

Controlling Moisture in Commercial Buildings

Part Load Problems

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The Holmes Agency, Inc.

Consulting and Forensic Engineers

Historical Perspective

□ *Willis Carrier*

“Air conditioning is the **control of the humidity** of the air by either increasing or decreasing its moisture content. Added to the control of humidity is the control of the temperature by either heating or cooling the air, the purification of the air by washing or filtering the air, and the control of air motion and ventilation”



The ASHRAE Guide for Buildings in Hot & Humid Climates

**Section 1
Common Issues**

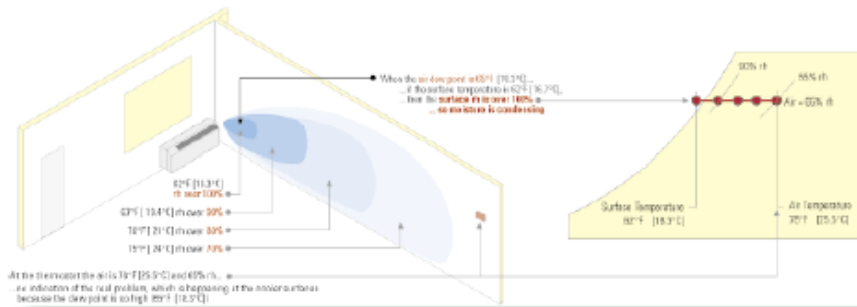
Lewis G. Harriman III

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.



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Ventilation rates depend on occupancy + square footage.....	44
Recommended rates are minimums, not maximums.....	44
Rates assume odors will still be perceived by newcomers	45
The building must either exclude water, or tolerate it.....	46
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Use the peak dew point for dehumidification calculations	48
65% rh upper limit - a 55°F dew point is a better one	48
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Replace outdoor air filters every month	50
Observe position & operation of outdoor air dampers every 3 months.....	51
Recalibrate outdoor air sensors every six months	51
Clean coils, drain pans and damp duct interiors once a year.....	51

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Key Points 85

Excess Moisture Leads to Bugs, Mold & Rot 85

Human Health Effects of Bugs, Mold & Rot 86

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Mold growth - water activity in the food vs. rh in the air 87

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The owner—not the law—makes the key decisions 90

Suggestions for owners and Architects 90

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Assessing Mold Risk in Existing Buildings 105

Bacteria: locate any standing water, then drain it or dry it 105

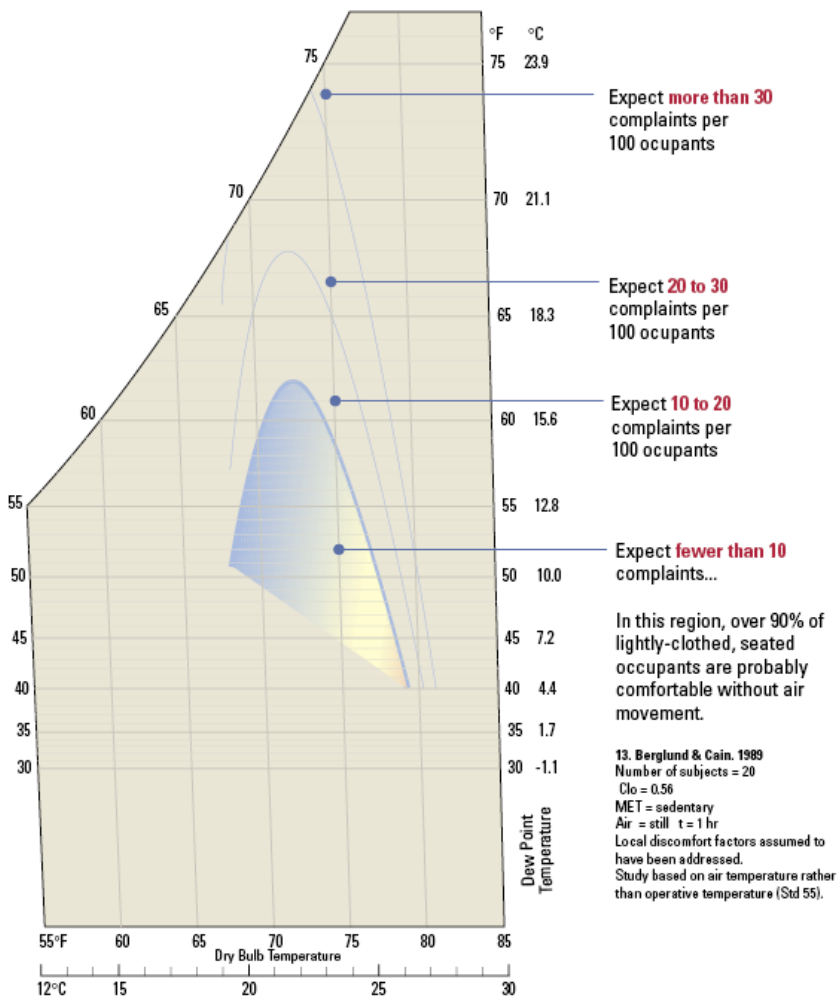
Mold - keep moisture content below 14% WME 106

Measuring moisture 107

Locating excess moisture in buildings 108

Risky Misconceptions and Half-truths 113

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**Comfort - Keep
 the dew point
 under control,
 and comfort
 happens at
 warmer, more
 energy-
 efficient
 temperatures**

ASHRAE Std 62.1 - 2004

Ventilation for Acceptable Indoor Air Quality

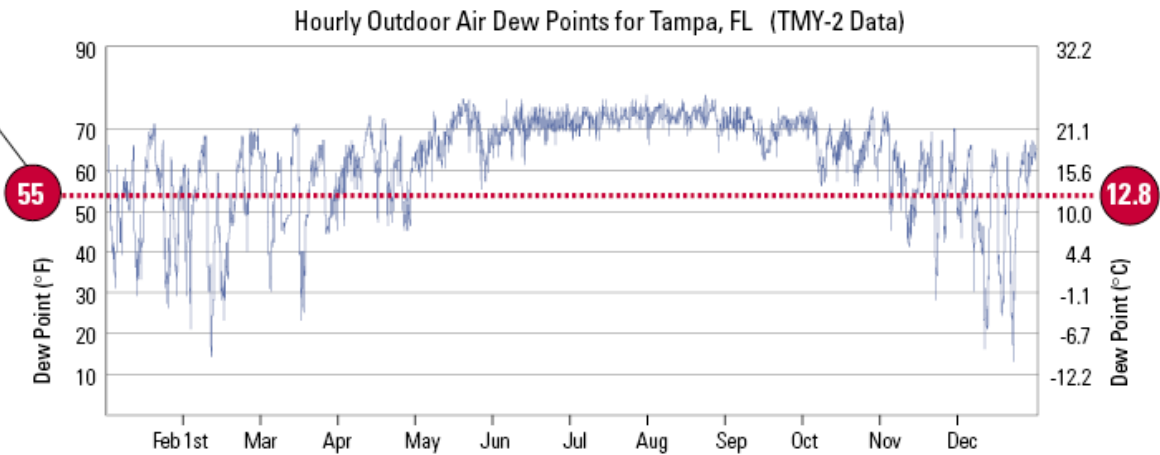


Ventilation - If it's not dried... you're in trouble

Indoor vs. Outdoor Air Dew Points

In hot and humid climates, the outdoor air dew point can be very high even during "winter."

So the system must dry the ventilation air in **all** seasons.

