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# *Dehumidification: Energy Efficiency Comparisons*

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# *Why Optimize Dehumidification?*

- Over-dehumidification results in high energy costs.
- Optimal humidity control strikes the best balance between humidity and energy costs.
- Advanced control strategies provide active dehumidification without expensive reheat.

# The Mold-Energy-HVAC Link

**The most energy-efficient humidity control strategies cost 30-60% less to operate than reheat.** ***Reheat is the most common and the least energy efficient method.***

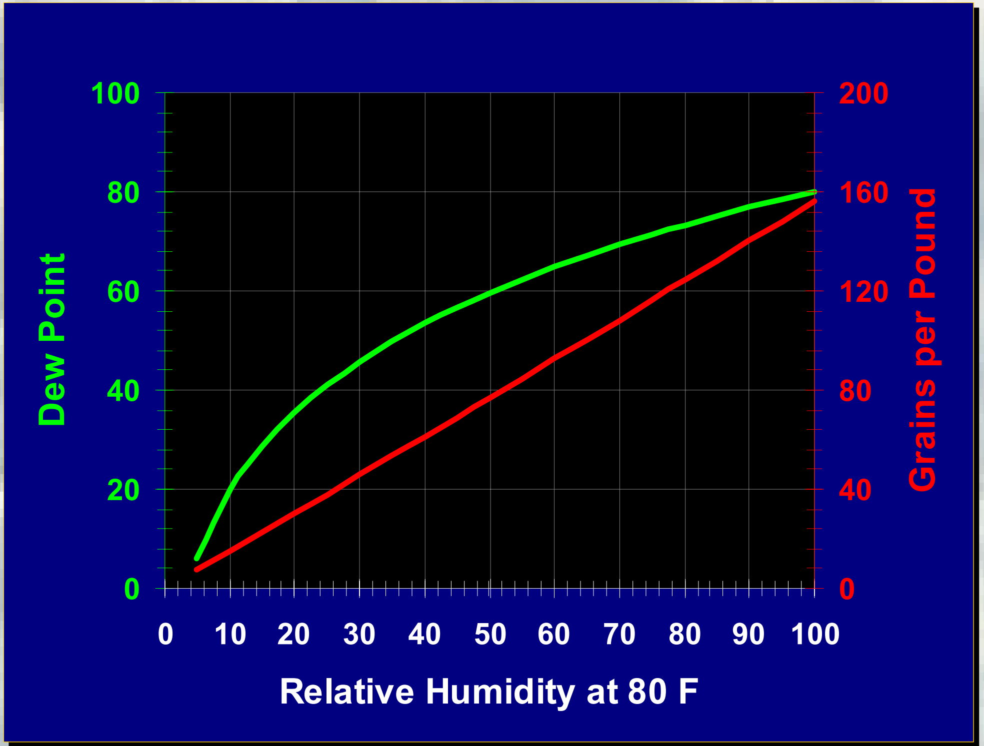
- Excess humidity and deteriorated equipment leads to microbial contamination.
- Mold causes most IAQ problems in hot & humid climates such as the US Southeast and Caribbean
- Some HVAC systems control humidity at a lower cost than others

# Humidity Terms

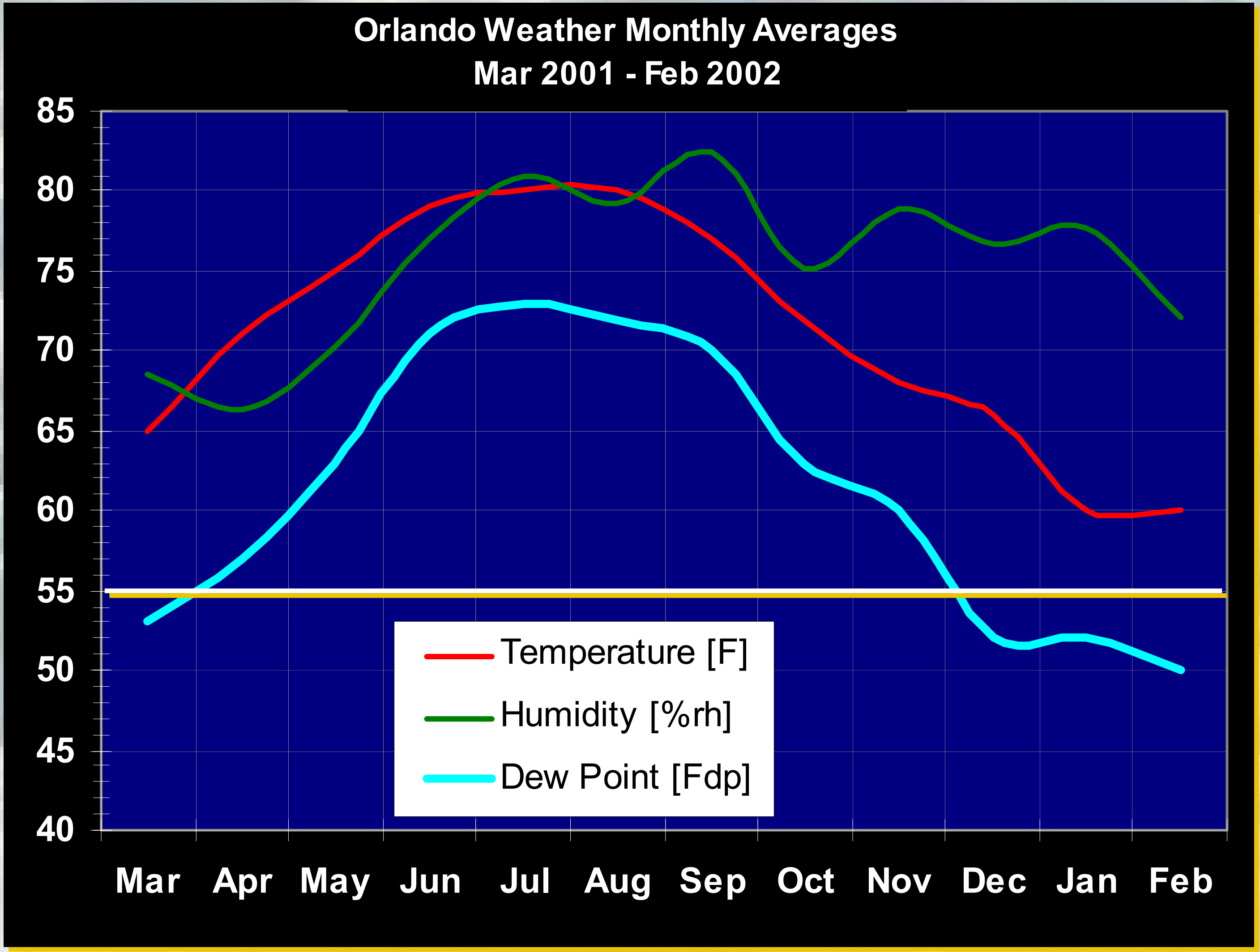
- Relative Humidity
  - amount of moisture in air compared with the maximum amount air will hold
  - warmer air can hold more moisture
- Absolute Humidity
  - amount of moisture in air by mass
  - uses “grains” by convention = 1/7000 lb
  - units are *grains of water per pound of air*
- Dew Point
  - the temperature at condensation

