For Information
on 20 April 2009

Legislative Council Panel on Health Services
Findings of Technical Feasibility Study on Smoking Rooms

Purpose

This paper reports to Members the findings of the study by the Food and Health Bureau on the technical feasibility and overseas experience of smoking rooms.

Background

2. During the deliberations of the Smoking (Public Health) (Amendment) Bill 2006, the Administration indicated that it would undertake a study on the feasibility of "smoking rooms". Specifically, it was proposed to study the technical feasibility of a room which is solely meant for smokers to smoke therein. No other activities, including the serving of food and beverages or provision of any other services, should be permitted within the room, and no non-smokers, including employees, should be allowed to enter the smoking room while smoking goes on.

3. The primary consideration for undertaking the study is to examine whether a smoking room can afford protection to non-smokers by providing a more effective separation between smokers and non-smokers, thereby minimizing exposure of non-smokers to second-hand smoke, technically also referred to as environmental tobacco smoke (ETS). The overarching principle is to protect the health of non-smokers outside the room. In undertaking the study, it was recognized that there was no internationally recognized safety standard or scientific research on the acceptable risk level of exposure to ETS.

4. In August 2007, the Food and Health Bureau commissioned the Electrical and Mechanical Services Department as the consultancy manager and engaged the Hong Kong University of Science and Technology (HKUST) as the consultants to carry out the technical feasibility study of smoking rooms, drawing on their engineering and other relevant professional and technical expertise. The two-stage study was completed in March 2009. The study

report is now being finalized and will be made publicly available upon completion. The executive summary of the study is at ***Annex A***.

Scope of the Study

5. HKUST was requested to research and identify any widely accepted, internationally recognized or statutorily prescribed engineering or technical standards applicable or relevant to the design of smoking rooms in overseas countries, as well as to examine the effectiveness of the engineering systems currently available in the market, through computer simulation of ventilation and construction and testing of actual models, in controlling the leakage of ETS to adjacent non-smoking areas, against any of the identified engineering or technical standards. The study focuses on the engineering feasibility to control the leakage of ETS and does not purport to determine the acceptability of the health risk involved.

Summary of the Study

6. HKUST conducted a literature survey on overseas practices and engineering standards. Survey findings indicate that ventilation system is the most important element in engineering control measures for ETS dilution and for prevention of ETS leakage to non-smoking areas. Internationally, there were engineering standards that used to be promulgated by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers). Most economies have also specified engineering standards for smoking rooms.[1] However, no internationally recognized standard could be identified on what would be regarded as an acceptable level of concentration of ETS from a health risk point of view. In fact, ASHRAE has withdrawn the aforementioned engineering standards since 2004 on the grounds that there is <u>no</u> acceptable level of risk associated with concentration of ETS.

7. After the literature survey, HKUST proceeded to carry out computer simulation of smoking room designs as part of the Stage I study, which aimed at investigating and comparing the performance of several ventilation system designs for smoking rooms of varying sizes. The results of the simulations showed that the displacement ventilation system achieved the

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[1] Most economies that allow smoking rooms specify engineering standards for their smoking rooms in terms of: (i) air pressure inside the rooms; (ii) ventilation and air-conditioning systems; (iii) airflow velocity; (iv) size of the rooms; and (vi) prohibiting activities inside the smoking rooms other than smoking.

lowest room-averaged ETS tracer concentrations in the smoking room among all the system designs simulated. It is also found in the simulations that a -5 Pa negative air pressure setting is important for reducing ETS leakage, and that larger smoking rooms can achieve less ETS leakage compared to smaller smoking rooms at the same ventilation level.

8. During the Stage II study, HKUST carried out experimental studies of ETS accumulation and the effectiveness of ETS leakage control in a purpose-built model smoking room. The model smoking room was designed and constructed based on the numerical modelling results obtained from the Stage I study. The room was maintained at a negative pressure level of at least -5 Pa in all experiments. A displacement ventilation system (DV) with 100% fresh air supply and direct air exhaust was adopted for the ventilation and air conditioning system design. All internal walls, ceiling and floor had stainless-steel surface finishing to minimize absorption and desorption of ETS.

9. The internal size of the model smoking room was adjustable to allow experiments to be run under different numbers of simulated smokers (i.e. a room for 35 smokers or 12 smokers at about $1m^2$/smoker). The experiment was conducted on a model smoking room with a single glass sliding door with automatic opening and closing facility, as well as a double-door design with interlocking feature in a 12-smoker room setting to explore potential improvement to ETS leakage prevention. To simulate the effect of human movement in and out of the room, a manikin was installed on a computer-controlled motorized rail system.

Key Findings of the Study

10. The key findings of the study are as follows:

(a) ETS leakage is mainly affected by two parameters – inward face velocity of the air flow across the door opening and room ETS concentration. The inward face velocity depends primarily on the negative pressure setting. The room ETS concentration depends on both the ventilation rate and the type of ventilation system used. At the same ventilation rate, displacement ventilation system can maintain a lower ETS concentration compared to dilution type and local exhaust type ventilation systems.

