objective data on percentage reduction of airborne tobacco smoke particulates or gases and vapours are given in the document.

5.4 Field Investigations

The author of this report personally visited two facilities in the greater Auckland area that were portrayed in the HANZ document. One was a sports pub in Newton, Auckland, and the other was an up scale café restaurant in Takapuna on Auckland's North Shore.

The Auckland pub had four *Aironic^{tm}AE 2000* ionising air filtration units installed on the ceiling of the sports bar area. All were turned on, but the fan speed setting was not known, Sixteen (16) patrons were present, about a quarter (4) of whom were observed smoking at any one time, giving a ratio of smokers to non-smokers of 1:3. The large patio doors were open to the outside deck, allowing natural ventilation. When queried, bar staff said that it had been a relatively quiet night, and numbers of patrons had been more or less constant. Despite the open doors and the four air filtration units, the facility had a very strong tobacco smoke odour and the environment produced some acute eye, nose and throat irritation to the author. When asked about the ceiling units, the bar staff knew the unit's intended function, but when asked how well the units worked, the staff suggested that the units were "not all that effective."

The Takapuna bar and grill had only one *Aironic^{tm}AE 2000* ionising filter unit visible mounted in the ceiling of the restaurant area. When queried about the device, restaurant staff did not know its true function and suggested it was a dehumidifier. The ceiling surfaces around the unit were significantly discoloured with visible black streaks of particle deposition, suggesting that the unit and installation needed cleaning. The environment in the restaurant was very clean, fresh and pleasant. There was an absence of noticeable tobacco smoke odour. Low numbers of patrons were present, and there were no visible smokers during the hour-long visit. Open windows and patio deck doors on opposite sides of the facility coupled with the Takapuna sea breeze, resulted in a significant flow of natural cross ventilation through the Restaurant. Thus, the clean indoor air was more clearly related to the absence of smokers and the ample natural dilution ventilation, rather than any effects of air filtration.

Despite the author's extensive experience with Indoor Air Quality and ventilation systems, these limited field investigations were observational and therefore somewhat subjective. However, they paint a far less rosy picture of the effectiveness of ventilation and air filtration systems to control ETS than does the glossy publication from HANZ.

5.5 Hospitality Industry Fears

Internationally and in New Zealand, continuation of smoking in bars and restaurants has had commercial and financial support from the Tobacco Industry and the Hospitality Industry. These groups, along with industry-sponsored consultants like Healthy Buildings International (HBI) doggedly and unscientifically maintain that ventilation and air filtration systems can resolve the ETS problem. This position attempts to align itself with the tobacco industry influenced consensus ventilation standards that allow smoking controls in indoor environments. These standards only address comfort criteria and ignore the more serious issue of control of ETS health hazards. Despite the persistence of this stance, the position that normal ventilation systems and air cleaning devices can control ETS is simply not sustainable on the facts.

The Hospitality Industry in New Zealand, like in other countries has been influenced by the Tobacco Industry over purported fears of business risk. These include costs of compliance with more stringent ventilation standards and more importantly the loss of patronage from smoking bans in the Hospitality Industry. These concerns are mirrored, and to an extent driven, by projected loss of revenue by the Tobacco Industry as non-smoker numbers continue to rise. (*The Tobacco Industry's Successful Efforts to Control Tobacco Policy Making in Switzerland*, Lee and Glantz, University of California, January 2001)

Countering these industry-based concerns are recent data on the reduced numbers of New Zealanders who continue to smoke, and the greater emphasis on preventative life-style related health issues. Additionally, the data suggest that the majority of Kiwis strongly support smoke free bars and restaurants or physically segregated and ventilated smoking areas in bars and restaurants. *(Public Attitude Research Report - Attitudes Toward Environmental Tobacco Smoke, Ministry Of Health, July 1999)*

Thus, the basis of the Hospitality Industry's commercial fears is brought into question. Further, the Hospitality Industry appears not to have assessed or factored into the current situation the potential regain of patrons previously lost to them due to the nuisance and health risks posed by ETS in facilities where smoking is permitted.

6.0 Conclusion

The issue of this report is not whether an individual has a right to smoke as a personal choice. The issue is whether practical and effective methods exist to adequately control ETS so that smoking in public restaurants and bars can continue without exposing Hospitality Industry workers and non-smoking patrons to the health and nuisance risks of ETS.

The health and nuisance hazards of ETS are real and significant. At present, most Hospitality and Tobacco Industry approaches to ETS control are aimed only at the subjective reduction in observable tobacco smoke particulates and odour by ventilation and smoke particulate filters. These methods are mostly cosmetic, and are not aimed at significant reduction or elimination of the nuisance and health hazards of all the components of ETS.

- Existing ventilation standards are based upon ensuring acceptable levels of comfort. They are not based upon adequate control or elimination of the health hazards of ETS and in fact are marginal even for addressing ETS nuisance.

- Review and analysis of ventilation system designs and available air cleaning devices lead to the conclusion that these systems are insufficient to adequately and reliably control the health hazards from ETS in bars and restaurants.

- Mechanical ventilation systems have practical limits on the benefits afforded by dilution and area exhaust ventilation.

- Although air filtration devices are highly touted as a panacea for ETS in New Zealand bars and restaurants, their actual effectiveness is limited to only reducing the particulate fraction of ETS. The hazardous gases and vapours, including such chemicals as 1,3 butadiene, remain unaffected.

- Besides these technical and practical limitations of ventilation and air cleaning systems, their limited effect on ETS reduction is likely to degrade over time due to poor maintenance.

- Finally, there is another significant complication to ensuring even limited ETS control in bars and restaurants by ventilation and air filtration systems. At present, no regulatory authority has the staff, resources or expertise to routinely inspect and enforce even the existing NZS 4303-based indoor ventilation standards in eating and drinking facilities.

6.1 Summary of Effective ETS Control Approaches

The only effective and practical means to control exposure to ETS in bars and restaurants are to:

- Construct physically segregated and separately ventilated smoking areas
- Ban smoking on the premises

6.1.1 Segregated Smoking Areas

Physically segregated smoking areas, with independent ventilation systems, will prevent the exposure of non-smoking patrons to ETS hazards and nuisance. However, Hospitality Staff in these areas will still be occupationally exposed to the ETS health threats, in fact, their exposures may be worsened. Unless staff are excluded from these areas, this remains the most serious flaw in the segregation/isolation smoking area approach.

As with the item above, to ensure reliability of this method, the ventilation systems require proper design installation, commissioning, and adequate routine maintenance. Proper maintenance is not assured.

6.1.2 Banning Smoking

Banning smoking as a source control method eliminates the source of the ETS pollutants and is the most effective control strategy. Only banning smoking eliminates the source of all ETS hazards. From the standpoint of reliability, cost effectiveness and consistency, this is the best way to protect both patrons and Hospitality Industry Staff from the risks and nuisance of ETS exposure.

6.2 Perspective on the ETS Control Issues

Society has witnessed many changes in smoking practices over the past two decades. These have included:

- Banning smoking in public buildings
- Banning smoking in most commercial buildings
- Smoke free workplaces and worksites
- Prohibition of smoking on commercial aircraft

When first proposed, all of these changes met with strong opposition from some quarters. However, time and experience has proven the benefits of these actions. For reasons of practicality, occupational health and safety of hospitality staff, and public health and comfort, it is suggested that restaurants and bars be added to the above list of facilities where smoking is banned.