立法會 CB(2)694/05-06(01)號文件

提交立法會《2005 年吸煙（公眾衞生）（修訂）條例草案》委員會

英美煙草就 2005 年 10 月 24 日會議提出的進一步意見

慨論

於 2005 年 10 月 24 日，立法會《2005 年吸煙（公眾衞生）（修訂）條例草案》委員會（「委員會」）聽取了 James Repace 先生及 Christopher Proctor 博士就環境香煙煙霧（亦即「二手煙」）對健康的影響，以及通風系統對減低環境香煙煙霧風險的成效的意見。

此跟進意見書旨在評論 Repace 先生向委員會提供的論據的可信性和正確性。對於 Repace 先生作出香港每年有 150 名飲食業從業員死於二手煙的假設，我們希望指出這假設是套用過時的海外風險模型於本地數據所推論以成。除了這個海外風險模型不適用於香港外，本地數據的正確性所引起的疑問，亦使這個 150 死亡數字變得缺乏說服力。雖然，我們深明環境香煙煙霧是一個重要的公共課題，但我們亦深信環境香煙煙霧會帶來健康風險實際上是言過其詞。事實上，大部分有關二手煙會增加非吸煙人士患上慢性疾病的研究都沒有一致的結論，若要利用這些研究指出接觸環境香煙煙霧會帶來風險，其風險程度亦小至難以準確地測量。

Repace 先生聲稱只有「龍捲風級數」的通風系統才足以減低環境香煙煙霧的風險。不幸地，這結論是由誇大的風險模型計算而成，並假設環境香煙煙霧必須降至遠低於目前的空氣質素標準。在現今社會，通風系統已在世界各地被廣泛採用，並証實能有效地把污染物減低至可接受水平。環境香煙煙霧，當中含有一般在燃燒過程中所釋放的氣體以及本身飄浮於空氣中的微粒，可以透過各種方法降至符合政府要求的空氣質素標準，這些方法包括但不限於通風系統、過濾技術、分離和隔離措施。

我們認爲環境香煙煙霧不應被分開獨立處理。環境香煙煙霧成份的監管，應該與其他源頭所釋放的同類物質相同。法例應保障員工免於非自願地吸入二手煙及不可接受的污染水平。因此，我們建議飲食業經營者應獲給予選擇，透過自然或機械式通風系統以確保場所符合空氣質素標準，或利用吸煙室或吸煙亭分隔開選擇吸煙的顧客，從而爲員工提供「受保護」的環境。

以下各項詳細列出了我們評論的基礎。

1. REPACE 先生及其論據的可信程度

1.1. 自我引證

Repace 先生就其每年有 150 名飲食業從業員死於吸入二手煙，以及只有「龍捲風級數」的通風系統才可把環境香煙煙霧降低至安全水平的推論，提出以下參考資料：

- Repace et. Al；*Passive Smoking and Risks for Heart Disease and Cancer in Hong Kong Catering Workers. Hong Kong Council on Smoking and Health, Report No. 8 (2001).* [*香港飲食業從業員：二手煙與心臟病及癌病風險。*香港吸煙與健康委員會第八號報告書 （2001）]
- James Repace；*Controlling Tobacco Smoking Pollution. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc,* ASHRAE IAQ Applications Vol. 6, No. 3（2005）.

此外，在計算美國及英國因吸入二手煙而死於肺癌的人數時，Repace 先生提出以下資料：

- Repace JL, and Lowrey AH. *A Quantitative Estimate of Nonsmokers' Lung Cancer Risk From Passive Smoking*. Environment International 11: 3-22 (1985).
- Repace JL, and Lowrey AH. *An Indoor Air Quality Standard For Ambient Tobacco Smoke based on Carcinogenic Risk*. N.Y. State Journal of Medicine: 85: 381-383 (1985).
- Repace JL, and Lowrey AH. *Risk Assessment Methodologies in Passive Smoking-induced Lung Caner.* Risk Analysis, 10: 27-37 (1990).
- Repace et. al. *Air Nicotine and Saliva Cotinine as Indicators of Passive Smoking Exposure and Risk*. Risk Analysis 18: 71-83 (1998).
- Repace. *A Killer on the Loose – An Action on Smoking and Health Special Investigation into the Threat of Passive Smoking to the UK Workforce* (2003).

從這些參考資料明顯可見，Repace 先生提出支持其論據的調查及研究，都是由其本人及其夥伴進行的。Repace 先生的論據在很大程度上都是自我引證，其正確性及局限性便自然成疑。

1.2. 有關龍捲風的假設未獲專家審議

我們深感關注用以支持室內禁煙政策的理據，是基於誇大的說法，而並非準確的科學數據。

Repace 先生聲稱只有「龍捲風級數」的通風系統才足以清除環境香煙煙霧，難免令人懷疑當中的「專家」證據。該證據來自 Repace 先生在一份未獲有關專家審議的商業報告中的論述。此論述未有提供任何科學證據作爲支持，而發表的時間是他在 1988 年獲得 "Action on Smoking and Health Certificate of Appreciation" 及 "Americans for Nonsmokers' Rights Plaque of Appreciation" 後兩年。

這論述牽涉邏輯謬誤——龍捲風和旋風不單只會替房屋抽風，還會摧毀房屋，根本不應作爲關乎眾多香港市民健康福祉及民生的認真討論內容。

有關只有「龍捲風級數」的通風系統才足以減低環境香煙煙霧風險的結論，是由誇大的風險模型計算而成。Repace 先生假設環境香煙煙霧中的懸浮粒子必須降至遠低於目前的空氣質素標準。由此可以理解，以此推算的通風量將會大得非常驚人和不切實際。

1.3. Repace 先生對海外地區的假設是否適用於香港以及本地的數據是否準確

Repace 先生估計香港每年有 150 名飲食業從業員死於二手煙，主要是依據 2001 年由香港吸煙與健康委員會與 Repace 先生進行的一項研究，當中把 Repace 先生及其他研究員所建立的一個過時的海外風險模型（Repace et al., 1998）套用於本地數據所推論以成。從該研究報告的總結資料表可見，用於建立風險模型，以美國情況作準的假設，被應用於本港有關吸入二手煙的數據。毫無疑問，這些著眼於美國的假設根本不適用於香港。例如：

<u>美國吸煙人口統計的假設</u>		<u>香港吸煙人口統計</u>
• 美國每三名成年人便有一人吸煙，平均每天吸食三十二枝香煙	比較	• 在香港，每六點五名成年人當中有一人吸煙，平均每天吸食十四枝香煙（資料來源：控煙辦公室，2003 年）
• 美國有百分之三十八男性及百分之三十女性吸煙	比較	• 在香港，有百分之二十六點一男性及百分之三點六女性吸煙（資料來源：控煙辦公室，2003 年）

這些基於美國的統計數據而非香港數據的假設，並未有清楚的交代，因此很難判斷這些假設是否合理。然而，就已知的環境香煙煙霧流行病學研究來看，每年有 150 名飲食業從業員死於二手煙的說法是嚴重誇大了事實，實際的數字可能是零。

該項吸煙與健康委員會的研究亦引起有關環境香煙煙霧的本地數據的疑問。該研究並沒有記錄任何死亡數字，只是利用從 165 人身上獲得曝露於尼古丁的數據來估計環境香煙煙霧曝險率，並作出一系列的假設，其中包括，假設在 2001 年錄得的單次曝險紀錄在未來 40 多年內都會維持不變。這固然不能準確量度當前曝險率，更遑論長期的曝險率。另一個假設是，飲食業從業員會在同一環境工作逾 40 年，這也是不常見的，因爲甚少飲食業從業員會維持同一份工作長達 40 年。

該項吸煙與健康委員會的研究亦假設了二手煙所增加患上心臟病的風險，是增加患肺癌風險的 10 倍。我們希望指出，這個假設並不合理，因爲所有已公布有關二手煙的流行病學研究（參看附錄 1）都不支持這項假設。已公布的研究顯示，患肺癌及患心臟病的相對風險都接近於一。另外，吸煙所增加患上肺癌的相對風險遠大於患上心臟病，因此，二手煙所增加患上心臟病的機會不會大於患肺癌的機會。

根據 Repace 先生與其夥伴早前發表的刊物，我們可歸納出用來建立風險模型的其他假設，詳情見附錄 2。

2. 健康風險──環境香煙煙霧有異於吸煙

環境香煙煙霧是一種由側流煙（來自煙草悶燒）與呼出的主流煙（來自噴出的煙霧）混合而成的淡化煙霧。二手煙與吸煙兩種活動的化學及物理特性非常不同。此外，環境香煙煙霧和吸煙吸入的途徑亦各異，二手煙是由鼻孔吸入，而主流煙則是從口腔吸入。因此，環境香煙煙霧的曝險率遠較吸煙爲低。

環境香煙煙霧所含物質的濃度，一般都極低，而且其中的許多化學物，都會從其他源頭釋放出來，即使沒有吸煙活動，都存在於空氣中。因此，科學家與公共衛生組織決定須要個別就環境香煙煙霧曝險率進行流行病學研究，而不是以吸煙的情況爲基礎作出推論。

我們深明環境香煙煙霧是一個重要的公共課題，但我們亦深信環境香煙煙霧會帶來健康風險實際上是言過其詞。

我們必須指出，大部分科學家都同意，致癌作用或其他疾病形成過程都有其臨界點。換句話說，雖然攝取某一高濃度的物質會致病，但曝露於同一物質的較低濃度則未必存在可測量的健康風險。

