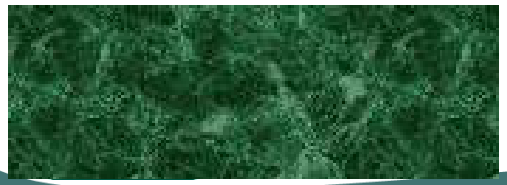
Optimizing solutions through Field Proven Pool Room Dehumidification Design Practices



Speaker Bio

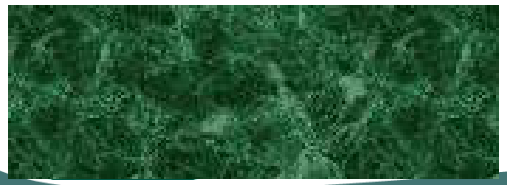
- Spence Braden has a 20-year history as a manufacturers representative specializing in latent energy management applications. He has supported hundreds of indoor pool room dehumidification projects during his tenure in the HVAC industry, as well as indoor grow cannabis and leafy greens applications, and numerous aerospace, medical, food processing, commercial, military, and industrial projects. Mr. Braden also has extensive background in desiccant dehumidification platforms as well as DX cooling and energy recovery dehumidification systems and has been involved in industrial and commercial adiabatic humidification applications.

Dehumidification Markets

- Indoor Pool
  - Residential
  - Hotel & Therapy
  - Natatorium
  - Waterparks
- Dedicated Outside Air Systems
- Ice Rinks
- Manufacturing & Storage
- WTP / WWTP pumping stations
- Indoor agricultural

TODAYS FOCUS: POOL ROOM DEHUMIDIFICATION

Design Basics



TECHNICAL FEATURE

Designing for IAQ In Natatoriums

By Randy C. Baxter

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The purpose of this article is to review the literature concerning the effects of disinfectant by-products on indoor swimming pool air quality and to propose practical methods for mitigating their impact in conventional (recreational and competition) indoor pools.

Trichloramine & Other By-Products

The literature is very clear that, of all the disinfectant by-products (DBPs) present in the pool atmosphere, trichloramine vapor (nitrogen trichloride) is the primary compound responsible for indoor pool air quality problems that cause adverse physiological responses in humans.[1-4,6] Other inorganic chloramines (mono- and dichloramine), as well as related organic DBPs are also present in chlorine-disinfected pool water and pool air.[1] These DBPs include trihalomethanes (such as chloroform), haloacetic acids and other compounds including haloketones, trichloroaldehydes, trichloronitromethane, and cyanogen chloride.[7] Organic DBPs have not been found to cause adverse physiological response or discomfort in the concentrations found in indoor swim-

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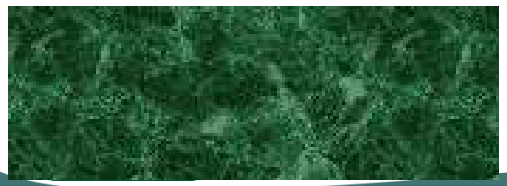
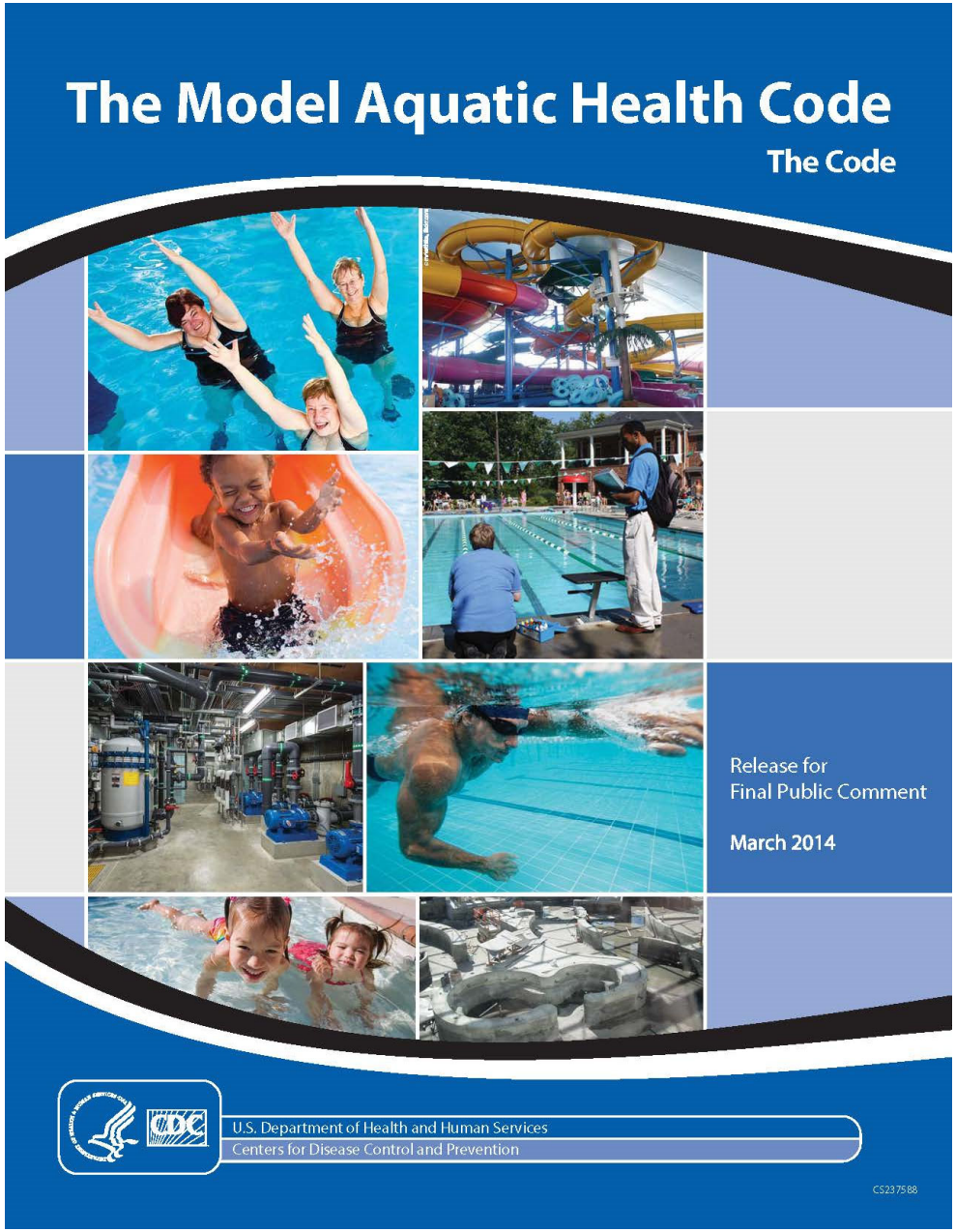
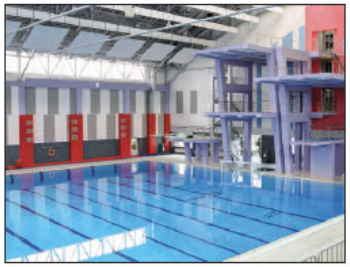
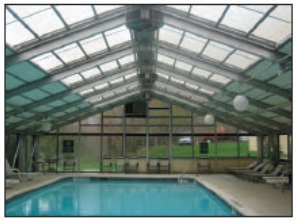
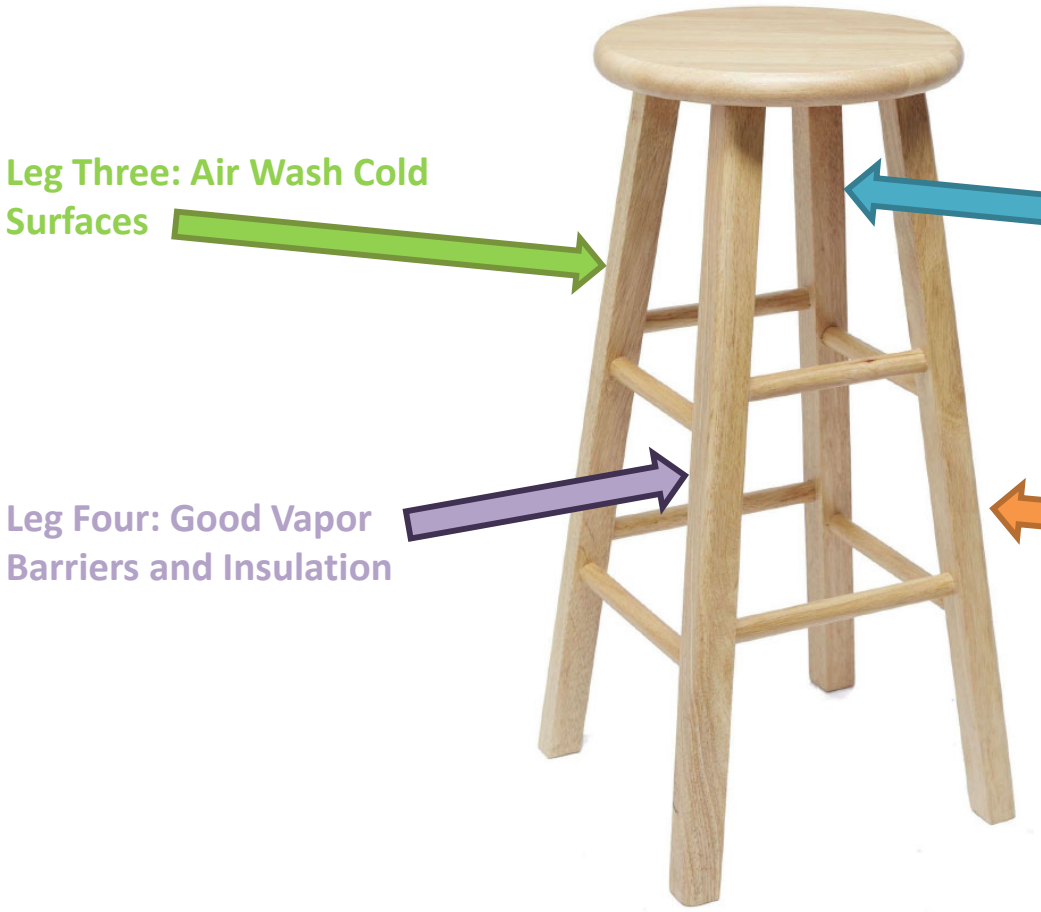



The Model Aquatic Health Code
The Code
Release for
Final Public Comment
March 2014
U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
CS237588

A Guide to an Integrated HVAC System Design for the 21st Century Natatorium


The Four Essential Legs of a Good Pool Room HVAC Design



LEG ONE: Pool Room Dehumidification & Ventilation ASHRAE Guidelines

- Maintain the pool room between 50-60% RH to protect the health of the occupants and the integrity/health of the building. Ideal target = 50% RH

- Provide a minimum outside air flow during occupied hours (while maintaining the pool room RH) for air quality proposes equal to .48 CFM per ft^2 of pool surface area & “wet deck” and .06 CFM per ft^2 for all other areas plus 7.5 CFM per spectator (if the pool has a spectator seating area).

