

**A Critical Evaluation of Lincolne Scott's *Burswood Casino*  
*Air Quality International Gaming Facilities Report***

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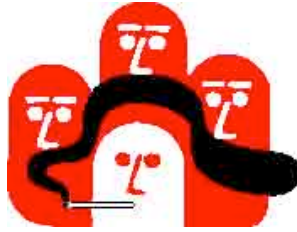
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## **Critical Review of the Lincolne Scott Proposal for the Burswood Casino**

### **Executive Summary**

- The Lincolne Scott report is flawed because it does not specify the casino smoker density, ignores the guidance of the Australian Ventilation Engineering profession, establishes air quality goals which produce air pollution levels consistent with massively unacceptable health risks for casino workers, and fails to compare the efficacy of its proposed ventilation technology to actual “best practice”, i.e., smoking bans.
- I estimate that the Lincolne Scott ventilation technology proposal to control SHS would expose Burswood Casino staff to risks exceeding U.S. Occupational Safety and Health Significant Risk of Material Impairment of Health level by 4- to 15-fold.
- Reduction of the risk of secondhand smoke exposure for Burswood Casino Staff to acceptable levels would require tornado-like air exchange rates greater than 120,000 air changes per hour, or more than 3400 times the highest rates proposed by Lincolne Scott in its ventilation technology scheme for the Burswood Casino.

## Introduction

I have been asked by Mr. Stephen Hall of the Australian Council on Smoking and Health to critically review an engineering report entitled “*Burswood Casino Air Quality International Gaming Facilities Report*”, authored by the firm Lincolne Scott (LS). The Burswood Casino apparently has retained Lincolne Scott to upgrade its ventilation systems in the Casino’s international gaming facilities (IGF). According to the LS Report, Burswood intends to expand its IGF and improve air quality in spaces with smoking (subject to government approval) according to “best practice” with respect to gaming environments. The LS proposal proposes to control the levels of secondhand smoke (SHS) (also known as environmental tobacco smoke, or ETS) using a combination of high volume outdoor air ventilation, directed airflows, air curtains, gaseous and electrostatically-enhanced particulate filtration, and maintenance procedures for removing deposited tobacco tars. My curriculum vitae may be viewed at [www.repace.com](http://www.repace.com) and a précis is included in Appendix B.

## Background

Secondhand smoke (SHS) is a known cause of lung cancer and heart disease mortality (CalEPA, 1997) and both recent and long-term SHS exposure have been associated with adult-onset asthma (Jaakkola et al., (2003). Casinos historically have been heavily polluted with tobacco smoke, and the casino industry has been resistant to smoke-free workplaces for its staff. Chronic exposure of staff to air pollution from smoking has led to illness and loss of livelihood, and has led to litigation in Australia and in the U.S. and the U.K. [Brook v. Burswood Casino (1999); Badillo v. American Tobacco et al. (1998); Avallone v. American Tobacco et al. (1998); Mullen et al. v. Treasure Chest (1999); Dunn v. Napoleon’s Casino (2003)] as well as occupational health complaints [Trout et al., 1996; 1998]. Repace (2004) found that in a large casino in the U.S. State of Delaware, that a state-imposed smoking ban in the casino led to a decrease in levels of dangerous respirable particles (RSP) and carcinogens (PAH) by 96% and 98%, respectively. Although casino owners often justify their resistance to smoking bans by inducing fears of loss of tax revenue for the state and loss of workers’ jobs, the smoking ban did not affect gaming revenues in this casino (Mandel et al., 2005). The prevalence of daily smoking among the West Australian adult population was 21% in 2001; an additional 4% of West Australian adults are occasional smokers, smoking less often than daily (DOHWA, 2005). By contrast, the same statistics for Delaware in 2001 totaled 25%.