(b) In the 12-smoker room, the negative pressure condition could be attained only when the fresh air ventilation rate was much higher than the typical office fresh air ventilation rate (at 10 L/s per person). This is because the suction of air into the room via the room gap is not adequate to create a -5 Pa negative pressure condition when the ventilation rate is not high enough. This indicated that it would be technically difficult and probably very expensive to achieve the required negative pressure in a room smaller than the 12-smoker room.

(c) Leakage of ETS tracers to the outside is undetectable in all settings when the smoking room door is completely shut at all time and when the following operational conditions are maintained at all time: at least three times (at 33 L/s per person) of a typical office fresh air ventilation rate; there is direct air exhaust without air recirculation; at least -5 Pa negative pressure is maintained; use of good quality sliding door or equivalent.

(d) Leakage of ETS tracers to the outside is significant in most settings when the smoking room door is fully opened at all time. Leakage is more significant for a smaller smoking room. Increasing the ventilation rate can reduce ETS leakage via the opened door, but cannot completely mitigate the ETS leakage. While in some cases certain (but not all) ETS tracers are below detection levels of the instruments, odour is still detected.

(e) Leakage of ETS tracers to the outside is unavoidable when smokers go in and out of the smoking room, even when the door is closed and opened only when smokers go in and out. The leakage is even more significant when compared to the door-opened scenario (sub-paragraph (d) above). The leakage is observed to be directly linked to human movement (the manikin in the experiment) in and out of the door. A double-door anteroom design can help reduce but cannot completely mitigate the ETS leakage due to human movement.

(f) Among the various ETS tracers, there was substantial leakage of respirable suspended particulate matters (RSP), especially ultra-fine particles (UFP), to non-smoking area via the door whenever the door is opened. Odour of smoke is readily detectable, most probably because ETS chemicals have been absorbed by ultra-fine particles that have leaked outside and reached the human olfactory organs. Recent research has revealed that these UFP have more harmful effects on health than other respiratory suspended particulate matters.

(g) Within the smoking room itself, even though increasing the ventilation rate could reduce the concentration of the various ETS tracers in the smoking room, the concentration is still found to be at a very high level even under ventilation rates much higher than typical office settings.

(h) After smoking activity stops in the smoking room, the residual content of nicotine inside the smoking room still stays at a high level. At least five hours of continuous ventilation afterwards is required for the nicotine concentration to return to an undetectable level, despite the use of stainless steel surface finishing in the smoking rooms and having no furniture inside the room. The residual content would be more significant if other materials instead of stainless steel are used as surface finish in the room.

11. The consultants further observed that there is currently no scientific data to define a "low" ETS concentration. The general opinion of the medical profession is that there will always be health hazards arising whenever and wherever there is exposure to ETS regardless of level of concentration. Thus there is no "acceptable level" of ETS concentration from a health risk point of view. In the experiment conducted under the study, leakage of UFP and RSP was found in all tested ventilation rates under the door opened and human movement scenarios. The study results also indicate that increase of ventilation rate cannot eliminate this leakage portion due to the strong human

movement effect. In addition, the 12-smoker room shows a much higher ETS leakage than the 35-smoker room under the same per person ventilation rate. It implies that smaller smoking room design is technically more difficult to achieve, and a room smaller than the 12-smoker room is practically impossible.

Overseas Experience

12. On the basis of the literature survey conducted by HKUST, we have surveyed the application of smoking rooms in other jurisdictions that have also applied a smoking ban. A summary of the jurisdictions we have surveyed and whether they have allowed the construction of smoking room is at ***Annex B***. A more detailed account of the experience of individual jurisdictions which have applied a smoking ban and at the same time allowed the construction of smoking room is at ***Annex C***. We have not been able to survey comprehensively all jurisdictions which have applied a smoking ban and/or allowed smoking room owing to the limited information readily available, especially for jurisdictions which do not publicise their information in either English or Chinese.

13. The following observations are worth noting from the survey of overseas experience –

(a) Out of the 27 jurisdictions surveyed that apply a smoking ban (full or partial), 15 of them allow smoking rooms to be built on a nation-wide basis. Those jurisdictions that allow smoking rooms did so when they first introduced either full or partial smoking bans. Most such jurisdictions have only started with a partial or full smoking ban in recent years. A major exception is Canada which introduced its first smoking ban legislation almost 20 years ago and allowed smoking rooms to be built in the first instance. It has subsequently banned smoking rooms from all but one province (Prince Edward Island) over the years. As far as we can gather, no jurisdiction which had introduced a smoking ban without allowing smoking rooms is contemplating introducing smoking rooms to premises which are already smoke-free.

(b) In jurisdictions where smoking rooms are allowed to be built, smoking rooms do not seem to be popular among proprietors, as shown by the low take-up rate, possibly because the rooms are expensive to build and operate up to the required specifications, and many proprietors found that the rooms may not necessary help them maintain or increase profits to justify the cost for the rooms. Some enterprising proprietors have found new ways to attract customers and boost sales, such as by offering a good food menu, snacks to replace cigarettes, and appealing entertainment performances. Bars have also attracted more female and non-smoking customers. Studies in some countries have also found that the majority of customers and workers welcomed the ban for the cleaner air indoors and the better protection from second-hand smoke.