- Provide 4-8 air rotations/changes per hour (can be OA, RA, or mixed air) to keep moisture and poor air quality pockets and from forming in the space. Ideal Target = 6 ACH. Commercial pools should target between 5-8 air rotations/changes per hour whenever possible.

- Maintain continuous 24/7 negative pressurization (.05”-.15” WC) to keep contaminated and relatively wet air from infiltrating into the pool room walls and adjacent spaces. (Note Leg Two)

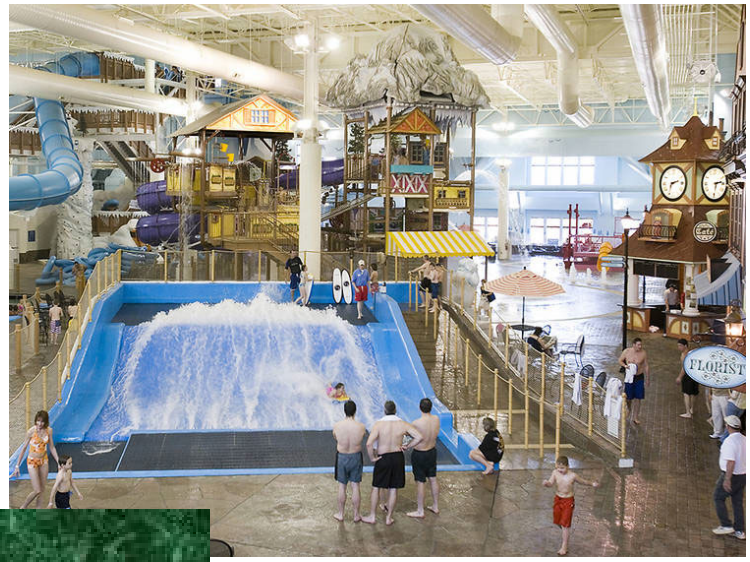
LEG ONE: Pool Room Dehumidification & Ventilation ASHRAE Guidelines Continued

- Maintain the room temperature 1^{o}-2^{o}F above the pool temperature (whenever possible) to reduce the pool surface vapor pressure and therefore the moisture load evaporating from the pool. A higher room temperature also makes the swimmers more comfortable when they are using the pool.

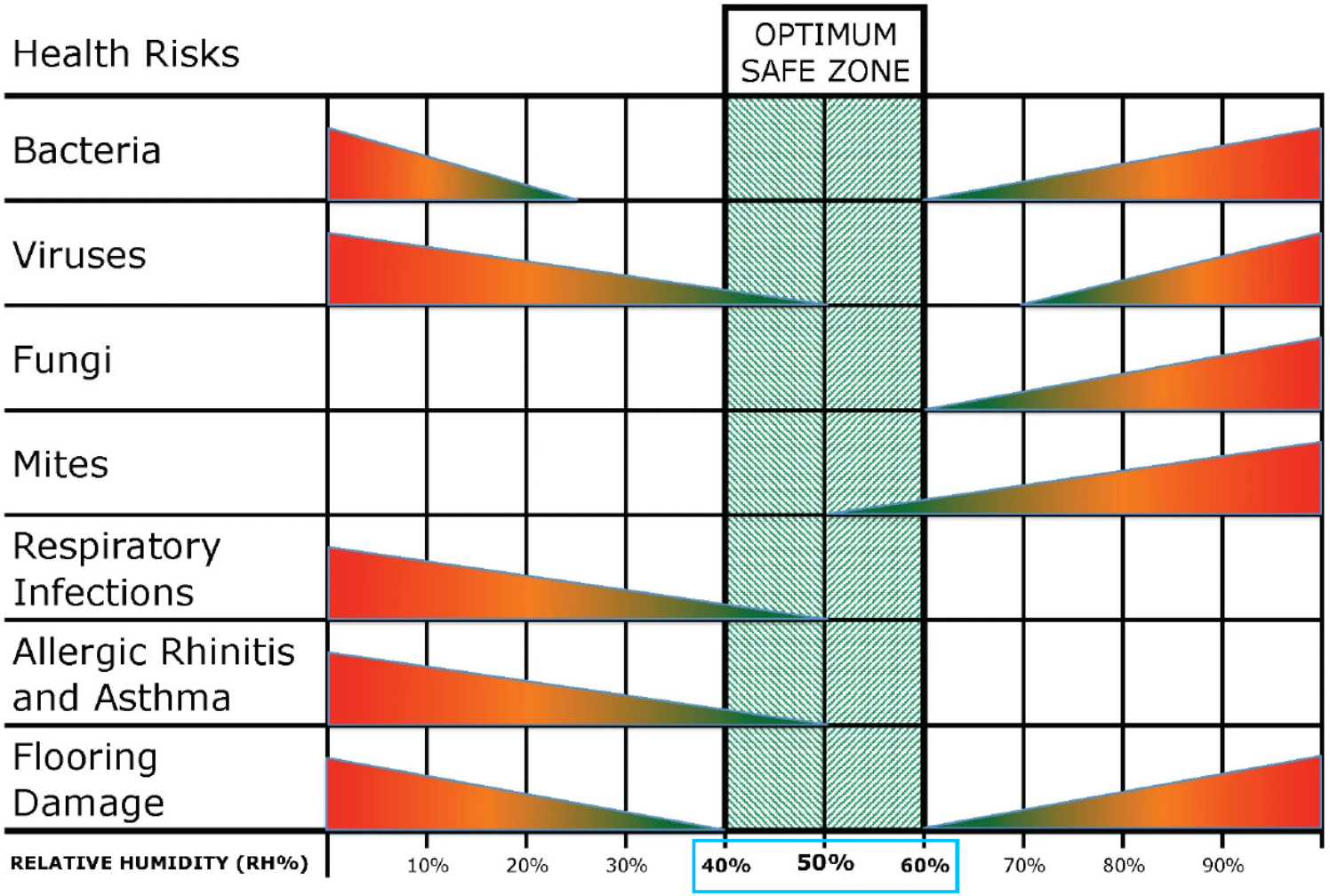
- Make sure to account for the pool surface activity factor. When calculating the evaporation rate ASHRAE accounts for the increased surface area of the pool due to the activity agitating the surface and making waves in the pool:

  - YMCA Pool = Activity Factor of 1.0
  - Hotel Pool = Activity Factor of 0.8
  - Spa/Jacuzzi = Activity Factor of 1.0
  - Residential Pool = Activity Factor of 0.5
  - Waterpark pool with water slides and/or water spray features = **Activity Factor of 2.0-6.0**

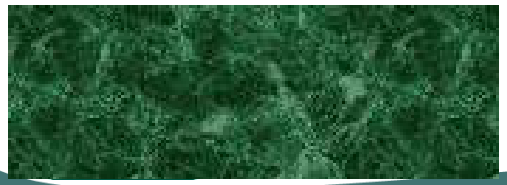
Waterpark Features



OPTIMUM RELATIVE HUMIDITY FOR MINIMISING ADVERSE HEALTH AFFECTS



Source: Theodore Sterling Ltd., A. Arundel Research Associates and Simon Fraser University



LEG TWO: Pool Room Negative Pressurization & Exhaust Source Capture

- ASHRAE Recommends maintaining continuous 24/7 negative pressurization (.05”-.15” WC) to help keep contaminated and relatively wet air from infiltrating into the pool room walls and adjacent spaces.

- An ASHRAE Sponsored 2012 Study found that trichloramine gases and other toxic by products of chlorine disinfection such as nitrogen trichloride, cyanogen chloride, trihalomethane, and hydrogen cyanide are all present at toxic levels in almost every pool room if they are not properly removed.

- Fortunately, the same study found that the above gasses are up to 4 x heavier than normal air and are all off gassing from the pool surface where a targeted source capture exhaust system can remove them.

- Therefore, the ASHRAE 2012 study concluded a targeted source capture exhaust system (with on the deck exhaust inlets) is more effective than trying to purge pool rooms with systems that use high amounts (50-100%) of outside air.

