

Casino Ventilation – Keeping Gamblers Comfortable

Large Casino Case Study

Part 2

IAQ Performance Monitoring

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Purpose of Study

- **To determine the effectiveness of the mechanical ventilation systems serving smoking – permitted gaming areas in controlling airborne concentrations of Environmental Tobacco Smoke (ETS) and providing comfortable IAQ conditions**

Methodology

Parameters Measured: General IAQ

- **Respirable Suspended Particulates (RSP) as an indicator of airborne particulate levels, including particle phase ETS**
- **Carbon Monoxide (CO₂) and Nitrogen Dioxide (NO₂) as indicators of the presence of gaseous combustion by-products, including ETS and automobile exhaust**
- **Carbon Dioxide (CO₂) as an indicator of the adequacy of the outdoor air supply provided by the mechanical ventilation system**
- **Temperature and Relative Humidity as indicators of occupant thermal comfort.**

Methodology

Parameters Measured: ETS

Specific parameters were measured as indicators of both particle phase and vapor phase ETS. These included:

Particle Phase

- Total Respirable Suspended Particulate (RSP)
- Ultraviolet particulate matter (UVPM)
- Fluorescent particulate matter (FPM)

Vapor Phase

- Nicotine
- 3 – Ethenylpyridine (3-EP)

Methodology

General IAQ

- **Specific parameters were measured in 5 casino locations each day over a four day period using continuous data collection instruments**
- **150 additional locations were monitored each day for 3 days using instantaneous data collection instruments.**

Methodology

ETS Indicators:

Integrated ETS samples were collected at three locations over a three day period

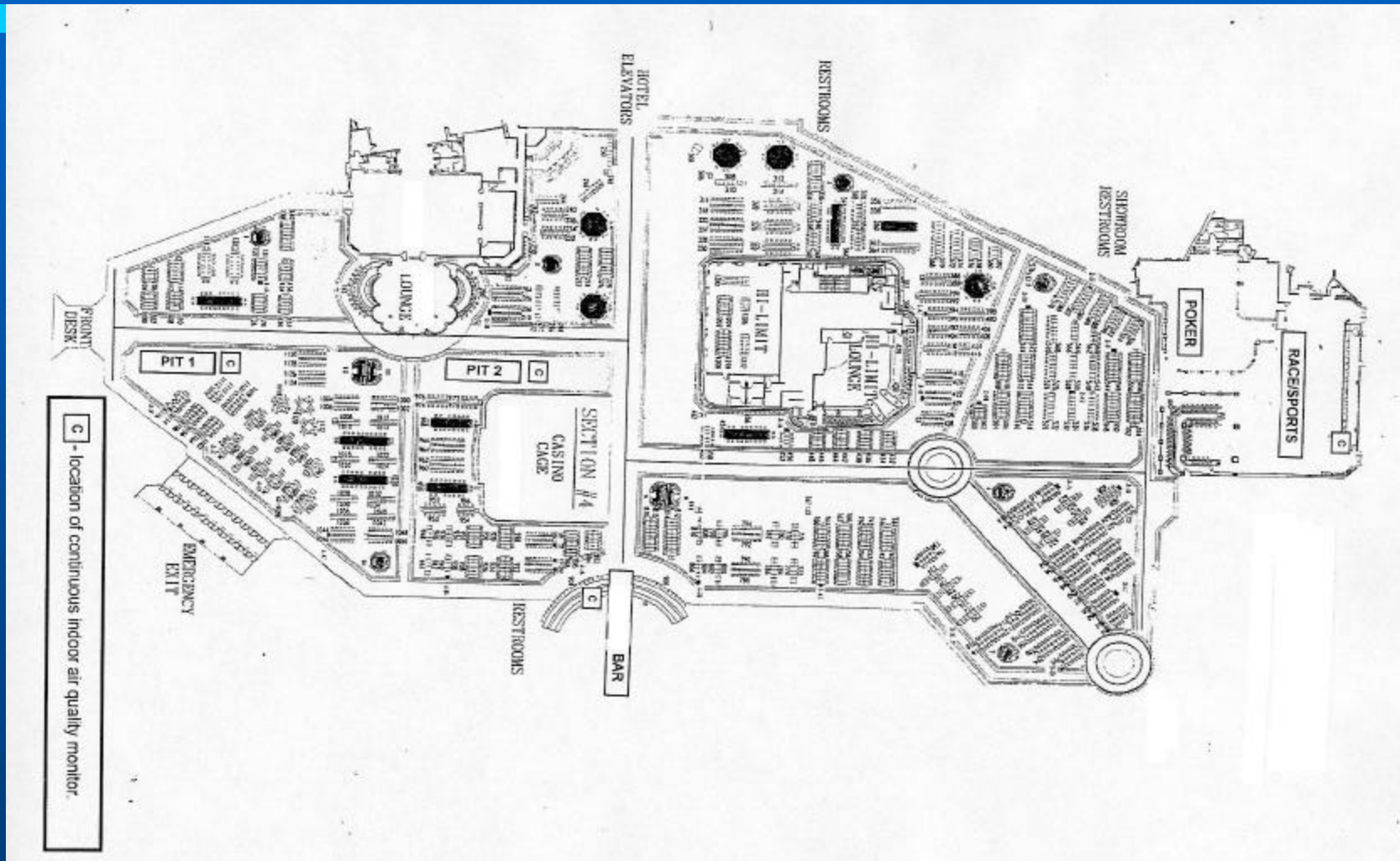
Methodology

Sampling Locations

Five typical casino areas were selected for sampling

- Poker Room
- Race/Sports Room
- Pit 1
- Pit 2
- Large Bar

Methodology



Methodology

- **Continuous monitors were placed in five locations for four days**
- **In addition, 30 instantaneous sampling locations were monitored each day in the vicinity of each of these locations for three days**
- **On days two, three and four ETS specific integrated samples were collected at all locations except the large bar area**

Methodology

Air Flow

- Air movement and pressurization relationships between indoor areas in the casino were qualitatively assessed using smoke pencils.
- During each test period smoke pencil testing was conducted to observe air flow patterns in the vicinity of each fixed location and between adjacent areas.

Methodology

Particulate-Phase ETS Indicators

- RSP concentrations are often used as an indicator of ETS, however because of the many additional sources of RSP indoors this tends to be an overestimate
- Better estimates of ETS are provided by UVPM and FPM analysis which specifically measure only combustion-related particles

Methodology

Vapor-Phase ETS Indicators

- CO and NO₂ are often used as ETS indicators, however because of the many additional sources of these two gases indoors this results in an over-estimate of ETS levels
- Nicotine and 3 Ethenylpyridine are more accurate indicators of vapor-phase ETS.

Methodology

Sampling Schedule

Day One

- Walkthrough inspection with casino staff
- Selection of five monitoring locations
- Installation of continuous monitors at Poker Room, Race/Sports Room, Pit 1, Pit 2 and Large Bar

Methodology

Sampling Schedule

Day Two

- Download continuous monitors and review data
- Collect 30 instantaneous measurements in the vicinity of each continuous monitoring location
- Conduct integrated (8 hour) ETS sampling at Poker Room, Race/Sports Room and Pit 1

Methodology

Sampling Schedule

Day Three

- Download continuous monitors and review data
- Collect 30 instantaneous measurements in the vicinity of each continuous monitoring location.
- Conduct integrated (8 hour) ETS sampling at Poker Room, Race/Sports Room and Pit 2

Methodology

Sampling Schedule

Day Four

- Download continuous monitors and review data
- Collect 30 instantaneous measurements in the vicinity of each continuous monitoring location.
- Conduct integrated (8 hour) ETS sampling at Poker Room, Race/Sports Room and Pit 2
- Remove the continuous air quality monitors

Results

General IAQ: Carbon Dioxide

- **CO₂ concentrations were slightly varied and generally low with daily average levels between 380 to 955 ppm indoors and 360 to 380 ppm outdoors**

Results

General IAQ: Temperature and RH

- Indoor temperature varied between locations ranging from 68°F to 76°F with outdoor conditions varying between 79°F and 83°F.
- Indoor relative humidity (RH) levels were low and slightly varied ranging from 20.4% to 38.8% RH indoors and 23.8% to 26.7% outdoors

Results

General IAQ: Respirable Particulates

- RSP levels measured using direct reading instruments for both continuous and instantaneous measurements showed indoor concentrations ranging between 12 and 48 $\mu\text{g}/\text{m}^3$ compared to outdoor levels ranging between 11 and 20 $\mu\text{g}/\text{m}^3$

Results

General IAQ: Carbon Monoxide and Nitrogen Dioxide

- CO concentrations were low and ranged between 0.8 and 2.0 ppm indoors compared to outdoor levels ranging from 1 to 2 ppm
- NO₂ concentrations were also low ranging between 0.23 and 0.46 ppm indoors.

Results

ETS Indicators: Total RSP, UVPM, FPM

- RSP concentrations determined gravimetrically were low and varied between locations, ranging between 19 and 58 $\mu\text{g}/\text{m}^3$
- UVPM concentrations ranged between 2 and 25 $\mu\text{g}/\text{m}^3$
- FPM concentrations ranged between 2 and 17 $\mu\text{g}/\text{m}^3$

Results

ETS indicators: Nicotine and 3 Ethenylpyridine

- Nicotine levels were low ranging between 3.4 and 9.2 $\mu\text{g}/\text{m}^3$
- 3 Ethenylpyridine levels were low ranging between 0.8 and 1.2 $\mu\text{g}/\text{m}^3$

Results

Air Flow Observations

- The casino was positively pressurized relative to outdoors
- Air movement in the casino was observed traveling upwards from occupant levels to the exhaust grills in the ceiling
- Vertical (rather than horizontal) air movement was observed at each monitoring location

Conclusions

- All measured parameters were within established OSHA workplace standards
- Ventilation was in accordance with ASHRAE Standard 62
- Temperature and Humidity were within the ASHRAE Standard 55 comfort range
- Both particle-phase and vapor-phase ETS indicators were low, demonstrating good performance of the HVAC systems in controlling ETS levels in the casino