# Dew Point

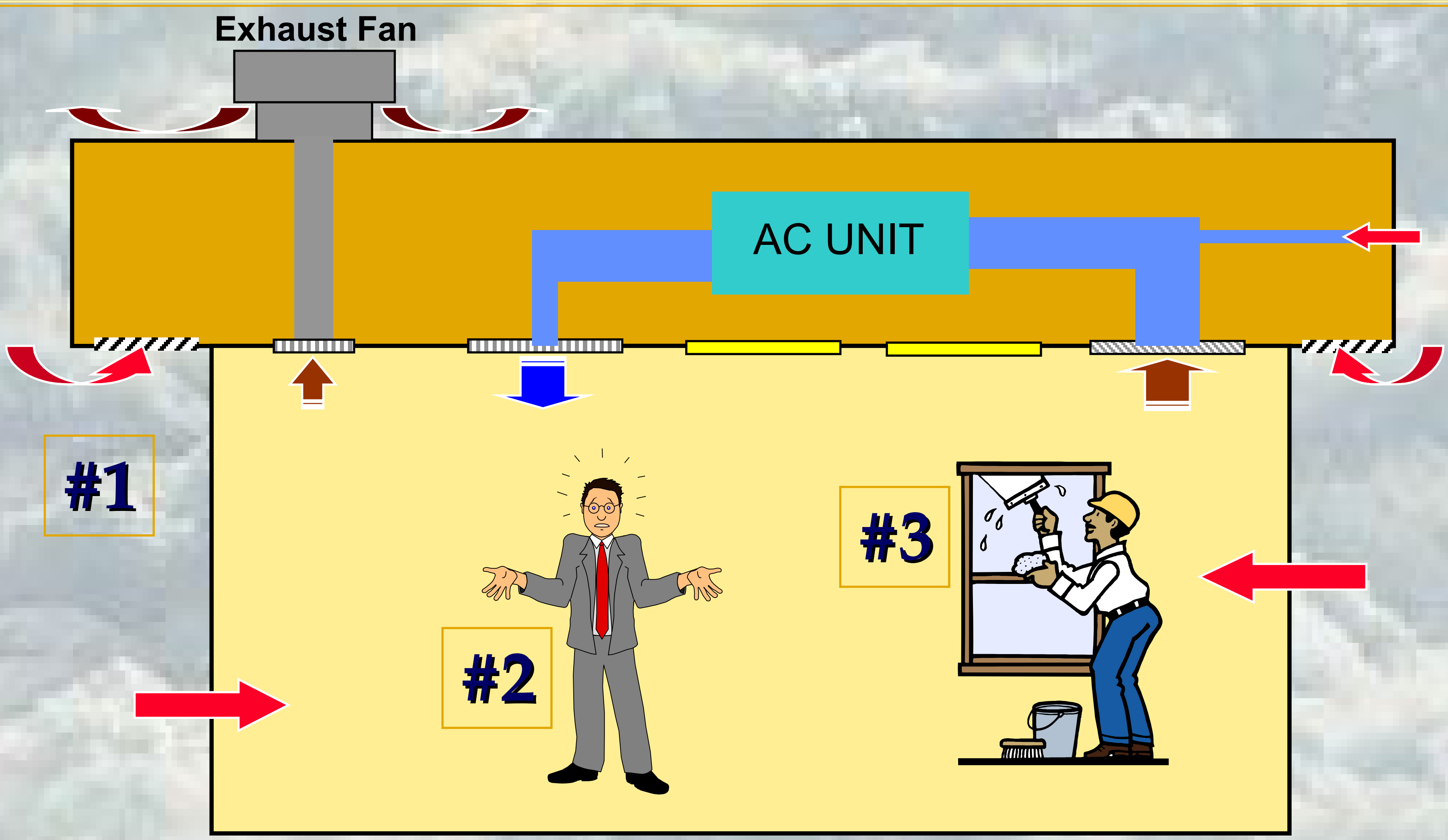

PEPSI


Dew Point
0
20
40
60
80
100
Grains per Pound
0
40
80
120
160
200
0
10
20
30
40
50
60
70
80
90
100
Relative Humidity at 80 F

# *Annual Weather Profile*



# Sources of Humidity



# *Sources of Humidity*

- #3 - Activities
  - washing
  - process equipment
- #2 - Occupants
  - depends on number and metabolic level
- #1 - Outdoor Air
  - depends on outdoor weather conditions and net airflow into building