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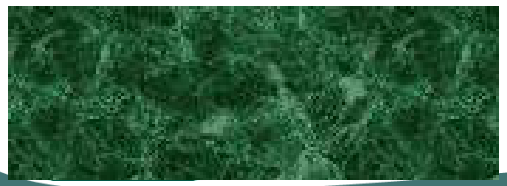
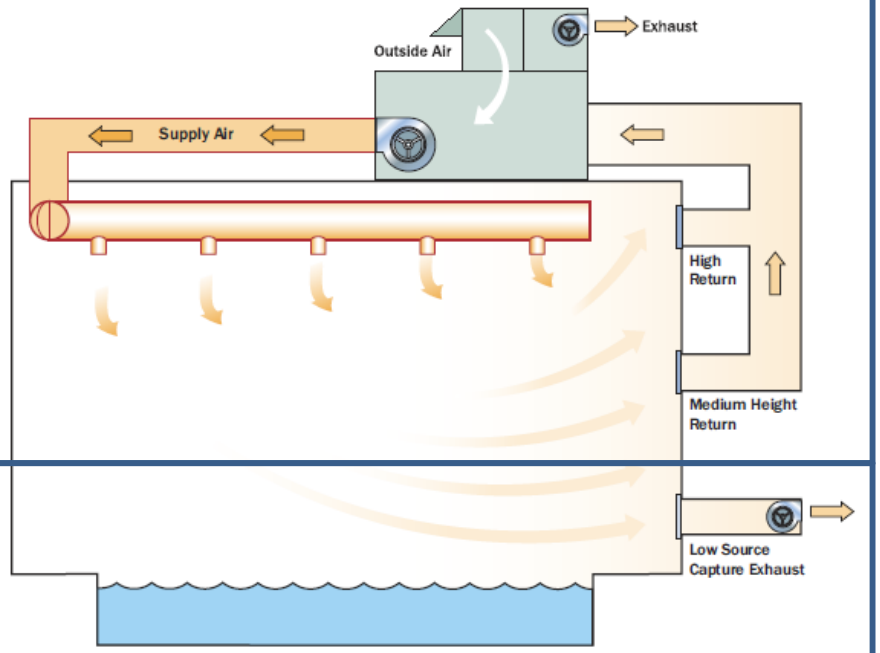
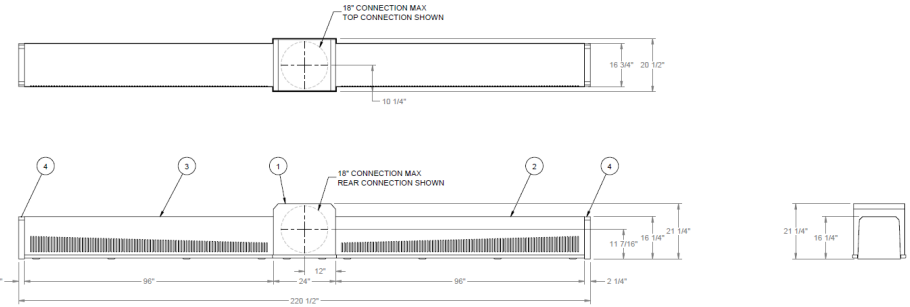


What Does a Source Capture Exhaust System Look Like?

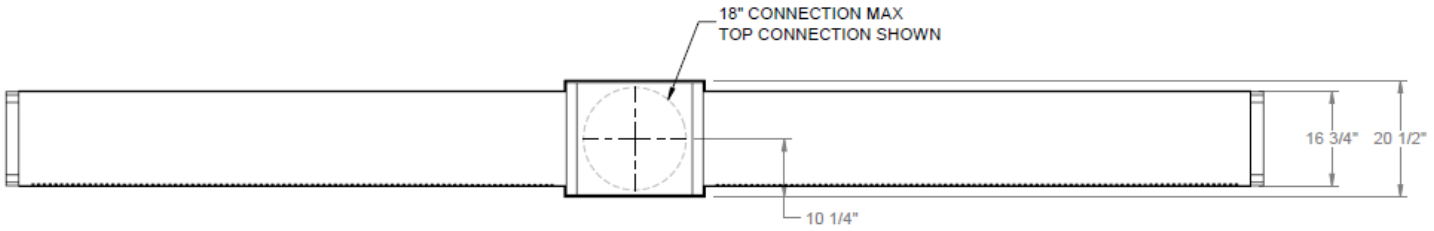
Dehumidification System

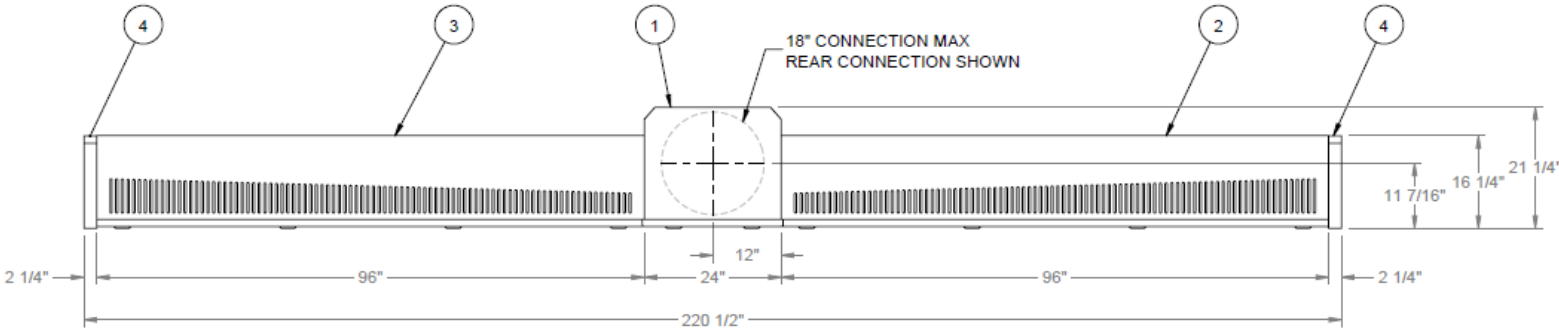


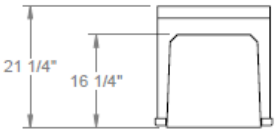
Separate Source Capture Exhaust System



Source Capture Dual Bench with Center Exhaust





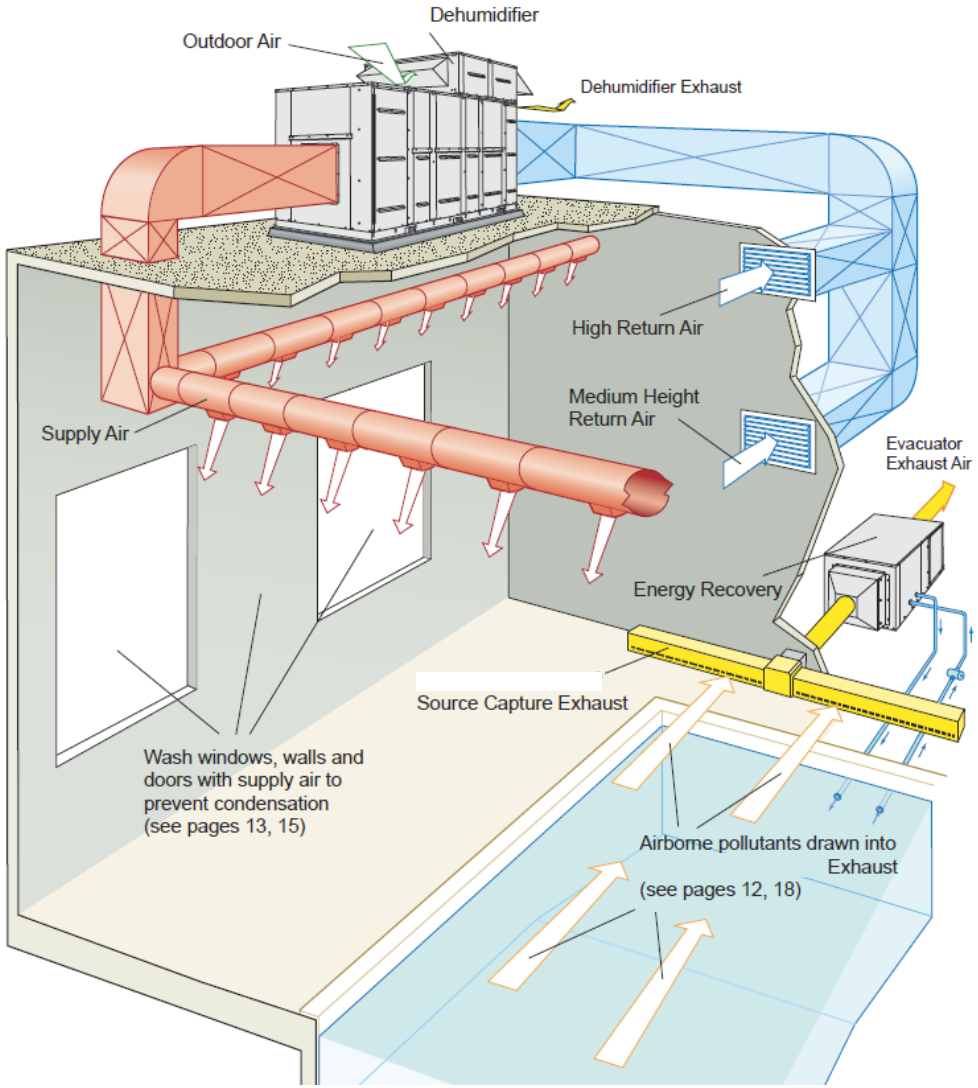


What About Source Capture Exhaust Energy Recovery?

Tons	Min	Max	THR MBH
02	550	3,190	33
03	800	3,390	51
04	1,100	3,770	74
05	1,400	3,770	88
06	1,900	5,550	113
08	2,080	5,550	123
10	2,500	6,870	162
12	3,400	7,230	205

Figure 2 - Unit Airflow Range and performance at EAT 82°F/60% and 82°F EWT

Integrated Dehumidification & Source Capture Exhaust Energy Recovery



LEG THREE: Air Wash Any Potentially Cold Interior Surface

- Air washing in pool rooms mean to blow warm dry supply air across any potentially cold surface (at or below the space design dewpoint). The potentially cold surfaces in pool rooms are typically the exterior facing skylights, roofs, windows, doors, and walls.

