

Welcome!

Natatorium Design:

better building and
mechanical system
performance.

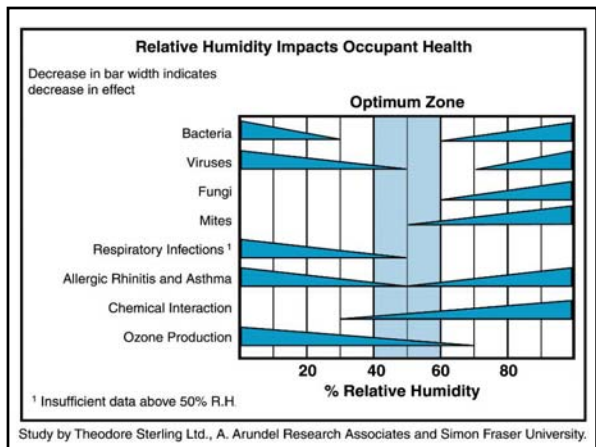
February 15, 2004 Moscow











ENVIRONMENT

BEWARE: TOXIC MOLD

Is the fungus in your floorboards making you sick?
With no clear answers, panic and lawsuits abound

By ANITA HAMILTON

SHARYN ILLER, 52, OF THE WOODLANDS, Texas, an upscale suburb of Houston, couldn't figure out what was wrong. Every time she went into her bathroom to put on makeup, her eyes started burning. She felt constantly exhausted, her vision was blurry and she had a dry cough that just wouldn't quit. Diagnosed with breast cancer in 1998, Iller feared the worst

last February. Inspectors had found a thick black mold growing between the stucco and the drywall of the master bedroom, bath, study and dining room. After some of it was identified as *stachybotrys atra*—a fungus that has been linked to everything from sinus infections to brain damage—an industrial hygienist warned the Illers to evacuate. Thirty minutes later, they abandoned their home forever. "I thought, This can't be happening to me," says Sharyn. "This is my sanctuary. This is where I come



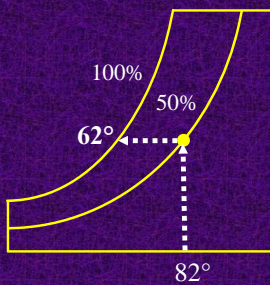
Design Issues

- Moisture Load calculation
- Condensation Control
- Pool Water Chemistry
- Exhaust Air
- Outdoor Air
- Air Distribution
- Duct Design
- Cooling
- Heating
- Energy recovery
- Mechanical dehumidification

Design Criteria #1: Establish the Space Dew Point

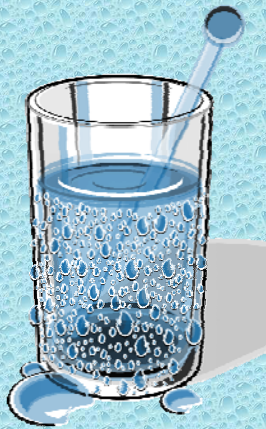
Everything vital to the pool
is based on this value.

Dew Point



82°F 50%RH
= 62 °F DP
70°F 50%RH
= 50 °F DP

Any
surface
below
62°F will
condense
moisture




Why does water evaporate?
Space dew point has a Vapor pressure

Water surface has a Vapor pressure

Why does water evaporate?
At 50% RH: $P_w \sim 2 P_{dp}$

(P_{dp}) Vapor pressure of dew point



(P_w) Vapor pressure at water surface



Evaporation Rate

$$Lb/h = 0.1 \times A \times \Delta P \times AF$$

- A: Water Area; ft²
- ΔP: Δ Vapor pressure; inches Hg
- AF: Activity Factor (0.5 = Baseline)

Evaporation Rate

$$Lb/h = 0.1 \times A \times \Delta P \times AF$$

Typical calculation has 2 scenarios:

- AF = 0.5 and space @ 50% (night)
- AF = 1.0 and space @ 60% (active)

Typical Design Conditions

Pool Type	Air Temperature
Competition	78 to 85 °F
Diving	80 to 85 °F
Elderly Swimmers	84 to 90 °F
Hotel	82 to 85 °F
Physical Therapy	80 to 85 °F
Recreational	82 to 85 °F
Whirlpool/spa	80 to 85 °F

Typical Design Conditions

Pool Type	Water Temperature	Activity Factor
Competition	76 to 82 °F	0.65
Diving	84 to 88 °F	0.65
Elderly Swimmers	85 to 90 °F	0.8
Hotel	82 to 86 °F	0.8 – 1.0
Physical Therapy	90 to 95 °F	0.65
Recreational	80 to 85 °F	1.0
Whirlpool/spa	102 to 104 °F	1.0

Knowing the activity level in advance is important







Similar to a pool ?

