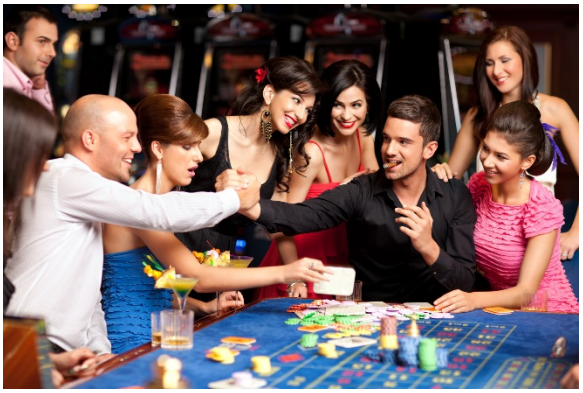
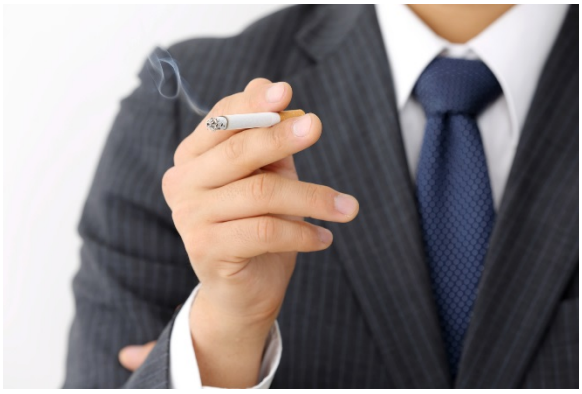
Measuring Indoor Air Quality in Casinos

Demand for good indoor air quality is increasing as people recognize the risks to their health and productivity from indoor pollutants. With this in mind, casinos want to provide guests and workers with a healthy environment. There are a number of ways to improve indoor air quality (IAQ). Removing pollutant sources is the highest priority, but not always practical in casinos where pollutant exposures must otherwise be reduced with appropriate ventilation, and air filtration. Since occupant loads vary significantly (and rapidly) and many casinos allow smoking indoors, the combination of environmental tobacco smoke, human-generated pollutants, heavy use of cleaning products and other factors pose special challenges for optimizing IAQ in Casinos.



According to the CDC, smoking is the largest preventable cause of death in the United States, resulting in more than 480,000 deaths each year[1]. Secondhand smoke related illnesses and deaths are a huge concern, since secondhand smoke contains many toxins along with inhalable particulates. Cigarettes contain roughly 600 ingredients, and when burned more than 7,000 chemicals are created. At least 69 of the chemicals created are known carcinogens[2].



State and local laws prohibit smoking in public areas in approximately 35 percent of the United States[3]. Any laws passed in gaming jurisdictions have generally exempted gaming areas in casinos. Since casinos host patrons from diverse cultures and backgrounds there are many needs and interests to be met, such as smoking. Some casinos have opted to implement smoking bans, but the impact may not always be positive. For example, in 2007, a statewide smoking ban in Illinois resulted in a reported first year loss of

[1] US Centers for Disease Control (CDC) http://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/effects_cig_smoking/

[2] American Lung Association http://www.lung.org/stop-smoking/about-smoking/facts-figures/whats-in-a-cigarette.html

[3] Taking the Lead on Indoor Air Quality. Fahrenkopf, Frank. Global Gaming Business. http://www.americangaming.org/newsroom/op-eds/taking-lead-indoor-air-quality

$200M in tax revenue[4]– something the rest of the casino industry does not want to experience. In this case, eliminating the source (cigarettes) is not ideal.

Instead the focus is on better ventilation and air purifying as the solution. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), in standard 62-1989, had recommended ventilation rates of 20 CFM per person in office spaces with moderate smoking. However, in more recent versions of that standard they have dropped any approval for smoking in occupied areas, except in designated smoking lounges that have local mechanical exhaust ventilation with no air recirculation it is recommended to have 60 CFM per person[5].

In a study conducted in casinos by Stanford and Tufts Universities, it was found that ventilation and air cleaning do not control indoor smoke levels, and the only way to control secondhand smoke is to limit the number of smokers[6]. This indicates that much more research should take place to make casinos a healthier environment. This is especially important because while smoking is not allowed in many adjacent areas to gambling areas, such as restaurants, there may be children or highly susceptible adults present and impacted by infiltration of smoke.

Some of the specific chemicals found in tobacco smoke are, acetone, acetic acid, ammonia, arsenic, benzene, butane, cadmium, carbon monoxide, formaldehyde, hexamine, lead, naphthalene, nicotine, tar, and toluene[7]. Many of these compounds have specific health effects and various government and industry guidelines, some of which can be seen in the table on the next page.

In addition to the presence of tobacco smoke there are other factors that will affect the indoor air quality in any facility. Cleaning products can contain large amounts of ammonia, chlorine or specific volatile organic compounds (VOCs) and produce unpleasant odors. Some casinos use ozone generators or air purification devices to clean the air, but they may leave residual amounts of ozone behind. Also, due to the fluctuating number of patrons in a casino at any given time, the Carbon Dioxide (CO2) concentration (from human respiration) and other human generated bioeffluents will also fluctuate. Monitoring CO2 is useful in determining ventilation rates and acts as a tracer gas for other pollutants that might not be practical to directly monitor on-site.