- The design dewpoint in a typical pool room with a design condition of 84^{o}F @ 55% RH = 66^{o}F DP. In a pool room with a 66 ^{o}F Design Dewpoint any interior surface that drops below 66 ^{o}F will create condensation **even if the dehumidifier is working perfectly!**

- Condensation in pool rooms can combine with chloramine gases to create a highly corrosive acid rain. In addition, to causing extensive moisture damage to the building envelope through corrosion, condensation encourages the growth of black mold, bacteria, and viruses. Condensation can also rain down on occupants as cold rain making everyone uncomfortable.

- Maintaining the space below 60% RH and air washing potentially cold surfaces with 3-5 CFM per ft^2 of warm dry air that is above the space dewpoint will help to significantly mitigate the formation of condensation. Therefore, the proper placement of air washing supply diffusers is critical to good pool room design.

- Properly designed fabric supply diffusers are usually the best method of distributing the supply airflow without excessive velocity; the UL listed polypropylene fabric is more corrosion resistant than SS or marine grade aluminum, and costs less to install than galvanized sheet metal duct.

Typical Indoor Poolroom Dew Points

Temperature	Humidity	Dew Point
78° F	50%	58° F
78° F	60%	63° F
80° F	50%	60° F
80° F	60%	65° F
82° F	50%	62° F
82° F	60%	67° F
84° F	50%	64° F
84° F	55%	66° F
84 F	60%	69° F