# #3 Activities

- Washing

example: Floor washed once each day[1]

given: 10,000 square feet of tile floor

1 gallon per 1000 square feet

humidity: 10 gallons

10 gallons = 83 pounds of water per day

83 pounds → 7,400 Btuh = <u>0.6 tons</u>

[1] retail store open 12 hours per day

# #2 Occupants

- Respiration and perspiration

given: 50,000 square foot area

100 occupants at 3.6 ounces per hour[2]

humidity: 2.8 gallons per hour

2.8 gallons = 24 pounds of water per hour

24 pounds → 25,000 Btuh = <u>2.1 tons</u>

[2] range is 1.5 for seated to 12.5 ounces per hour for very active

# #1 Outside Air

- Depends on outdoor weather conditions and airflow into building

Warm Spring Day: 80 F and 50% rh

Dewpoint = 60 → 77 grains per pound

Typical Summer Day: 88 F and 60% rh

Dewpoint = 72 → 120 grains per pound

Humid Late Summer Day: 92 F and 65% rh

Dewpoint = 78 → 149 grains per pound

# #1 Outside Air

- Net airflow into building

given: 20 cfm per person according to code

100 occupants → 2,000 cfm fresh air

given: leaky, depressurized building

0.7 air changes per hour

50,000 square feet  and 14-foot roof

700,000 cubic feet → 8,200 cfm outdoor air

# #1 Outside Air

- Minimum 20 cfm per person (latent only)

Warm Spring Day

2.2 gallons per hour → 19,400 Btuh = <u>1.6 tons</u>

Typical Summer Day

9 gallons per hour → 79,700 Btuh = <u>6.6 tons</u>

Humid Late Summer Day

13 gallons per hour → 119,000 Btuh = <u>9.9 tons</u>

Indoor temperature 74 F and 50% rh

# #1 Outside Air

- Leaky, depressurized building

Warm Spring Day

9 gallons per hour → 79,600 Btuh = 6.6 tons

Typical Summer Day

37 gallons per hour → 327,000 Btuh = 27 tons

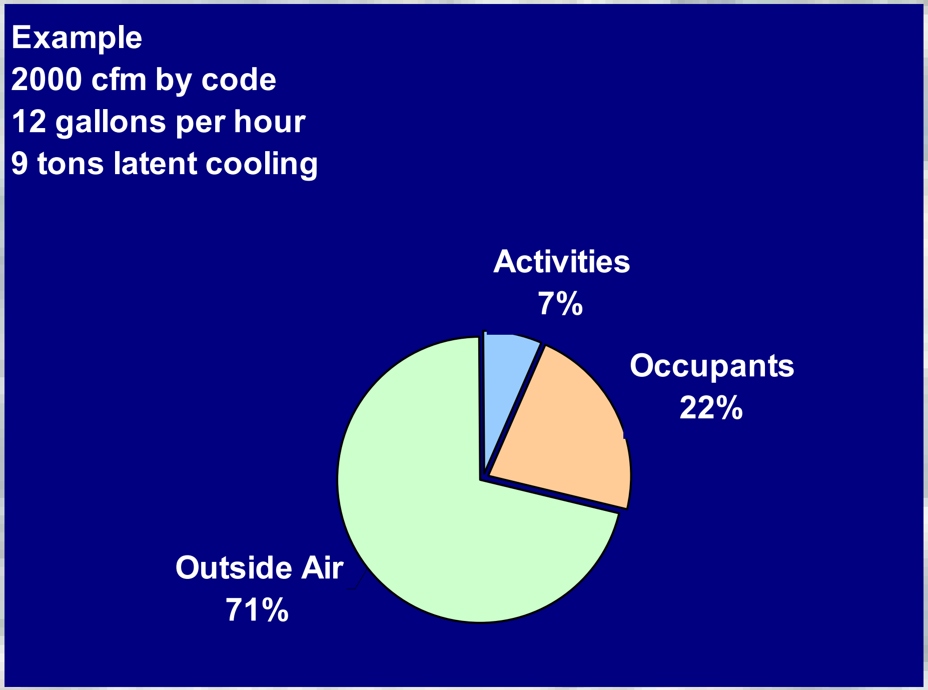
Humid Late Summer Day

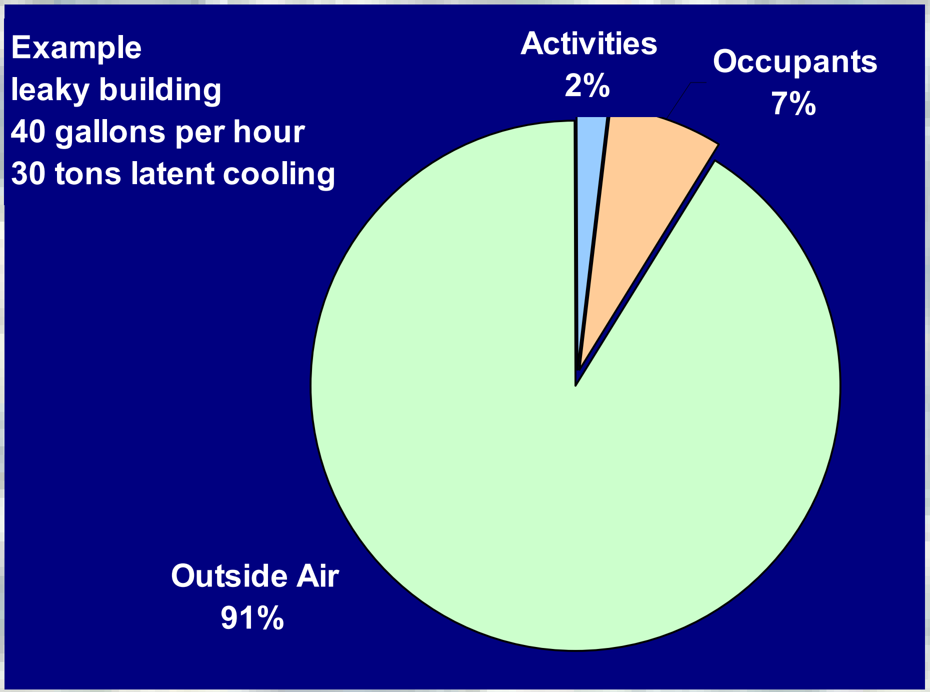
55 gallons per hour → 488,000 Btuh = 40 tons

Indoor temperature 74 F and 50% rh

# Sources of Humidity

- Typical summer day 88F 60%rh



# Compare with Total AC Load

- What portion of the total air conditioning load is the latent load?

given: 50,000 square foot area

average load of 60 tons[3]

2,000 cfm outdoor air → 15% of load

8,200 cfm outdoor air → 50% of load

[3] 800 square feet per ton is a rough estimated load average over a day

# Compare with Sensible Load

- *Sensible Heat Ratio (SHR)* is the percentage of the total load that is sensible load.