Heat

Olympic Pool Example

Water Area : 165 ft x 70 ft, 11550 ft ²	
Water Temperature	77° F
Air Temp and RH	79° F - 50%
Dew Point	58° F
Activity Factor	1.0
Evaporation Rate	490 lb/h
Heat Loss due to evaporation	510,000 btu/h

Olympic Pool Example

Water Area : 165 ft x 70 ft, 11550 ft ²		
Water Temperature	77° F	77° F
Air Temp and RH	79° F - 50%	82° F - 50%
Dew Point	58° F	62° F
Activity Factor	1.0	1.0
Evaporation Rate	490 lb/h	425 lb/h
Heat Loss due to evaporation	510,000 btu/h	450,000 btu/h

Energy Consideration:

Higher Air Temperatures

Reduce evaporation

Rule of Thumb:

Air 2°F warmer than water

Condensation Control

1) Indoor surface temperature control

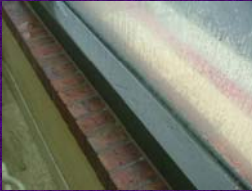
Remember: 62 °F DP



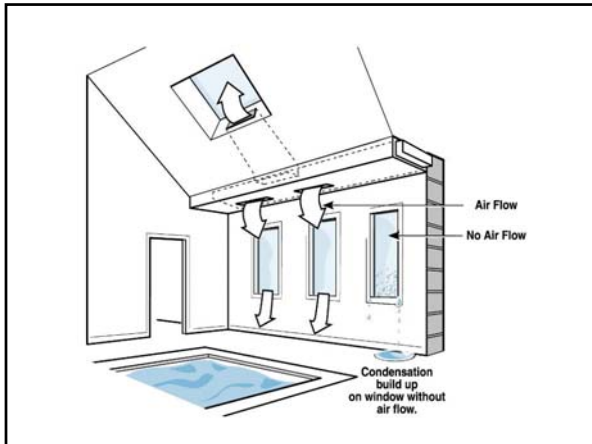


**Expensive Windows.....
aren't the answer.**

- 85°F Space
- -10°F Outdoors
- A TRIPLE pane window has a 57 °F inner surface temperature.
- A double pane window has a 45 °F inner surface temperature.