Condensate on windows


Good air washing

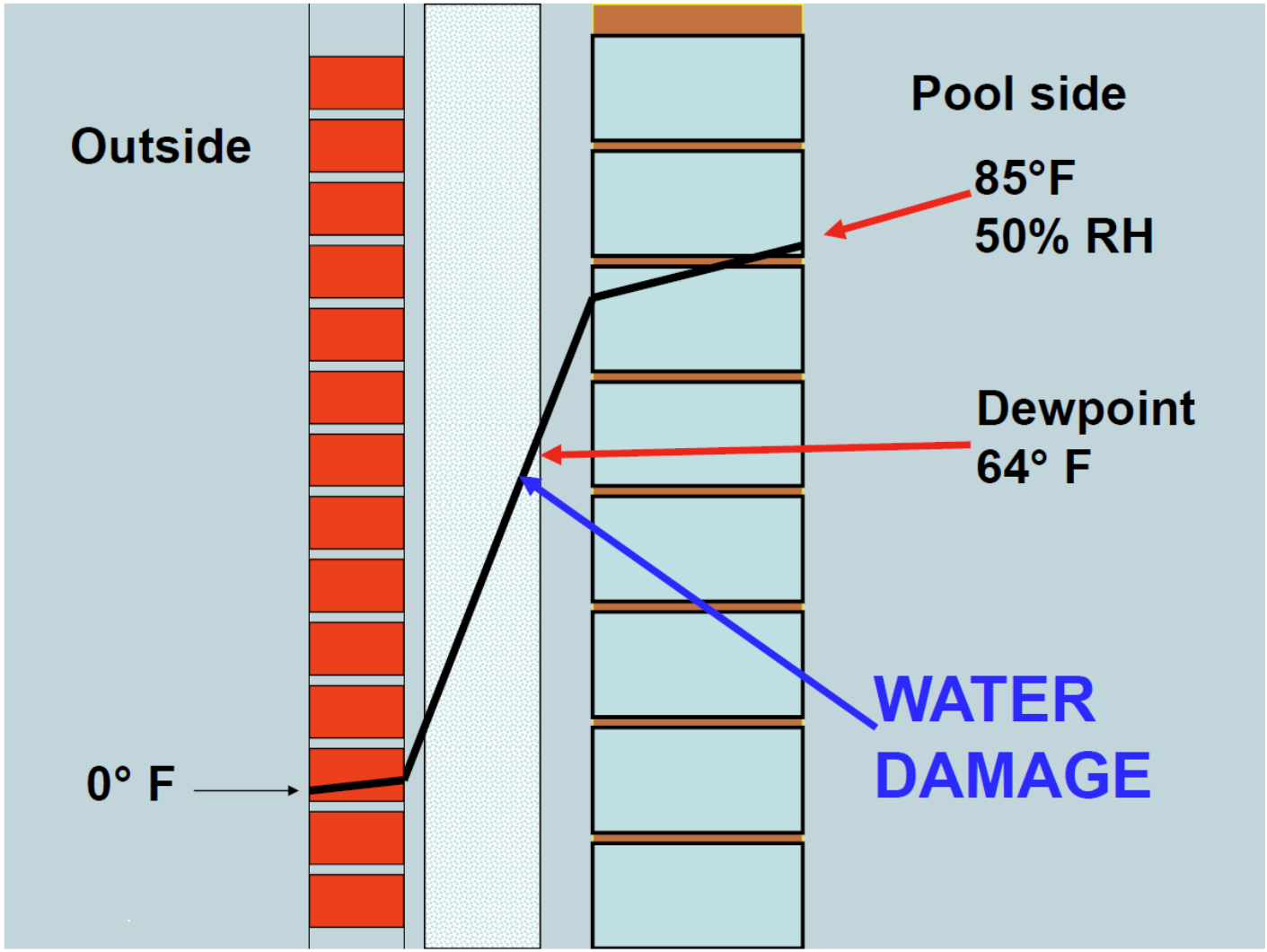
UL Listed Fabric Diffusers

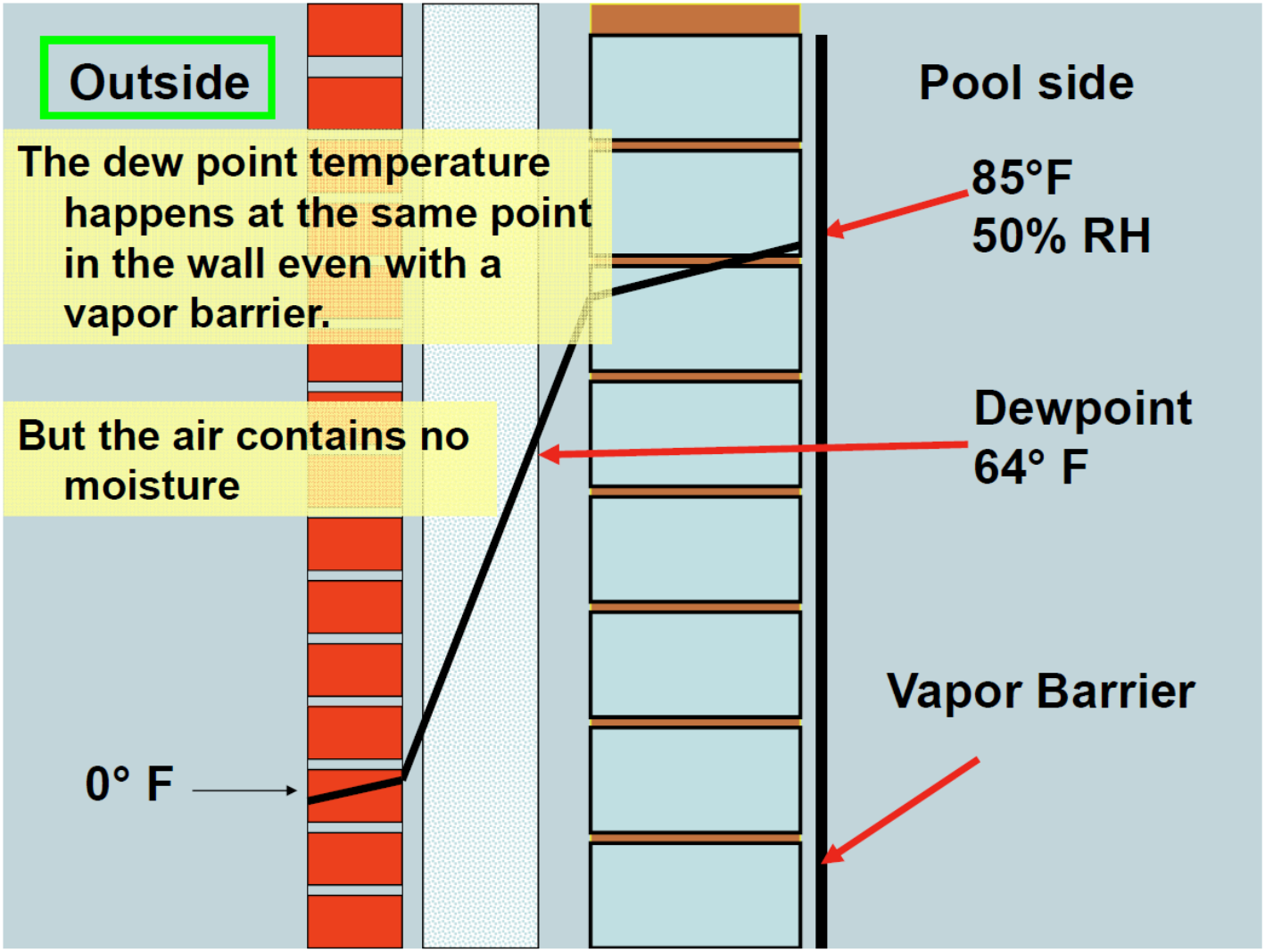
Ideal for poolrooms

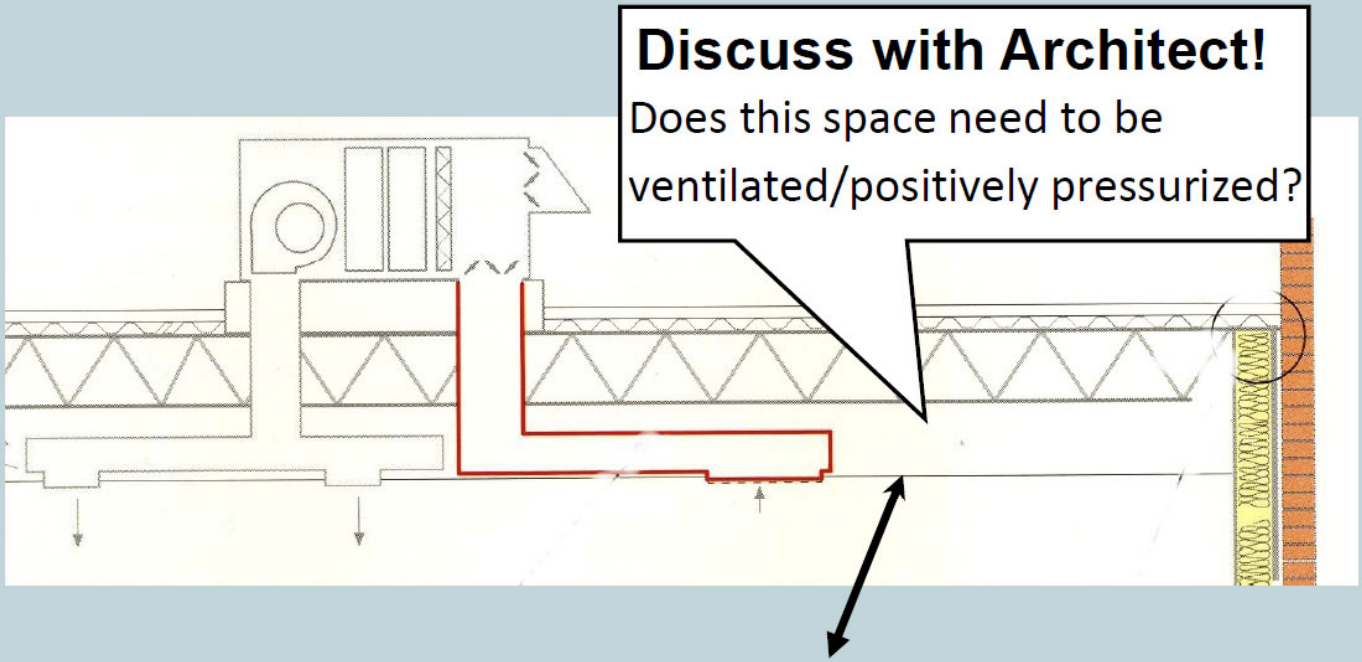
LEG FOUR: Good Interior Vapor Barriers and Moisture Resistant Insulation

- All the interior pool room surfaces need to be highly impervious to moisture and must have a robust vapor barrier behind directly them.
- Windows should be double or triple pane and have highly corrosion & water-resistant framing. Use closed cell foam or similar insulation that does not adsorb water; avoid fiberglass insulation that can act like a sponge whenever possible.
- Avoid skylights that open and/or sliding windows and doors that are designed to stay open; all it takes is one human error for a skylight, window, or door to be left open when the outside temperature at night drops (below 80^{o}F) and quickly causes the space to run out of control. Cold air and a warm pool = an exponential increase in vapor pressure and moisture load. Corrosive condensation can form on surfaces in a matter of minutes when the space is not under control.
- Avoid interstitial spaces (like false ceilings) where vapor pressure from the pool room will cause moisture to migrate and eventually condense unseen until it is too late.
- Without good vapor barriers & insulation, a good dehumidifier (LEG ONE) negative pressurization (LEG TWO) good air-washing (LEG THREE) it is possible for condensation to form inside the building walls where it will not be noticed until the damage is already done.

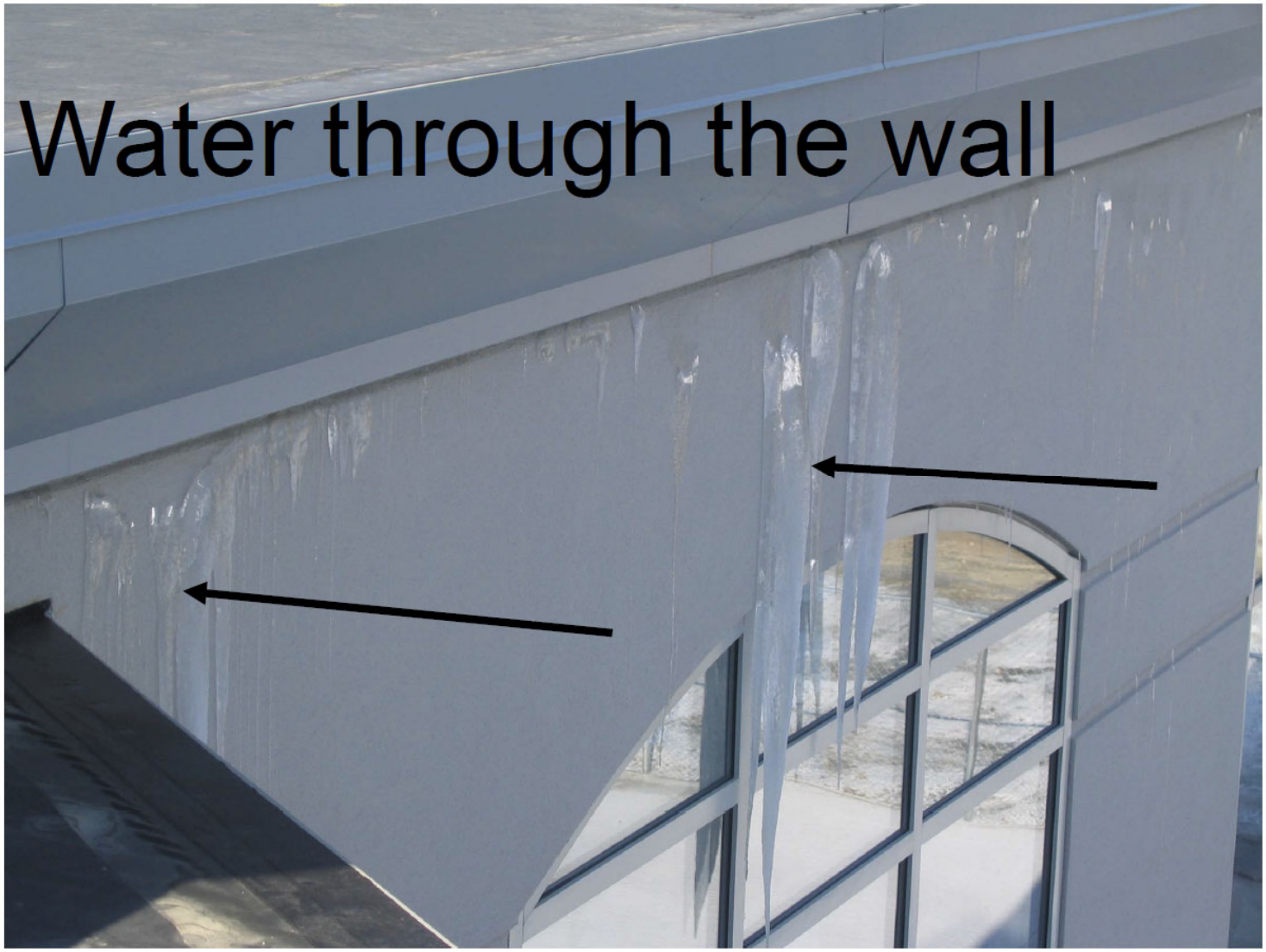
Condensate in Pool Rooms is NOT ALWAYS VISIBLE




Outside
Pool side
The dew point temperature happens at the same point in the wall even with a vapor barrier.
85°F
50% RH
But the air contains no moisture
Dewpoint
64° F
0° F
Vapor Barrier



Vapor Barrier for ceiling also required


Water through the wall


MESQUI
RECREAT
CENTE
Lok Box

What happens when the design does not include the “FOUR LEGS”

What About a Dry Climate like Nevada? Why Not Use Outside Air for Dehumidification??

- Due to extremes that occur in Vegas outside air on design dehumidification days (the wettest days of the year) **are not dry enough** to perform any dehumidification, in fact, the **outside air will increase the latent/moisture load** in a pool room during those days and nights that have thunderstorms and the humidity spikes that follow those storms

- Why bring in more outside than what is needed to control the space and maintain good air quality? ASHRAE minimum occupied outside air does not provide enough dehumidification to a pool room in Vegas even on a typical summer day. Bringing in more outside air than what is needed increases the sensible heating and cooling load and is not energy efficient.

- Not only does more outside air than necessary increase the sensible cooling load on a hot day it also increases the sensible heating load during cooler night-time hours and on cold days. There are still many nighttime hours, shoulder season hours, and winter hours where the outside temperature drops well below 80^{o}F in Vegas & Reno (approximately 5,400 hours out of 8,760 of every year).