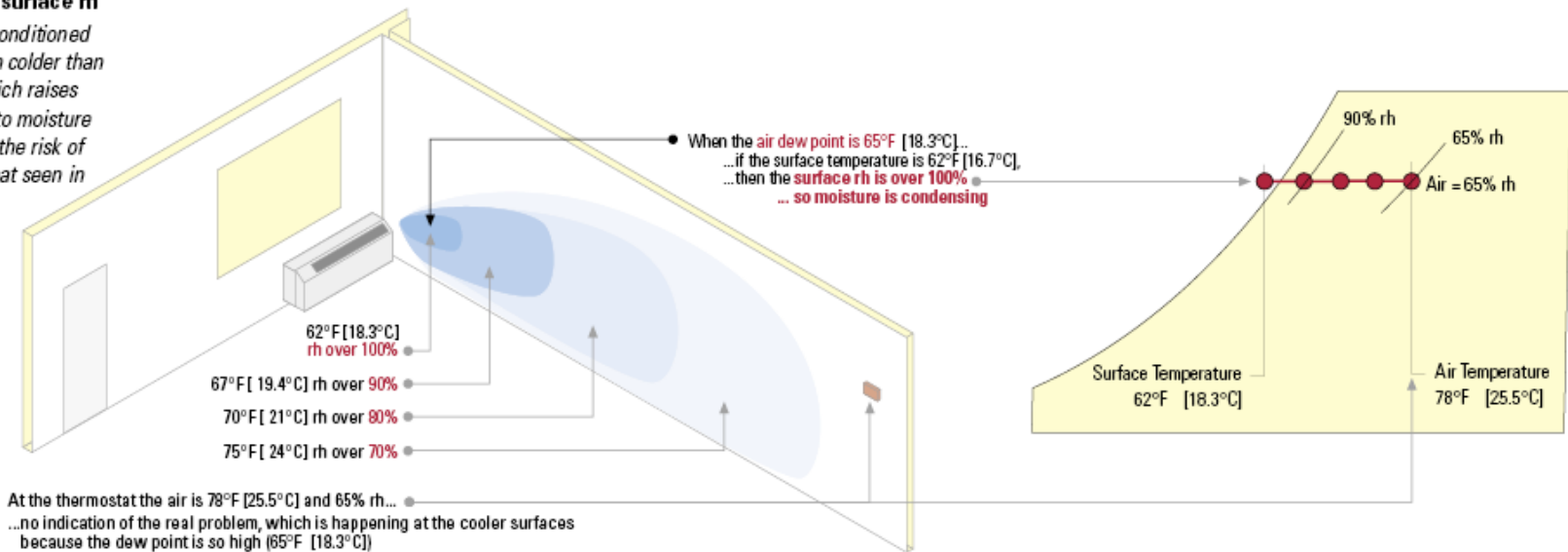


Mold - It's the surface rh that counts.. So keep the dew point down, and things go well

Fig. 5.5

Cold surfaces = high surface rh

The surfaces in an air conditioned building are often much colder than the surrounding air, which raises the local rh, and leads to moisture absorption and then to the risk of mold growth such as that seen in figure 5.6.



Mold Growth

- ❑ Enzymes on mold spore combine with surface moisture to dissolve food source... paper, wood, ceiling tile
 - ❑ Osmotic pressure causes liquid nutrients to diffuse across spore wall allowing spore to absorb the nutrients
 - ❑ Spore germinates producing filamentous hyphea
 - ❑ Hyphea grows quickly creating mycelium mat
 - ❑ Mold grows conidia which generates and releases spores into the air
-

Water Activity

- ❑ Water activity indicates how much water is biologically available to fungus in its food source.
 - ❑ Water activity of 0.8 refers to the amount of water absorbed into a material when the surrounding air is at 80% RH
 - ❑ Water activity of a material is very different from the relative humidity of the material
 - ❑ Mold growth is a risk when surface relative humidity stays above 85% for extended periods
-

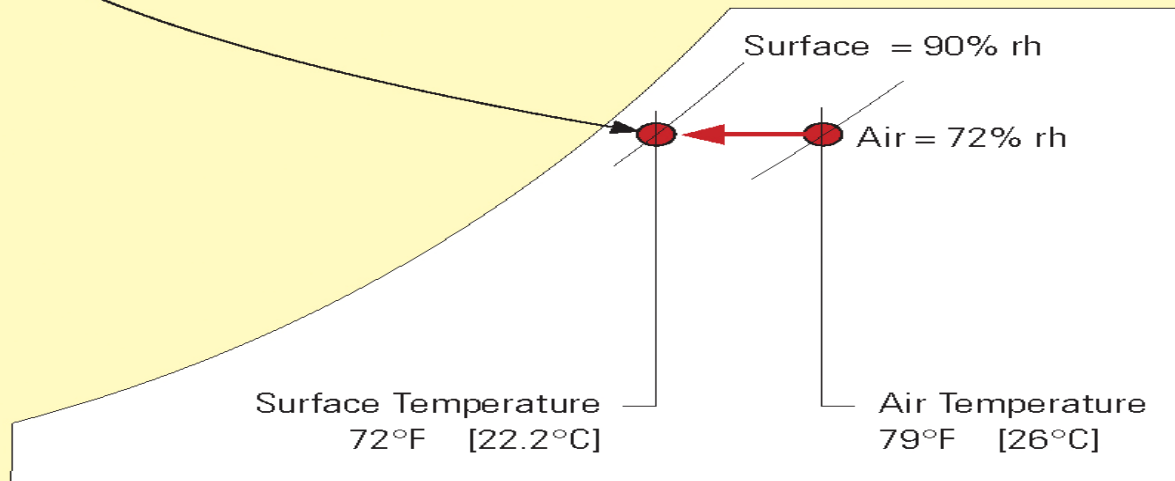
Moisture Content and Surface Relative Humidity



**At this cool surface,
the RH is about 90%...**



**...even though the RH in the air
is only 72%.**



Uncontrolled air flow

- Buildings which have never reported relative humidity above 65% still may have mold growth



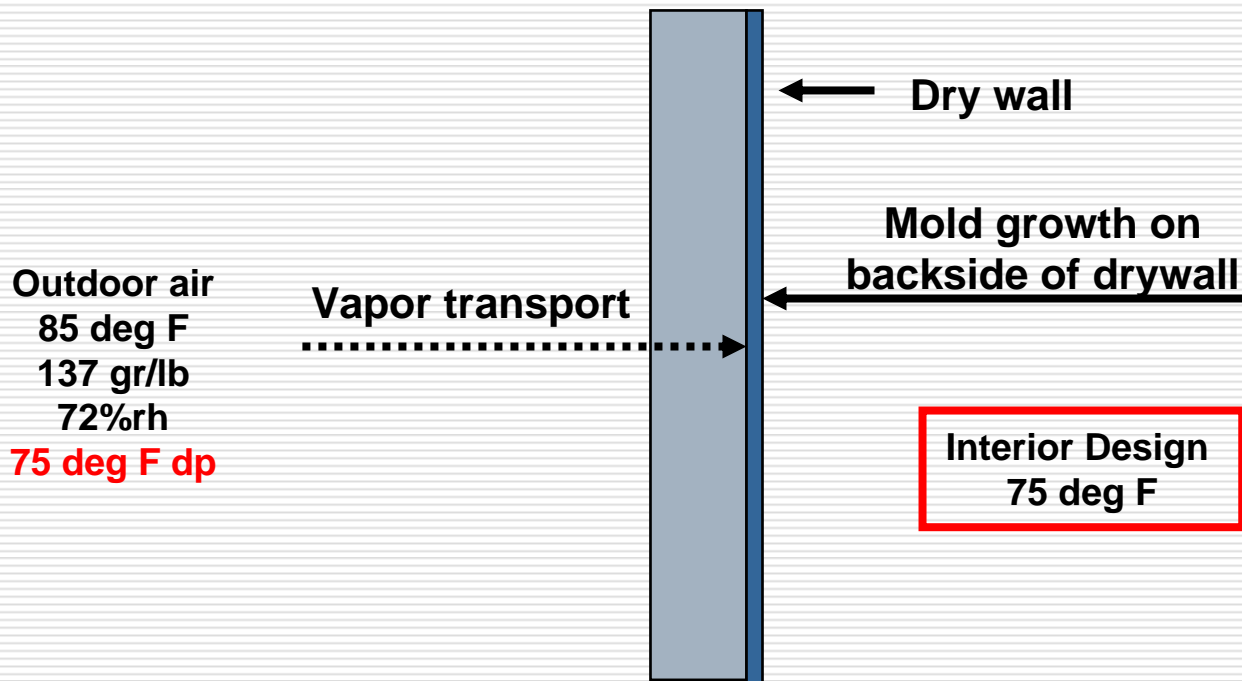
THE MOISTURE PROBLEM

- Highest enthalpy occurs at peak dew point.. **NOT** peak dry bulb
 - ASHRAE 2005 Fundamentals lists
 - Extreme DB with MCWBexample Kansas City, MO (1%) 93db/75wb (107 gr/lb) 68dp
 - Extreme DP with MCDB (.4%) 75dp/85db (137 gr/lb) (78wb) **poor performance at part load!!**
-