(c) For jurisdictions that do not allow smoking rooms, there is little evidence to show any significant drop in the profits or employment figures of the catering and hospitality establishments because of the smoking ban. In the United States for example, establishments selling beer and wine in California were found to have seen an increase in annual sales by more than $2 billion between 1997 and 2002 after the smoking ban was introduced in 1994. In New York, business tax receipts for restaurants and bars increased by over 8% one year after a smoking ban was introduced in 2003. Over 10,000 jobs were created in the sectors during the same period. Sales and employment at restaurants and bars were also reported to have increased in Florida, Delaware after full smoking bans took effect.

(d) There are a number of jurisdictions, including Oklahoma in USA and 12 provinces in Canada, which used to allow smoking room since 1989, but had eliminated or have been considering the elimination of smoking rooms in recent years, after finding that such rooms create both public health and enforcement problems. In practice, it was difficult for business to comply with and for the government to enforce the stringent standards and requirements for smoking rooms at all times, e.g. to ensure that the room and all ventilation as well as exhaust systems are properly built and well maintained, that doors are always closed and no other activities go on inside the room, and that cleaners and staff would only enter the room at least several hours after smoking stops for their own protection. The failure to comply with these would result in more people being affected by second-hand smoke. For instance, employees of establishments with smoking rooms in Canada had complained of health problems due to leakage of second-hand smoke.

Observations

14. In the light of the findings of the technical feasibility study and the survey of experience with smoking rooms in other jurisdictions, we have the following observations -

(a) The feasibility study on smoking rooms indicates that it is practically impossible to prevent the leakage of second-hand smoke when there is human movement in and out of the room, even with stringent design and ventilation standards. So far, none of the evidence gathered suggests that smoking rooms can be effective in fully protecting non-smokers from second-hand smoke. This echoes the World Health Organization (WHO)'s advice that "*ventilation and separate smoking rooms do not reduce exposure to second-hand smoke to an acceptable or safe level*".

(b) The feasibility study also suggests that up-to-standard smoking rooms, especially their air conditioning and exhaust systems, are technically demanding and costly to build, operate and maintain. The stringent design and ventilation standards, especially the size, door, room sealing, air supply and exhaust, would probably be difficult to meet in many practical settings due to building and environmental constraints. The practicability of installing and operating smoking rooms up to standards is therefore questionable, especially in the local context.

(c) Both the technical study and overseas experience show that it is difficult for business to comply with the stringer requirements for the construction, operation and maintenance of smoking rooms; and even more difficult for government to enforce them and ensure all smoking rooms are always properly constructed, managed, and maintained to standard at all times. Significant financial and manpower resources would have to be devoted to regulate and enforce the related laws and regulations. The cost-effectiveness of using public funds for such purpose will have to be evaluated against the policy objective of protecting public health.

(d) Overseas experience indicates few catering and entertainment premises construct a smoking room even when such rooms are allowed. Most establishments, especially smaller ones, chose to go entirely smoke-free to comply with the smoking ban rather than building a smoking room. Reasons most commonly cited are the high costs involved and not enough space for building the room. There might also be complaints of lack of level playing field when some businesses not least the larger ones may better afford to build such smoking rooms.

15. The findings indicate that there is as yet no conclusive evidence to substantiate the effectiveness of smoking room in separating smokers and non-smokers and protecting non-smokers outside the room from exposure to second-hand smoke. Meanwhile, we note that some overseas jurisdictions do not allow smoking rooms when they implement indoor smoking bans, while others allow smoking rooms to be built when they implement indoor smoking bans, and yet some jurisdictions have banned smoking rooms after a number of years of allowing them. The Government thus at this juncture cannot draw a definitive conclusion on the feasibility of smoking room. We will continue to keep in view the trend and experience of smoking rooms in overseas jurisdictions, as well as relevant international studies and research on the subject matter, in further examining the feasibility of smoking room in the local context.

Advice Sought

16. Members are advised to take note of the contents of this paper.

Food and Health Bureau
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Annex A

Study on the Technical Feasibility of Smoking Rooms
Executive Summary

Objective

This study aims at investigating the technical feasibility of setting up smoking rooms in Hong Kong for the purpose of preventing non-smokers from being exposed to Environmental Tobacco Smoke (ETS).

Stage I

2. The study began with an extensive literature survey to :

(a) review the properties and composition of ETS and identify representative ETS tracers

(b) review the international standards and guidelines on engineering specifications for the smoking room

(c) review and identify existing smoking room system designs

3. The literature survey revealed that ETS is a complicated mixture of thousands of constituents in both gas and particle phases. Due to such complexity, four ETS tracers were identified including respirable suspended particulate (RSP), carbon monoxide (CO), nicotine and 3-ethenylpridine (3-EP) to represent ETS. Many overseas standards and guidelines recommend complete physical separation between the smoking room and adjacent non-smoking areas with ventilation rates ranging from 10-58 L/s/person and a negative pressure of 5Pa. Independent ventilation system with no air recirculation is commonly suggested. Three types of mechanical ventilation system, including the dilution, displacement and local exhaust systems were identified for further investigations on their effectiveness in smoking room applications.