2,000 cfm outdoor air → 15% of load

85% is sensible so <u>SHR = 0.85</u>

8,200 cfm outdoor air → 50% of load

50% is sensible so <u>SHR = 0.50</u>

[3] SHR = Sensible tons / Total Tons

# *Importance of "SHR"*

- SHR is a direct indicator of what the humidity will be inside a building
- The SHR capacity of the air conditioning equipment MUST match the SHR of the building load
- If the SHR of the equipment is too high, humidity will be excessive
- If the SHR is too low, energy is wasted

# Equipment Comparison

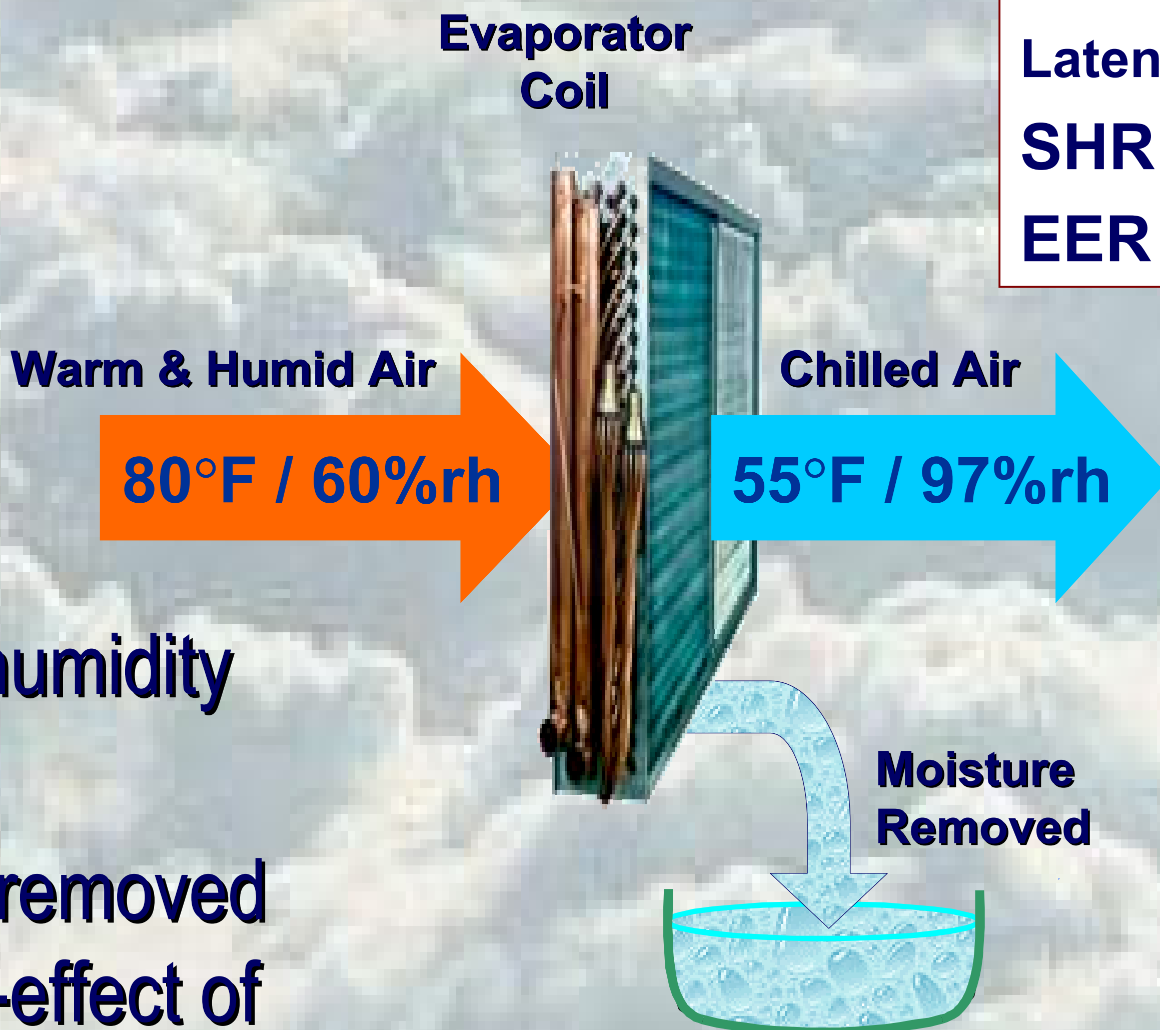
- Standard Rooftop Units
  - Electric reheat
  - Optimized airflow and control
  - Dehumidifier heatpipe coil
- Upgraded Package Units
  - *Lennox* "Humiditrol"
  - *Carrier* "Moisture Miser"
- Cutting-edge technologies

# *Reheat versus Optimal Control*

- REHEAT
  - Electric Reheat
  - Hot-gas Reheat (*Humiditrol*™)
  - Subcool Reheat (*Moisture Miser*™)
- OPTIMAL CONTROL (all are patented)
  - Subcool-Bypass (*Comfort Stat*™)
  - Controllable Heatpipes
  - Crossflow Moisture Exchange