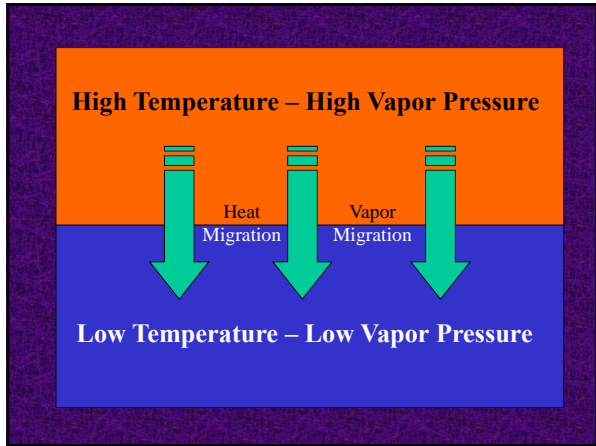
Room dew point = 62 °F

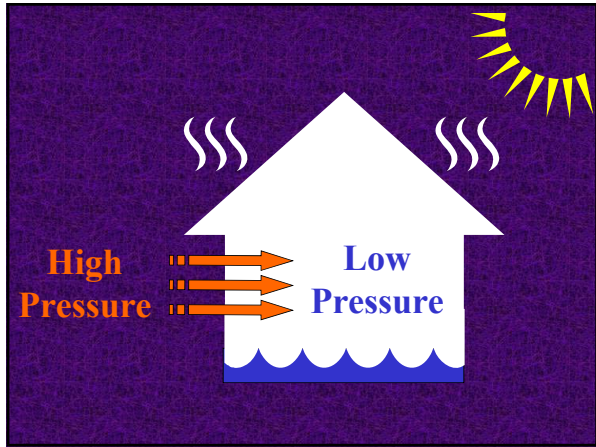


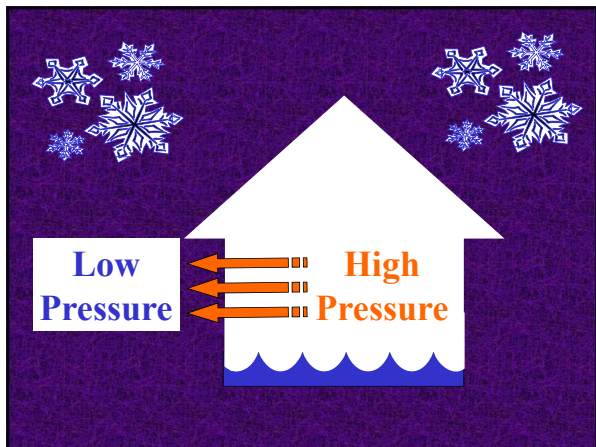


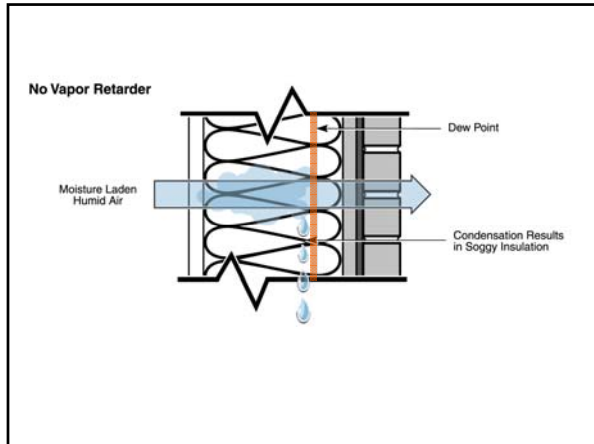
Condensation Control

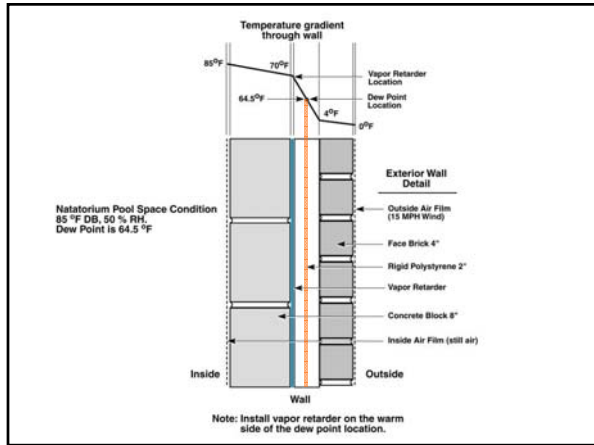
- 1) Inside surface temperature control
- 2) Moisture migration prevention