## Analysis

The goal of this critical review is to evaluate whether these “best practice” methods proposed by LS would actually achieve acceptable indoor air quality. LS’s design criteria are *inter alia*, carbon dioxide (CO<sub>2</sub>) levels less than 1000 ppm, nicotine levels less than or equal to ( $\leq$ ) 40 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ), carbon monoxide (CO) levels  $\leq$  9 ppm, and respirable dust (RSP) levels  $\leq$  300  $\mu\text{g}/\text{m}^3$ . LS does not state whether these proposed Air Quality goals yield acceptable air quality, and does not specify a smoker density commensurate with these target levels. Moreover, no data are

given for the actual measured levels, nor what the smoker density was in the casino at that time. LS also proposes air exchange rates of 25 air changes per hour (ACH) for the Function, VIP and existing International rooms, an increase from “the current 8 ACH.” LS proposes an increase “from 12 ACH” to 35 ACH for Private Gaming Salons. For bar areas within smoking-permitted rooms supply air is proposed over the bar area with returns in the patron area to “limit” the amount of smoke exposure of bar staff. LS does not specify the smoker density for any of the spaces. LS does not state whether these “current” air exchange rates are the result of actual measurements or are design values for those spaces.

In 1999, I issued an affidavit (Repace, 1999) in a legal case, Brook v. Burswood Casino. In a table (Table 4) in that affidavit, reproduced below as Table 1 in this evaluation, I compared my estimates of RSP and nicotine concentrations based on estimated smoker densities, and average air exchange rates, to actual measurements that had been made by others. My average estimated nicotine concentration, assuming a casino smoking prevalence of 29%, was 23  $\mu\text{g}/\text{m}^3$ , and average estimated RSP from SHS was 250  $\mu\text{g}/\text{m}^3$ , which compared very well to actual measurements. From the preceding paragraph we see that LS proposes to triple the air exchange rate over existing values. Holding smoker density constant, this would reduce the average air pollution from SHS by a factor of 3. However, if the new designated smoking-permitted rooms contain largely smokers, the new smoker density could increase by a factor of 3, negating the increase in ventilation. A major flaw in the LS report is that it does not specify the current or new smoker density, and does not appear to recognize that the concentration of SHS is directly proportional to the smoker density as well as inversely proportional to the air exchange rate.

**Table 1. Comparison of theoretical calculations for low, average, and high smoking occupancy and average ventilation vs. environmental measurements for the Burswood Casino from various depositions (Repace, 1999).**

| Est.Nicotine Conc. ( $\mu\text{g}/\text{m}^3$ ) | Meas.Nicotine Conc. ( $\mu\text{g}/\text{m}^3$ ) | Est. Total RSP Conc. ( $\mu\text{g}/\text{m}^3$ ) | Measured RSP Conc. ( $\mu\text{g}/\text{m}^3$ ) |
|---|--|---|---|
| Repace<br>Low: 3                                | LeSouef (p.252)<br>23.8                          | Repace<br>Low: 50                                 | LeSouef *<br>200-300                            |
| Repace<br><b>Ave.: 23</b>                       | Langley (p.217)<br>26.8                          | Repace<br><b>Ave.: 250</b>                        | Gordon (p.99)<br>216-476                        |
| Repace<br>High: 41                              | HBI (Brook)<br>15.8                              | Repace<br>High: 430                               | HBI (Brook)<br>62-226                           |

\*Letter from Peter Le Souef, MD to Hon Ian Taylor dated 31 December 1996, quoting data presented by Burswood Casino 23/11/96 to Taskforce on Passive Smoking.

If we hold the Burswood smoker density constant, and if the air exchange rates are increased by a factor of 3, I conclude that at best, the exposure concentrations of SHS for Buswood Staff would decrease by a factor 3 to about 80  $\mu\text{g}/\text{m}^3$ . However, LS do not

specify a smoker density, and LS's target RSP concentration is nearly 4 times that level, at 300  $\mu\text{g}/\text{m}^3$ .