我們認爲，有關環境香煙煙霧對非吸煙者的慢性健康影響的研究，以一般標準而言是很薄弱和缺乏說服力的（參看附錄 1）。儘管研究指出在統計學上存在一定的聯系，該相對風險的幅度實在太小（一般都低於“2.0”）。以一般流行病學標準來說，都不足以作爲公共衛生政策的依據。例如，帕丁頓區傑爾（Baroness Jay of Paddington）女爵向政府陳述其對相對風險因素的看法時表示：「一個較強的聯系（大於“2.0”）才能反映因果關係，弱於此的聯系（小於“2.0”）則可能反映研究方法上有偏頗，或者只能反映非因果性的間接聯系」。

相對風險的少量升幅，有時候會以百分比的方式作報告。例如，“1.2” 的相對風險，會被普遍化地說成百分之二十的風險增幅，給人的印象是若有 100 人曝露於該風險，其中便有 20 人患上該疾病，誤導性非常高。一個很小的數值增加了百分之二十，最終的數值依然會很小。正如帕丁頓區傑爾女爵所指：「考慮風險因素的實際重要性，須視乎背後的風險多少而定。把一個甚小的機會率（風險）增加一倍，譬如說一千萬分之一，依然是很小的疾病風險」。若相對風險在統計學上並不顯著，科學上便可以肯定，不能排除該疾病的個案並無增加。

大部分有關環境香煙煙霧及心臟病的研究，都沒有發現顯著的風險上升。因吸煙而患上冠心病的相對風險，大幅低於患肺癌的風險，那麼，非吸煙者所受的影響應不足以被測量。United States Surgeon General 於 2000 年發表的一份報告指出：「由於吸煙只是心臟病病原學中眾多風險因素之一，要量化環境香煙煙霧與此疾病的確切關係，是很困難的」。John Bailar 教授在英國醫學期刊 New England Journal of Medicine 的編者語中表示：「我很遺憾地總結說，我們仍未確知曝露於環境香煙煙霧在多少程度上，甚至會否增加患上冠心病的風險。」

3. 通風系統的成效

在現今社會，通風系統已被廣泛採用來把污染物含量減低至可接受的水平，例如打開窗户以產生自然的通風效果，或使用風扇把「新鮮」空氣引入大廈內及抽走室內的污濁空氣，形成機械式通風效果。

在現代商業或工業環境裡，每個空間都受到氣體及微粒的污染。即使在高科技的「潔淨室」(“Clean Rooms”)，最高標準仍容許每立方呎空氣中有一粒大於 0.5 微米的微粒。這極高的標準，透過慣常的通風及過濾技術都可以達到，當中所須的空氣流通量當然遠遠低於「龍捲風級數」。

當然，這是相當極端和昂貴的例子。在香港，在污染水平較低，而成本及後勤負擔遠遠大於利益的情況下，都會採用環境保護署的「辦公室及公眾場所的室內空氣質素指標」的「良好級」爲評核標準。

香煙煙霧固然是香港室內空氣質素的一個重要考慮因素，它含有一般在燃燒過程中所釋放的氣體以及本身飄浮於空氣中的微粒。根據現實經驗，有效的通風系統及在有需要時採取隔離措施，可把污染水平降低至符合「良好級」的空氣質素標準，而且必定低於在香港大街小巷上經常錄得的污染水平。

由加拿大酒店協會（“Hotel Association of Canada”）贊助的 “Black Dog” 研究（見附件）顯示，採用手術室常用的壓力通風系統（更具成本效益的水平），無須設置由地面至天花的間隔，都可有效地

將香煙煙霧隔絕於非吸煙區以外。這例子顯示在這種非吸煙區（而非「非吸煙室」）內的微粒含量，甚至低於一般完全非吸煙的快餐廣場，其環境被煮食過程釋放的微粒所污染。

此意見書並附有香港國際機場其中一間吸煙室的測量結果（見附錄 3），當中顯示雖然吸煙量非常高，大部分的標準都能符合。值得注意的是，這些吸煙室內並無員工工作，進入房間者亦完全出於自願。香港政府一直繼續容許這種控煙措施，顯示了本地已採用可行的技術以達致高效能的方案。

全面禁煙並非唯一解決有關室內空氣質素疑慮的可行方案，其他更能平衡各方利益的方案包括但不限於通風系統、過濾技術、分離和隔離措施。雖然吸煙會增加空氣中的污染物，但我們應該容許場所經營者自行決定如何達致「良好級」的空氣質素標準，不論是禁止吸煙，或採用其他方法改善空氣質素。

合符邏輯地，環境香煙煙霧只是空氣污染物的眾多源頭之一。在人數眾多的室內空間，許多污染物都會來自衣服及皮膚中的微粒，及清潔液的化合物等。通風技術已被廣泛採用，以減少來自環境香煙煙霧及其他源頭的污染物，達致符合「良好級」的標準。

4. 海外地區的做法

世界各地的國家均採用了不同方法，以解決有關環境香煙煙霧的問題。除了少數例子外，大部分國家均沒有實施任何限制，或者推行自願性守則、強制性限制或有所豁免的禁制。例如，即使在法規嚴厲的國家如挪威，Bingo Halls 內沒有員工直接招待的地方仍然容許吸煙，理由是顧客是在完全自願的情況下曝露於二手煙中。意大利、瑞典及南非則選擇設立具通風系統的隔離吸煙室。馬來西亞則選擇推行空氣質素標準，容許場所經營者自行選擇如何達致標準。

5. 適合香港的方案

我們認爲環境香煙煙霧不應被分開特別處理。環境香煙煙霧成份的監管，應該與其他源頭所釋放的同類物質相同。法例應保障員工免於非自願地吸入二手煙及不可接受的污染水平。因此，我們建議飲食業經營者應獲給予以下兩種選擇：

1. 透過自然或機械式通風系統以確保場所符合空氣質素標準，或
2. 利用吸煙室或吸煙亭分隔開選擇吸煙的顧客，從而爲員工提供「受保護」的環境。

5.1. 通風系統

爲了展示通風系統可大大減低環境香煙煙霧及改善整體室內空氣質素，英美煙草香港最近與香港酒吧及卡拉 OK 業權益促進組〈「促進組」〉攜手，進行一項示範計劃，改善一酒吧場所的通風系統。該計劃旨在改善場所整體的空氣質素，使場所每個角落在密集吸煙的情況下都能令員工及顧客感到舒適。

藉著英美煙草在這方面的國際經驗，我們爲這個本地的通風系統項目請來了一位室內空氣質素專家，負責早期的策劃工作。該名專家提供了改善抽風系統的建議，以確保屬於促進組的選定示範酒吧能符合高室內空氣質素標準。這些建議繼而由一間合資格的工程顧問公司落實爲具體的工程及機械藍圖，再由選定的承建商施工實行。改善工程預計於 2006 年初完成，屆時我們將邀請委員會的議員參觀該示範場地，親身體驗通風系統的成效。

5.2. 吸煙室

除了替整個場所設立通風系統外，另一可行的方案就是設立具備通風設施的「吸煙室」。吸煙者可繼續在「吸煙室」內吸煙，而有效的隔離措施可避免環境香煙煙霧中的成份「漏」出吸煙室，爲外面的員工及非吸煙者提供一個空氣質素達到「良好級」的環境。「吸煙室」內的通風設備亦可把環境香煙煙霧中的成份含量減至極低水平，讓員工在營業時間後入內進行清潔。

英美煙草香港現正著手進行另一項示範計劃，以展示在香港的酒吧及卡拉 OK 場所內的「吸煙室」容許吸煙的可行性。

5.3. 吸煙亭

通風技術日新月異，現已發展出開放式的「吸煙亭」，以取代傳統的吸煙室或戶外吸煙（參見附錄 4）。吸煙亭的空氣處理系統會抽掉吸煙者旁邊的空氣，包括所有香煙煙霧，然後透過兩種過濾器，清除煙霧中百分之九十九的微粒以及有害氣體和氣味，除之把清新的空氣還回室內。

此技術方案相當有效，因爲吸煙者處於被包圍的空間，氣流強度足以避免煙霧飄走。這些吸煙亭在歐洲各地均有發售，其中包括控煙法規非常嚴厲的國家，因爲吸煙亭內的空氣完全不會漏走。

我們相信此方案適用於香港的酒吧，因爲其成本較低，而且體積較小，並可設立在靠近吸煙者的位置，使他們無須步行到大廈外吸煙。吸煙亭的外觀亦非常吸引，可以融入成爲場所的一部分，無須另闢空間。

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註：此文件翻譯自英文原文，若中、英文版本有任何不符，應以英文版本爲準。

ETS Health Studies - List of all studies published, with their relative risks

TABLE 1: Relative risk of lung cancer among lifelong nonsmoking women in relation to smoking by the husband