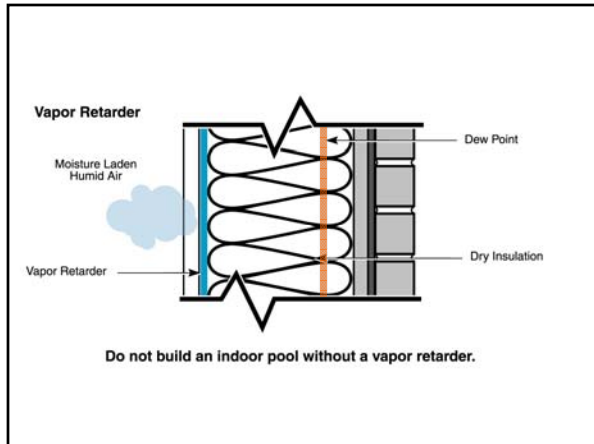






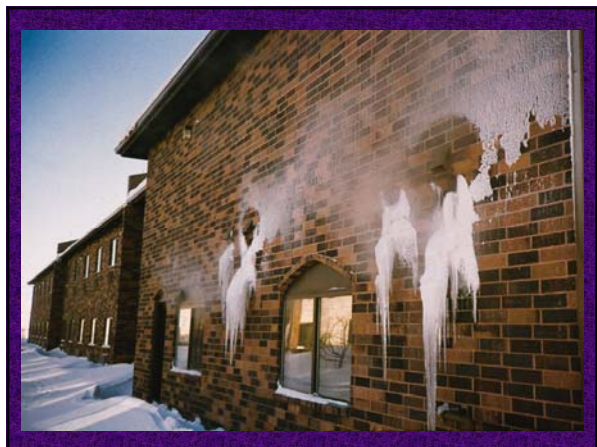












Areas of Condensation Control

- Room dew point temperature control
 - Inside surface temperature control
 - Prevention of moisture migration through building materials
- ?
 - ?
 - ?

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 - Duct layout

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- Room dew point temperature control
- Inside surface temperature control
- Prevention of moisture migration through building materials
- Mechanical Dehumidifier
- Duct layout
- Building Design

Pool water quality is the single biggest IAQ problem and it impacts the mechanical systems

Cause

Effect

- | | |
|--|----------------------------------|
| • Under Chlorination | • Combined Chlorines (foul odor) |
| • High pH level or high total alkalinity | • Scale forming |
| • Low pH level or low total alkalinity | • Corrosion |

Addressing the IAQ problem:

- ✓ Outdoor Air
- ✓ Exhaust Air

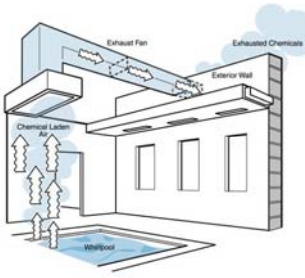
Outdoor Air



Per Standard 62-2004:
- 0.48 CFM per ft² of pool and (wet) deck area or
- 7.5 CFM per spectator
Add Spectator OA CFM to baseline.

Water parks: Double the OA!

Exhaust Air



Per Chapter 4 Applications:
0.05 to 0.15" WC negative pressure.

Rule of thumb: 110% of OA

The Art of Air Distribution

Air changes per ASHRAE

- 4 – 6 per hour in a natatorium
- 6 – 8 per hour in a spectator area
- 8 per hour (occupied) in a water park

Specify CFM needed to satisfy this requirement.

The Art of Air Distribution

Supply and Return location.

- Supply air to where condensation is predictable
 - Exterior windows
 - Exterior doors
 - Thermal bridging?

The Art of Air Distribution

Supply and Return location.

- Return location must complement supply duct layout.

Watch for short circuiting!

This can effectively cut off 50-75% of the room from supply air.

The Art of Air Distribution

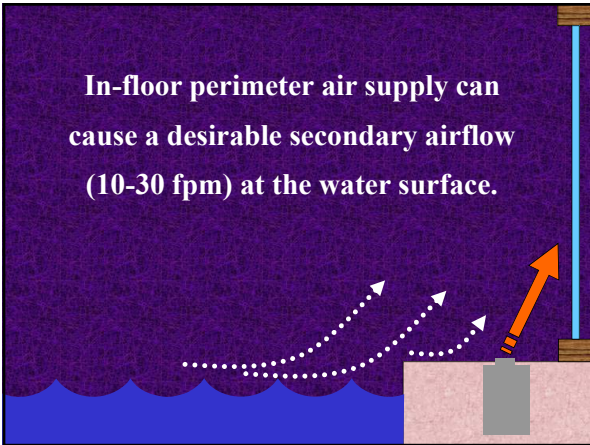
Air movement deck and water surface.

Stagnant air is an IAQ problem.

The USOC wants some air movement at the water level where the swimmers breathe.



In-floor perimeter air supply can cause a desirable secondary airflow (10-30 fpm) at the water surface.