Further, the LS report makes no reference to the Australian National Occupational Health & Safety Commission (2005) criteria for treatment of known carcinogens (Appendix), a category in which SHS is included. NOHSC states that a carcinogen is Category 1 if it is "known to be carcinogenic to humans," i.e., there is sufficient evidence to establish a causal association between human exposure to these substances and the development of cancer. NOHSC states that "Under the circumstances where substitution of less hazardous materials is technically not feasible, the use of these carcinogenic substances should be controlled to the highest practicable standard by the application of effective engineering control techniques and, where necessary, complemented by the use of appropriate personal protective equipment. Routine monitoring of the workplace is essential for indication of control performance. In some cases, health surveillance and biological monitoring can indicate exposure and thus reveal the need for re-assessment of the control measures and work practices. For some substances, specific control measures have been detailed in codes of practice."

Such a code of practice for SHS has been issued by the Australian Ventilation Engineering profession, but is totally ignored in the LS Burswood proposal. This guidance called the Environmental Tobacco Smoke Harm Index (ETSHI) [AS 1668.2 Supplement 1—2002]. The ETSHI is used to estimate the mortality risk associated with a specified exposure to SHS in an environment that is ventilated and that may be fitted with an air cleaner, as in the LS proposal. Appendix A of the ETSHI guidance estimates the combined lung cancer and heart disease mortality risk for office workers in a typical smoking-permitted office as: ETSHI = 225 deaths per million exposed workers per year. Assuming a 45-year working lifetime, this risk corresponds to a working lifetime risk of  $(45)(225 \text{ deaths/million}) = 10 \text{ deaths per } 1000 \text{ persons at risk}$ . Repace (2005) estimated that the predicted respirable smoke particulate (RSP) concentration during work hours corresponding to this risk is 211  $\mu\text{g}/\text{m}^3$ . In fact, Repace (2004) measured an RSP concentration of 205  $\mu\text{g}/\text{m}^3$  in the Delaware Park Casino in the U.S., with a corresponding carcinogenic particulate polycyclic aromatic hydrocarbon (PPAH) concentration of 163 nanograms per cubic meter ( $\text{ng}/\text{m}^3$ ) before a Statewide smoking ban, and corresponding RSP and PPAH concentrations after the smoking ban of 9  $\mu\text{g}/\text{m}^3$  and 4  $\text{ng}/\text{m}^3$  respectively. As Table 1 shows, measurements in the Burswood Casino are consistent with these values.

LS's target concentrations for nicotine and RSP do not represent a significant change from the existing measured values. An RSP concentration of 211  $\mu\text{g}/\text{m}^3$  is about 2/3 of LS's target value. Thus LS's target concentration of 300  $\mu\text{g}/\text{m}^3$  would have an estimated risk for Burswood casino staff of about 15 per 1000, or 15 times the OSHA Significant Risk level, and 10,000 times the U.S. *de minimis* or "acceptable risk" level carcinogens in air, water, or food (Travis et al., 1990; Repace et al., 1998). Moreover, LS presents no modeling to show that even these target values would be attained if its technology is adopted or has been attained in practice elsewhere. Assuming a best-case

3-fold reduction in concentration, at  $80 \mu\text{g}/\text{m}^3$ , the risk would be  $(80/211)(10 \text{ per } 1000) = \sim 4 \text{ per } 1000$  (rounded). Thus the estimated range in risk is between 4 and 15 per 1000, with the most likely value, based on measured data in Table 1 above, about 10 combined deaths from heart disease and lung cancer per 1000 workers per working lifetime of 45 years. This risk range is  $(10 \text{ per } 1000)/(1 \text{ per } 1,000,000) = 10,000$  times the de minimis or “acceptable” risk level. Therefore I find the LS proposal to be without merit in achieving acceptable indoor air quality in the Burswood Casino.

On the other hand, a total ban on smoking in the Burswood Casino – an option not considered in the LS report, would reduce the excess risk of mortality from SHS to zero.