THE MOISTURE PROBLEM

- ASHRAE 2005 Fundamentals lists extreme DP with MCDB...example Orlando, FL (0.4%) 83db/77dp (**142 gr/lb**) (79 wb) **again poor performance at part load!!**
-

TYPES OF MOISTURE PROBLEMS



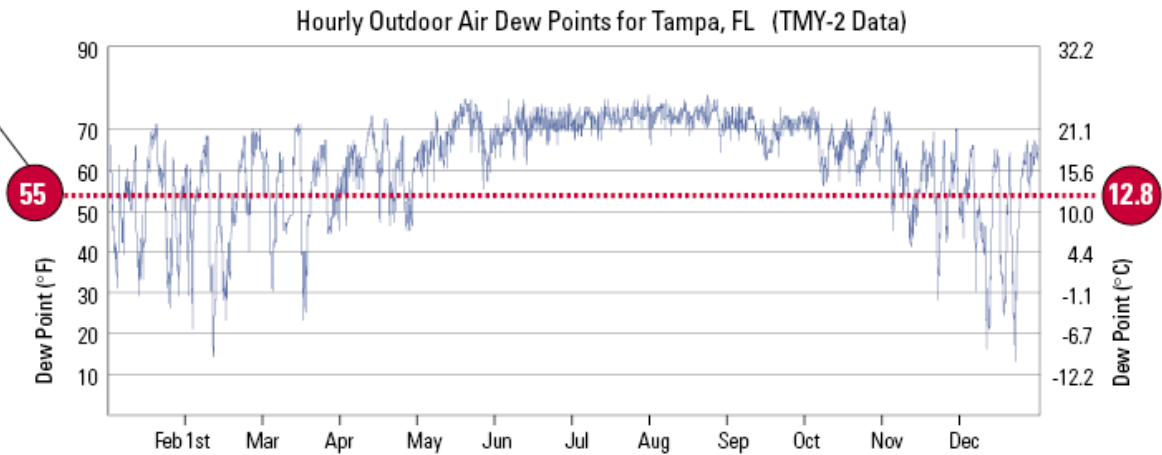
**Building Envelope
with poor vapor barrier**

Ventilation - If it's not dried... you're in trouble

Indoor vs. Outdoor Air Dew Points

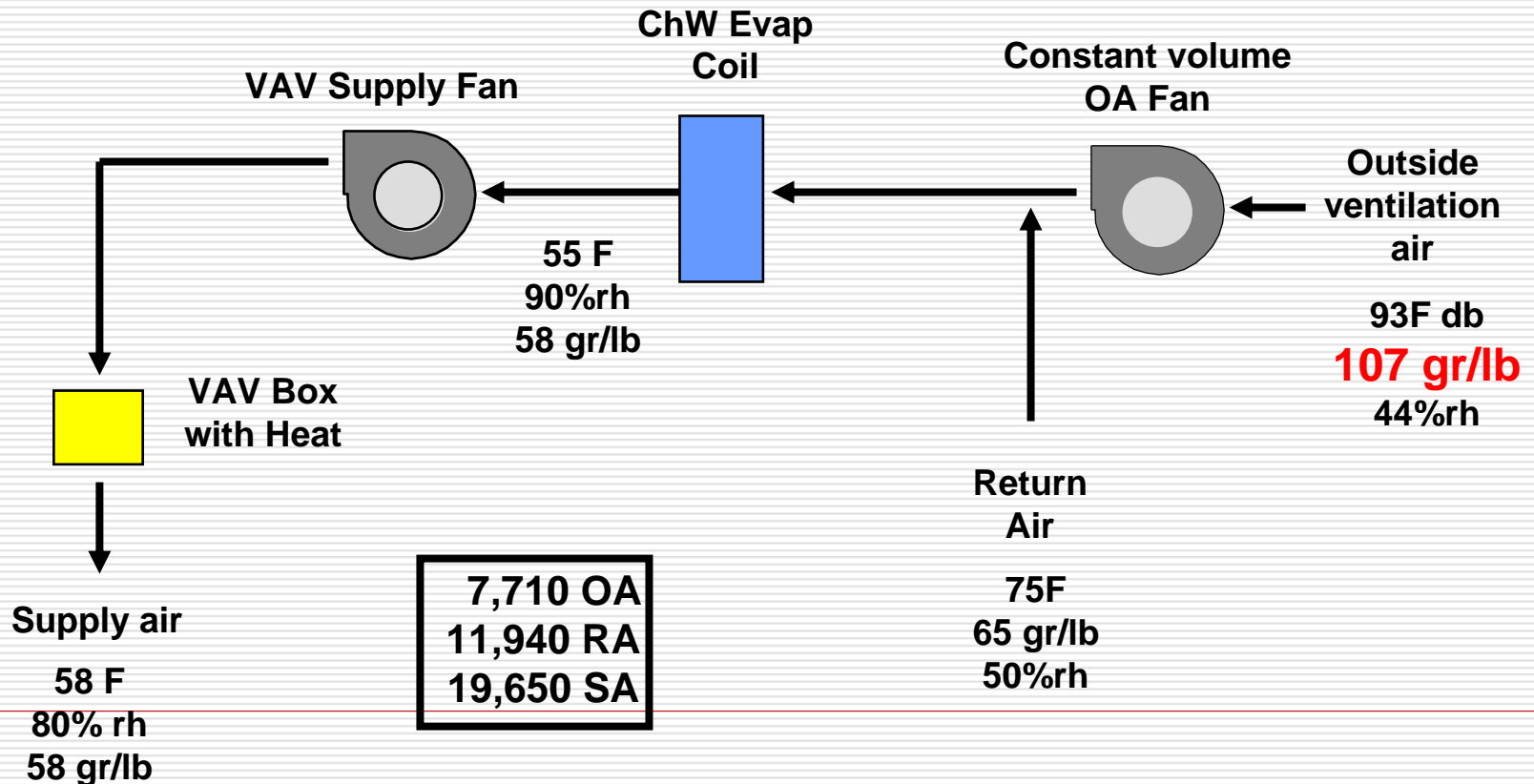
In hot and humid climates, the outdoor air dew point can be very high even during "winter."

So the system must dry the ventilation air in **all** seasons.