	Author	Year	Location	Type	Cases	RR (95% CI)		
1	Garfinkel 1	1981	USA	P	153	1.17 (0.85-1.61)		a
2	Chan	1982	Hong Kong	CC	84	0.75 (0.43-1.30)		u
3	Correa	1983	USA	CC	25	2.07 (0.81-5.25)		u
4	Trichopoulos	1983	Greece	CC	77	2.08 (1.20-3.59)	+	u
5	Buffler	1984	USA	CC	41	0.80 (0.34-1.90)		u
6	Hirayama	1984	Japan	P	200	1.45 (1.02-2.08)	+	a
7	Kabat 1	1984	USA	CC	53	0.79 (0.25-2.45)		mr
8	Garfinkel 2	1985	USA	CC	134	1.23 (0.81-1.87)		mr
9	Lam W	1985	Hong Kong	CC	75	2.01 (1.09-3.72)	+	u
10	Wu	1985	USA	CC	31	1.20 (0.50-3.30)		a
11	Akiba	1986	Japan	CC	94	1.50 (0.93-2.76)		ar
12	Lee	1986	UK	CC	32	1.00 (0.37-2.71)		a
13	Brownson 1	1987	USA	CC	19	1.68 (0.39-6.90)		ar
14	Gao	1987	China	CC	246	1.30 (0.89-1.91)		ar
15	Humble	1987	USA	CC	20	2.20 (0.76-6.56)		ar
16a	Koo	1987	Hong Kong	CC	88	1.64 (0.87-3.09)		ar
17	Lam T	1987	Hong Kong	CC	202	1.65 (1.16-2.35)	+	u
18	Pershagen	1987	Sweden	CC	83	1.20 (0.70-2.10)		ar
19	Butler	1988	USA	P	8	2.02 (0.48-8.56)		ab
20	Geng	1988	China	CC	54	2.16 (1.08-4.29)	+	u
21	Inoue	1988	Japan	CC	28	2.25 (0.77-8.85)		a
22	Shimizu	1988	Japan	CC	90	1.08 (0.64-1.82)		mr
23	Choi	1989	Korea	CC	75	1.63 (0.92-2.87)		u
24	Hole	1989	Scotland	P	6	1.89 (0.22-16.12)		uv
25	Svensson	1989	Sweden	CC	38	1.36 (0.53-3.49)		a
26	Janerich	1990	USA	CC	146	0.75 (0.47-1.20)		mrz
27	Kalandidi	1990	Greece	CC	91	2.11 (1.09-4.08)	+	ar
28	Sobue	1990	Japan	CC	144	1.13 (0.78-1.63)		ar
29	Wu-Williams	1990	China	CC	417	0.70 (0.60-0.90)	-	ar
30	Liu Z	1991	China	CC	54	0.77 (0.30-1.96)		ar
31	Brownson 2	1992	USA	CC	432	1.00 (0.80-1.20)		ar
32	Stockwell	1992	USA	CC	210	1.60 (0.80-3.00)		ar
33	Du	1993	China	CC	75	1.09 (0.64-1.85)		dmr
34	Liu Q	1993	China	CC	38	1.72 (0.77-3.87)		r
35a	Fontham	1994	USA	CC	653	1.29 (1.04-1.60)	+	ar
36	Layard	1994	USA	CC	39	0.58 (0.30-1.13)		ar
37	deWaard	1995	Netherlands	CC	23	2.57 (0.84-7.85)		u
38	Kabat 2	1995	USA	CC	69	1.08 (0.60-1.94)		mr
39	Schwartz	1996	USA	CC	185	1.10 (0.72-1.68)		arz
40	Sun	1996	China	CC	230	1.16 (0.80-1.69)		ar

41	Wang S-Y	1996	China	CC	82	2.53 (1.26-5.10)	+	u
42	Wang T-J	1996	China	CC	135	1.11 (0.67-1.84)		m
43a	Cardenas	1997	USA	P	246	1.20 (0.80-1.60)		ar
44	Zheng	1997	China	CC	69	2.52 (1.09-5.85)	+	u
46	Boffetta 1	1998	W. Europe	CC	509	1.11 (0.88-1.39)		ar
47	Shen	1998	China	CC	70	0.75 (0.31-1.78)		a
48	Zaridze	1998	Russia	CC	189	1.53 (1.06-2.21)	+	ar
49	Boffetta 2	1999	Europe	CC	66	1.00 (0.50-1.90)		ar
50	Jee	1999	Korea	P	79	1.72 (0.93-3.18)		ar
51	Rapiti	1999	India	CC	41	1.20 (0.50-2.90)		ar
52	Speizer	1999	USA	P	35	1.50 (0.30-6.30)		a
53	Zhong	1999	China	CC	504	1.10 (0.80-1.50)		ar
54	Lee C-H	2000	Taiwan	CC	268	1.87 (1.29-2.71)	+	arv
55	Malats	2000	EU/Brazil	CC	105	1.50 (0.77-2.91)		arz
56	Wang L	2000	China	CC	200	1.03 (0.60-1.70)		ar
57	Johnson	2001	Canada	CC	71	1.20 (0.62-2.30)		arv
58	Lagarde	2001	Sweden	CC	242	1.15 (0.84-1.58)		artz
59	Nishino	2001	Japan	P	24	1.80 (0.67-4.60)		ar
60	Ohno	2002	Japan	CC	191	1.00 (0.67-1.49)		acr
62	Seow	2002	Singapore	CC	176	1.29 (0.93-1.80)		u
63	Enstrom	2003	USA	P	177	0.94 (0.66-1.33)		ar
64	Zatloukal	2003	Czech Rep	CC	84	0.48 (0.21-1.09)		apr
65	IARC: Kreuzer	2004	Germany	CC	100	0.80 (0.50-1.30)		ar
66	McGhee	2005	Hong Kong	CC	179	1.38 (0.94-2.04)		ar
67	Vineis	2005	W. Europe	P	70	1.05 (0.55-2.02)		arz

Notes for Table 1

Study 33 (Du) also reported that ETS was not statistically associated with lung cancer in an earlier similar study.
Study 67 (Vineis) reported two type of analysis, each giving estimates of relative risk. The result quoted here is from the analysis of the whole cohort using Cox's proportional hazards model. A nested case-control analysis gave an odds ratio of 1.42 (0.63-3.20). Using this value rather than the result quoted above made no difference to meta-analyses of spousal smoking.

Index of exposure is based on smoking by the spouse or, if not available, the nearest equivalent as described below under 'Indices of ETS exposure used other than husband smoked'

- Study author is name of first author in publication from which data extracted, see references.
- Study year is year of that publication.
- Study type: CC case control; P prospective
- Number of lung cancers in lifelong nonsmokers are study totals for females; for specific exposures numbers may be less.
- Where necessary, relative risks and 95% confidence limits were estimated from data presented.

- Significance: + statistically significant increase at 95% confidence level - significant decrease.
- Notes: see 'Notes column' below.

Notes column:

a adjusted for age;
b based on "Spouse-Pairs Cohort" as "AHSMOG Cohort" not never smokers;
c based on data for hospital controls. Data for population controls not used as non-response rate very high;
d based on data for two control groups combined;
m lifelong nonsmoking cases and controls matched for age but no age adjustment in analysis;
p based on data for two pathological groups of lung cancer combined;
r adjusted or matched for other factors (shown below);
t based on data by radon exposure;
u unadjusted for age or other factors;
v relative risks were presented adjusted for age but only by level of exposure;
z relative risks were presented for sexes combined and assumed to apply to each sex separately, with confidence intervals weighted according to numbers of subjects by sex.

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TABLE 2: Studies providing information on risk of heart disease in relation to ETS exposure in lifelong non-smokers

Study					Endpoints		Number of heart disease cases in lifelong non-smokers		
Ref	Author	Year	Location	Type	Fatality	Disease	Females	Combined	Males
1a	Hirayama	1984	Japan	P	F	IHD	494		
2	Garland	1985	USA/California	P	F	IHD	19		
3	Lee	1986	England	CC	NF	IHD	77		41
4	Martin	1986	USA/Utah	CS	NF	PHA	23		
5	Svendsen	1987	USA	P	F,NF	IHD,IHD			69
6	Butler	1988	USA/California	P	F	IHD	80		
7	Palmer	1988	USA/?	CC	NF	MI	336		
8	Hole	1989	Scotland	P	F,NF	IHD,A/E	55		65
9	Jackson	1989	New Zealand	CC	F,NF	IHD,MI	73		230
10	Sandler	1989	USA/Maryland	P	F	AHD	988		370
11	Humble	1990	USA/Georgia	P	F	CVD	76		
12	Dobson	1991	Australia	CC	F+NF	IHD+MI	160		183
13	La Vecchia	1993	Italy	CC	NF	FMI	44		69
14	Layard	1995	USA	CC	F	IHD	914		475
15	LeVois (CPS-I)	1995	USA	P	F	AHD	7133		7758
16	Mannino	1995	USA	CS	NF	CVD	*		*
17	Muscat	1995	USA/4 cities	CC	NF	NMI	46		68
18	Tunstall-Pedoe	1995	Scotland	CS	NF	IHD		428	
19	Steenland	1996	USA	P	F	IHD	1325		2494
20	Janghorbani	1997	Iran	CC	NF	IHD	200		
21	Kawachi	1997	USA	P	F+NF	IHD+MI	152		
22	Ciruzzi	1998	Argentina	CC	NF	FMI	180		156
23	McElduff	1998	Australia	CC	F+NF	MI+MI	85		198
24	Spencer	1999	Australia	CC	NF	FMIS			91
25a	He	2000	China	CC	NF	MI/CS	115		
26	Iribarren	2001	USA	CS	NF	HD	1856		2945
27	Rosenlund	2001	Sweden	CC	NF	FMI	135		199
28	Pitsavos	2002	Greece	CC	NF	FMI/UA		279	
29	Enstrom	2003	USA	P	F	IHD	3645		2287
30	Chen	2004	Scotland	CS	NF	IHD		385	
31	Nishtar	2004	Pakistan	CC	NF	CAD	*		*
32	Whincup	2004	Great Britain	P	F+NF	IHD			111
33	McGhee	2005	Hong Kong	CC	F	IHD	225		359

Notes for Table 2

McElduff (ref 23) reported results for 3 samples. Only those for Newcastle 1992-94 are included under study 23. Results for Auckland 1986-88 and for Newcastle 1988-89 are additional to earlier reports by Jackson (ref 9) and Dobson (ref 12) and are considered under studies 9 and 12 respectively.

