CASE STUDY

[In each issue, **IEQS** *presents a case study on an indoor air investigation in a particular building. The information in the cases comes from various sources, including published material, reports in the public record, and, in some cases, reports supplied by the consultants involved in the case.* **IEQS** *presents a variety of approaches to investigation and mitigation implemented by consultants with a broad range of experience, philosophies, and expertise. Inclusion of a particular case study in the newsletter does not imply* **IEQS***'s endorsement of the investigative procedures, analysis, or mitigation techniques employed in the case.* **IEQS** *invites readers to submit comments, suggestions, and questions concerning any case. At the discretion of the editors, correspondence may be presented in a future issue.]*

Casino Investigation Finds ETS Exposure Among Workers

Gambling and smoking seem to go hand in hand. An IEQ investigation at a US casino has found elevated blood and urine cotinine concentrations among nonsmoking workers, although concentrations of airborne contaminants were consistent with those found in other nonindustrial environments. Nevertheless, the investigators — from the US National Institute of Occupational Safety and Health (NIOSH) — recommended that smoking at the facility be eliminated or more tightly controlled.

The case involves a major casino in Atlantic City, New Jersey, where employees had confidentially requested that NIOSH conduct a health hazard evaluation (HHE) because the employees were concerned about their exposure to environmental tobacco smoke (ETS). In response, NIOSH investigators visited the casino for four days during the spring to conduct the evaluation.

Douglas Trout, M.D., and John Decker, CIH, conducted the survey and reported their findings in an HHE report, from which this case study was taken.

The building, constructed in 1979, contains a main casino floor with a total area of 71,380 square feet (ft^2). A separate poker room consists of 8,679 ft^2. The casino employs about 800 persons who work over three shifts, as the facility operates 24 hours a day, seven days a week. The number of employees on duty at any one time varies with the number of patrons expected.

HVAC Description

A building management system controls the HVAC operation, which includes a total of 17 supply and return fans that serve 80 variable air volume (VAV) boxes on the casino floor. The supply fans are rated at 47,000 cubic feet per minute (cfm), and the return fans at 45,000 cfm. Each VAV box provides 4,000 cfm.

The outdoor air (O/A) intake depends on outdoor conditions, increasing during mild climatic conditions and decreasing when the outside temperature is either very hot or very cold. The investigators reported that the O/A specifications weren't available from management, but they had been told that the minimum O/A setting was 30%.

The investigators calculated that if the 30% minimum O/A rate were correct, the casino would have a minimum O/A rate of 25 cfm/person at maximum occupancy. The poker room had a separate supply fan that supplied 24,000 cfm.

Smoking was allowed throughout the casino, although some gaming tables were designated as nonsmoking. However, the nonsmoking tables were adjacent to the tables where smoking was allowed. The employee cafeteria had smoking and nonsmoking sections, although they weren't physically separated. Employee lounges are nonsmoking, and employees don't smoke on duty.

The NIOSH investigation was in response to confidential employee complaints about possible ETS exposure, and the report notes that management was reluctant in its support for the study.

Investigation Techniques

The investigators visited the casino over four days in the spring and performed various studies, including:

- Environmental monitoring to assess nicotine and respirable particulate concentrations in area air samples;
- Personal breathing zone (PBZ) sampling;
- Monitoring of occupant comfort parameters, including carbon dioxide (CO_2), temperature, and relative humidity (RH);
- A self-administered questionnaire; and

- Biologic monitoring, including pre- and post-shift blood and urine samples from participants who volunteered.

After explaining the tests to employees and enlisting volunteers for the biologic monitoring, the investigators performed their studies on two days — a Thursday and Friday during the second shift, generally the busiest shift of the day.

Results

Nicotine vapor exposures for both area and personal sampling during the Thursday testing ranged from 6-12 micrograms per cubic meter ($\mu g/m^3$). The highest reading came from one location in the poker room. In the Friday evening sampling, area concentrations ranged from 8-16 $\mu g/m^3$ and personal exposures, from 4-15 $\mu g/m^3$. The highest concentrations again occurred at the same location in the poker room.

On both evenings, respirable dust ranged from nondetectable to 90 $\mu g/m^3$. According to the investigators, this is comparable to levels found in office settings. They detected no correlation between respirable dust and nicotine vapor concentrations.