What About a Dry Climate like Nevada? The case for DX Dehumidification Continued:

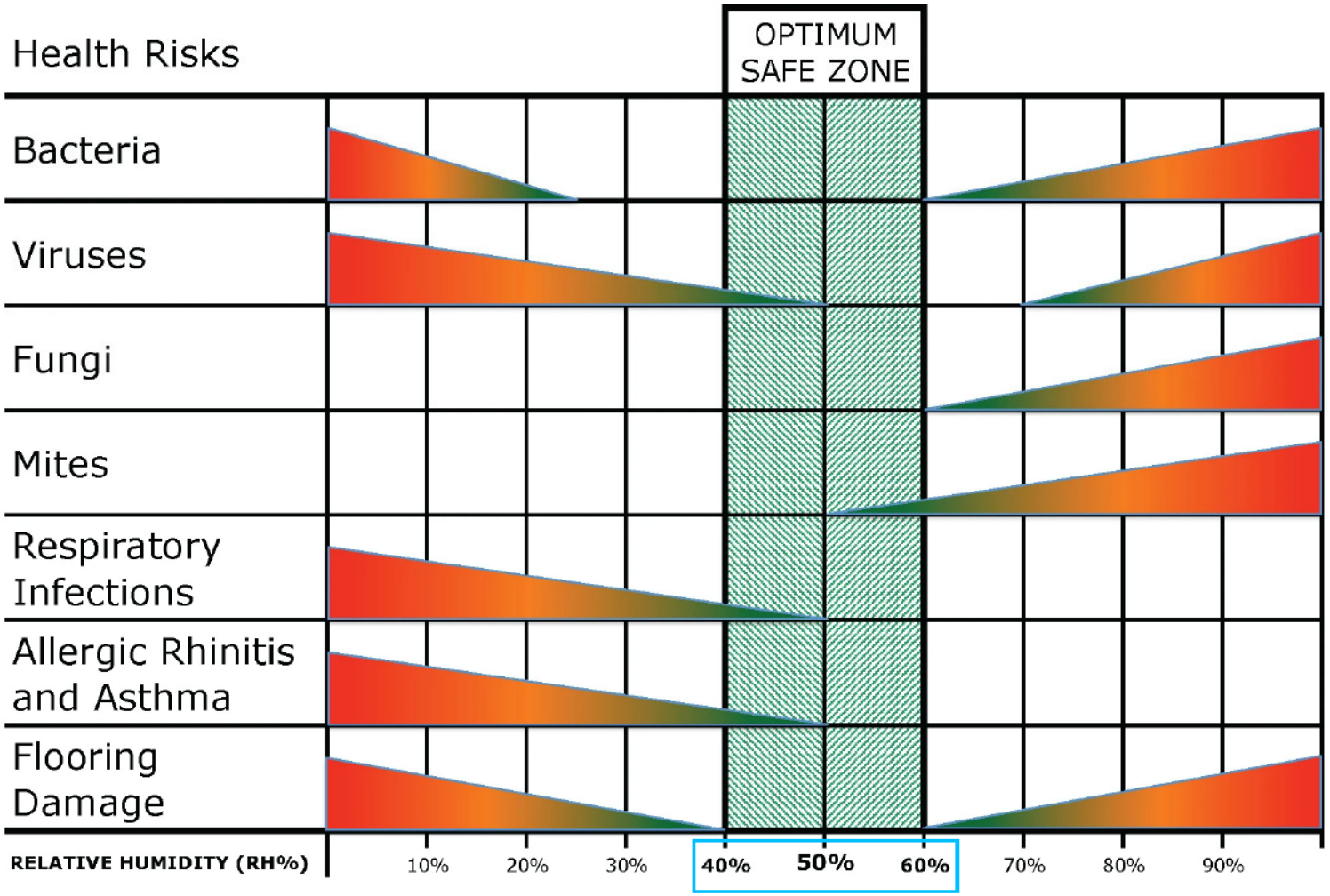
- During unoccupied hours DX pool room dehumidifiers require no outside air (which is usually adding to the sensible load because it is too hot or cold) and may not properly dehumidify the space due to outdoor humidity spikes. Furthermore, whenever dehumidification is required, a properly designed DX pool room dehumidification unit will be providing free sensible cooling or heating whenever it is in dehumidification mode.

- During the winter months in Vegas and Reno the outside air is so dry that even the ASHRAE minimum recommended outside air volume will over dry the pool room. Therefore, the ability to shut off outside air during unoccupied hours will help to mitigate the over drying during occupied hours and provide a healthier and more comfortable space.

- An average 1000 ft^2 size indoor hotel pool will lose approximately 43,000 gallons per year to the atmosphere that could other wise be recovered as condensate from a DX dehumidifier.

- Additional condensate can be recovered from a RecoverAire source capture exhaust system. The constant flow of condensate **will not be stagnant** and can be returned to the pool water filtration system inlet as clean condensate.

OPTIMUM RELATIVE HUMIDITY FOR MINIMISING ADVERSE HEALTH AFFECTS



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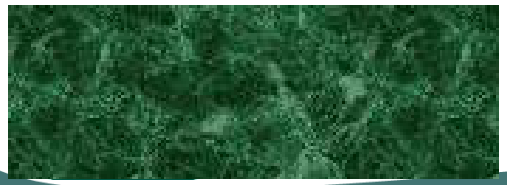
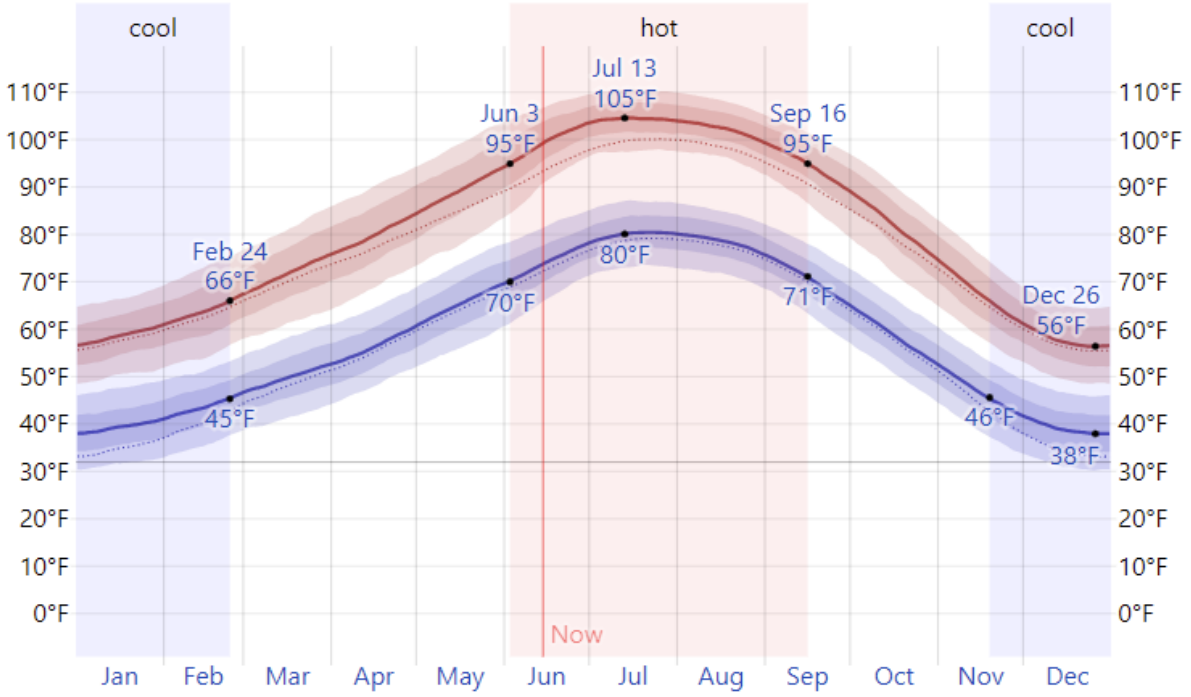


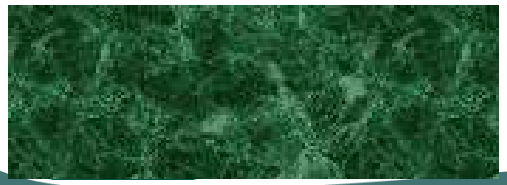
Average High and Low Temperature in Las Vegas

Link Download Compare History: 2022 2021 2020 2019 2018 2017 2016 2015 2014



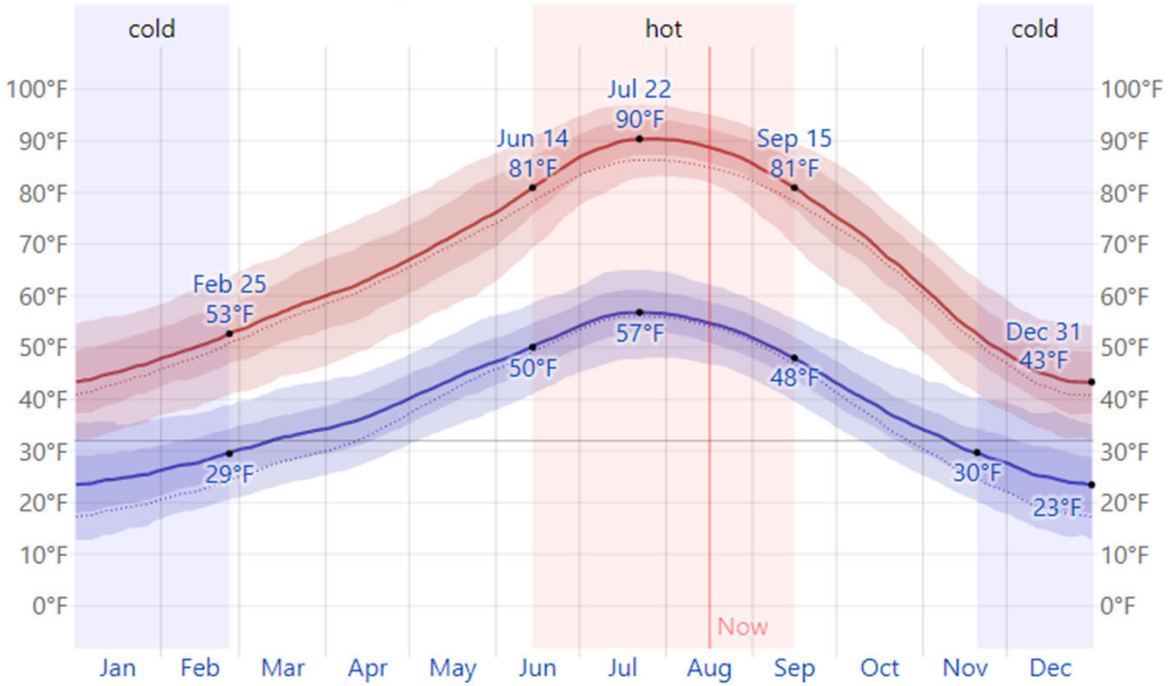
The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.

Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	59°F	64°F	72°F	80°F	90°F	100°F	104°F	102°F	94°F	82°F	67°F	58°F
Temp.	48°F	52°F	60°F	67°F	77°F	87°F	93°F	90°F	82°F	69°F	56°F	47°F
Low	39°F	44°F	50°F	57°F	66°F	74°F	80°F	78°F	70°F	58°F	46°F	39°F



Average High and Low Temperature in Reno

Link Download Compare History: 2022 2021 2020 2019 2018 2017 2016 2015 2014



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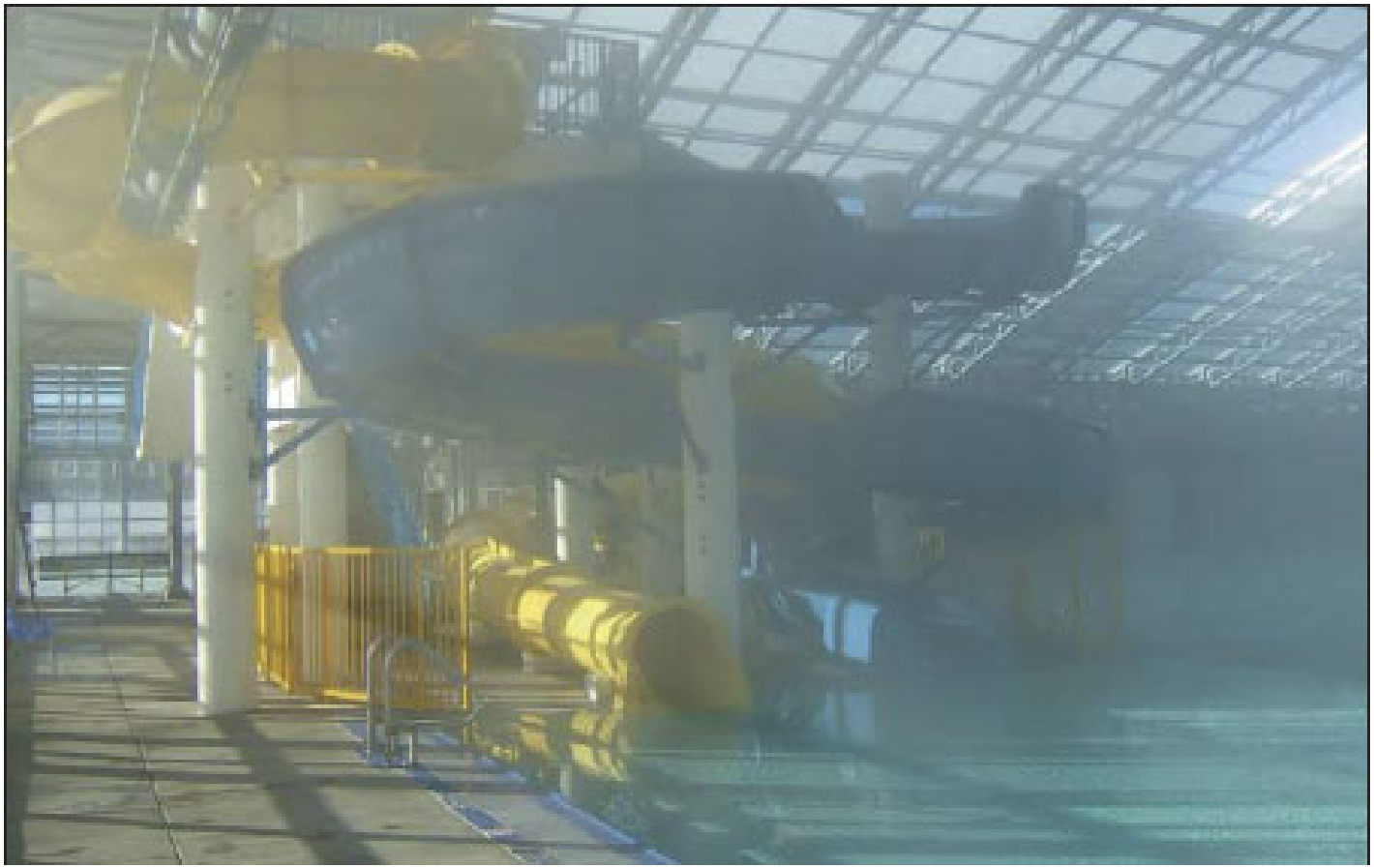
Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	45°F	51°F	57°F	63°F	72°F	82°F	90°F	88°F	80°F	68°F	54°F	45°F
Temp.	33°F	38°F	44°F	49°F	58°F	66°F	74°F	72°F	64°F	52°F	41°F	33°F
Low	25°F	28°F	33°F	37°F	44°F	51°F	56°F	54°F	47°F	38°F	30°F	25°F

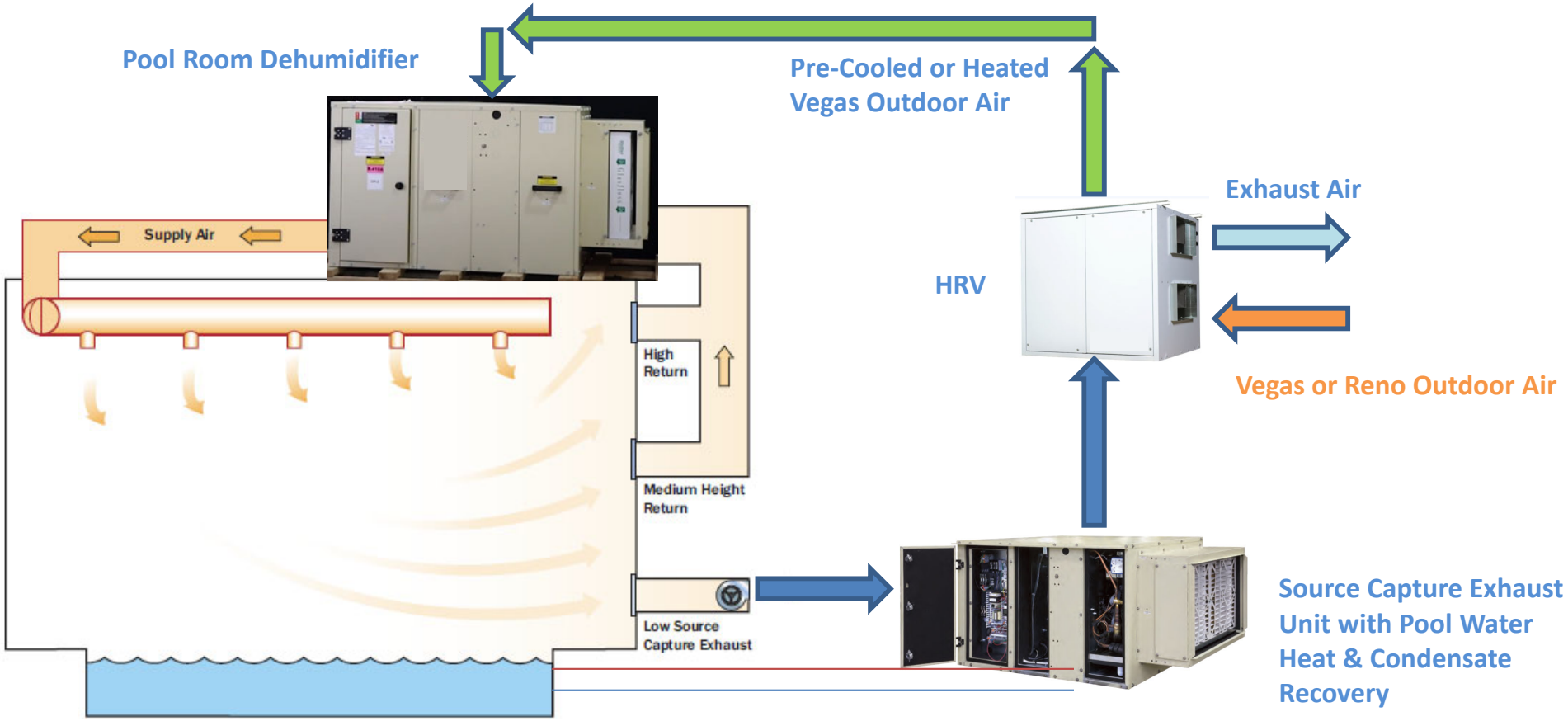
Vegas has a significantly higher dehumidification design day load than Seattle!!

View pdf Sample Pool Load Calculations

Overwhelmed Pool Room Dehumidification Systems Can Fail Within Hours not Days



What would an Optimum Nevada Hotel (Under 15-Tons) Pool Room DX Dehumidification Schematic Design Look Like?