4. Based on the findings of the literature survey, a series of numerical simulations was conducted in Stage One of the study to evaluate the performances of different ventilation systems in removing Environmental Tobacco Smoke (ETS) and preventing ETS leakage in smoking rooms. The impacts of ventilation rates, pressurization settings, inward face velocity of the airflow across the door opening, door operation, occupant movements and wall material on the performance of the smoking rooms were also investigated. Some of the key findings of Stage One of study are:

(a) With the same ventilation rate, displacement ventilation system can maintain a lower room ETS concentration compared to the dilution type and local exhaust type ventilation systems.

(b) ETS leakage is mainly affected by two parameters – inward face velocity of the air flow across the door opening and room ETS concentration. The inward face velocity is governed by the negative pressure setting while the room ETS concentration is affected by both the ventilation rate and the type of ventilation system used. ETS leakage can be reduced by having a higher inward faces velocity and a lower room ETS concentration.

(c) Adequate inward face velocity is easier to be attained at the doors of larger smoking rooms for ETS leakage prevention compared to smaller smoking rooms.

(d) With the smoking room maintained at -5 Pa pressure relative to the surroundings, ETS leakage is insignificant when the door is closed provided that there is sufficiently high ventilation. Noticeable ETS leakage could, however, be found in some cases when the door is opened. ETS leakage due to occupant movements across the door opening is unavoidable.

(e) The desorption of some adsorbed ETS constituents (e.g. nicotine) is very slow so these constituents can remain at certain levels in the smoking room for a prolonged period after smoking activity has stopped. These adsorbed ETS constituents cannot be removed by ventilation in a practically reasonable time period.

Stage II

5. Experimental studies of ETS accumulation and the effectiveness of ETS leakage control in a model smoking room have been carried out in this stage of study. The model smoking room was designed and constructed based on the numerical modelling results obtained from the previous phase of the study. Displacement ventilation system (DV) with 100% fresh air supply and direct air exhaust was adopted for the ventilation and air conditioning system design of the current model smoking room due to its best performance in terms of minimizing the accumulation of ETS in the room and maximizing leakage prevention compared to other types of ventilation design. The internal size of the model smoking room was adjustable to allow experiments to be run under different numbers of simulated smokers (i.e. 35-smokers vs. 12-smokers). The model smoking room had a single glass sliding door with automatic opening and closing facility. All internal walls, ceiling and floor had stainless-steel surface finishing. In the final round of the experiments, a double-door design with interlocking feature was also tested in a 12-smoker room setting to explore potential improvement to ETS leakage prevention.

6. The following key experimental findings were observed in this stage of study:

(a) Even though increase of ventilation rate could reduce the concentrations of the various ETS tracers in the smoking room, the concentrations could still exist at high levels even under ventilation rates much higher than typical office settings.

(b) The -5 Pa negative pressurization criterion could not be achieved in the 12-smoker room (assuming 1 smoker per m^2) at 10 L/s per person ventilation rate since when the ventilation rate is not high enough, the suction of air into the smoking room via the door gap may not be strong enough to attain a -5 Pa negative pressure level. This indicated that it would be very challenging for a room size smaller than 12 smokers to achieve the negative pressurization criterion of -5 Pa unless the ventilation rate is very high or a door of much better tightness control is used.

(c) Under sufficient negative pressure and ventilation rate, there is no distinguishable leakage of ETS tracers when the smoking room door is closed. Prevention of ETS leakage may somewhat be attained in the door closed condition under at least 3-5 times of a typical office fresh air supply rate, direct air exhaust without air recirculation, at least 5 Pa negative pressure setting, and the use of good quality sliding door or equivalent on top of good maintenance practice.

(d) Significant leakage of ETS tracers could occur in some cases when the door is opened. Increase of the ventilation rate may reduce ETS leakage via the opened door but could not completely mitigate the problem. This is further intensified when the smokers are walking out of the room. The double-door anteroom design showed some improvement to ETS leakage prevention. However, the problem still cannot be completely mitigated. The leakage of respirable suspended particulate matters and particularly the ultra-fine particles to non-smoking area via the door in the door opened cases remains the most challenging part to be resolved, not to mention the cost of system installation and high energy consumption in ventilation and air conditioning.

(e) The leakage of ETS tracers by the movement of the occupants could not be avoided under the current setting unless a "very strong" (e.g. at least 30 cm/s) inward face velocity of the air flow across the door opening is used which is not feasible technically mainly due to the chance of over-depressurization in the smoking room operation.