VAV AIR CONDITIONING

Full Load





ASHRAE PSYCHROMETRIC CHART NO.1

NORMAL TEMPERATURE

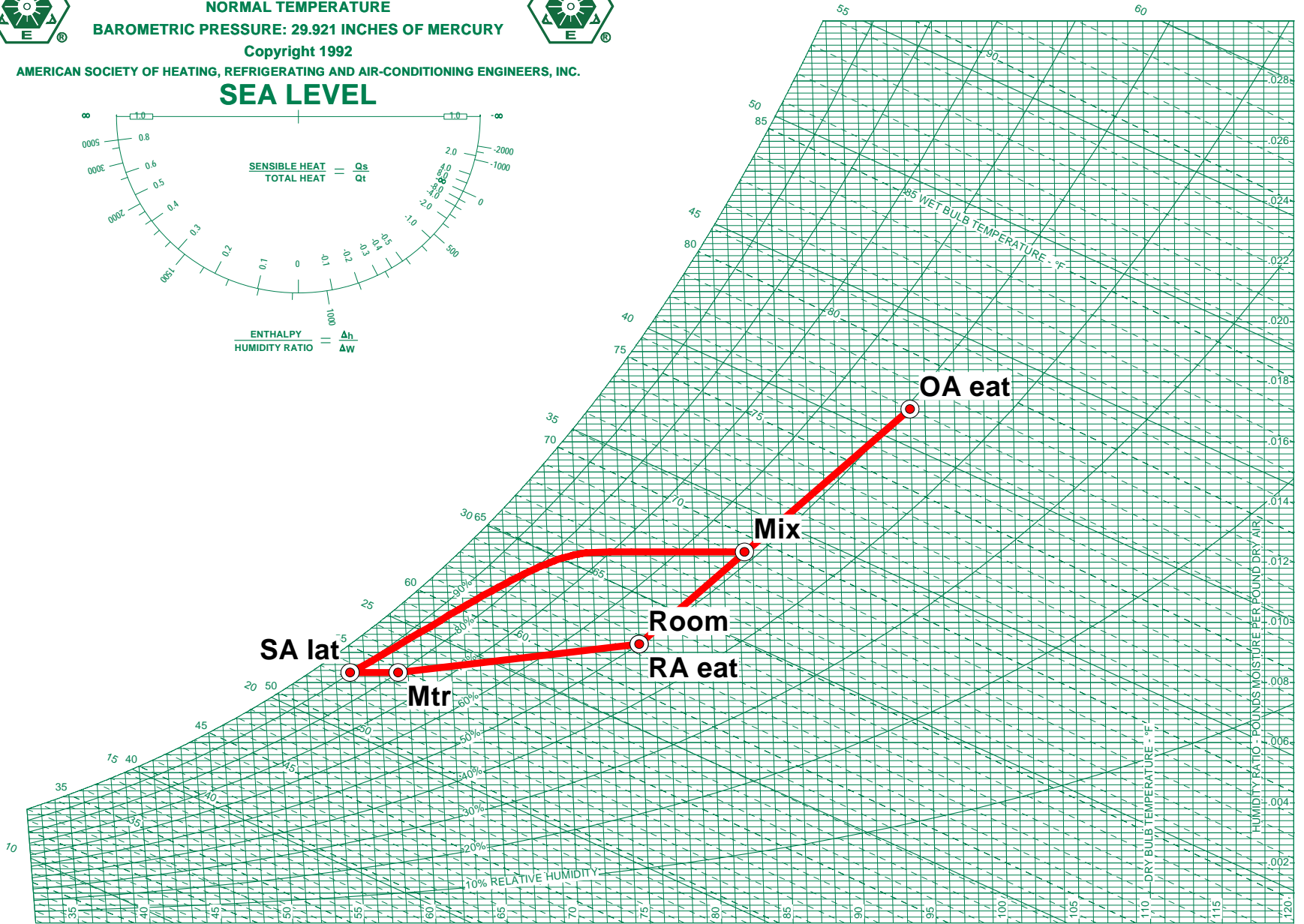
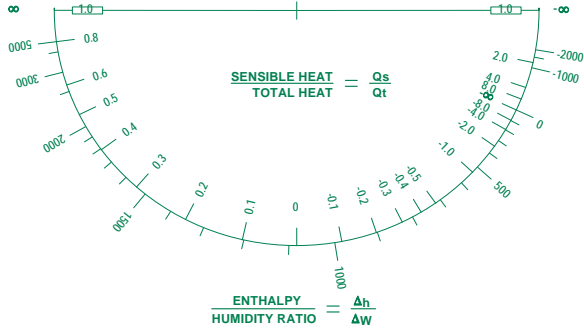
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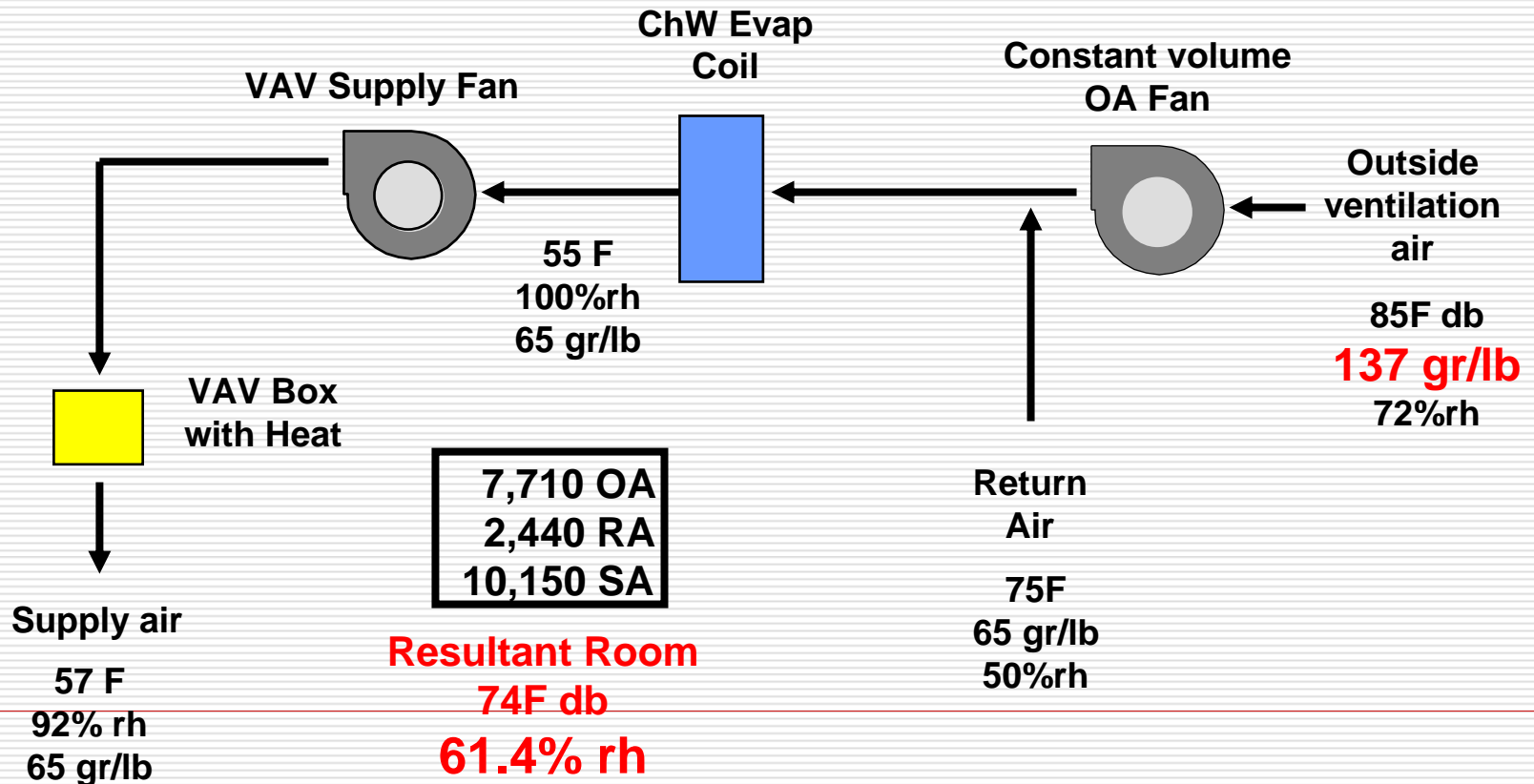
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SEA LEVEL