Table 1 — Pre- and Post-Shift Cotinine Concentrations in Casino Employees

Participant	Nicotine * ($\mu g/m^3$)	Pre-Shift Serum Cotinine (ng/ml)	Post-Shift Serum Cotinine (ng/ml)	Pre-Shift Urine Cotinine (ng/ml)	Post-Shift Urine Cotinine (ng/ml)
1	7	2.74	2.62	159.0	197.0
2	9	NA **	NA	47.6	54.0
3	6	0.926	1.47	16.2	23.6
4	9	2.72	2.56	21.2	45.3
5	NA	1.19	1.45	37.7	54.4
6	10	1.58	2.22	16.7	39.1
7	12	2.78	2.91	42.4	58.6
8	6	113.0	73.0	4,664.0	4,137.0
9	6	0.885	1.36	21	28.4
10	NA	1.07	1.21	5.76	20.7
11	8	1.3	1.57	14.0	7.21
12	NA	0.967	1.32	23.7	26.7
13	NA	2.81	2.61	51.4	50.5
14	NA	4.24	3.52	61.1	59.3
15	10	1.14	1.95	27.3	35.9
16	10	1.37	1.77	28.4	33.9
17	11	1.39	1.16	23.4	25.3
18	15	0.23	2.7	7.63	58.0
19	NA	1.49	2.03	7.98	28.1
20	12	0.768	1.54	16.4	22.65
21	4	1.15	1.41	37.0	43.2
22	12	1.05	2.33	17.4	32.5
23	9	2.19	2.57	44.9	52.6
24	NA	0.516	0.959	2.54	3.87
25	14	1.35	1.96	35.6	51.2
26	NA	2.38	2.56	26.8	31.2
27	NA	2.89	3.19	19.5	21.7
28	NA	0.659	0.917	23.0	24.1
29	NA	1.16	1.42	27.2	33.3

* For workers who had personal breathing zone samples
** Not taken

Source: Trout and Decker, NIOSH

During the Thursday testing, CO_2 concentrations ranged from 425 parts per million (ppm) to 650 ppm, and on Friday ranged from 475-850 ppm. At the time of the sampling, outside temperatures were mild, indicating that the HVAC system was most likely bringing in large amounts of O/A. Temperature and RH levels were generally within ranges specified in ASHRAE standards, according to the report.

About 10% — 29 — of the eligible employees on duty at the time participated in the medical evaluation, including 18 dealers and 11 supervisors. Of these, 20 were male, and ranged in age from 21 to 53. None of the participants reported current tobacco use — although one was later classified as a current smoker and this person's data was eliminated from the statistical analysis. More than half — 17 — of the participants reported no ETS exposure outside the workplace.

Six persons showed a pre- to post-shift drop in serum or urine cotinine levels, but generally there was a significant increase in these concentrations among participants. Table 1 shows the concentrations. Also, for those who had PBZ sampling during their shift, there was a weak positive correlation between biologic results and airborne levels.

Those who worked at the nonsmoking tables showed no significant difference when compared with those who worked at the smoking tables, but those who worked at the poker tables had the highest post-shift serum cotinine concentrations.

Conclusions and Recommendations

The investigators conclude that the casino workers experienced more ETS exposure than a representative sample of the US population, as measured in the Third National Health and Nutrition Examination Survey (NHANES III). The mean serum cotinine levels of the casino employees was 1.34 nanogram per milliliter (ng/ml) pre-shift and 1.85 ng/ml post-shift, compared to 0.93 ng/ml in the NHANES III study for those who reported ETS exposure both at home and at work.

The investigators also conclude that separate smoking and nonsmoking tables appeared to have little effect on ETS exposure, and that other casino employees are most likely experiencing the same or similar exposures.

The report notes the lack of correlations between cotinine levels and airborne concentrations and hypothesizes that this could be due to several factors:

- The small number of persons evaluated;
- The relatively narrow range of cotinine values; and
- Limitations associated with questionnaires, nicotine air sampling, and cotinine as a biomarker.

The investigators recommend that the best way to eliminate worker exposure to ETS is to eliminate tobacco use from the workplace and to implement a smoking cessation program for employees. Until this can be done, the report suggests isolating smoking areas from nonsmoking areas, using direct exhaust in smoking areas to prevent recirculation.

For more information on this report or to request a health hazard evaluation, contact NIOSH at (800) 35-NIOSH.

TOOLS AND TECHNIQUES

World Wide Web Sites Offer Wealth of Information on IEQ Issues

As the Internet and the World Wide Web (WWW) maintain their nearly explosive growth, and as new users sign on by the thousands, it's more important than ever for IEQ professionals to keep tabs on those sites that can offer much-needed information at any hour of the day or night.

We have compiled a list of some of the Web sites we refer to on a regular basis and offer them to our readers as a jumping-off point for finding information. Some of these sites have general knowledge and others have more specific information. As with any information source, knowing what you are looking for — and the general area where to find it — will increase your chances for productivity and success.

For those who simply don't have the time to spend searching the Web, ***IEQS*** tries to keep close tabs on what's going on — although that is becoming more difficult as sites proliferate — and we bring to your attention information we feel will be of interest.