- The study author is usually the first author of the publication providing the data - see references.
- The study year is the year of that publication.
- The study types are CC=case control, CS=cross-sectional and P=prospective.
- Fatality is indicated by F=fatal heart disease and NF=non-fatal heart disease. F + NF implies data only available for fatal and non-fatal heart disease combined.
- Disease is indicated by A/E = angina or ECG abnormality, AHD = arteriosclerotic heart disease, CAD = coronary artery disease, CVD = cardiovascular disease, FMI = first myocardial infarction, FMI/UA = first myocardial infarction or unstable angina, FMIS = first myocardial infarction surviving 28 days, HD = heart disease, IHD = ischaemic (coronary) heart disease, MI = myocardial infarction, MI/CS = myocardial infarction or coronary stenosis, NMI = newly diagnosed myocardial infarction, PHA = previous heart attack.
- Numbers of heart disease cases in lifelong non-smokers are totals in the study; for analyses relating to specific types of exposure numbers may be less than this. For studies 16 and 31 (indicated by *) numbers were not given. For studies 18, 28 and 30, data were only provided for sexes combined. For study 6, numbers relate to the spouse-pairs cohort only, the AHSMOG cohort including ex-smokers.

TABLE 3: Relative risk of heart disease among lifelong non-smokers in relation to smoking by the spouse (or nearest equivalent)

Study Ref	Author	Sex	Exposure Index	Fatality	Relative risk (95% confidence limits)	Significance
1a	Hirayama	F	E	F	1.16 (0.94-1.43)	
2	Garland	F	E	F	2.70 (0.63-11.58)	
		F	C(N)	F	2.25 (0.32-15.74)	
3	Lee	M	E	NF	1.24 (0.59-2.59)	
		F	E	NF	0.93 (0.54-1.61)	
4	Martin	F	E	NF	2.60 (1.20-5.70)	+
		F	C	NF	3.40	?
5	Svendsen	M	C	F+NF	1.61 (0.96-2.71)	
6	Butler	F	E	F	1.07 (0.65-1.75)	
		F	C(N)	F	1.40 (0.51-3.84)	
7	Palmer	F	E	NF	1.20	?
8	Hole	M	E	F	1.73 (1.01-2.96)	+
		F	E	F	1.65 (0.79-3.46)	
9	Jackson	M	C	F+NF	1.06 (0.39-2.91)	
		F	C	F+NF	3.74 (1.15-12.19)	+
10	Sandler	M	C	F	1.31 (1.05-1.64)	+
		F	C	F	1.19 (1.04-1.36)	+
11	Humble	F	C(N)	F	1.59 (0.99-2.57)	
12	Dobson	M	C	F+NF	0.97 (0.50-1.86)	
		F	C	F+NF	2.46 (1.47-4.13)	+
13	La Vecchia	M	E	NF	1.09 (0.47-2.53)	
		F	E	NF	1.27 (0.52-3.09)	
		M	C(N)	NF	1.09 (0.39-3.01)	
		F	C(N)	NF	1.36 (0.46-4.05)	
14	Layard	M	E	F	0.97 (0.73-1.28)	
		F	E	F	0.99 (0.84-1.16)	
15	LeVois (CPS-I)	M	E	F	0.97 (0.90-1.05)	
		F	E	F	1.03 (0.98-1.08)	
		M	C(N)	F	0.98 (0.91-1.06)	
		F	C(N)	F	1.04 (0.99-1.09)	
16	Mannino	M+F	C	NF	1.12	?
17	Muscat	M	E	NF	1.38 (0.70-2.75)	
		F	E	NF	1.33 (0.59-2.99)	
18	Tunstall-Pedoe	M+F	C	NF	1.34 (1.07-1.67)	+

TABLE 3 (continued): Relative risk of heart disease among lifelong non-smokers in relation to smoking by the spouse (or nearest equivalent)

Study Ref	Author	Sex	Exposure index	Fatality	Relative risk (95% confidence limits	Significance
19	Steenland	M	E	F	1.09 (0.98-1.21)	
		F	E	F	1.04 (0.93-1.16)	
		M	C(N)	F	1.22 (1.07-1.40)	+
		F	C(N)	F	1.10 (0.96-1.27)	
20	Janghorbani	F	E	NF	1.38 (0.95-2.01)	
21	Kawachi	F	C	F+NF	1.53 (0.81-2.90)	
22	Ciruzzi	M	C	NF	1.18 (0.55-2.52)	
		F	C	NF	1.73 (0.89-3.36)	
23	McElduff	M	C	F+NF	0.82 (0.55-1.22)	
		F	C	F+NF	2.15 (1.18-3.92)	+
24	Spencer	M	E	NF	No significant association	
25a	He	F	E	NF	1.60 (0.94-2.90)	
26	Iribarren	M	C	NF	1.13 (1.00-1.27)	+
		F	C	NF	1.20 (1.09-1.30)	+
27	Rosenlund	M	E	NF	0.96 (0.64-1.44)	
		F	E	NF	1.53 (0.95-2.44)	
		M	C(N)	NF	0.98 (0.57-1.69)	
		F	C(N)	NF	2.59 (1.27-5.29)	+
28	Pitsavos	M+F	E	NF	1.33 (0.89-1.99)	
29	Enstrom	M	E	F	0.93 (0.83-1.04)	
		F	E	F	0.99 (0.92-1.08)	
		M	C(N)	F	0.92 (0.80-1.05)	
		F	C(N)	F	0.97 (0.89-1.06)	
30	Chen	M+F	C	NF	1.20 (0.70-2.20)	
31	Nishtar	M+F	U	NF	2.38 (1.04-5.42)	+
33	McGhee	M	P	F	1.30 (0.88-1.93)	
		F	P	F	1.39 (0.95-2.04)	

Notes for Table 3

In study 1, estimates are adjusted for the age of the husband. Alternative estimates, adjusted for the age of the subject are also given by Hirayama (1b), and are very similar.
In study 4 (exposure index E) and study 21, the estimates were given by Wells (34).
In study 8 the estimates were given by Wells (35).
In several studies (8,9,10,12,16,18,21,23,24,26,28,30,33) the index of exposure is actually based not on spousal smoking but on the nearest equivalent index (see Table 2).
See Appendix B for the covariates considered in adjusted analyses.

- The study author is usually the first author of the publication providing the data – see references.
- Exposure index: E = ever smoked (compared to never smoked); C(N) = current smoker (compared to never smoked); C = current exposure (compared to non-current exposure); P = in the past; U = undefined.
- Fatality: F = fatal; NF = non-fatal; F+NF = fatal and non-fatal combined.

• Significant (p<0.05) positive (negative) relative risks are indicated by + (or -). ? indicates not known if significant or not.

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Assumptions

From earlier publications of Mr. Repace and co-workers, it is possible to list some of the other assumption used in developing the models.

Assumptions on Exposure

	The US Demographic		**An Elaboration on the applicability of the assumptions to Hong Kong**
1	That one in three US adult smoked, at an average of 32 cigarettes per day	………	*One in 6.5 adult smokes at the average of 14 cigarettes a day (Tobacco Control Office, 2003)*
2	A single amount of exposure can be assigned to a home, an office, a restaurant etc	………	*It is unlikely that exposure to ETS will be the same at home, at work or at leisure. Many offices have self-regulated against smoking for many years, and ETS exposure at home will depend on many factors including size of the home, number of smokers, how often the smokers are at home and whether they smoke with windows open or shut, etc*
3	Total exposure can be calculated by simply adding up the time the population spends in each of these places	………	*This is unlikely to be applicable to Hong Kong given the above 2 factors.*
4	Employed persons, who spend between 2 and 3% of time out doors are representative of the whole population		
5	Assume that married housewives spend 20.5 hours per day at home.	………	*This is unlikely to hold for Hong Kong, or even for US housewives*
6	US worker breathe 8m^3 of air per 8 hour workshift		
7	90% of white-collar workplaces and 72.5 of blue collar workplaces allow smoking	………	*Given the 14.4% smoking incidence in Hong Kong, this is unlikely to be applicable to Hong Kong*
8	75% of all white collar workers are exposed to ETS at work, and that 50% of blue-collar workers are exposed	………	*Ditto*
9	The number of people in the workplace is a surrogate for the number of smokers Women work less hours per day than men, and that the average daily working time is 6.13 hours	………	*Number of working hours is likely to be higher in Hong Kong*
10	The average level of particulates in the workplace air throughout the 8 hour shift is 242 ug/m^3, resulting in an exposure of 1.47mg of tobacco respirable suspended particulates (RSP) per working day	………	*According to an IAQ survey conducted by Environmental Protection Department in 1995, the average indoor RSP levels at the 40 office premises were found to range from 6.8 to 163.6 µg/m^3 (mean = 29.7 µg/m^3, standard deviation = 24.2 µg/m^3).*