(f) After smoking activity stops, the residual content of nicotine inside the smoking room can still stay at high level even after long hour of diluting the smoking room. Based on the measurement results, more than 5 hours were necessary for the nicotine concentration to return to a level below the detection limit of the instrument, even though the building materials of the 35-smoker room mainly had stainless steel surface finishing and there was no furniture inside the room. Thus, it may not be practically possible to ensure a safe environment for the maintenance and cleaning workers to work inside. This effect was even more dominant when other building materials instead of stainless steel were used as surface finish in the room.

Details of the Experimental Set up and Findings under Stage II

7. In the Stage II study, the experiments were conducted in the model smoking room with 35 and 12 simulated smokers ("35-smoker room" and "12-smoker room" hereafter) arranged in 1 smoker / m^2 of floor area density. Each smoker was represented by a 0.6 m (W) 0.4 m (D) × 1.6 m (H) smoking machine with galvanized steel surface finish. A 1-m^2 double door anteroom with floor to ceiling partitions was constructed in the 12-smoker room in order to investigate how the addition of a double door anteroom would contribute to the leakage prevention performance of the smoking room. The inner side of the double door anteroom was equipped with a glass swing door. The two doors were interlocked with each other such

that neither could be opened at the same time. Exhaust was provided in the double door anteroom and negative pressure was kept between that inside and outside the room.

8. The model smoking room was maintained at a negative pressure level of at least 5 Pa. Four common ETS tracers that represent the particle and gas phase contaminants, including respirable suspended particulate matters (RSP, in the form of particulate matters of size under 2.5 micron, $PM_{2.5}$), 3-ethenylpyridine (3-EP), carbon monoxide (CO) and nicotine, were monitored. In addition to these 4 tracers, ultrafine particles (UFP), which are defined as those less than 0.1 μm, was also monitored in an attempt to provide more comprehensive leakage information due to the fact that more severe health related hazard caused by UFP compared to larger particles has recently been reported in the research community. Another reason for including UFP in this phase of study is that odor of the ETS could clearly be detected outside the room during the sampling period of some cases even though measurements of the four other tracers showed unnoticeable readings. It was inferred that the detectable odor might be correlated to the gas phase compounds absorbed onto the ultrafine particles.

9. Different scenarios were considered in order to simulate and evaluate the performance of a real smoking room under daily continuous operations, namely full load scenario (door closed), worst case scenario (door opened), manikin movement scenario and post-operation scenario. The door was kept closed throughout the measurement period in the full load scenario while the door was kept opened in the worst case scenario. In the manikin movement scenario, a manikin was installed on a computer-controlled motorized rail system to simulate the situation when the occupant walks past the entrance of the room. The smoking frequency was kept at 6 cigarettes per smoker per hour, which has been specified in an earlier version of ASHRAE Standard 62 as the design condition of a heavy smoking room. The suitability of using economizer as a potential energy saving solution was also tested in selected cases by installing a commercial heat exchange system to evaluate whether cross-contamination would occur throughout the total heat exchange process between the exhaust air stream and fresh air stream.

10. Experiments under ventilation rates of 33 L/s per person, 20 L/s per person and 10 L/s per person were conducted in the 35-smoker room while those data under 58 L/s per person, 33 L/s per person and 20 L/s per person were obtained in the 12-smoker room. It is noted that increase of the ventilation rate could reduce the ETS tracer concentrations (after deducting background levels, same hereafter) inside the model smoking room. In summary, the room concentrations in the 35-smoker room ranged from 142000 to 250200 particles/cm^3 for UFP, 1.1 to 1.7 mg/m^3 for RSP, 1.7 to 4.2 ppm for CO, 315 to 440 μg/m^3 for nicotine and 27.3 to 46.2 μg/m^3 for 3-EP in the 35-smoker room. When the ventilation rate increased from 10 to 20 L/s per person, the room concentrations of the ETS tracers were reduced by about 8% to 40%. Further increase of the ventilation rate to 33 L/s per person reduced the room concentrations of the ETS tracers by about 29% to 59%, compared to 10 L/s per person. The concentrations of the ETS tracers inside the smoking room remained at high levels in all cases.

11. No distinguishable leakage of ETS tracers was observed during full load scenario (door closed) under 33 L/s per person of ventilation rate in the 35-smoker room and 58 L/s per person of ventilation rate in the 12-smoker room. This verifies that depressurization is a high priority measure for ETS leakage control. A negative pressure of at least 5 Pa and the subsequent induced inward airflows at the door gap may prevent the ETS

from leaking outside when the door is closed. Noticeable amount of UFP leakage was however found in the ventilation rates of 10 L/s per person case (about 5%) as well as in the 20 L/s per person case (about 2%) in the 35-smoker room experiments, which suggests that the ventilation rate of the smoking room should also be considered besides the negative pressure level. Approximately 2.9% of UFP, 1.0% of RSP and 0% of CO leakages were found in the 12-smoker room experiments even at a high ventilation rate of 33 L/s per person, in contrary to the negligible leakage found in the 35-smoker room setting under the same per person ventilation rate.