# *Standard*

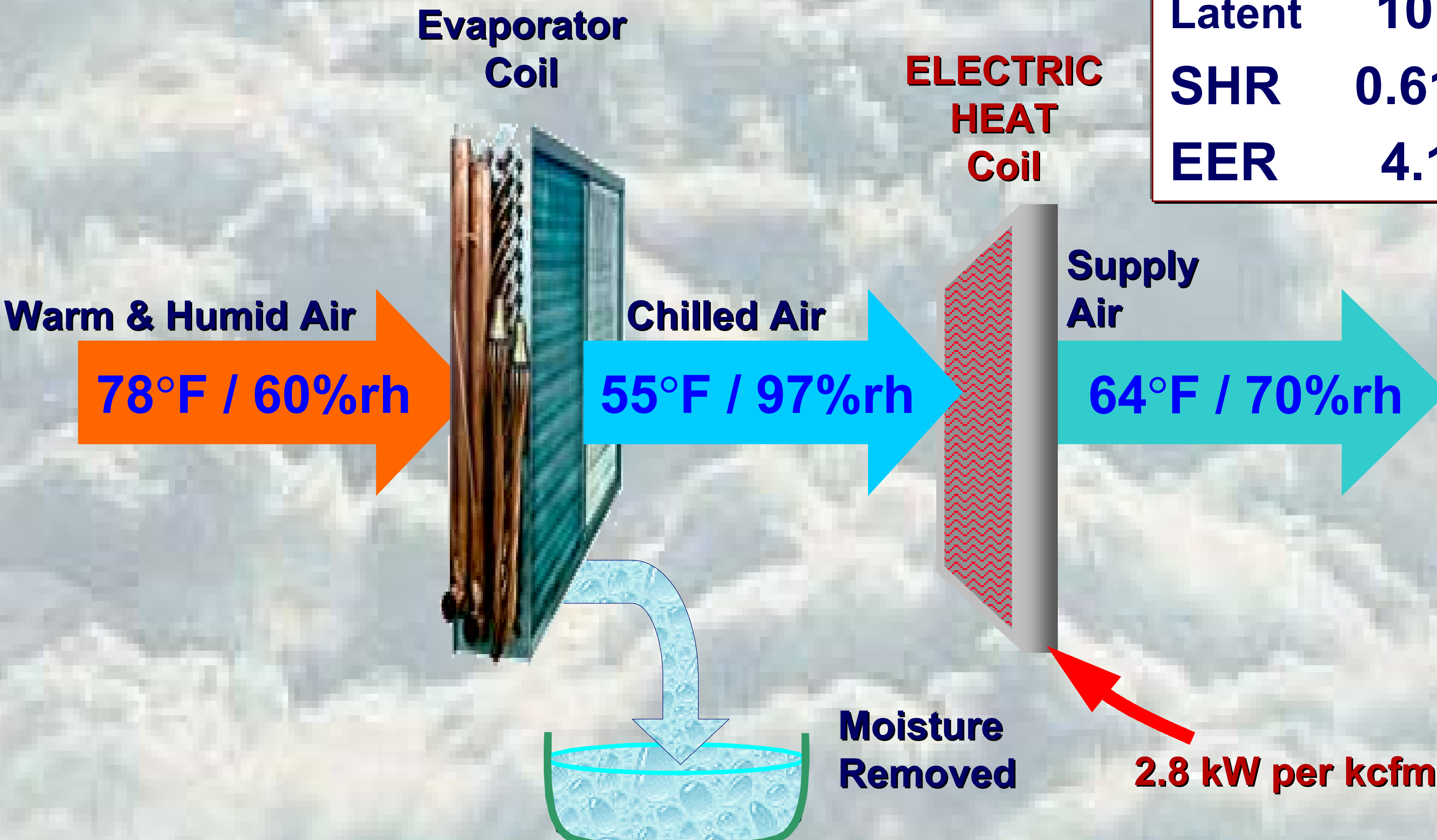
| REPORT CARD | |
|---|---|
| Capacity | 35MBH/kcfm |
| Latent | 10 |
| SHR | 0.71 |
| EER | 10.0 |



