

Natatorium (Indoor Pool) HVAC Design and Safety Requirements

TB17-1005

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Background:

Indoor pools and the HVAC units that service those areas have various design challenges that need to be accounted for in the design and installation process. As in all spaces, user comfort is of utmost concern but, additionally, due to the chlorine content in the air, specific precautions must be followed to ensure life safety and unit longevity are addressed.

User Comfort:

For user comfort, either direct fired (DF) or indirect fired (IBT) heaters are acceptable for pool heating with the proper precautions and controls in place. A dedicated outdoor air unit (DOAU or DOAS) is also a valid product for use.

DOAS designs offer additional benefits when it comes to precise temperature control for summer months, however DF or IBT are acceptable for heating only applications.

Life Safety – Carbon Monoxide Risk:

Life safety issues present themselves in cases where a heater, fan or duct fail and allow dangerous levels of carbon monoxide to build up in a space. Carbon monoxide is an odorless, colorless and tasteless gas that is close to the same density as air. This means that it will not significantly rise or fall within a building and the ability for it to build up in a space undetected is always present when utilizing natural gas or LP heating equipment. The Occupational Safety and Health Administration (OSHA) states “that the Permissible Exposure Limit (PEL) for carbon monoxide is 50 parts per million (ppm) and the Recommended Exposure Limit (REL) is 35 ppm [1].

A recent accident at a Michigan hotel's indoor pool left a 13-year-old boy dead and 14 hospitalized with carbon monoxide poisoning after the heater exhaust system malfunctioned. When police arrived, carbon monoxide levels at the hotel were 800 ppm, 16 times the allowable limit. The pool area had no carbon monoxide sensors [2].

Another recent accident led to the evacuation of an intermediate school and the evaluation of at least 60 people at a local hospital after the belt on an exhaust fan in the school's boiler system broke. The fan stopped venting and the area built up with carbon monoxide. Again, there were no CO sensors [3].

In response to this, **carbon monoxide sensors are required for all indoor pool applications**. Each detector covers 10,000 cubic feet of building volume

Application Guidelines:

All indoor pool applications must utilize 100% dedicated outdoor air designs with separate exhaust fans to ensure life safety and unit longevity. This requirement is due to the fact that the chlorine content in the air of most indoor pools will result in rapid corrosion of the burner assemblies of both direct fired and indirect fired heating units. The burners may prematurely fail, and consequently introduce carbon monoxide into the space.

Even though ASHRAE 62.1-2016 allows for as low as 0.48 cfm/ft² of outdoor ventilation, it is the opinion of CaptiveAire that 1.0 cfm/ft² of outdoor air and the use of Demand Control Ventilation (DCV) should be used for user comfort and humidity control. In fact, Note C (see table) for swimming pools specifically calls out the fact that this 0.48 cfm/ft² of ventilation does not account for humidity control. The unaccounted for “wetted area” can contribute significantly to the humidity within a space and larger amounts of outside air can be used to combat the wide variations in occupancy and activity levels within the space. See a portion of Table 6.2.2.1 at the end of this document [4].

The supply and exhaust fans utilized for these applications should always be specified as direct drive units to avoid the risk of having carbon monoxide buildup due to a belt failure. The supply air fan should include a motorized low leakage discharge damper to prevent chlorine from migrating back into the unit when it is switched off. Additionally, any exhaust fan should utilize a Totally Enclosed Fan Cooled (TEFC) motor.

The pool area should be kept slightly negative relative to the rest of the building to ensure that the smell of chlorine does not migrate to other areas. Direct drive supply and exhaust fans will ensure that initial testing and balancing (T&B) will be accurate throughout the life of the product. Exhaust should exceed supply by no more than 5%.

All indoor pool applications must utilize dedicated prewired control systems which coordinate the activation of the exhaust fans and HVAC simultaneously. The prewire must include the CO detector and exhaust and supply fan proving options, so that if any one fan were to fail, the system would deactivate.

All jobs must be verified through a System Design and Verification (SDV) process to be in working condition, wired properly, with a functional test of the CO detector shutdown of the supply fan as well as the fan proving interlock. The prewire should be monitored by the building Annunciator (fire alarm) Panel for a CO detector activation. Typically, each CO detector may cover up to 10,000 cubic feet of building volume, although specific coverage should be verified by reviewing the specification sheet of the detector.

Additionally, it is recommended that there be carbon monoxide detectors throughout the entire building which are wired directly to the building Annunciator Panel. This is particularly important for any units which may inadvertently pull the chlorinated exhaust air into their intakes. Mechanical rooms should also have CO detectors unless the heaters located there use dedicated combustion air.

CaptiveAire stocks an audible alarm and it is a standard option set up for heaters. It has a relay that can be used with the AUX interlock in an electrical prewire. This will energize the exhaust fan and shut down the heater.

Finally, it is recommended that the flue duct for pool water heaters be stainless steel duct listed to UL 1738. The water heater should also be located in its own mechanical room with separate combustion ventilation.

Sources

- [1] "Indoor Air Quality: Carbon Monoxide's Impact on Indoor Air Quality." Internet: <https://www.epa.gov/indoor-air-quality-iaq/carbon-monoxides-impact-indoor-air-quality>, 3/13/2017 [Apr. 7, 2017].
- [2] "Carbon Monoxide at Hotel Pool Suspected in Michigan Death." Internet: <http://www.cnn.com/2017/04/01/us/michigan-carbon-monoxide-poisoning/>, 4/2/2017 [Apr. 7, 2017].
- [3] "School Carbon Monoxide Leak Traced to Broken Fan Belt." Internet: http://www.nj.com/gloucester-county/index.ssf/2017/04/school_carbon_monoxide_leak_traced_to_broken_fan_b.html, 4/6/2017 [Apr. 7, 2017].
- [4] "ASHRAE Standard 62.1-2016: Ventilation for Acceptable Indoor Air Quality." ASHRAE.

TABLE 6.2.2.1 Minimum Ventilation Rates in Breathing Zone (Continued)
(Table 6.2.2.1 shall be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate		Area Outdoor Air Rate		Notes	Default Values				
	R_p		R_a			Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		Air Class	
	cfm/person	L/s·person	cfm/ft ²	L/s·m ²		#/1000 ft ² or #/100 m ²	cfm/person	L/s·person		
Sports and Entertainment										
Gym, sports arena (play area)	20	10	0.18	0.9	E	7	45	23	2	
Spectator areas	7.5	3.8	0.06	0.3	H	150	8	4.0	1	
Swimming (pool & deck)	—	—	0.48	2.4	C	—	—	—	2	

- ITEM-SPECIFIC NOTES FOR TABLE 6.2.2.1**
- A For high-school and college libraries, the values shown for "Public Assembly Spaces—Libraries" shall be used.
 - B Rate may not be sufficient where stored materials include those having potentially harmful emissions.
 - C Rate does not allow for humidity control. "Deck area" refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.
 - D Rate does not include special exhaust for stage effects such as dry ice vapors and smoke.
 - E Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.
 - F Default occupancy for dwelling units shall be two persons for studio and one-bedroom units, with one additional person for each additional bedroom.
 - G Air from one residential dwelling shall not be recirculated or transferred to any other space outside of that dwelling.
 - H Ventilation air for this occupancy category shall be permitted to be reduced to zero when the space is in occupied-standby mode.