11	Men spend 34.4% of the waking day (with 8 hours asleep) at home, employed women spend 45.9% of the waking day at home and housewives spend 81% of the waking day at home		
12	62% of homes with children have one or more smokers	………	*Given the 14.4% smoking incidence in Hong Kong, this is far from local reality*
13	38% of men and 30% of women smoke	………	*In Hong Kong, 26.1% of men and 3.6 of women smoke (Tobacco Control Office, 2003)*
14	Smoking wives smokes 22 cigarettes per day at home and the husband 11 cigarettes	………	*Smokers smoke an average of 14 cigarettes a day (Tobacco Control Office, 2003)*
15	Each cigarette smoked contributes to 0.88ug/m3 of respirable particulates in a typical home, and to 2.11 ug/m^3 in an "energy-efficient" home.*)*	………	*It is not possible to extrapolate exposure in US homes to exposure in Hong Kong homes, as many factors are very different*
16	Exposure from home averages 0.45mg per day	………	*Ditto*
17	From a study of 89 people average cotinine in saliva was1.0ng/ml for those living with a smoker and 0.8 ng/ml for those working with a smoker	………	*This study is based on a very small sample size in the US, and therefore, is unlikely to be translated to Hong Kong*

Assumptions on Risk

	The US Demographic		**An Elaboration on the applicability of the assumptions to Hong Kong**
1	Assume that in 1980, 108,504 people in the US died of lung cancer, and that 85% of these deaths were due to smoking	………	*Due to the reduction in smoking incidence, it is unlikely to apply some aging data in 1980 in the US to current situation in Hong Kong.*
2	Assume lung cancer only occurs at ages above 35 years		*This is very unlikely to be true*
3	Assume in 1980 in the US there were 29,335,000 smokers above 35 years of age	………	*See comment for Assumption #1*
4	Assume there was 3.156 x 10-3 lung cancer deaths per smoker of lung cancer age	………	*Such precision is inappropriate, and given that the underlying assumptions do not apply to Hong Kong, neither can the rate apply to Hong Kong*
5	Assume that the average cigarette had 17mg tar and the average smoke smoked 32 cigarettes a day, giving 544mg per day per smoker.	………	*Tar ceiling for any cigarette to be sold in Hong Kong is restricted below 17mg. Therefore, it is not meaningful to assume an average tar yield at 17mg. Besides, according Tobacco Control Office figure in 2003, smokers in Hong Kong smoke an average of 14 cigarettes a day.*

6	Assume that mainstream cigarette tar and ETS respirable particles have the same carcinogenic potential	………	*Science does not support this assumption. There is far less retention of ETS particles than mainstream smoke particles. ETS tends to be breathed in, and filtered through nose, while mainstream smoke was inhaled through mouth.*
7	Assume a 1980 lung cancer death is associated with a 20 to 40 year smoking history in which smoking rates doubled and tar levels halved.	………	*Due to the reduction in smoking incidence, it is unlikely to apply some aging data in 1980 in the US to current situation in Hong Kong.*
8	Assume 5.8 x 10-6 lung cancer deaths/year per mg/day per smoker.	………	*This is a mathematical assumption*
9	Assume passive smoking gives an exposure of 1.5mg per day and so annual lung cancer risk for passive smoking is 0.87 x 10-5	………	*See comment for Assumption #4*
10	Assume 63.8 x 106 passive smokers at risk, results in 555 lung cancer deaths per year in the US from passive smoking	………	*See comment for Assumption #4*
11	Take a group of Seventh Day Adventists from Southern California between 1960 and 1976 and assume few of the Seventh Day Adventists smoke or are exposed to smoke	………	*See comment for Assumption #4*
12	Take a group of non-Seventh Day Adventists from a similar place and compare the lung cancer rates with those that were Seventh Day Adventists	………	*See comment for Assumption #4*
13	Assume the entire death rate difference is due to passive smoking	………	*This is very unlikely to be true*
14	Assume all SDA are not exposed and all non-SDA are all exposed	………	*This is very unlikely to be true*
15	Assume there are no differences between men and women		*This is very unlikely to be true as there are obvious differences between men and women for lung cancer and heart disease risks*
16	Assume there are no other differences between the groups	………	*This is very unlikely to be true*
17	Assume, using the differences that ETS is associated with 4,666 lung cancer deaths per year in the US	………	*This is very unlikely to be true* *See comment for Assumption #4*
18	Assume a relative risk of lung cancer from workplace exposure is 2	………	*WHO suggested an assumption that uses a relative risk much higher even than that*
19	Assume a linear dose response relationship	………	*While there are clearly dose response relationships for active smoking and lung cancer and heart disease, they are not always linear*

Smoking Lounge Sponsored by BAT HK
(Lounge 5.3)

In 2000 – 2003, British American Tobacco sponsored to set up and maintain a smoking lounge with the state-of-the-art ventilation system in the Hong Kong International Airport, catering the needs of smoking travellers who are unable to smoke in open areas due to security reasons. The Lounge was designed based on two international standards for smoking area. They are widely adopted by building engineers in designing ventilation to maintain acceptable indoor air quality.

1. **ASHRAE Standard 62 – 2001 (USA)** (American Society of Heating, Refrigerating and Air-Conditioning Engineers)
2. **CIBSE Guide A (UK)** (Chartered Institution of Building Services Engineers)

Based on the results of an independent study that measured the indoor air quality of the smoking lounge as compared to the EPD IAQ objectives, the air quality of the lounge was considered satisfactory. This case demonstrates that even in the most congested environment concentrated with tobacco smoke, an advanced and properly managed ventilation system is still effective in ensuring high indoor air quality. The Hong Kong Airport Smoking Lounge experience can serve as an important reference for the government in addressing the ETS issue in catering and entertainment premises.

The Ventilation system

- The ventilation system adopted the concept of “Displacement Flow” and “Localized Source Control” to maximize the ventilation effectiveness and to reduce the level of pollutants.
- The raised-floor ventilation system ensured treated air to supply via floor grills from the adjacent hall while the stale air was extracted and filtered via ceiling exhaust air grilles and vented outdoors. The floor-to-ceiling displacement flow can yield excellent thermal comfort and air quality by removing tobacco smoke.
- In addition, local exhaust points were provided at each ashtray such that tobacco smoke can be extracted locally into filters of the floor air grilles before diffusing throughout the space.
- The lounge was maintained at a negative pressure in order to avoid the tobacco smoke from entering the adjacent space.

Maintenance

Daily	Monthly	Quarterly	Annually
▪ Routine cleaning at least 4 times a day for ashtray cleaning and room maintenance	▪ Cleaning and maintenance of floor and ceiling ventilation systems, including exhaust fans, air-conditioning and bio-oxygen generator	▪ Quarterly maintenance of ductworks and filter units ▪ IAQ tests	▪ Annual ventilation and ductworks overhaul ▪ Remedial works (when necessary)

Indoor Air Quality Control

- Indoor air quality of the smoking lounge was closely monitored and controlled in accordance to EPD guidance. IAQ tests were carried out on a quarterly basis by a registered IAQ Laboratory to ensure that the indoor air quality will be acceptable to occupants.

Parameters	EPD IAQ Objectives		IAQ Test Results (on 17 Dec 2002)			
	Level 1	Level 2	Smoking Lounge	Level	Intake Air	Level
Carbon Dioxide	<800	<1,00	660	1	610	1
Carbon Monoxide	<2,000	<10,000	1,600	1	1,800	1
Respirable Suspended Particulates	<20	<180	410	> 2	58	2
Nitrogen Dioxide	<40	<150	160	> 2	110	2
Ozone	<50	<120	< 50	1	<50	1
Formaldehyde	<30	<100	52	2	49	2
Total Volatile Organic Compounds	<200	<600	180	1	170	1
Radon	<150	<200	Not Measured		Not Measured	
Airborne Bacteria	<500	<1,000	85	1	29	1
Room Temperature	20 – 25.5	< 25.5	20.5	1	20.1	1
Relative Humidity	40 – 70	< 70	51	1	47	1
Air Movement	<0.2	<0.3	0.25	2	0.21	2

吸煙亭 **("Smoking Booth")**

附件

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Environmental Tobacco Smoke in the Nonsmoking Section of a Restaurant: A Case Study

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This study tested the concentrations of environmental tobacco smoke (ETS) components in a small restaurant/pub with smoking and nonsmoking areas—a facility outfitted with a heat-recovery ventilation system and directional airflow. The ETS levels in the nonsmoking area were compared with those in other similar restaurants/pubs where indoor smoking is altogether prohibited. The results indicate that ETS component concentrations in the nonsmoking section of the facility in question were not statistically different ($P < 0.05$) from those measured in similar facilities where smoking is prohibited. The regulatory implications of these findings are that ventilation techniques for restaurants/pubs with separate smoking and nonsmoking areas are capable of achieving nonsmoking area ETS concentrations that are comparable to those of similar facilities that prohibit smoking outright.

INTRODUCTION

Several studies have examined environmental tobacco smoke (ETS) concentrations and/or personal exposure in a variety of public restaurants and drinking establishments ("hospitality facilities"). Earlier studies tended to focus on either short duration area measurements or personal monitoring measurements on surrogate "customers" (Brunnemann *et al.*, 1992; Thompson *et al.*, 1989; Oldaker *et al.*, 1990; Turner *et al.*, 1992; Collett *et al.*, 1992; Lambert *et al.*, 1993). More recent investigations have focused on the personal exposure to ETS of night-club musicians (Bergman *et al.*, 1996), casino workers (Trout *et al.*, 1998), or wait staff and bartenders (Maskarinec *et al.*, 2000). With the strict segregation of smoking and nonsmoking areas in those hospitality facilities that still permit smoking, the use of directional airflow and heat-recovery ventilation systems has become increasingly popular. However, little data have been reported with which to assess the effectiveness of such systems in securing adequate air quality in the nonsmoking areas of such facilities. The intuitive benchmark for such a comparison is the air quality level in hospitality facilities where indoor smoking is prohibited. In most instances, such facilities will not be absolutely free of ETS, since smoking is often permitted immediately outside the establishments and traces of ETS components could be introduced from human and material traffic and other sources extraneous to smoking. The purpose of this study was to test a directional-flow heat-recovery ventilation and filtration system in a pub that segregates smoking and nonsmoking areas and its effectiveness in providing nonsmoking areas ETS concentrations comparable to the ETS concentrations in similar facilities where indoor smoking is prohibited.