12. Significant leakage of ETS tracers was found in some cases under the worst case scenario (door opened). In the 35-smoker room setting with ventilation rate of 10 L/s per person, the outside / room concentration ratios were 3.7% for CO, 4.2% for RSP and 4.9% for UFP, indicating noticeable ETS leakage. By increasing the ventilation rate to 20 L/s per person, the outside / room concentration ratios were reduced to 3.1% for CO, 1.3% for RSP and 2.6% for UFP. The outside / room concentration ratio for CO was reduced to 0% for CO by further increasing the ventilation rate to 33 L/s per person but the ratios for RSP and UFP remained at 1.3% and 2.4%, respectively. These results show that increase of the ventilation rate may reduce ETS leakage via the opened door but could not completely mitigate the problem. As the amount of air exchanged inside the room is directly proportional to the designed number of smokers inside the room, the velocity of the air flowing through the door gap is higher in larger room setting. More leakage was found from the ETS tracers in the 12-smoker room. At 33 L/s per person, for example, 7.1% for CO, 3.2% for RSP and 8.4% of UFP were found in the 12-smoker room setting compared to 0% for CO, 1.3% for RSP and 2.4% for UFP found in the 35-smoker room setting.

13. ETS leakage due to the human movement effect was found to be significant. Concentration spikes as high as half of the room UFP concentration were found during each "push" by the manikin when it left the room. For the tested ventilation rates in the 35-smoker room setting, the outside / room concentration ratios were 2.4 – 6.2% for CO, 1.2 – 4.1% for RSP and 5.1 – 13.3% for UFP. The high concentration ratios indicate that the leakage in the manikin movement scenario was even more severe than the worst case scenario due to the movement pattern of the manikin. The normal walking speed of the manikin (30 cm/s) was an order of magnitude greater than the inward face velocity across the door opening (about 4 cm/s in our experiments; further increase of this would lead to over depressurization of the room during door closed case and was not technically feasible.). Similar to those observed from the full load and worst case scenarios, higher outside / room concentration ratios were found in the manikin movement scenario for the 12-smoker room compared to the 35-smoker room. 7.2 – 9.1 % for CO, 2.1 – 8.4% for RSP and 8.4 – 12.5% for UFP were measured under the tested ventilation rates.

14. The establishment of a double door anteroom was found to be able to reduce the ETS tracer leakage to some extent. However, leakage was still detected in the manikin movement scenario. 0 – 7.7% for CO, 1.7 – 4.8% for RSP and 2.5 – 3.9% for UFP were measured in the double door anteroom setting under various ventilation rates compared to 7.2 – 9.1 % for CO, 2.1 – 8.4% for RSP and 8.4 – 12.5% for UFP measured under the same ventilation rates without the anteroom provision.

15. After smoking stops, the residual ETS tracers in the air inside the room will be "diluted" by the continuous operation of the ventilation system. For tracers that have less significant material sorption/desorption effects, including CO, RSP, UFP and 3-EP, it took

less than one hour of continuous operation of the ventilation system to bring the room concentrations back to the background level. For nicotine, which has significant sorption/desorption effect, the room concentrations were found to remain at high levels due to the slow desorption of nicotine from the building material surfaces. This effect was more dominant when other building materials were used as surface finish in the room. The room nicotine concentration could not be significantly reduced by continuous operation of the ventilation system within a practical period of time. Based on the measurement results, more than 5 hours were necessary for the nicotine concentration to return to a level below the detection limit of the instrument, even though the building materials of the 35-smoker room mainly had stainless steel surface finishing and there was no furniture inside the room. This indicates a certain level of health hazard to maintenance or cleaning workers unless prolonged hours (more than 5 hours) of high ventilation rate is operated in the room after smoking activity stops.

16. An air-to-air total heat (sensible and latent heat) exchange system was installed to exchange the heat between the exhaust and fresh air streams. However, cross-contamination of the fresh air stream was found. About 4 $\mu g/m^3$ of nicotine was found in the main supply air duct immediately downstream of the heat exchange system. This result makes the use of air-to-air total heat exchange system not a feasible solution to lower the already high energy consumption in the smoking room.

17. It should be noted that there is currently no scientific data to define a "low" ETS concentration. The general consensus is that health hazard always exists wherever there is smoking activity. Under the door closed scenario, the general observation from this study is that the ETS leakage could perhaps be prevented with a ventilation rate of 33 L/s per person or above which is more than 3 times of the recommended ventilation rate adopted in an office environment for the 35-smoker room and the ventilation rate needs to be raised to 58 L/s per person for a 12-smoker room. However, leakage of UFP and RSP was found in all tested ventilation rates under the door opened and manikin movement scenarios. Our results also indicate that increase of ventilation rate can hardly minimise this leakage portion due to the strong human movement effect when compared to the relatively low inward face velocity of the air moving into the room through the door under practically feasible cases. The 12-smoker room shows a much higher ETS leakage than the 35-smoker room under the same per person ventilation rate. It implies that small smoking room design creates more leakage problem than a large smoking room.