## Conclusions.

- Under the Lincolne Scott proposal, to use ventilation technology to control SHS, Burswood Casino staff would be exposed to an unacceptable risk of morbidity and mortality from lung cancer, heart disease, as well as respiratory disease.
- Assuming a 3-fold reduction in measured concentrations of SHS under the LS proposal, Burswood Casino staff's would have a residual estimated working lifetime (45 yr.) mortality risk of lung cancer and heart disease from SHS 4 per 1000, compared to U.S. OSHA's level of 1 death per 1000 workers, defined as "significant risk of material health impairment." At the target concentration listed in the LS proposal, this risk would be 15 per 1000. At the level of the typical measured data for the Burswood Casino, estimated excess risk due to SHS is very hazardous, at 10 times the Significant Risk level, and 10,000 times the *de minimis* or acceptable risk level.
- Casino staff's estimated risk is significant, material, and substantial, and there is no reasonably practical means of mitigating, reducing, or avoiding the risk other than smoke-free working conditions.
- Smoking bans, rather than ventilation technology, constitute "best practice" for the control of secondhand smoke.
- The Lincolne Scott report is flawed because it does not specify the casino smoker density, ignores the guidance of the Australian Ventilation Engineering profession, establishes air quality goals which produce air pollution levels consistent with massively unacceptable health risks for casino workers, and fails to compare the efficacy of its proposed ventilation technology to smoking bans.

## **References**

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## Appendix A. National Occupational Health & Safety Commission (2005)

<<http://www.nohsc.gov.au/OHSInformation/NOHSCPublications/fulltext/docs/h4/596.htm>>



### 13. CARCINOGENS

13.1 Unlike most chronic toxic effects, which usually manifest themselves sometime during the period of exposure, a carcinogenic process, from the initiating event to clinical expression of the disease, may take from a few to many years to complete. A diagnosis of cancer may not be made until long after cessation of exposure.

13.2 The incidence of cancer is usually dose related; the greater the exposure to the chemical carcinogen the higher the risk of developing the cancer associated with that chemical. Accordingly, the smaller the exposure the lower the probability of a cancer developing.

13.3 Because of the limitations of both epidemiological and animal studies at very low dosage, 'no effect' levels of exposure cannot be confidently identified for carcinogenic substances at the present time. Nevertheless, there do appear to be practical thresholds for most carcinogens at which the effects cannot be distinguished against the natural background,<sup>33</sup> although for some of the more potent carcinogens elimination of exposure is the only recommendable goal.

13.4 Since some carcinogenic substances are unavoidable in particular industrial processes, and to some extent also occur in nature, it may be impossible to eliminate exposure to these substances completely. For this reason the following general guidelines should be observed:

- \* Substances which have been identified as carcinogens should be replaced, where possible, by substances which are not carcinogenic and are less hazardous.

- \* Engineering controls, such as exhaust ventilation, process enclosure and/or improved work practices, should be implemented to eliminate or minimise worker exposure. As skin absorption can be a significant source of exposure for some carcinogens, particular

attention may need to be given to plant hygiene and the selection of appropriate skin protection.

\* Routine air monitoring, or biological monitoring where appropriate, should be employed in the workplace to ensure exposure is being maintained at the minimum which can be practically achieved, and in all cases below the appropriate exposure standard. Because the levels of exposure may be very low, analytical methods of appropriate sensitivity should be employed. The frequency at which monitoring is undertaken is determined by the magnitude of the potential exposure and the reliability of the process controls.

\* Where exposure to these substances cannot be eliminated by the use of process control techniques, the use of personal protective equipment may be required. The selection of appropriate protective equipment will be determined not only by the nature and magnitude of the potential exposure, but also by the particular chemical and physical characteristics of the substance and the nature and magnitude of its carcinogenic effect.

\* All personnel likely to be exposed to carcinogenic substances should receive adequate information regarding the hazards, and training in minimisation of risk.

13.5 Although exposure to potentially carcinogenic substances should be eliminated or reduced to as low a level as is practicable, the use of exposure standards can, in many cases, act as a useful guide to the efficiency of engineering controls and the work practices which have, or need to be, implemented to reduce worker exposure.

13.6 To this end, where there is sufficient information to allow the assignment of exposure standards, these are given as a guide to good practice. However, because of the incompleteness of our knowledge of carcinogens, it is at present not possible to reliably estimate the risk posed by some carcinogenic substances. Therefore, compliance with these exposure standards should not preclude further efforts to reduce worker exposure.