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METHODS

Two organizations were involved in the conduct of the study. The Chemical and Analytical Sciences Division of Oak Ridge National Laboratory (Oak Ridge, TN) was responsible for overall protocol development, preparation of the ETS sampling media and analysis of the collected samples, interpretation of the data, and overall reporting. Finn Projects (Toronto, Ontario, Canada) was responsible for the system conceptual design and modifications, field sampling, and real-time field measurements.

Facilities Surveyed

The facility to be studied, the Black Dog Pub, is located in Scarborough, Ontario, Canada, a suburb of Toronto. Prior to the selection of the Black Dog Pub as the test site, a number of restaurants were reviewed and inspected. The Black Dog was selected as the owner had already shown commitment to improving air quality, having previously invested in heat-recovery ventilation technology, and was willing to cooperate in retrofitting the ventilation system. Also, it was believed that the test facility should have a very high

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average occupancy and a high percentage of smokers, so that it could represent a wide spectrum of bars and restaurants.

The Black Dog Pub has a designated smoking area of approximately 110 m^2, with a seating capacity of 45 individuals. Patrons may order drinks from a bar in this area (15 seats at the bar) and/or food from several (8) tables located around the bar. A nonsmoking eating area, approximately 70 m^2 in area, with a seating capacity of 99, is located adjacent to the smoking bar/eating area. It is separated from the smoking area by a wall with two pass-through windows and by two open doorways. Patrons may order drinks or food in this area from one of 20 tables. Note that there are no physical barriers in the pass-through and doorways, in order to ensure the free flow of air from the nonsmoking to the smoking section.

Ventilation for the Black Dog Pub is provided by a 3100 ft^3/min (cfm) energy/heat recovery ventilation system (ERV or HRV), with a desiccant wheel that was retrofitted in 1999. The HRV is tied into two existing rooftop heating, ventilation, and air conditioning (HVAC) units, with a capacity of 5 tons each. The new system creates directional flow of air (west to east of the facility in Fig. 1) from the nonsmoking area to the smoking area where it is exhausted, while energy (heating and cooling) is recovered by the HRV desiccant wheel on the exhaust side. The ventilation system was redesigned such that 1600 cfm of fresh air was introduced from the west side into the nonsmoking area and 1500 cfm was introduced at the borderline between the smoking and nonsmoking areas through three new ceiling diffusers. Also, the design included two new exhausts on the opposite (east) side of the bar, near the entrance doorway, with an exhaust volume of 1550 cfm each.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE 62-99) for food and beverage service facilities prescribes a rate of 20 cfm/occupant fresh-air input for dining room areas and 30 cfm/occupant for bars and cocktail lounges. Thus, based on an occupancy of 90 in the dining room and 45 in the bar/lounge, 3150 cfm of outdoor air is required to meet this standard for the Black Dog Pub. No make-up air is provided to the pub; only 100% fresh outdoor air is provided.

The rooftop intake hood of the HVAC unit is fitted with an aluminum mesh prefilter and a secondary bank of disposable filters to remove pollen, dust, etc. The filters are replaced ever 3 months. Since 100% fresh air is used, the filtration system only needs to reduce outdoor contaminants and does not have to address ETS, cooking fumes, or other indoor contaminants. The net result is that the air flows from the nonsmoking area into the smoking area, where it is exhausted, while the energy (heat/cool) is transferred to the incoming fresh air. It is estimated that 78% of the energy is recovered by the HRV unit.

Smoke tests were carried out to ensure that the directional airflow prevented intrusion from the smoking to nonsmoking areas of the Black Dog Pub. The tests were primarily concentrated at the interface of the two sections, i.e., at the open doorway and pass-through in the walls that separate the areas (Fig. 1). Smoke tests

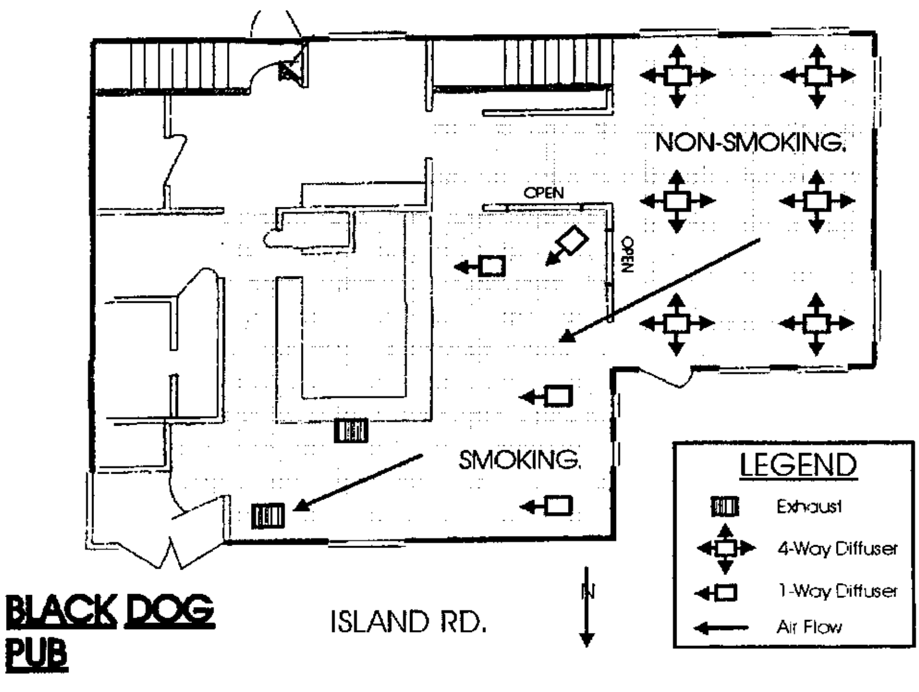

FIG. 1. Schematic diagram of layout of Black Dog Pub.

were also carried out in the smoking section to ensure effective removal of the ETS in that section as well.

Following initial sampling of the Black Dog Pub in December 2000, a purge unit was added to the HRV unit, to correct a potential carry over of the exhausted air into the fresh air stream from 4% to a much reduced 0.4%. At the same time an additional bank of filters was added downstream of the HRV to capture any nicotine/particles that might be carried over to the fresh air supply.

Control Facilities

Three "control" facilities were regulated by local ordinance as nonsmoking hospitality establishments and were used for comparative purposes. No smoking was observed in any of the facilities during the test periods.

The Eaton Centre North Food Court is located in the north end of the Eaton Centre Building in downtown Toronto. An atrium extends from the third level below grade to the second floor above grade. Three levels of escalators lead down to the food court after entering the complex from the Yonge & Dundas street level entrance, and access is also provided by elevators. The building in which the food court is contained is a regulated nonsmoking establishment. The only areas where smoking is allowed in this facility are in the restaurants located on the ground level and second floor above grade, a significant distance from the North Food Court and separated by several levels of escalators.

Facility M is located approximately 15 km southeast of Kitchener, Ontario, Canada. The building in which the facility is located is an indoor sports complex including indoor climbing walls, batting cages, a video arcade, etc. On one side of Facility M is the bar, with seating at the bar and at tables for approximately 70 people. The bar has an exit to the patio where staff and customers can smoke. On the other side of the facility is the restaurant area with seating at tables for approximately 150. The entrance to the kitchen is located in the restaurant area. In between the bar and the restaurant area is the host/hostess station at the entrance to the facility.

Facility B is located on the second and third floors of an historic hotel in downtown Waterloo, Ontario, Canada. The hotel consists of three bars, one of which is Facility B. A pool hall is located on the second floor, and a restaurant occupies the basement. One entrance to Facility B is from the stairwell at the entrance of the hotel; Facility B can also be accessed through an entrance from the pool hall. Facility B has seating for approximately 75 people on its first level and another 60 people on its second level. The entrance to the kitchen and the washrooms are located on the first level. Also on the first level is an exit to an outdoor patio with additional seating. The patio is often used as a smoking area year-round.

Details of the ventilation systems in the control facilities were not sought, for they had been installed in accordance with local building codes.

Real-Time Measurements

Respirable suspended particulate concentrations were determined in real time, using a DustTrak 8520 aerosol monitor (TSI, Minneapolis, MN). The DustTrak operates on the principle of nephelometry (light scattering by particles) and employs a 90° light-scattering laser photometer. The instrument had been recently factory calibrated using the respirable fraction of standard ISO 12103-1 for A1 test dust (Arizona Test Dust). Although data were measured continuously (once per second), data were reported as 1-min averages. For these studies, the calibration factor was maintained at 1.00. Average particle concentrations were determined by calculating the mean concentration reported from 1-min averages over the duration of the measurement interval. In each facility, the single DustTrak was colocated with an ETS component sampler in the facilities in question. In the Black Dog Pub, this was at the cashier/wait station in the nonsmoking section of the facility. In two of the other facilities, the DustTrak was located behind the bar. In the food court, the DustTrak was located in the middle of the seating section.

The carbon dioxide (CO_2), humidity, and temperature monitor used was the YES-206LH Falcon (Young Environmental Systems, Richmond, British Columbia, Canada), acquiring data at a 2-min interval. In all cases except the food court, the CO_2 (a nondispersive infrared-based sensor) and humidity/temperature sensor was colocated with the DustTrak. In the food court, the sensors were placed in the southwestern corner of the seating area. The data were measured continuously and reported as 2-min time-weighted averages.