VAV AIR CONDITIONING

Part Load





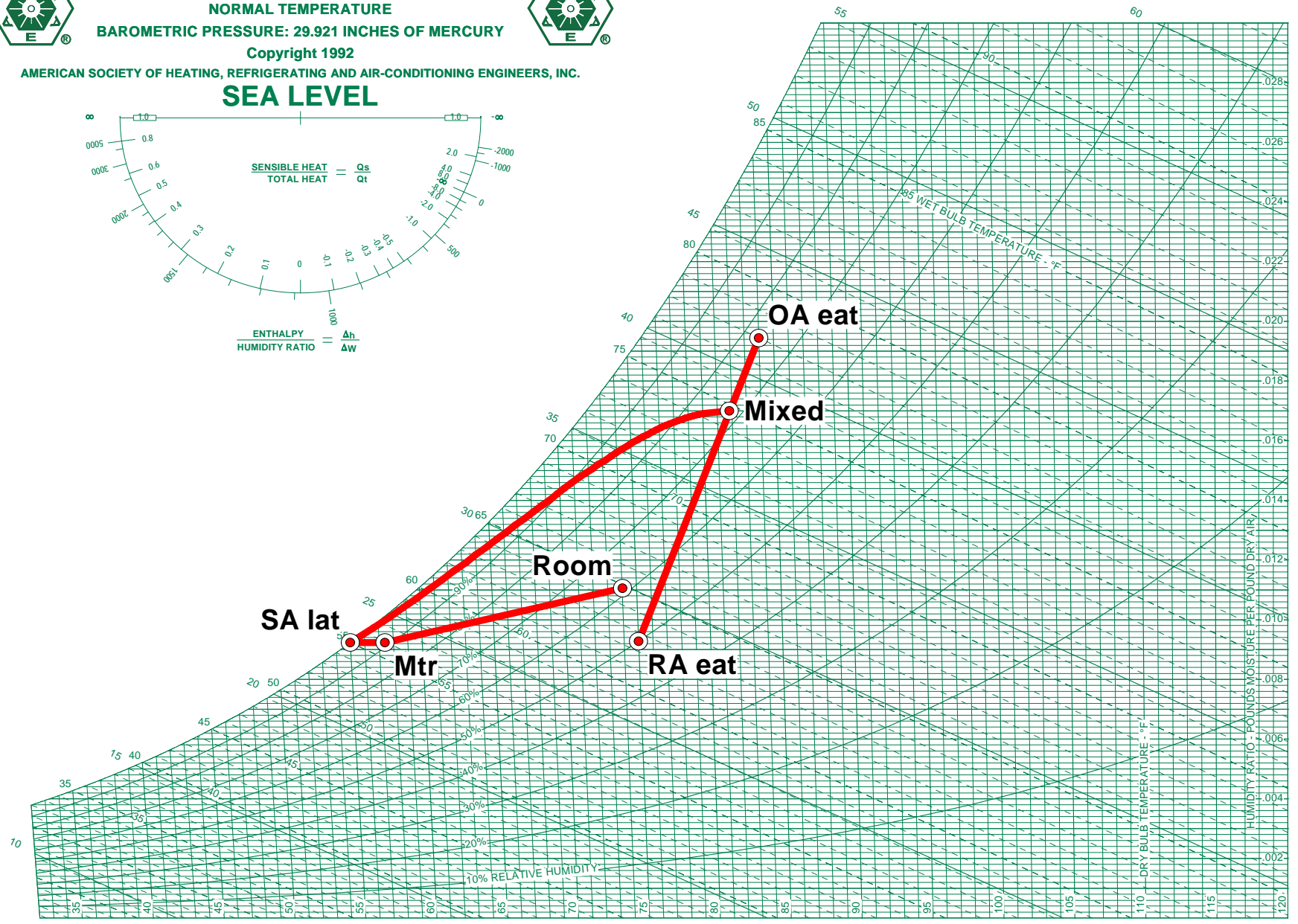
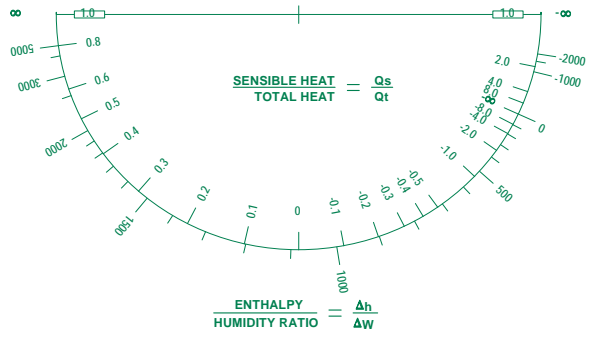
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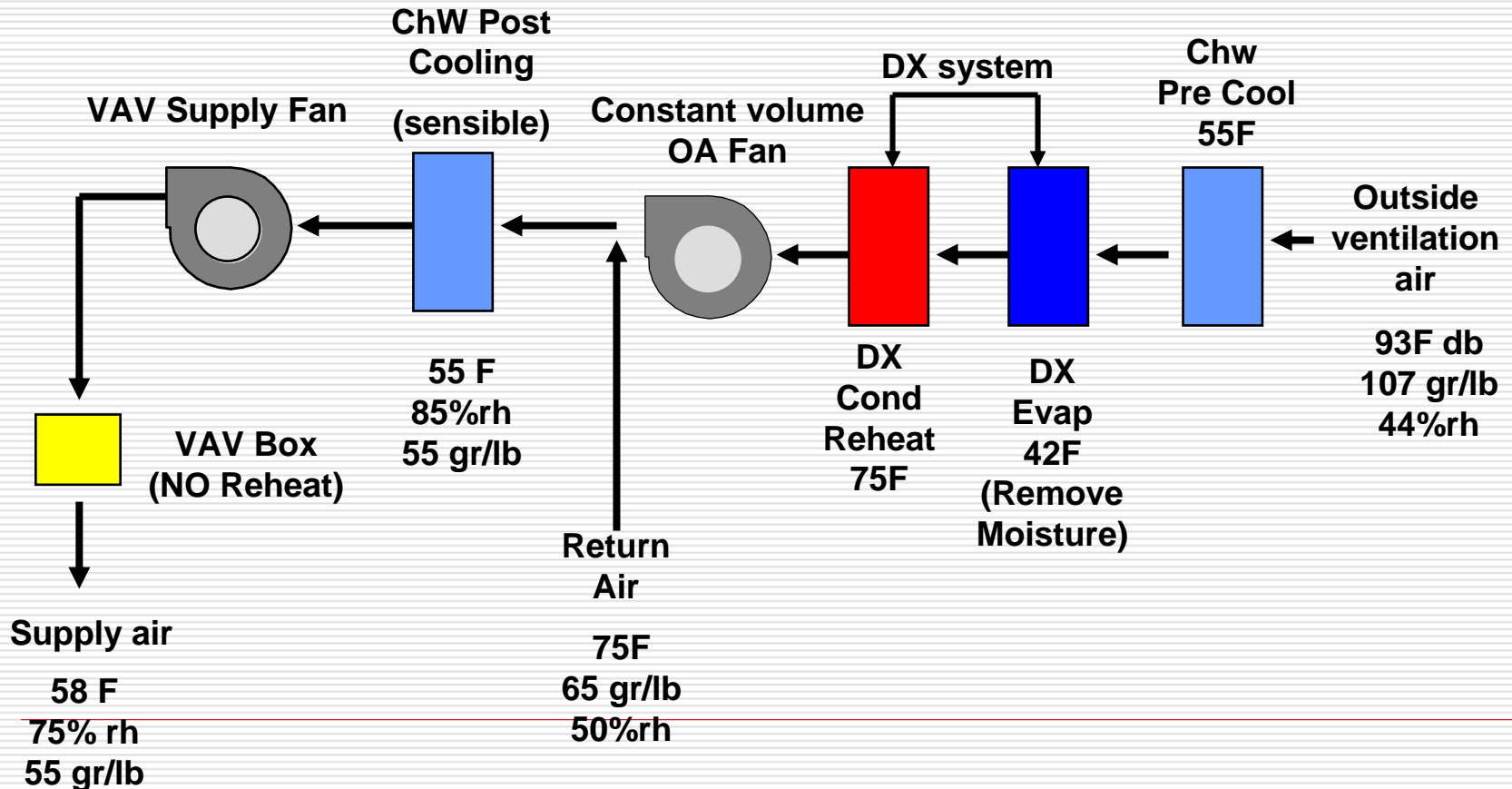
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SEA LEVEL