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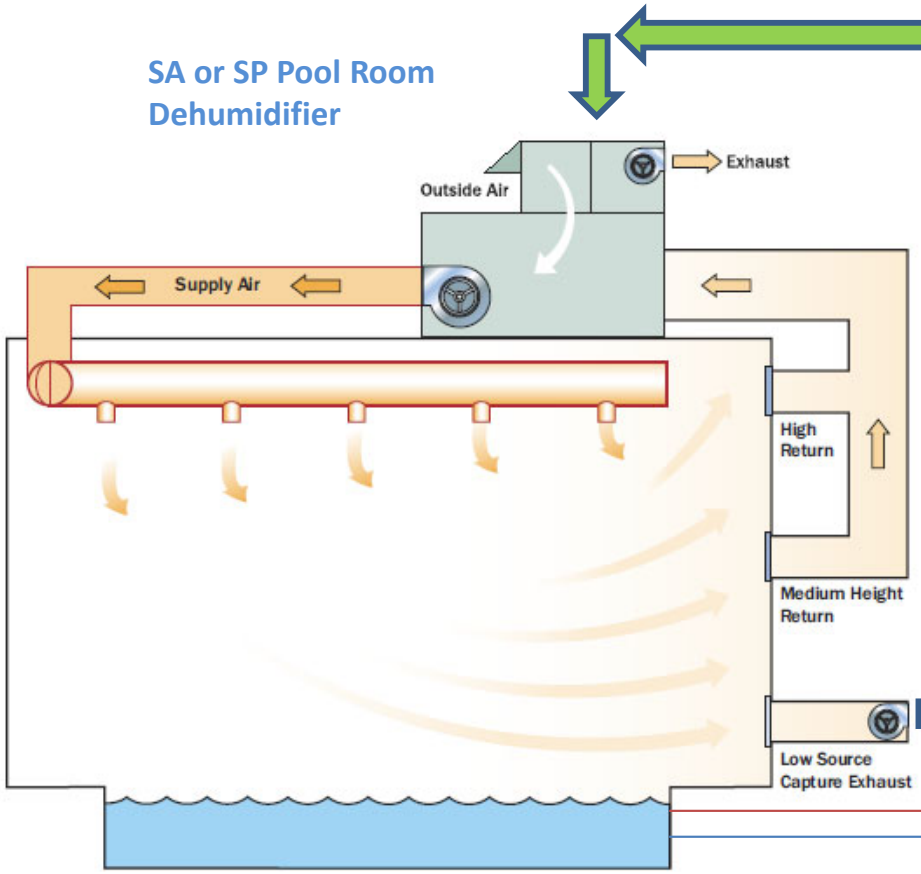


Pre-Cooled or Heated Vegas Outdoor Air

Exhaust Air

HRV

Vegas or Reno Outdoor Air

Source Capture Exhaust Unit with Pool Water Heat & Condensate Recovery

Up to 60-Tons SA Spilt System Refrigeration Circuit

SA Series Airflow & Energy Recovery Schematic:

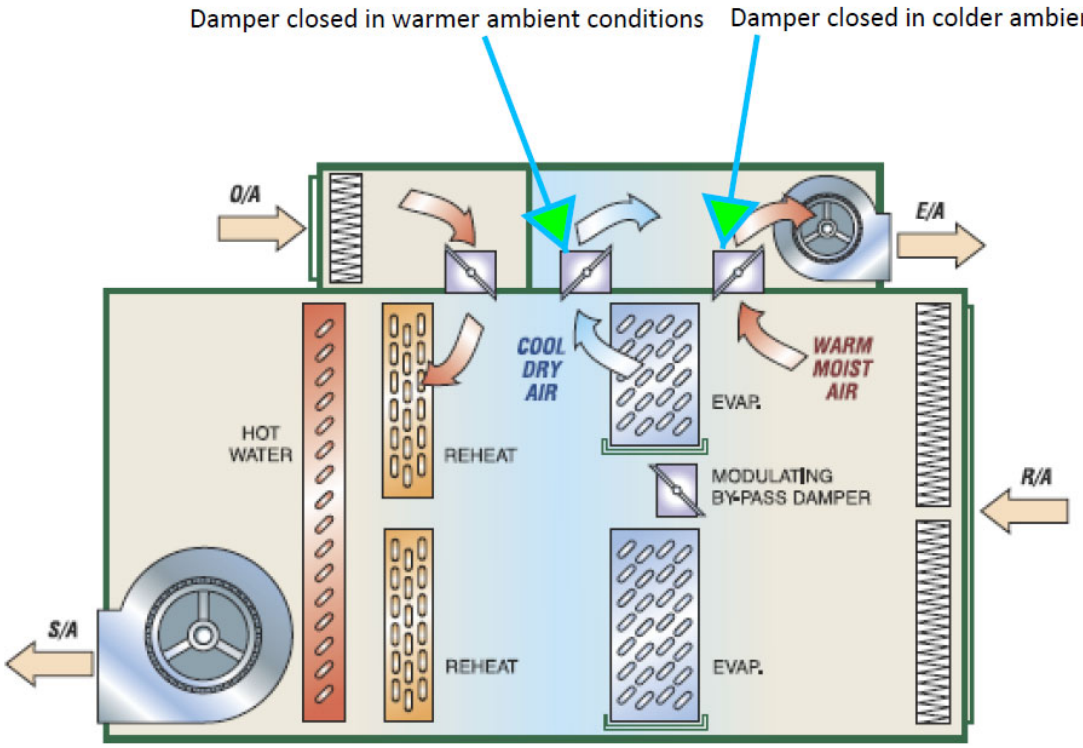


Figure 2 - Schematic for Outdoor Air

Up to 80-Tons SP Packaged System Refrigeration Circuit

SP Series Airflow & Energy Recovery Schematics:

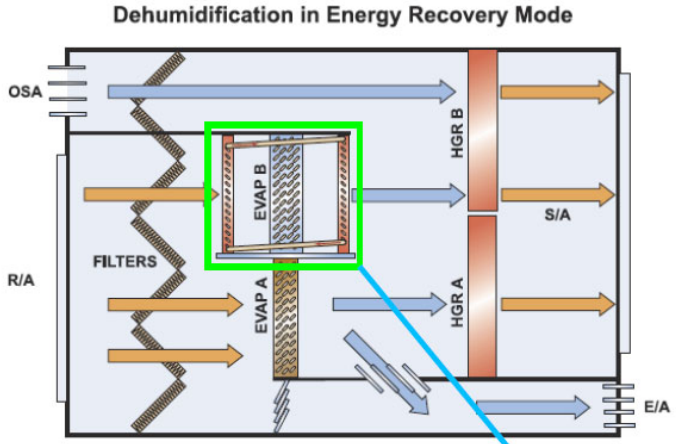


Figure 3 - Dehumidification in **Energy Recovery** Mode

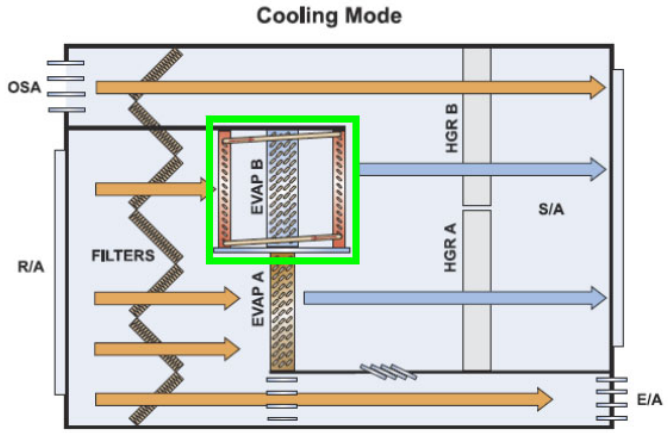


Figure 4 - Dehumidification in **Cooling** Recovery Mode

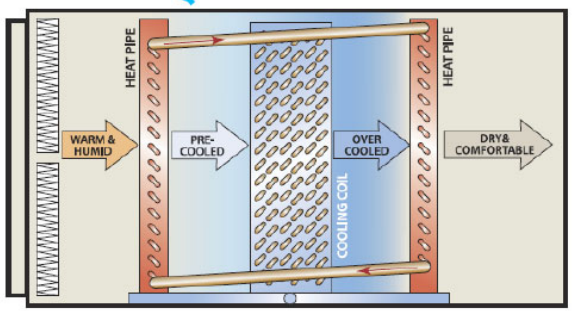
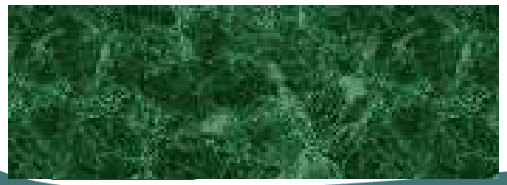
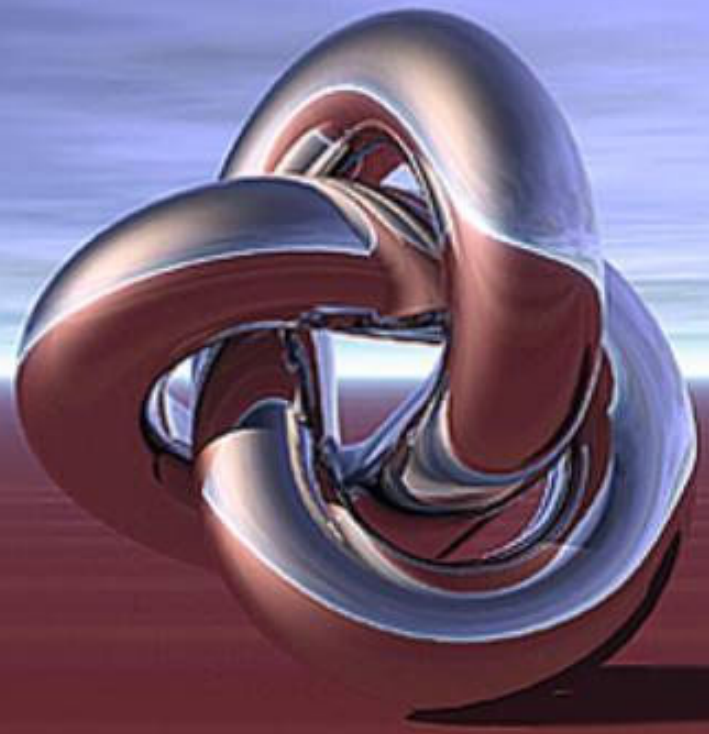


Figure 1 - enhanced latent design with heat pipe assembly



Think About Your Design



Questions?? & Ideas!