ENGINEERING WHITE PAPER

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AirReps™

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Natatorium Design and Construction

Indoor pools are becoming more popular yet not frequent enough for everyone to stay sharp in the design considerations and rules of thumb. This document provides the means for calculating dehumidification loads, guidelines for airflow and its distribution, as well as concerns with lack of control.

I have heard many times that a natatorium dehumidification system is not for comfort, but rather a "building preservation unit". A poor design will allow entrainment of moisture into the structure eventually compromising the building itself, making it unsafe to occupy. This can happen as quickly as a few months after commissioning.

Dehumidification Loads

Table 1 – Natatorium Design Conditions

Typical Natatorium Design Conditions		
Pool Type	**Air Temperature (°F)**	**Water Temperature (°F)**
Competition	75 to 85	76 to 82
Diving	80 to 85	84 to 88
Elderly Swimmers	84 to 85	85 to 90
Hotel	82 to 85	82 to 86
Physical Therapy	80 to 85	90 to 95
Recreational	82 to 85	80 to 85
Whirlpool/spa	80 to 85	102 to 104

Table 2 – Activity Factors

Type of Pool	Activity Factor
Elderly swim	0.65
Fitness club – Aquafit	0.65
Hotel	0.8
Institutional - School	0.8 – 1.0
Physical Therapy	0.65
Public / YMCA	1.0
Residential	0.5
Swim Meet	0.65
Wave Pool	1.5 – 2.0
Whirlpool	1.0

Always request the plans for the natatorium. Drawings will allow you to verify the load and airflows quickly and assure the design will work properly. Evaporation rate (ER) is based on the pool temp (°F), pool surface area (sq.-ft), room temp (°F), room RH (%), and pool use (agitation or activity factor). A Site Survey spreadsheet is available on the server to assist in gathering the proper information.

Airflow Calculations

$$Design_{\ CFM} = Volume\ x\ \left(\frac{ACH}{60\ min/hr}\right)$$

$$OA_{\ CFM} = 0.48\ x\ (Pool\ A + Wet\ Deck\ A) + (7.5\ x\ Spectators)$$

The gathered plans (plus average room height) will also allow you to calculate the design room airflow and outside air required. Design airflow is based on Air Changes per Hour (ACH). Therefore, the natatorium volume is needed. Minimum outside air is based on evaporation area (pool surface and wet deck) plus ventilation for any non-swimmer (spectators). Wet deck is defined a 3-6 feet from the perimeter of the water.

More outside air assists with dehumidification and provides proper ventilation but increases supplemental heating. If the natatorium is designed with a spectator section (not just standing) and not on a separate system, additional OA airflow is needed at 0.06 cfm per sq.-ft of dry deck. It is recommended to serve spectator areas on a separate system.

Rules of Thumb:

- Negative pressure in the space!!
- 4-6 Air changes per hour (typical swim pools)
- 6-8 Air changes per hour (competition pools with spectator areas)
- Easy airflow calculation = Volume/10 (provides 6 ACH)
- 0.48 cfm of OA per square foot of pool + wet deck
- 0.06 cfm of OA per square foot of dry deck (Spectator area if included)
- 7.5 cfm of OA per spectator (in pool area)

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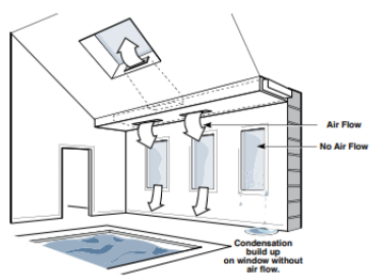
Negative Pressure

This is so important it deserves to be addressed separately. Pools are mostly recirculative air systems. The addition of outside air for ventilation and chemical removal needs to be offset with exhaust airflow (10% greater than designed OA airflow). Negative pressure is a MUST. Positive pressure will do the following:

1. Force moisture into the building structure (vapor barriers are a design MUST)
2. Allow for surfaces to condense more readily (walls, ducts, windows)
3. Drive pool smells into adjacent spaces (chlorine + contaminants = chloramines)
4. Allow chloramines to settle over pool and spectators

ASHRAE recommends the natatorium space to be maintained at 0.05 – 0.15 in-wg negative at all times.

Air Distribution



Stainless steel is typically not recommended

Second only to negative pressure is air distribution. Once we have dehumidified the air, it needs to be distributed and returned properly to make a good design. Although not part of the "equipment" we need to support this part of design with our engineers. Supply air is distributed first on windows and then walls (building preservation). Returns should be located both high and low. The low returns being more critical since chloromines are heavy and settle on the pool surface where swimmers breathe. Higher temperature whirlpools should have exhaust directly above. Ductwork can be made of almost any material provided the negative pressure is maintained.

Room Control

This is not equipment sequence. But the dehumidifier is staged due to dew point more than RH (building preservation). To assure we do not condense on surfaces, we recommend a Cold Wall Sensor to be provided along with the system operation controls. This is located on the coldest surface (typically a window or the south facing wall). The dehumidification will increase if this sensor approaches the dew point before condensing.

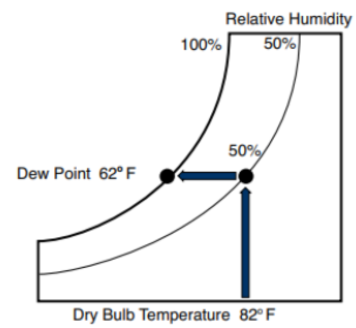


Figure 6—Dew Point Temperture

Pool Verses Air

Typical designs would like to have the air temperature at 3 degrees greater than the water. This is a means of evaporation suppression and comfort. Many pools will lose $\frac{1}{4}$- $\frac{1}{2}$" of water per day while maintaining 3 °F difference. It does not sound like much until we consider a very typical 20'x30' pool (600sq-ft). That averages to 140 gallons per day (51,100 gallons per year). Many applications push for 2 degree approach or even design air temperature less than water. For those applications the water loss can be 2x-3x greater, require more energy by the dehumidifier, and create instability in the water chemical treatment.

The difference between air and water sometimes cannot be achieved. In therapy zones the water temperature is typically 104 °F. In these cases, we stop the air temperature at 88-90 °F and increase the ACH.

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Energy Efficiency

A common question from engineers not often exposed to pools design is, "what is the EER and does it comply with codes?". Energy Efficiency Ratio (EER) is defined as the BTUH of cooling per Watts of power

needed to provide that cooling. However.... we are not cooling. Natatorium equipment is a humidity controller (and building preservation unit). They are not part of AHRI-910. However, they are tested for humidity performance. The critical conversation is regarding the hot refrigerant gas, its use in heating load, pool water heat, or rejection to ambient. Best practice is never to reject until air and water are satisfied (typically in that order). The efficiency of humidity control has yet to be established.

If there are any questions or concerns, please feel free to contact the engineering department.

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