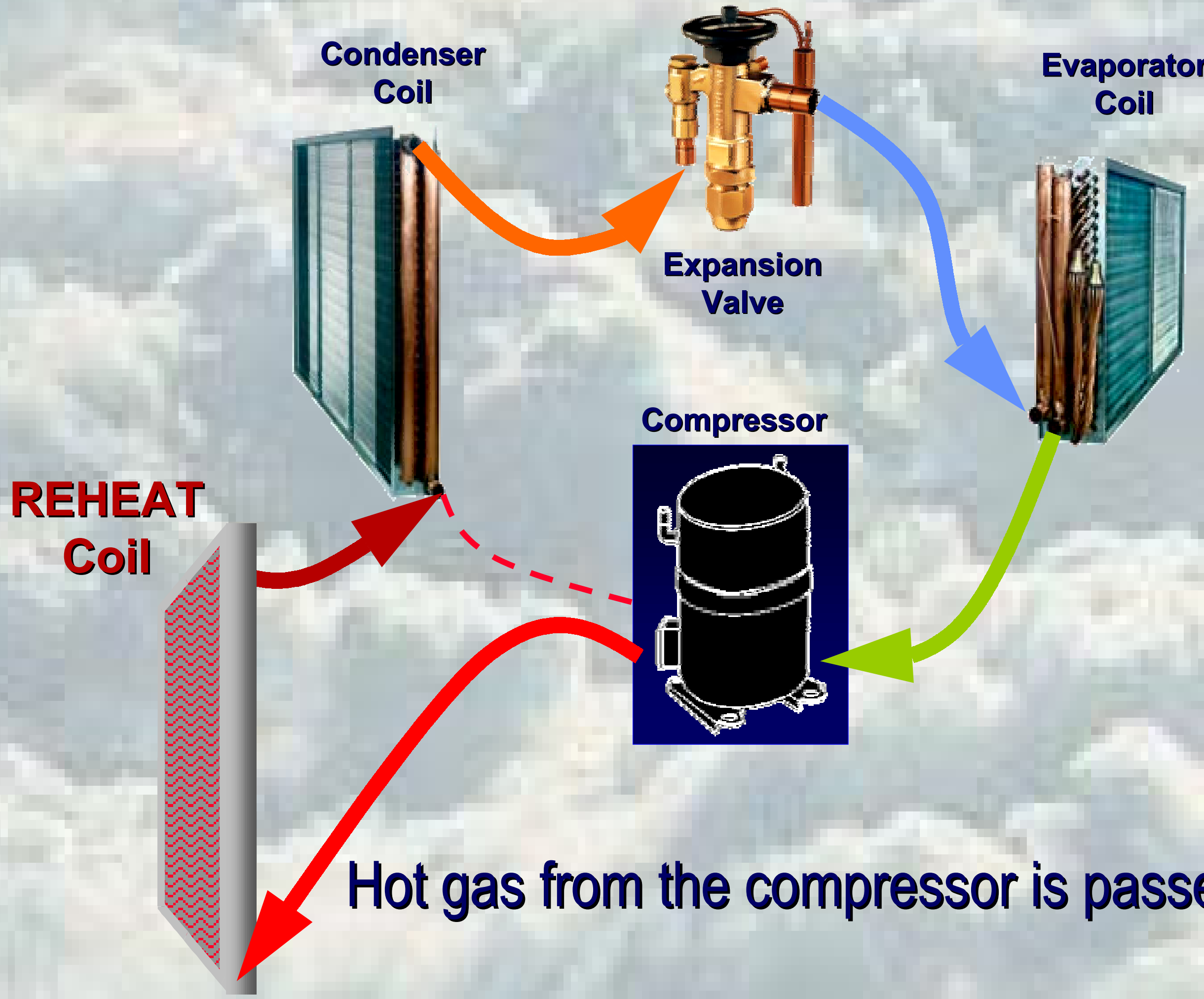

- Passive humidity control
- Moisture removed as a side-effect of cooling

# *REHEAT: Electric*

| | |
|---|---|
| Capacity | 26 |
| Latent | 10 |
| SHR | 0.61 |
| EER | 4.1 |



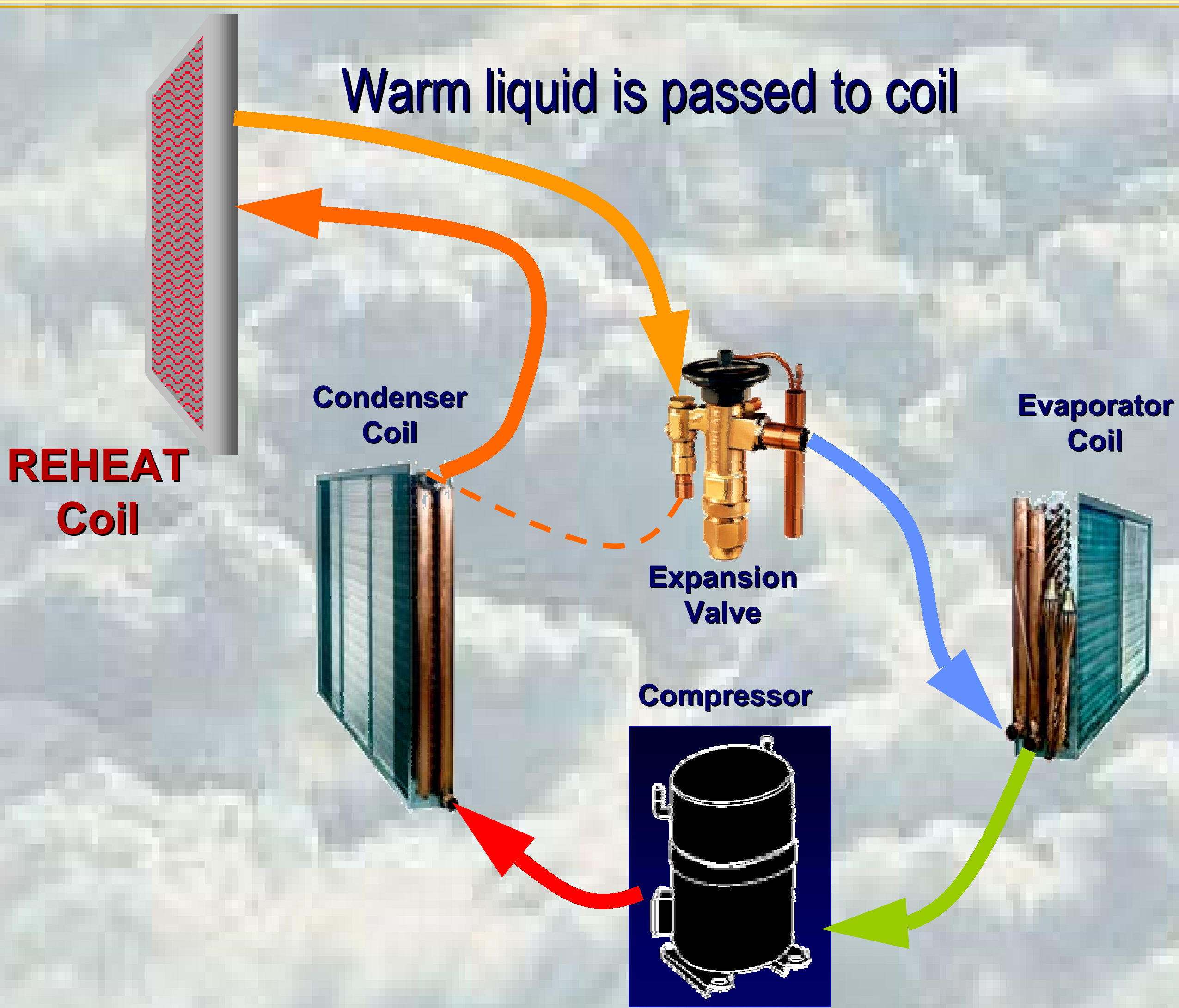
# *REHEAT: Hot-gas (Humiditrol)*




| | |
|---|---|
| Capacity | 23 |
| Latent | 13 |
| SHR | 0.42 |