END

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Commissioned by
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Smoking Ban and Smoking Rooms in Other Jurisdictions[2]

Place	Smoking Ban	Smoking Room Allowed?	Smoking Prevalence
Australia	All indoor places with exemptions on a state-by-state basis, e.g. casino private gaming area in New South Wales, multi-unit residential accommodation in Queensland	No	23.3% in 2005
Belgium	All indoor places except bars serving 'light meals'	Yes	27.6% in 2004
Brazil	All enclosed public places	Yes	16.2% in 2006
Canada	Full or partial smoking ban in all 13 provinces.	1 out of 13 provinces with smoking ban.	17.3% in 2005
France	All indoor public places	Yes	25% in 2005
Germany	Smoking is banned on public transport, hospitals, airports and in public and federal buildings in some states.	Yes	27.2% in 2005
Iceland	All enclosed public places and transport.	No	Not available
India	All workplace, restaurants and hotels	No	Not available
Ireland	All public places and indoor workplaces with exceptions in dwelling, prison, hotel room, and premises provide living/sleeping accommodation	No	Not available
Italy	All indoor places	Yes	22% in 2005
Lithuania	All public places and public transportation.	No	31.5% in 2004
Malaysia	Partial smoking ban—pubs, nightclubs, discos and casinos exempted	Yes	21.5%in 2006

2 For the purpose of studying the experience with smoking rooms, this survey is on jurisdictions with nation-wide or state/province-wide full or partial smoking bans. Jurisdictions with no such bans, such as China and Japan, are not included.

Place	Smoking Ban	Smoking Room Allowed?	Smoking Prevalence
Mexico	Nationwide smoking ban.	Yes	18.9% in 2006
New Zealand	All indoor public workplaces with exemptions at private homes, temporary private premises, and home-like environment such as rest homes, hotel rooms, hospitals, individual prison cells, and residential care facilities.	No	20.7% in 2006
Netherlands	All government workplaces, and education and healthcare buildings, with exemptions at private premises, smoking clubs, pavement cafés with overhead covering like parasols or awnings, or with partitions on the side	Yes	28% in 2004
Norway	All public buildings and private buildings that are open to the public	Yes	37% in 2004
The Philippines	All indoor public places	Yes	34.7% in 2003
Portugal	All public places and workplaces.	Yes	17% in 2005
Singapore	All indoor public places and some outdoor places such as playgrounds and exercise areas.	Yes	12.6% in 2005
Spain	All indoor places and public transport with exemptions in hotels, psychiatric and prison establishments	Yes	33.2% in 2002
Switzerland	Full or partial smoking ban in 7 out of its 26 cantons.	Yes	31% in 2005
Taiwan	All indoor workplaces, theaters, restaurants, office buildings and public establishments.	Yes	23% in 2001
Thailand	All indoor air conditioned establishments and most public places.	No	21.1% in 2004
UK	Nationwide smoking ban with exemptions in private dwelling, designated rooms in hotels, care homes, hospices, prisons	No	26% in 2002
Uruguay	All enclosed public places.	No	33.3% in 2003

Place	Smoking Ban	Smoking Room Allowed?	Smoking Prevalence
USA	34 out of 50 states have full or partial smoking ban with exemptions on a state-by-state basis, e.g. private residence, hotel room, retail tobacco business, membership associations (volunteer only), 25% outdoor dining area in New York State, cigar bar, casino, hotel room, tobacco retail establishment in State of New Jersey	1 out of 34 states with smoking ban	18% in 2005
Vietnam	Smoking ban in offices, production facilities, schools, hospitals, and on public transport. Restaurants, pubs and bars are exempted	No	Not available

Sources:
WHO's report on the global tobacco epidemic 2008
http://en.wikipedia.org/wiki/List_of_smoking_bans#.C2.A0Spain
http://www.health.nsw.gov.au/publichealth/healthpromotion/tobacco/legislation.asp
http://www.health.qld.gov.au/atods/tobaccolaws/index.asp
http://data.euro.who.int/tobacco/?TabID=2402
http://www.gov.cn/banshi/2005-08/02/content_19159_3.htm
http://www.health.gov.bc.ca/tobacco/communities.html#q3
http://www.health.gov.on.ca/english/public/updates/archives/hu_04/hu_tobacco_leg.html
http://www.eurofound.europa.eu/eiro/2007/03/articles/fr0703039i.htm
http://news.bbc.co.uk/2/hi/europe/7533132.stm
http://www.ino.searo.who.int/EN/Section3_30.htm
http://www.otc.ie/legislation_national.asp
http://www.moh.govt.nz/moh.nsf/wpg_Index/About-smokefreelaw-about-overview
http://www.minvws.nl/en/themes/smoking/default.asp
http://www.helsedirektoratet.no/selectedtopics/tobacco/legislation_history
http://www.doh.gov.ph/ra/ra9211
http://www.ensp.org/files/legislation_on_smokefree_workplaces_200807.pdf
http://tobacco.bhp.doh.gov.tw/
http://www.searo.who.int/EN/Section1174/Section2469/Section2472.htm
http://www.searo.who.int/LinkFiles/Legislation_and_Policy_Thai_legislation.pdf
http://www.opsi.gov.uk/acts/acts2006/ukpga_20060028_en_2#pt1-ch1-pb2-l1g3
http://www.smokefreeengland.co.uk/faq/exemptions.html
http://www.health.state.ny.us/nysdoh/clean_indoor_air_act/ciaalaw.htm
http://www.state.nj.us/health/ctcp/smokefree/act.shtml
http://www.legco.gov.hk/yr04-05/english/bc/bc61/papers/bc610120cb2-918-2e.pdf
http://www.msc.es/gabinetePrensa/notaPrensa/desarrolloNotaPrensa.jsp?id=500