OA Pre Treatment with Post Cooling

Full Load





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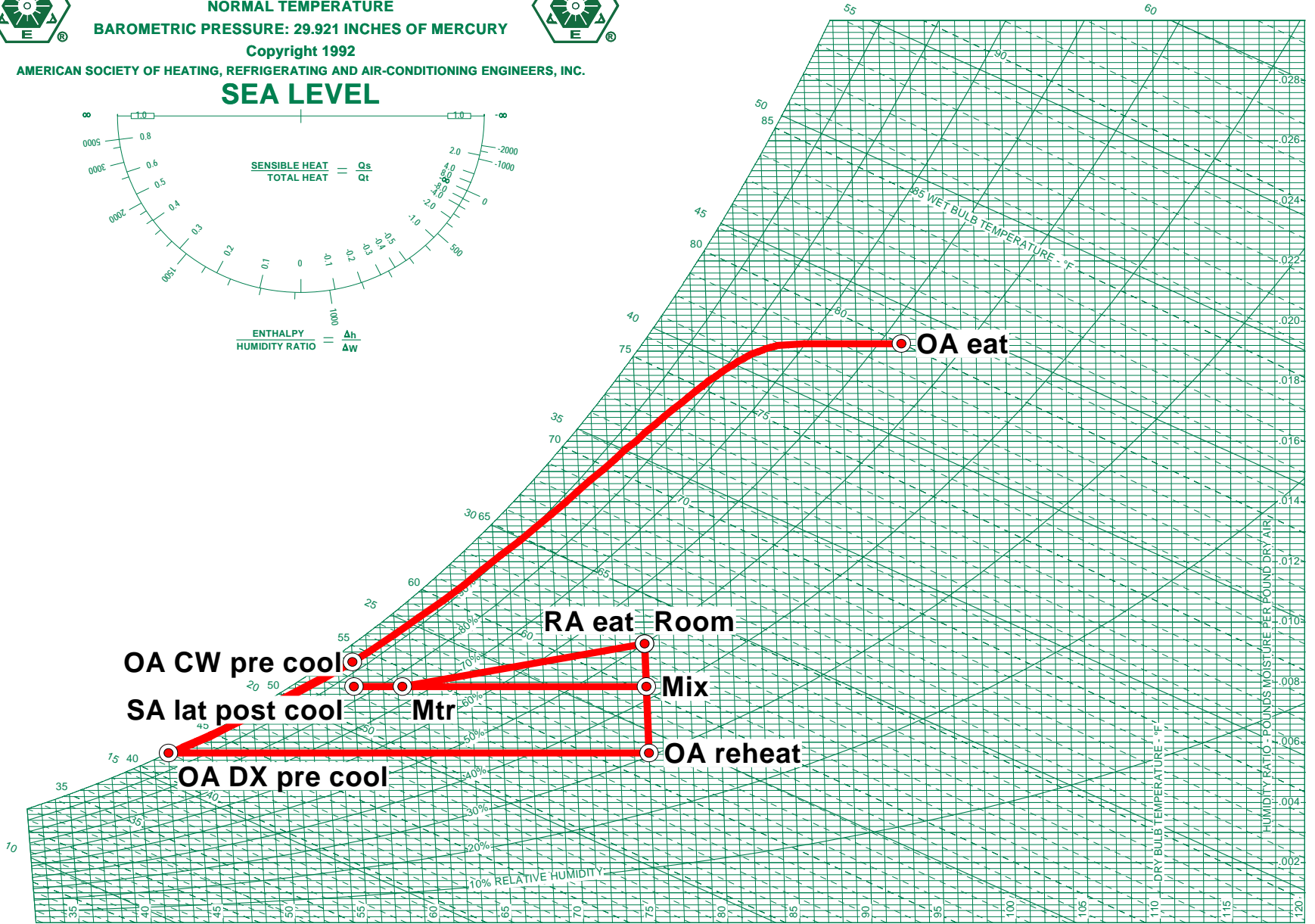
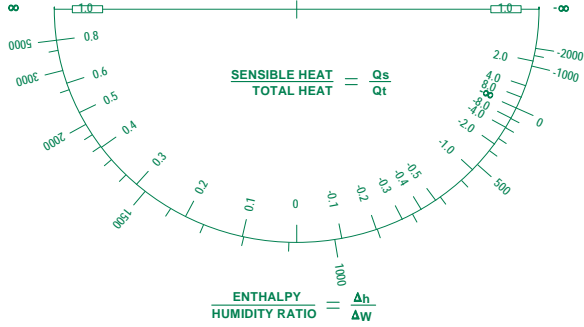
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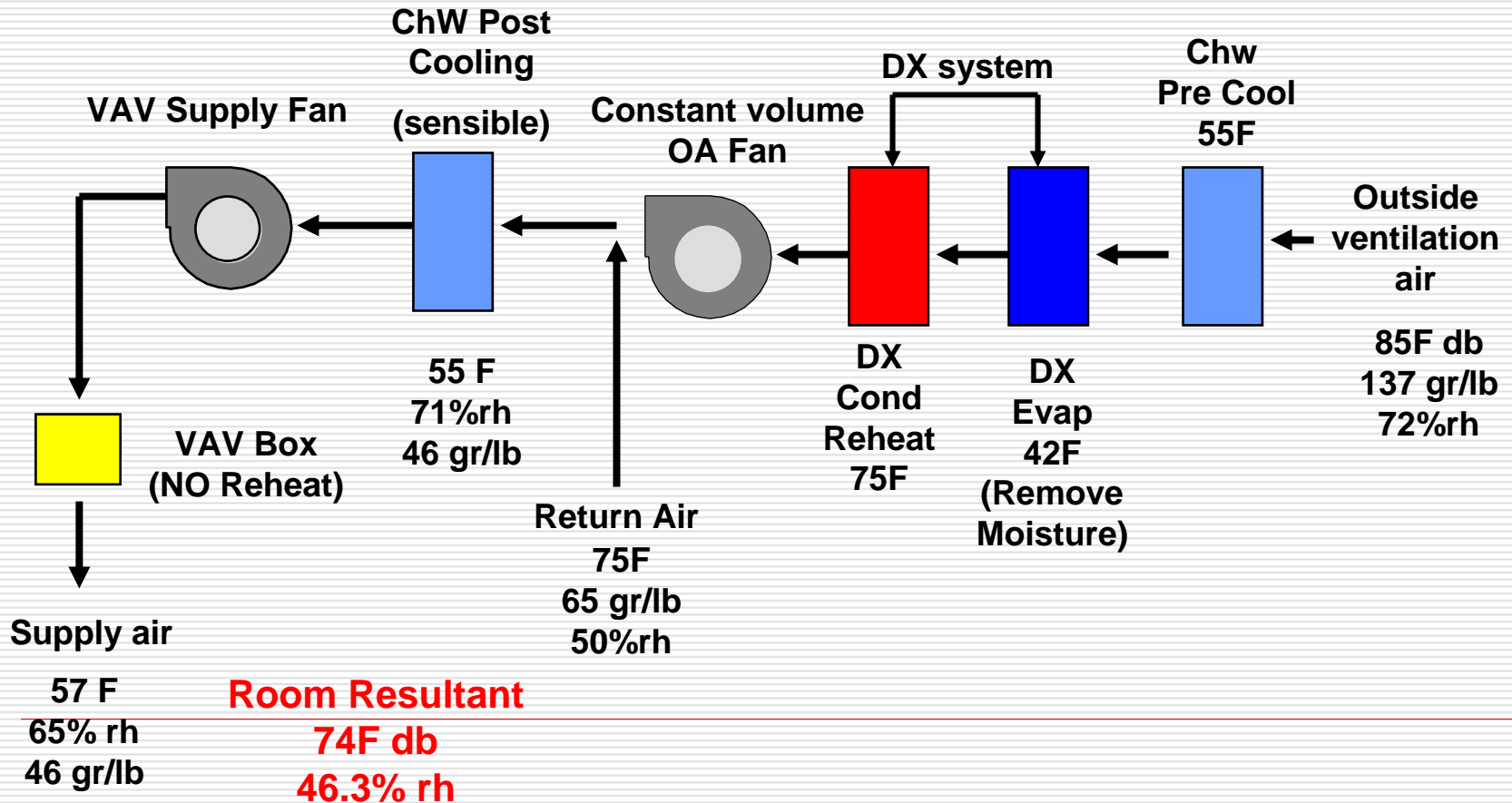