[4] Can Smoke Free Casinos Still Cash In? Einhorn, Bruce. 2015. http://www.bloomberg.com/news/articles/2015-03-24/can-smoke-free-casinos-still-cash-in-

[5] American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). 1989. ASHRAE 62-1989: *Standards for Acceptable Indoor Air Quality.* Atlanta: ASHRAE.

[6] Secondhand smoke raises the stakes in America's casinos. Myers, Andrew. http://news.stanford.edu/news/2011/march/casino-secondhand-smoke-032511.html

[7] American Lung Association http://www.lung.org/stop-smoking/about-smoking/facts-figures/whats-in-a-cigarette.html

All of the parameters mentioned in the example table below (ammonia, carbon monoxide, formaldehyde, and particulate matter) can be monitored specifically by GrayWolf equipment. Additional contaminants of concern may also be measured, including total volatile organic compounds (TVOC), chlorine, hydrogen sulfide, nitrogen oxide and nitrogen dioxide and ozone. The use of GrayWolf equipment enables quick spot checks within casinos, along with long term trend logging. Remote WiFi access to data is optionally available. Additional GrayWolf software, VentCal, can be used with the CO2 sensor to calculate and report on specific ventilation rates. All of the GrayWolf equipment is available for purchase (worldwide) or rental (in N. America, Europe and some other locations).

	US OSHA[8]	ACGIH TLV[9]	NIOSH[10]	WHO[11]	China[12]
Ammonia (NH3)	50 ppm 8 hr TWA	25 ppm TWA, 35 ppm STEL	25 ppm TWA, 35 ppm STEL	25 ppm	0.20 mg/m3 1 hr mean
Carbon Monoxide (CO)	50 ppm 8 hr TWA	25 ppm 8 hr TWA	35 ppm, Ceiling 200 ppm	9 ppm for 8 hr	10 ppm 1 hr mean
Formaldehyde (HCHO)	0.75 ppm 8 hr TWA	0.3 ppm 15 min STEL	0.016 ppm 8 hr TWA	0.1 mg/m3 30 min TWA	0.10 mg/m3 1 hr mean
Particulate Matter (PM10)	5.0 mg/m3 8 hr TWA	3 mg/m3 8 hr	N/A	20 µg/m3 annual mean	0.15 mg/m3 daily mean value

Examples of Government and Industry Guidelines

[8] US OSHA Regulation (Standards - 29 CFR), 1997 TABLE Z-1 Limits for Air Contaminants. - 1910.1000 TABLE Z-1 PEL (Permitted Exposure Level), updated as of July 2011

[9] ACGIH TLVs (Threshold Limit Values) Guideline, 2015

[10] The National Institute for Occupational Safety and Health (NIOSH) NIOSH Pocket Guide to Chemical Hazards last reviewed April 2011

[11] The World Health Organizations (WHO) Guidelines for Indoor Air Quality, Selected Pollutants (2010)

[12] Chinese Indoor Air Quality Standard, GB/T 18883-2002

Application Note

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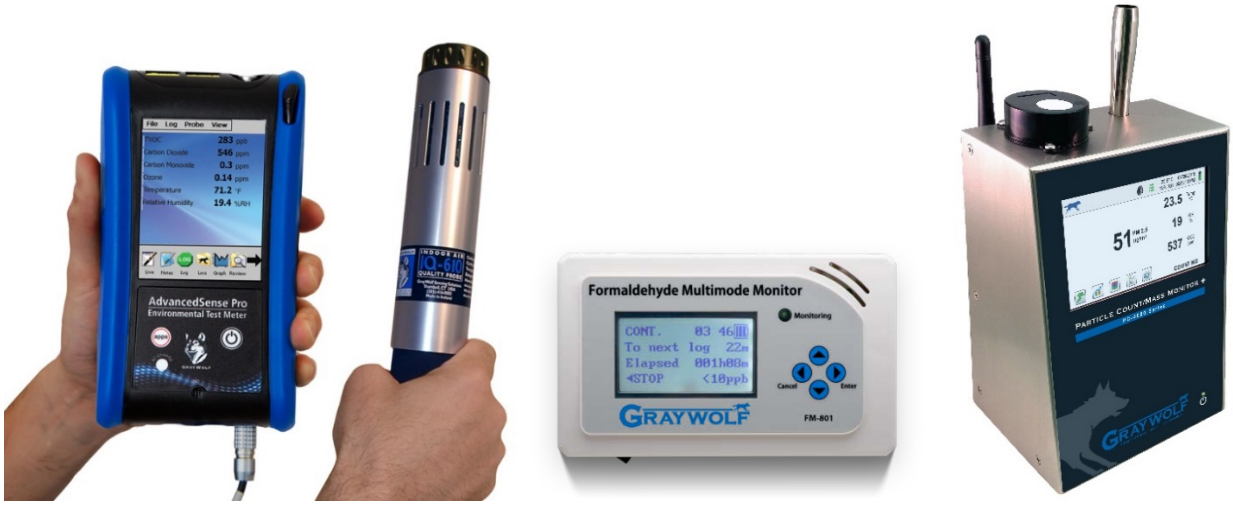

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