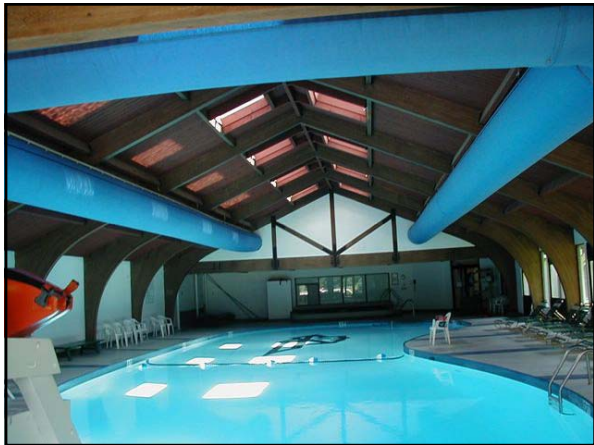


The Art of Duct Design

Duct Materials

- Galvanized – Aluminum – Fabric
- Avoid Stainless Steel!

Ensure proper throw and direction from all diffusers





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Heating and Cooling

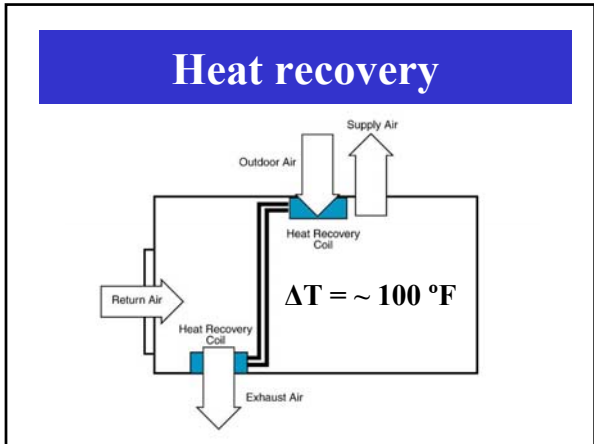
The space is generally
10-15°F warmer
than a traditional room.