13.7 Chemical substances which have been identified as suspected or established carcinogens, or substances associated with industrial processes which have been identified as suspected or established carcinogens, have been highlighted in the list of adopted exposure standards. The Commission of the European Communities (EEC) system of classification of carcinogenic substances<sup>34</sup> is used to indicate the strength of the causal association between these substances and the development of cancer. (Note: The categorisation of individual substances by the Exposure Standards Working Group may vary from the EEC assignment in some instances.) A detailed description of the criteria used in this classification system is available in A Guide to the Classification of Carcinogens, Mutagens and Teratogens under the Sixth Amendment,<sup>35</sup> which is based on the interpretation, for human exposure at the workplace, of the findings of the International Agency for Research on Cancer on carcinogenesis. The most stringent of the three categories, with the appropriate levels of control required, is described below.

**(a) Category 1**

**Established human carcinogens are those substances known to be carcinogenic to humans. There is sufficient evidence to establish a causal association between human exposure to these substances and the development of cancer.**

**Under the circumstances where substitution of less hazardous materials is technically not feasible, the use of these carcinogenic substances should be controlled to the highest practicable standard by the application of effective engineering control techniques and, where necessary, complemented by the use of appropriate personal protective equipment. Routine monitoring of the workplace is essential for indication of control performance. In some cases, health surveillance and biological monitoring can indicate exposure and thus reveal the need for re-assessment of the control measures and work practices. For some substances, specific control measures have been detailed in codes of practice.5,6,36**

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36. National Occupational Health and Safety Commission, National Code of Practice for the Safe Use of Vinyl Chloride [NOHSC:2004(1990)], Australian Government Publishing Service, Canberra, 1990.

## APPENDIX B. Précis of J.L. Repace's Curriculum Vitae

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### James L. Repace, MSc.

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James L. Repace, MSc., is a health physicist who is currently in private practice as an international environmental smoke consultant. Repace also holds an appointment as Visiting Assistant Clinical Professor of the Department of Family and Community Medicine at Tufts University School of Medicine.

One of the world's leading authorities on secondhand smoke (SHS) or environmental tobacco smoke, or ETS), Repace was a science policy analyst and staff scientist at the Environmental Protection Agency (EPA) from 1979 to 1988. He has conducted research on SHS for 30 years and has published 30 scientific papers on the topic. Among his many major accomplishments, Repace:

- Influenced EPA's policy against tobacco air pollution (1974).
- Identified ETS as a major source of indoor air pollution in a groundbreaking paper that received international scientific attention (1980); in a seminal study, estimated that 5,000 lung cancer deaths per year in the U.S. were caused by passive smoking (1985).
- Funded the National Academy of Sciences Report on Environmental Tobacco Smoke (1986); issued the Surgeon General's Report on Involuntary Smoking (1986); and issued an EPA study that resulted in the agency concluding that ETS is a Class "A" or "known" human carcinogen (1992).
- Developed the first equations for the prediction of levels of ETS nicotine in air and its metabolic, cotinine, in the blood, urine and saliva of nonsmokers, and calibrated dose-response equations relating these levels to nonsmokers' lung cancer and heart disease mortality (1993, 1994).

Repace has testified before Congress on numerous occasions; has served on the Surgeon General's National Advisory Committee on Smoking and Health, and has served as a consultant to the World Health Organization, U.S. Department of Health and Human Services, National Cancer Institute, and many other organizations. He serves on many distinguished scientific panels and committees, is the recipient of many awards, and lectures frequently. Repace is Associate Editor for *Passive Smoking of Tobacco Control*.

Repace received his BSc (1963) and MSc (1968) in Physics from Brooklyn Polytechnic University and completed post-master's studies in physics at the University of Maryland (1969) and Catholic University (1972). Prior to joining the EPA, Repace worked as a physicist with the Home Research Laboratory and as a research associate with PCC's David Sarnoff Research Center.

Repace is one of five individuals selected to receive The Robert Wood Johnson Foundation's Innovators Combating Substance Abuse award in 2005. His business, Repace Associates, Inc., is based in the greater Washington, DC area.

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