SEA LEVEL



OA Pre Treatment with Post Cooling

Part Load





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NORMAL TEMPERATURE

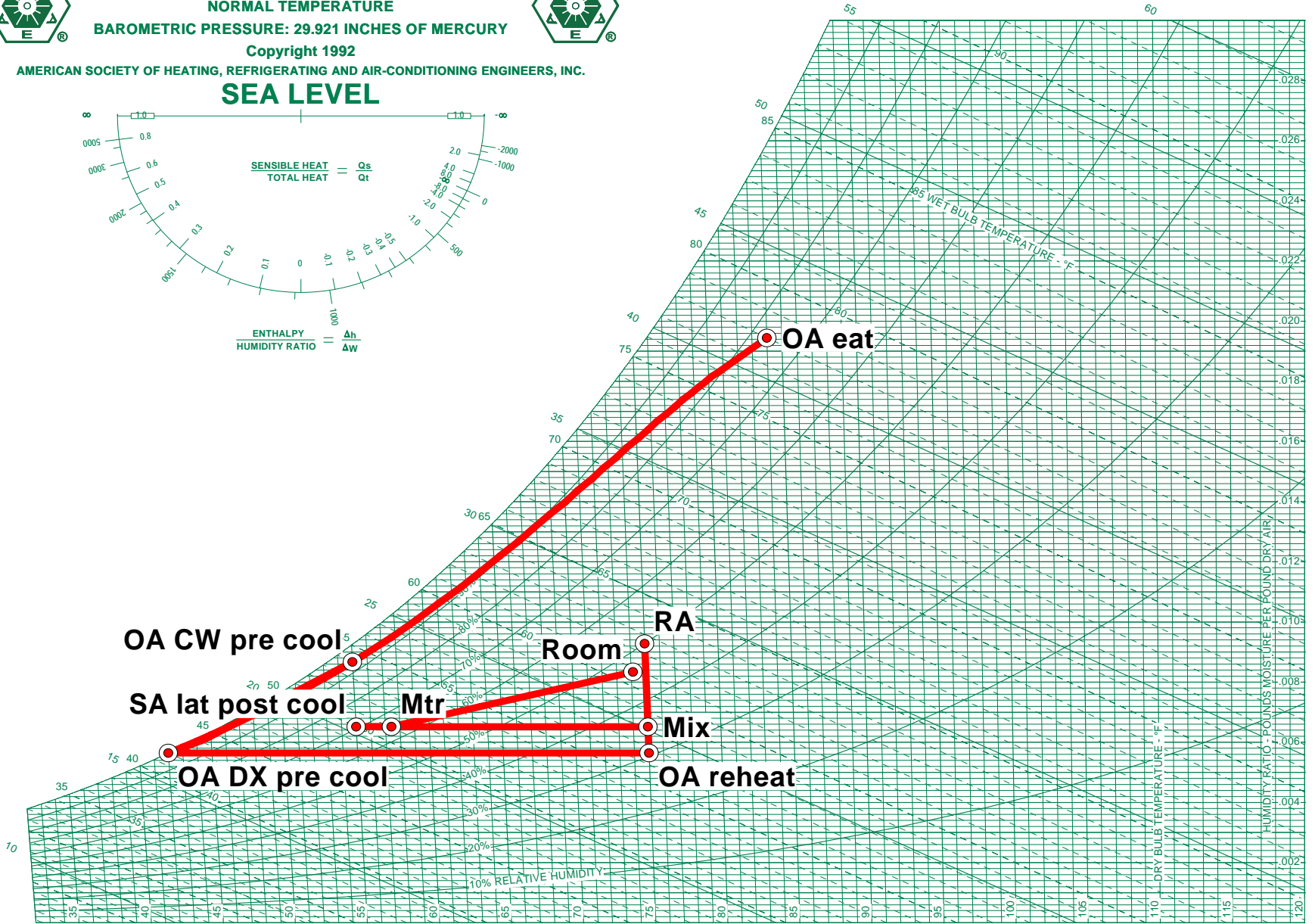
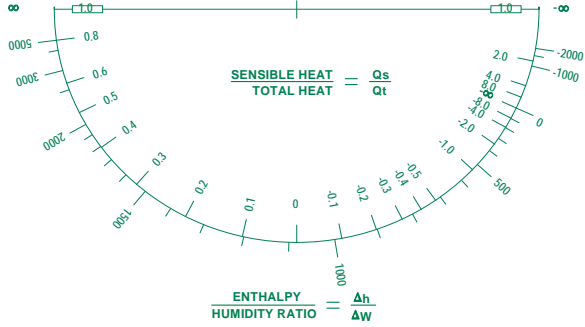
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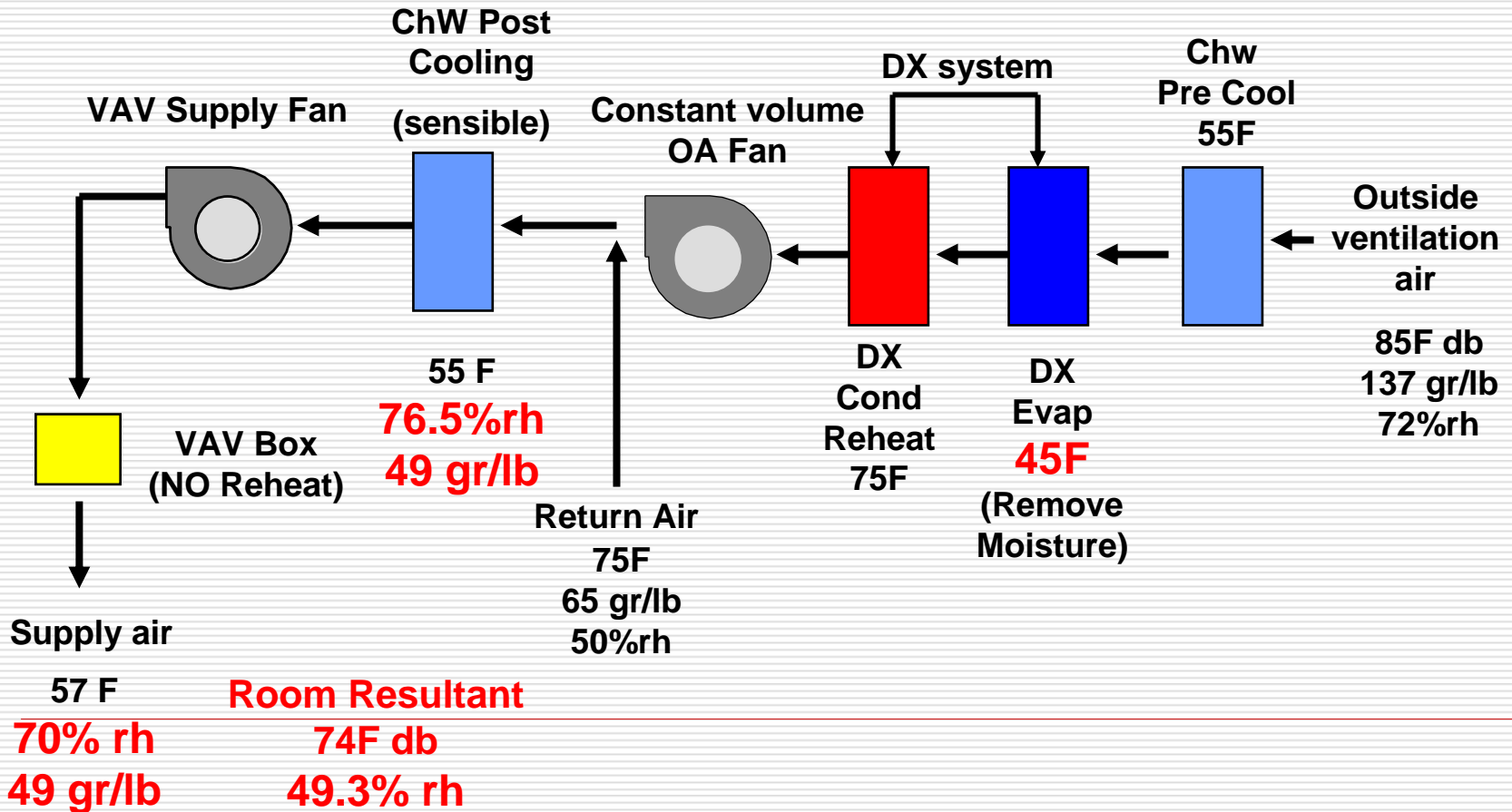
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SEA LEVEL