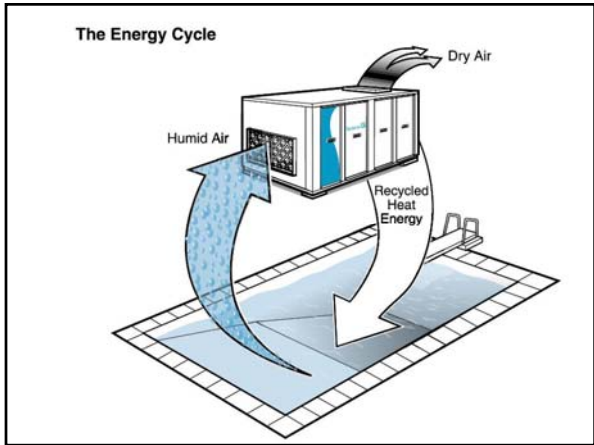
Heating and Cooling

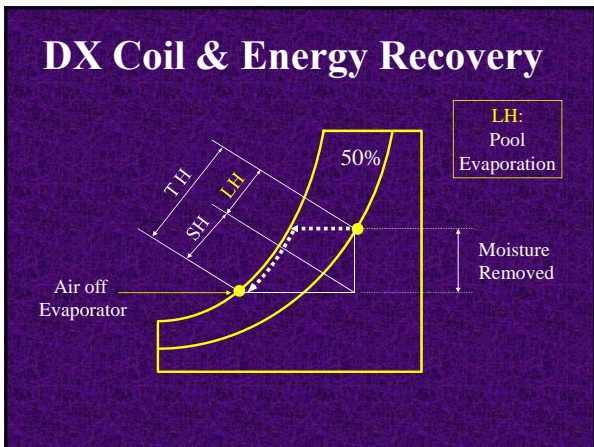
More btu/ft² heating

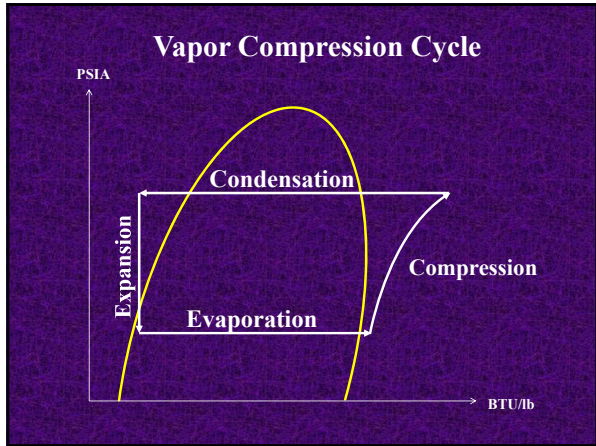
Less btu/ft² cooling

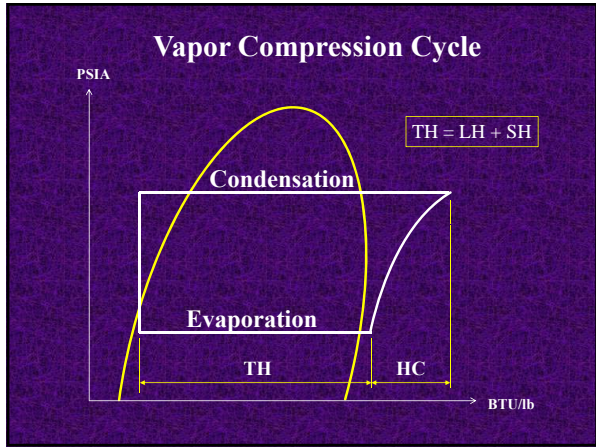
Don't forget Outdoor air in your load calculation. (~50% of heating load!)

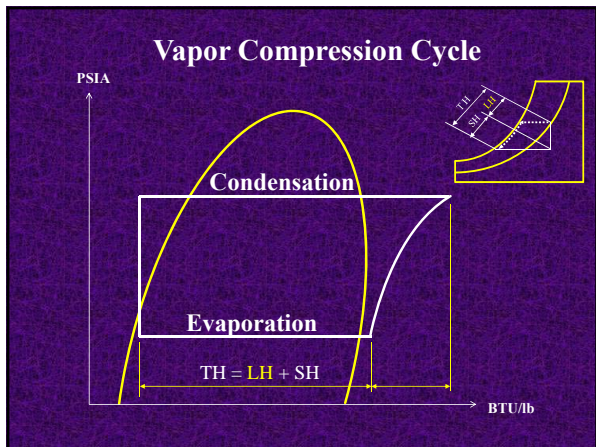


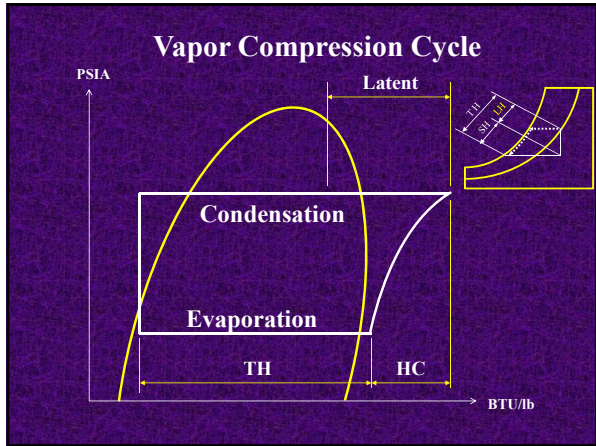


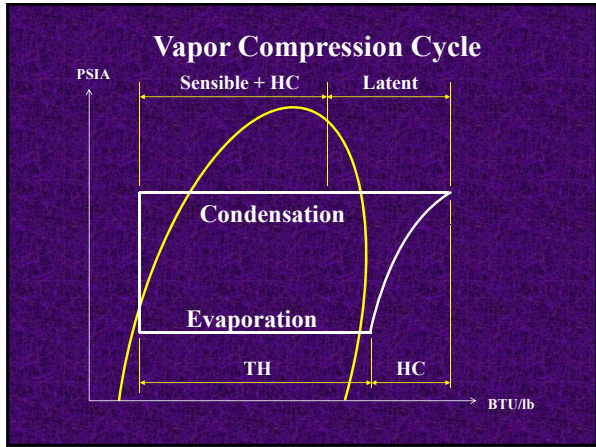


























Mechanical Room as Return Air Plenum



Locker Room as Return Air Plenum



Perhaps a good idea not to have things above the pool that need service....



..... stick with approved electrical devices.....



Thank You!