Sampling Durations and Schedules

All facilities were sampled during a traditionally very busy time at Toronto/Waterloo/Kitchener restaurants: the week between Christmas and New Years 2000. The Black Dog Pub was sampled on two evenings, whereas the others were sampled for one evening each. Following a minor modification in the ventilation system, the nonsmoking areas of the Black Dog Pub also were resampled on two evenings in early January 2001. All facilities were sampled during what was perceived to be their busiest time of day. For the taverns, this was typically in the time period of 5:30 PM until 11:30 PM. For the food court, sampling was conducted between 10:20 AM and 3:40 PM. Sampling periods are summarized in Table 1. The number of patrons present in the facility was counted on an hourly basis and averaged over the course of the sampling period. Those data are presented in Table 1 as well.

TABLE 1
Dates and Times of Indoor Air Quality Sampling

Facility	Date	Sampling time	Average hourly patron count
Black Dog Pub			
Night 1	December 29	6:10 PM–11:30 PM	79
Night 2	December 30	5:30 PM–10:20 PM	58
Night 3	January 9	5:20 PM–11:10 PM	29
Night 4	January 10	5:10 PM–10:35 PM	25
Nonsmoking Facility M	December 27	6:20 PM–11:25 PM	123
Nonsmoking Facility B	December 28	6:20 PM–11:25 PM	34
Mall food court	December 28	10:20 AM–3:40 PM	216

Sampling Locations at the Designated Facilities

The initial sampling at the Black Dog Pub included simultaneously collecting two ETS marker samples from the smoking section and three from the nonsmoking section. The sampling locations in the nonsmoking area were located at the cashier station (immediately adjacent to the smoking station), on a fireplace (across from the opening to the smoking section), and on a window sill (south wall of the nonsmoking section) (see Fig. 1). In the second sampling at the Black Dog Pub, samples were collected only in the nonsmoking section. For the mall food court, three ETS marker samples were collected: one in the northwest corner of the food court, one in the southwest corner, and one on the east side of the court. In Facility M, five ETS marker samples were collected, one each from the following locations: left of the fireplace in the restaurant area, one at the condiment station at the kitchen entrance in the restaurant, one at the hostess station, one near the entrance to the outdoor patio/smoking area in the bar, and one behind the circular bar. In Facility B, five samples were also collected, one each in the northwest and northeast corners of the bar, one behind the bar, one near the entrance to the outside patio and smoking area, and one near the wait station.

ETS Constituent Sampling System

The sampling equipment for ETS markers and particle phase species was similar to that described by Ogden *et al.* (1996) and is now commercially available as the Double Take sampler, manufactured by SKC, Inc. (Eighty-Four, PA). Two sound-insulated constant-flow pumps are built into a single unit and were used to collect the vapor phase and particulate phase samples. Vapor phase samples were collected using XAD-4 cartridges (Cat. No. S2-0361, SKC, Inc.) at a rate of approximately 1.1 L/min. Particulate phase samples were collected using 37-mm Fluoropore filters at a flow rate of 2.2–2.3 L/min, through a BGI-4 (BGI, Waltham, MA) cyclone separator. The cyclone vortex provided a 50% cutoff of particles of 4-μm diameter. Primary differences between the sampling system described by Ogden *et al.* (1996) and the units used in this study were the use of two pumps in a single unit, an opaque conductive plastic sampling train for the particles, and a modified cyclone vortex. Particle phase markers determined as part of this study were ultraviolet-absorbing particulate matter (UVPM), fluorescing particulate matter (FPM), and solanesol. The filter cassette was fabricated from opaque conductive plastic. A cyclone vortex assembly preceded the filter cassette, such that the material collected on the filter was all of respirable (50% cutoff at 4 μm mass median aerodynamic diameter) size. The sampling systems were assembled in a nonsmoking office area in a building geographically removed from the establishments to be sampled, using the following procedure. Filters were placed in cassettes identified by unique labels that were, in turn, affixed in the sampling head. Vapor phase samples were collected on XAD-4 cartridges located in a secondary airflow path and analyzed for nicotine and 3-ethenyl pyridine. XAD-4 cartridges were labeled, and the glass tips were broken off and installed in the sampling head. Using two mass flow meters, the particulate phase flow was adjusted to 2.2–2.3 L/min, vapor phase flow was adjusted to 1.0–1.1 L/min, and both were recorded. When the sampling systems were returned to the nonsmoking office area at the end of the sampling period, sample durations and flow rates were recorded again. Average flow rates (mean of start and ending) and sampling duration were used to calculate the volume sampled and thus the ETS marker concentrations. Following sample collection, samples were stored at 4°C and shipped while being maintained at this same temperature to Oak Ridge National Laboratory for analysis. Field blanks were collected for each facility sampled.

Analysis of Indoor Air and ETS Components

Analytical chemical procedures used in this study were identical to those used in our previous studies (Jenkins *et al.*, 1996; Maskarinec *et al.*, 2000). Vapor phase samples were analyzed for nicotine and 3-ethenyl pyridine, according to the method of Ogden (1991). The XAD-4 cartridges were extracted using 1.5 ml ethyl acetate containing 0.5% (v/v) triethylamine and 8.2 μg/ml quinoline (internal standard). The analysis was performed using a Hewlett–Packard Model 5890A gas chromatograph equipped with a Model 7673 autosampler, a 30-m DB-5MS fused silica capillary column (0.32 mm i.d., 1 mm film thickness) (Part No. 123-5533, J & W Scientific, Folsom, CA), and a nitrogen/phosphorus detector.

Methods used for the determination of particulate phase ETS markers have been described in detail elsewhere (Ogden *et al.*, 1990; Conner *et al.*., 1990 Ogden and Maiolo, 1992). UVPM, FPM, and solanesol were

TABLE 2
Environmental Conditions in Surveyed Establishments

Facility	Temperature, °C			Relative humidity, %			Carbon dioxide concentration, ppm			DustTrak particle concentration,[b] μg/m³		
	Average[a]	Minimum	Maximum	Average[a]	Minimum	Maximum	Average[a]	Minimum	Maximum	Average[a]	Minimum	Maximum
Black Dog Pub												
Night 1	20.6	15.9	21.6	20.8	13.5	31.4	701	468	1216	24	11	49
Night 2	21.7	15.5	22.4	23.4	20.5	36.5	578	471	691	21	4	162
Night 3	21.9	14.0	23.1	18.7	16.8	27.4	504	446	630	NA	NA	NA
Night 4	21.4	15.3	22.0	23.2	21.7	34.0	587	535	723	49	34	132
Nonsmoking Facility M	23.6	12.9	24.5	25.0	20.9	49.6	1083	769	1277	16	0	61
Nonsmoking Facility B	19.4	15.4	20.1	27.9	24.0	36.9	1156	674	1734	36	27	57
Mall food court	21.2	16.7	22.8	19.0	17.5	28.9	841	557	1270	127	45	269

[a] Average responses were determined by taking the mean response of 1-min averages over the duration (see Table 1) of the measurements.
[b] Note that DustTrak reading may over- or underrepresent actual gravimetric respirable suspended particulate values in these venues.

determined after extraction of the filter with 1.5 ml methanol. UVPM and FPM were determined simultaneously using a Hewlett–Packard Model 1090 HPLC equipped with an autosampler, a short section of 0.2-mm tubing (to replace the column), and sequential diode array and fluorescence detectors. 2,2′,4,4′-tetrahydroxybenzophenone was used as a surrogate standard for the UVPM measurement, while scopoletin was used for the determination of FPM. Solanesol was determined using a Hewlett–Packard Model 1090 HPLC equipped with an autosampler, a Deltabond ODS column, 250 × 3 mm, 5 μm particle diameter (Part No. 255-204-3, Keystone Scientific, Inc., Bellefonte, PA), and a diode array detector operated at 205 nm. The mobile phase was acetonitrile/methanol (95/5 v/v), operated at 0.5 ml/min.

All values were measured in micrograms per sample and converted to micrograms per cubic meter using the flow rate and duration data. Conversion factors (to convert the response to the standard to a particulate matter equivalent) were taken from those reported by Nelson *et al.* (1997) for a sales-weighted average for Canadian cigarettes. Actual conversion factors used were as follows: FPM, 41; UVPM, 7.3; Sol-PM, 68. Limits of detection for an individual sample depends on the sample volume, which in turn is dependent on the sampling flow rate and duration. Assuming a 5-h sample collection period, estimated limits of detection (typically 3× the signal background) for UVPM, FPM, Sol-PM, nicotine, and 3-EP were 0.9, 0.8, 9.4, 0.09, and 0.11 μg/m³, respectively. This assumes a total volume sampled for the particle phase and vapor phase constituents of 0.66 and 0.33 m³, respectively.

RESULTS AND DISCUSSION

The environmental conditions, CO_2, and optical particle concentrations measured in the facilities are reported in Table 2. Average temperatures ranged from ca. 19 to 24°C. Since this study was conducted in the winter, outside air was especially dry, and thus, as expected, the relative humidity (RH) inside these facilities was relatively low. Average RHs ranged from ca. 19 to 28%. The effect of the improved heat recovery ventilation in the Black Dog Pub is evident in the CO_2 concentrations. Average CO_2 concentrations ranged from 500 to 700 ppm, compared with average concentrations of ca. 840–1150 ppm in the other facilities. In general, the maximum observed concentrations were also lower in the Black Dog Pub, compared with the wholly nonsmoking facilities. Differences in overall ventilation is likely to contribute to some of these differences. Interestingly, the highest maximum CO_2 concentration was observed in the facility with one of the lower mean patron counts, Facility B.