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Experience of Smoking Rooms in Overseas Jurisdictions

(a) France

Smoking was banned in all public places starting 2007 but bars and restaurants were exempted until 1 Jan 2008. Subject to specified conditions, smoking rooms up to 20% of the total floor space of the establishments are allowed. According to the National Committee against Smoking (CNCT) under the French Health Ministry, only around 1% of establishments have created smoking room so far. Given the high level of pollution inside the smoking room and the huge costs involved, café and restaurant owners are not keen on building smoking rooms. Compliance is reported to be good and there is no report of a significant drop in the business of smoke-free catering and entertainment premises.

(b) Italy

Since January 2005, it is forbidden to smoke in all public indoor spaces, including bars, cafés, restaurants and discos. Smoking rooms not exceeding 50% of the floor space are allowed and food can be served inside. So far, only around 1% of all public establishments have opted for setting up a smoking room because of the huge costs of installing ventilation system and doors. According to the Government-affiliated National Centre of Epidemiology, Surveillance and Health Promotion which funded research to monitor the situation before and after the implementation of the smoking ban in 2005, the compliance rate of the smoking ban has been surprisingly high, and there is no report of any significant loss of business for the smoke-free premises.

(c) Singapore

Smoking has been prohibited in all indoor workplaces starting July 2007. Entertainment outlets may designate up to 10% of the indoor refreshment area as smoking rooms governed by strict rules. However, only 6% of all 9,000 outlets have applied for building smoking rooms. According to the government, businesses were not affected by the smoking ban as the ban was applied to all outlets equally. According to the Singaporean authorities, dining and entertainment establishments that experienced a growth in their business after going entirely smoke-free were those that were able to retain and bring in new customers by promotional and educational activities, and to target non-smoking patrons who otherwise did not visit entertainment outlets before the ban.

(d) Malaysia and Taiwan

Smoking rooms are allowed in certain premises of both jurisdictions, but Malaysia, unlike Hong Kong, only has a partial smoking ban that still permits smoking in pubs, nightclubs, discos and casinos, while Taiwan's smoking ban only came into effect from January 2009. It is premature to draw any conclusions on the success or otherwise of their experience with smoking rooms at this stage.

(e) USA

There is no nationwide smoking ban. Smoking policies are instituted at state and/or local levels. Among the 50 states, 23 states have varying statewide smoking bans on the workplace, restaurants and bars and 11 have statewide partial smoking bans (allowing smoking in certain exempted areas, such as workplaces, bars, restaurants or private clubs). Only 16 states do not have any statewide smoking ban. Smoking rooms are not allowed in most states. Oklahoma is one of the few states that allow smoking rooms in bars and restaurants. However, in view of the harm of second-hand smoke, Oklahoma plans to introduce a Bill in 2009 to ban such rooms in bars and restaurants.

(f) Canada

Smoking rooms used to be permitted in most provinces but have been gradually banned after comprehensive evaluations of their impact on public health and other policy implications conducted by several provinces. Smoking rooms used to be permitted but have been gradually banned in most provinces in recent years. For example, they were banned from Quebec, British Columbia, Yukon and Alberta in 2008. Prince Edward Island is now the only exception among all 13 provinces. The problems with smoking rooms identified by several provinces include the following[3]:

- no ventilation system can successfully remove all the tobacco in the air to meet the air quality standard
- problems such as sub-standard rooms and leakage of smoke are common
- workers have complained of being exposed to second-hand smoke
- it is costly and difficult for government to enforce the laws on construction, air quality and operation (e.g. service of food in the smoking room, entrance of hospitality workers, etc.)
- it is costly for proprietors to construct, maintain and manage the smoking rooms
- some small establishments complained of the unlevel playing field inadvertently created
- many smokers refuse to smoke inside the rooms because they are too smoky, while non-smokers complain of the smoke and odour leakage

For the above reasons, most Canadian provinces have decided to ban smoking rooms.

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[3] Sources:
Clean Air Coalition of British Columbia: http://www.cleanaircoalitionbc.com/ktf_ventilation.html#qfdsr
Ontario Campaign for Action on Tobacco: http://www.ocat.org/onlegislation/designated.html
York Region Health Department: http://www.ocat.org/pdf/york/DSR_presentation.pdf