| EER | 6.6 |

Hot gas from the compressor is passed to a reheat coil

# *REHEAT: Subcool (Moisture Miser)*




| | |
|---|---|
| Capacity | 29 |
| Latent | 14 |
| SHR | 0.52 |
| EER | 8.2 |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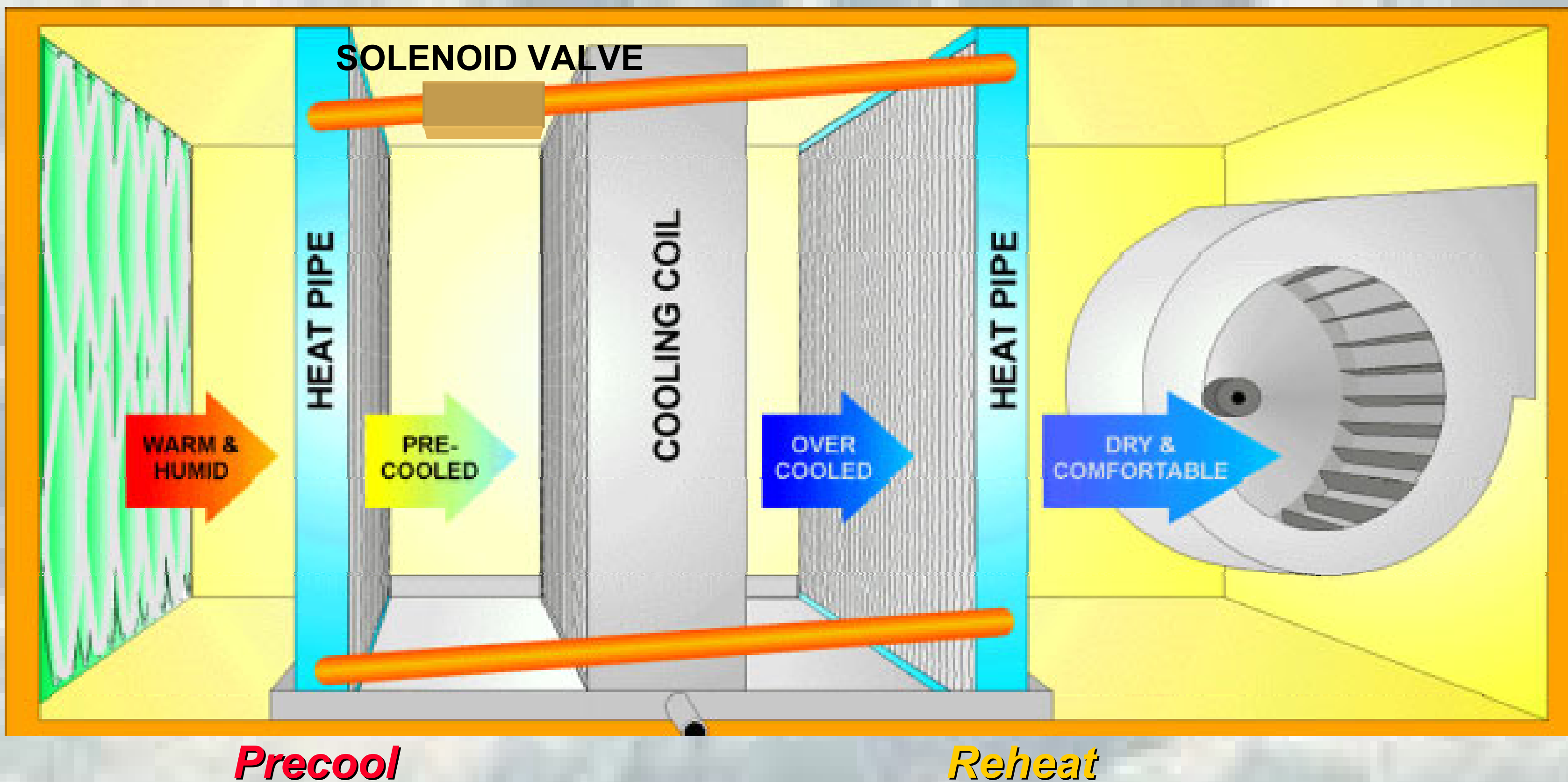
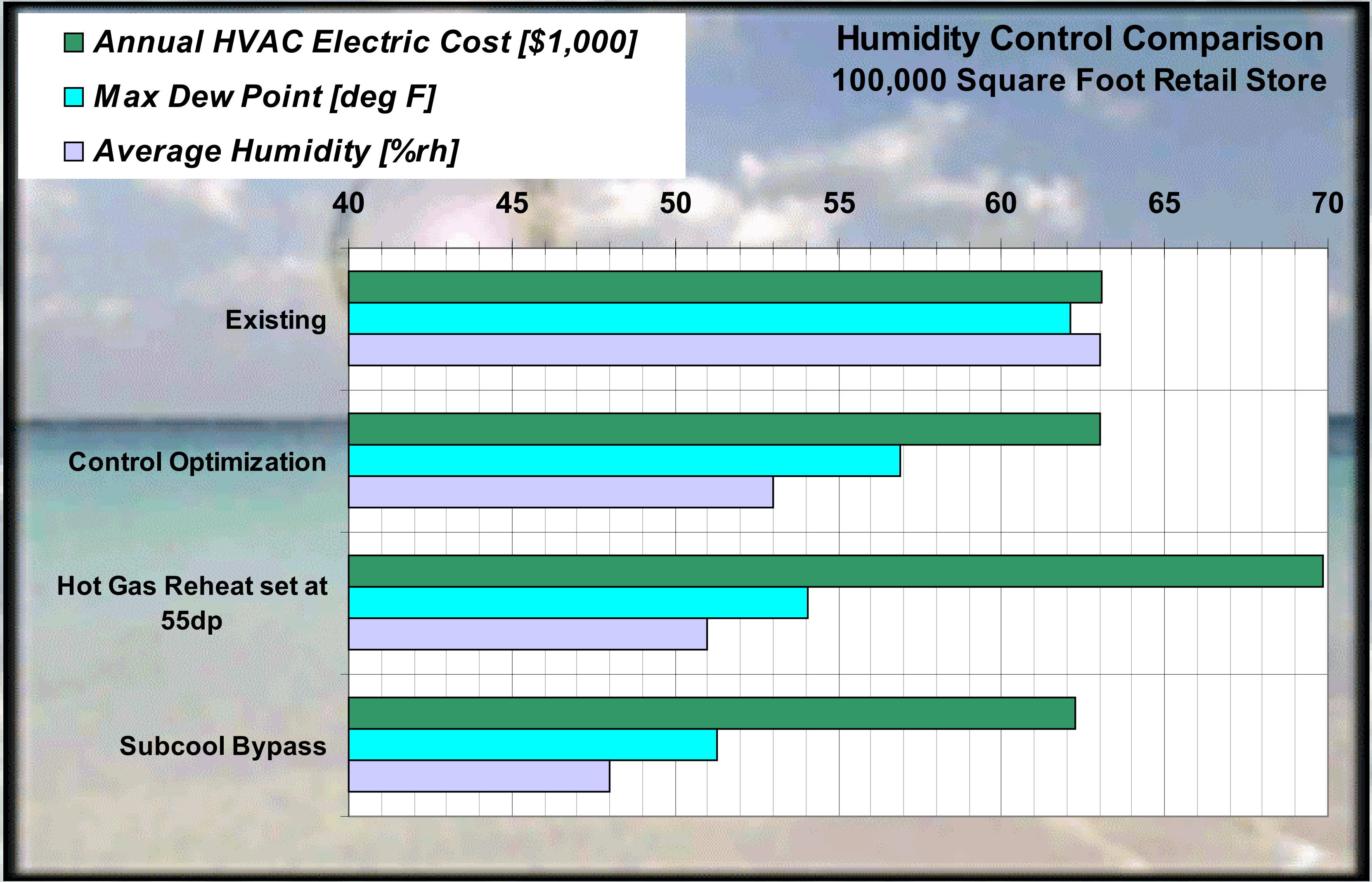
# Controllable Heat Pipes