The optical particle concentrations, as measured by the DustTrak (only in nonsmoking areas) were, on the whole, quite low. The highest observed average concentrations were in the food court facility, where the mean level was 127 μg/m³. It should be noted that using a calibration factor of 1.00, when measuring ETS, the DustTrak will tend to overestimate the actual respirable suspended particulate matter (RSP) levels considerably. For example, in some as-yet-unpublished studies in hospitality venues in the United States conducted by our laboratory, the mean ratio of the time-averaged DustTrak reading to gravimetric RSP was 3.01 ± 0.92 for 56 instances in which a DustTrak was colocated with a gravimetric RSP sampler. Some preliminary measurements in our laboratory suggest that the instrument may underreport gravimetric particle concentrations that are composed predominantly of cooking oil aerosol. Given that this represents a relatively limited data set, probably the most useful information to be gleaned from the optical particle measurements is relative airborne

TABLE 3
Concentrations of Environmental Tobacco Smoke Constituents Nonsmoking Areas in Black Dog Pub vs Comparative Nonsmoking Facilities

	Concentrations, $\mu g/m^3$				
	UVPM	FPM	Sol-PM	Nicotine	3-EP
Black Dog Pub nonsmoking areas, $N = 12$					
Median	3.4	5.4	0.0	0.00	0.18
Mean	3.5	5.8	2.5	0.44	0.23
SD	1.8	2.5	3.7	0.76	0.28
80th percentile	4.9	7.6	7.0	0.77	0.48
95th percentile	6.4	9.6	8.1	1.75	0.70
Nonsmoking tavern/food court data, $N = 13$					
Median	5.2	8.6	1.5	0.00	0.00
Mean	4.6	7.2	2.6	0.21	0.07
SD	2.3	4.0	3.0	0.28	0.10
80th percentile	6.3	10.7	5.5	0.49	0.16
95th percentile	7.9	12.1	7.1	0.64	0.23

particle concentrations, rather than absolute quantitative measures.

Based on the data collected in this study and reported in Table 3, mean ETS component concentrations in the nonsmoking section of the Black Dog Pub were not statistically different (at the 95% confidence level, i.e., $P < 0.05$, for all measured constituents) from those determined in the control nonsmoking facilities. (Note that the number of measurements in each category is not large, so that while medians and percentiles are reported to provide a sense of the data distribution, absolute values for anything other than means should be used with caution.) In the Black Dog Pub nonsmoking section, mean concentrations of UVPM, FPM, and ETS particles as Sol-PM, nicotine, and 3-EP were 3.5, 5.8, 2.5, 0.44, and 0.23 $\mu g/m^3$, respectively. This compared with levels of 4.6, 7.2, 2.6, 0.21, and 0.07, respectively, for the control facilities. Maximum levels of constituents observed in the Black Dog Pub nonsmoking section were 6.7, 9.8, 9.1, 2.54, and 0.82, $\mu g/m^3$, respectively.

Note that for the combustion-derived particles (UVPM and FPM) the FPM levels were determined to be somewhat higher than those of UVPM. At these low particle concentrations, the differences may be due to minor compositional differences in the atmospheres. The ETS-specific components were present in many of the samples in measurable concentrations. While initially counterintuitive for nonsmoking facilities, it is not unexpected to find low but measurable levels of ETS components in nonsmoking establishments. Virtually all of these facilities permit outdoor smoking immediately outside their establishments, and thus it is not unexpected that, depending on the location of air intakes for the facilities (including entryway doors), some ETS would be entrained into incoming air. Moreover, certain ETS components are generated from sources other than tobacco smoking. Field or analysis blanks did not contribute to the apparent level of ETS components in the comparative facilities. All blanks contained no detectable levels of the measured components. Note that the nonsmoking area levels are lower that those determined for the limited number of studies that have examined such in similar venues. For example, Lambert *et al.* (1993) reported mean nicotine levels in the nonsmoking sections of seven restaurants to be 1 $\mu g/m^3$, with a range of 0.2–2.8 $\mu g/m^3$, compared with a mean level of 0.44 $\mu g/m^3$ (and a median of 0.00) for this study. In a previous study (Jenkins and Counts, 1999), we reported that subjects in workplaces where smoking was banned or banned but smoking was observed (which did not include hospitality venues) experienced 8-h time-weighted average mean nicotine concentrations of 0.086 and 0.122 $\mu g/m^3$, respectively.

In Table 4, the smoking area concentrations observed in this study are compared with those determined from a subset of establishments (single room bars) most similar to the layout existing at the Black Dog Pub in a study of area and personal exposure samples in the hospitality industry reported previously (Maskarinec *et al.*, 2000; Jenkins and Counts, 1999). With the exception of 3-EP concentrations, there are no statistically significant differences ($P < 0.05$) between the levels of

TABLE 4
Comparison of ETS Component Concentrations in Smoking Areas Black Dog Pub vs Single-Room Bars

	Concentrations, $\mu g/m^3$, mean ± SD				
	UVPM	FPM	Sol-PM	Nicotine	3-EP
Black Dog Pub ($N = 8$)	95 ± 32	153 ± 32	165 ± 49	12.2 ± 19.3	1.7 ± 2.7
Knoxville single-room bars ($N = 26$)[a]	146 ± 107	133 ± 104	123 ± 113	21.9 ± 17.1	5.2 ± 3.3

[a] From Maskarinec *et al.* (2000) (these data are a subset of those facilities which resemble most closely those described in this study.)

measured ETS components in the Black Dog Pub and those determined in similar facilities in the comparative establishments. Mean 3-EP levels were about one-third those found in the comparative establishments. This suggests that the smoking levels in the smoking areas of the Black Dog Pub were not inordinately low, even though somewhat lower readings could be expected on account of the superior ventilation system installed. Thus, even though expected concentrations of ETS markers were observed in the smoking section of the Black Dog Pub, those of the same constituents in its nonsmoking areas were both low and comparable to those measured in similar nonsmoking establishments.

REGULATORY AND POLICY IMPLICATIONS

Since the publication of the 1992 EPA report entitled *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders*, wherefrom the agency classified ETS as a Group A carcinogen (US EPA, 1992), in the United States and Canada, and to a lesser extent in other industrialized countries, smoking is increasingly proscribed in enclosed public spaces. Despite unresolved ambiguities and controversies about the interpretation of epidemiologic data, the regulatory process to prohibit smoking in enclosed public areas has continued to gain momentum. This process has raised significant issues for the hospitality industry where many of the industry's restaurant and bar patrons wish to smoke. Some hospitality facilities have prohibited smoking, but many other facilities have sought to provide segregated smoking and nonsmoking areas, in an attempt to accommodate the preferences of all their customers. This, in turn, has led to a renewed concern on the part of both regulators and nonsmokers, about whether mechanical filtration and air handling systems are capable of ensuring adequate air quality standards in nonsmoking areas contiguous to smoking areas.

Here, the intuitive air quality benchmark is the average levels of ETS constituents that prevail in hospitality facilities where smoking is prohibited, since no stricter standard could be fairly imposed. ETS levels in nonsmoking facilities cannot be zero, for many ETS constituents are generated from sources other than tobacco or can be introduced in nonsmoking facilities from outdoor-air ETS residues, from material exchanges, from human traffic, and from sources other than tobacco smoking.

This small study provides important evidence to the regulator, the hospitality industry and the nonsmoking public that there are cost-effective alternatives to a prohibition of smoking in hospitality establishments, alternatives that can satisfy the concerns and interests of both nonsmoking and smoking customers. A system such as installed at the Black Dog Pub would cost the owner $329 per month on a 5-year lease, including installation and maintenance costs. ERV units use enthalpy wheel heat exchangers that reduce cooling loads in the summer and heating/humidification loads in the winter. HRV units use flat-plate heat exchangers and can be used in reducing heating loads in the winter. Directional airflow can be easily retrofitted at most facilities by creating sufficient positive pressure in the nonsmoking section with the introduction of a forced air supply. The air then flows toward the negative pressure area of the smoking section, where the exhausts are located. Supply air grills must also be positioned and conformed to direct the air toward the exhaust in the most unidirectional way.

Although limited in size, this study clearly shows that a suitably designed ventilation system installed in a restaurant/bar with both smoking and nonsmoking sections can produce ETS levels in the nonsmoking section that are not statistically different from those found in venues where smoking is prohibited. This alternative would avoid the contentious debate about "safe" ETS exposure limits by taking the level of ETS found in nonsmoking hospitality establishments as the baseline standard. If the hospitality venue that provides both smoking and nonsmoking areas can assure its nonsmoking customers that the ETS level in their area is comparable to that which they would find in a completely nonsmoking facility, then there would seem to be no rational reason for a prohibition of smoking in the controlled areas. As a word of caution, it should be noted that this study addresses only the issue of nonsmoking patron exposure to ETS, and it does not examine the issue of employee exposure.

CONCLUSIONS

This small study focuses on a restaurant/pub in which the smoking and nonsmoking sections were segregated and a heat-recovery ventilation system was installed, combined with directional airflow. Although additional studies are desirable, the data indicate that it is possible to reduce ETS in the nonsmoking section to levels that are comparable to those encountered in similar facilities in which smoking is prohibited altogether. The findings suggests that effective segregation of smoking and nonsmoking areas in hospitality facilities is both achievable and economically viable if sufficient attention is given to overall system design, robust air exchange rates, directional airflow, and the use of appropriate heat-recovery systems.

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