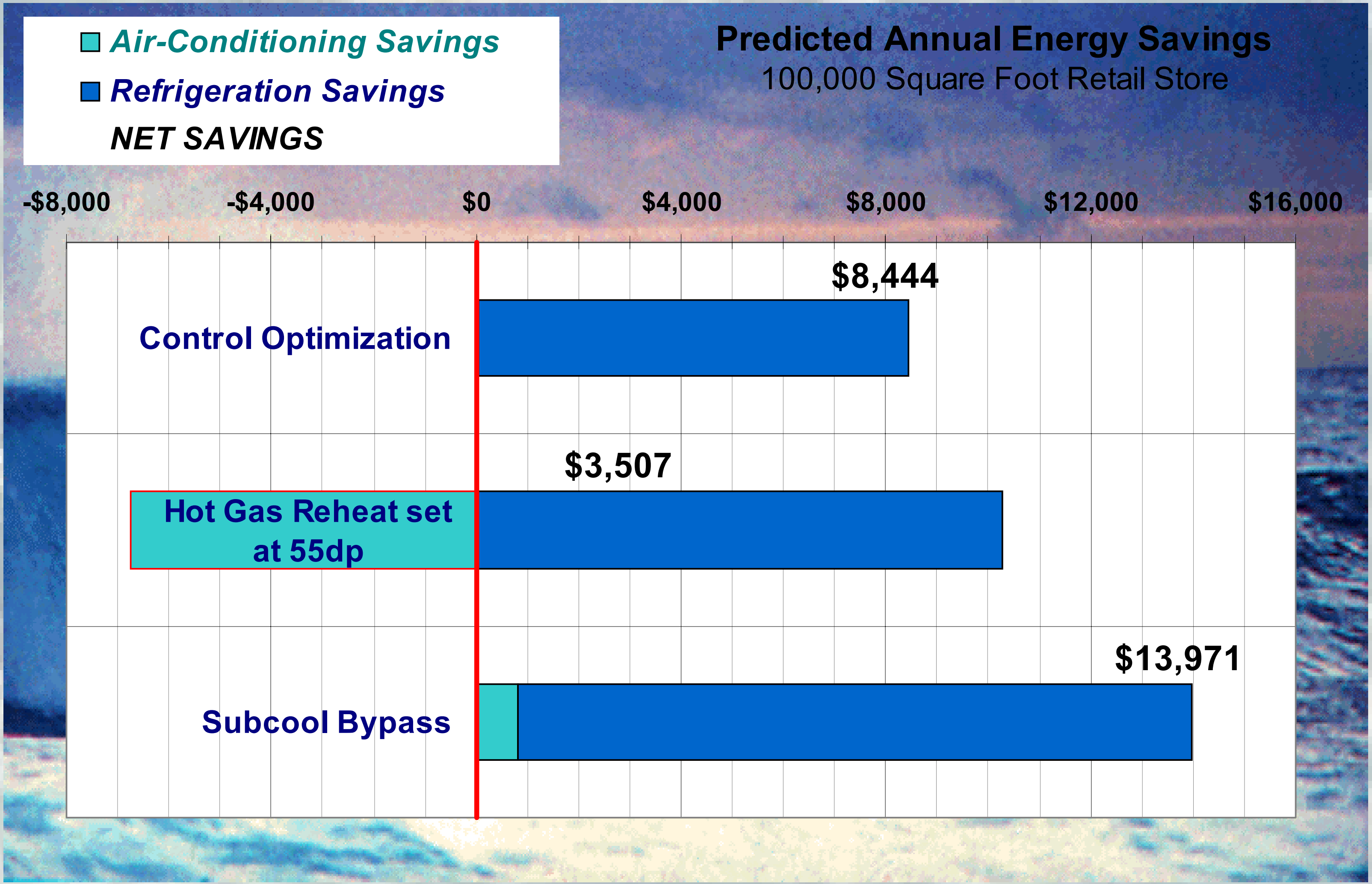
| | |
|---|---|
| Capacity | 34 |
| Latent | 17 |
| SHR | 0.50 |
| EER | 9.7 |



# CASE STUDY Comparison



# CASE STUDY Comparison



# *Main Points*

- **Reheat is energy intensive.**
- **Optimal strategies provide active dehumidification without reheat.**
- **Advanced strategies control humidity *and* reduce energy costs.**
- ***Thank You!***