OA Pre Treatment with Post Cooling

Part Load – reset DX





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NORMAL TEMPERATURE

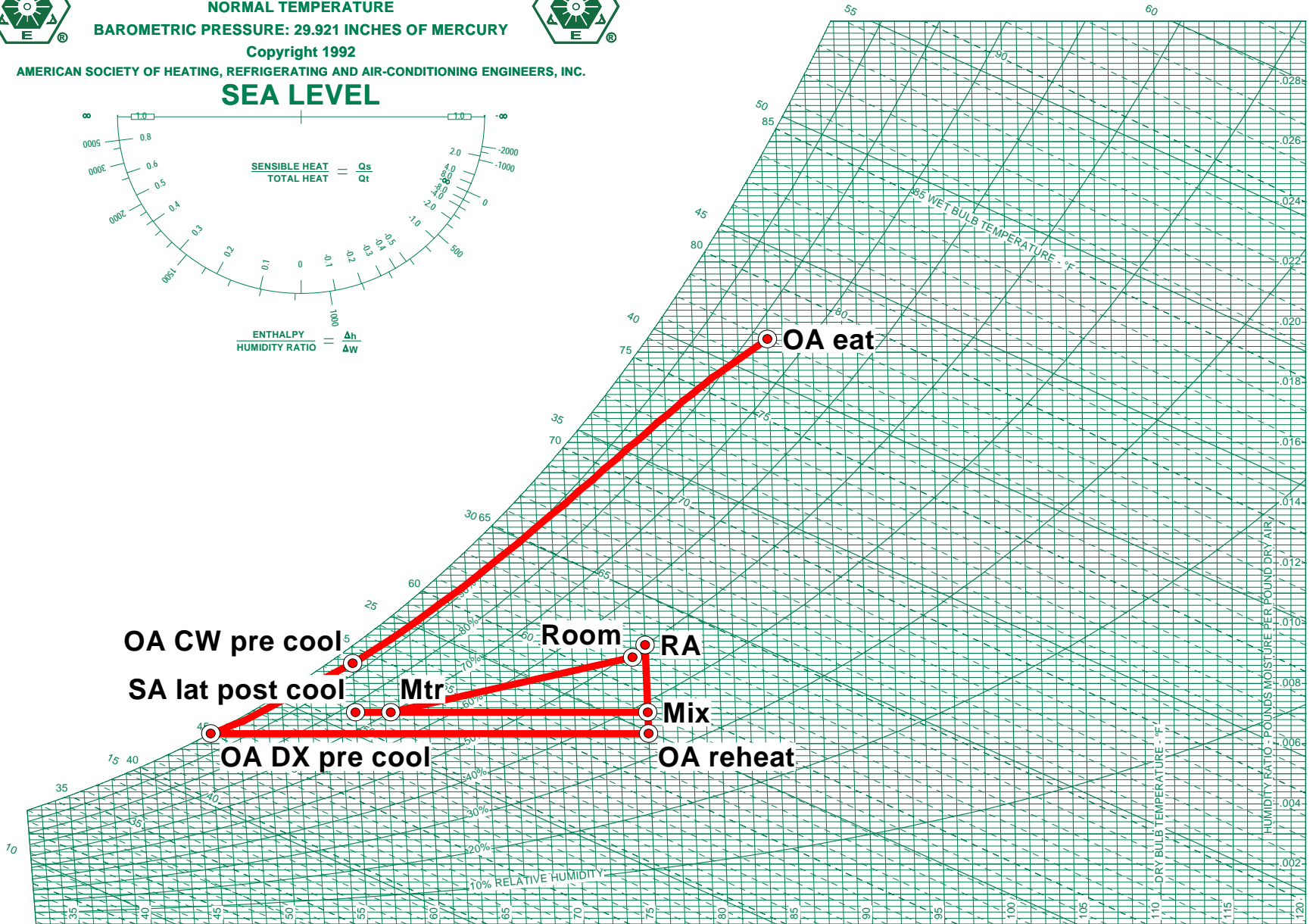
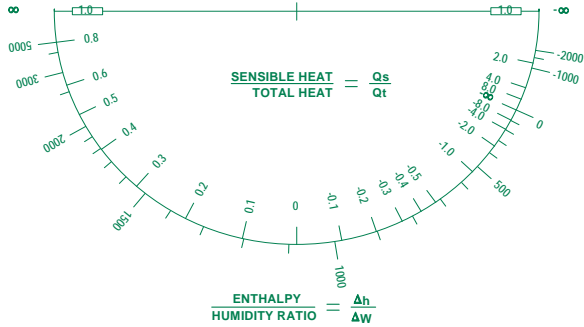
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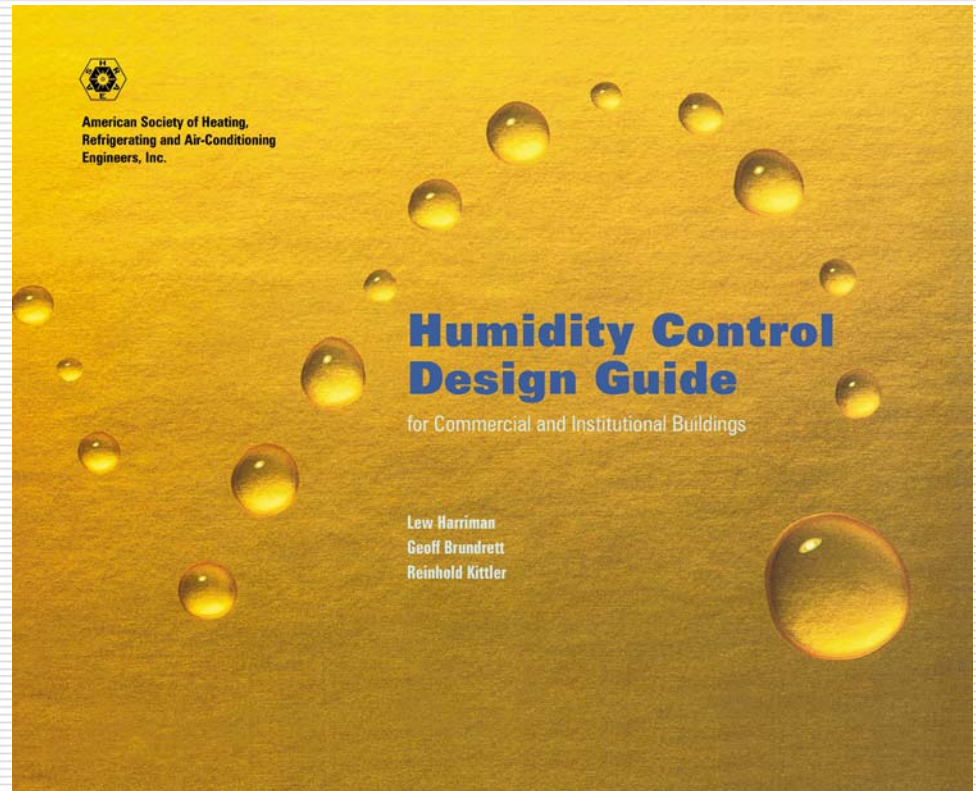


Design Considerations

- It's a system... not just a unit
 - The habitable space is a plenum
 - Uncontrolled air flow – ASHRAE Journal
 - Don't operate in a vacuum... it's a team effort
 - Sequence of operation
 - *Control outside air at the source*
 - Control condensation
-

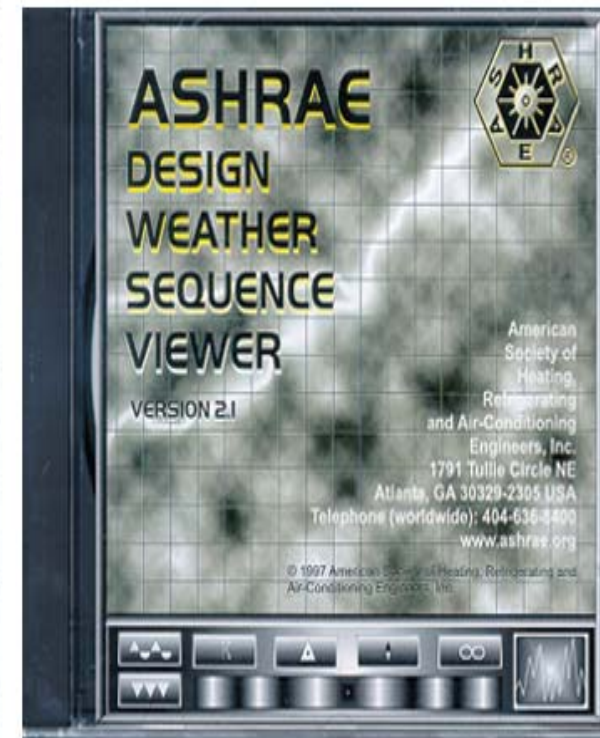
ASHRAE Standards and Publications

- Available from ASHRAE in Atlanta,
- **Humidity Control Design Guide**
For Commercial and Institutional Buildings



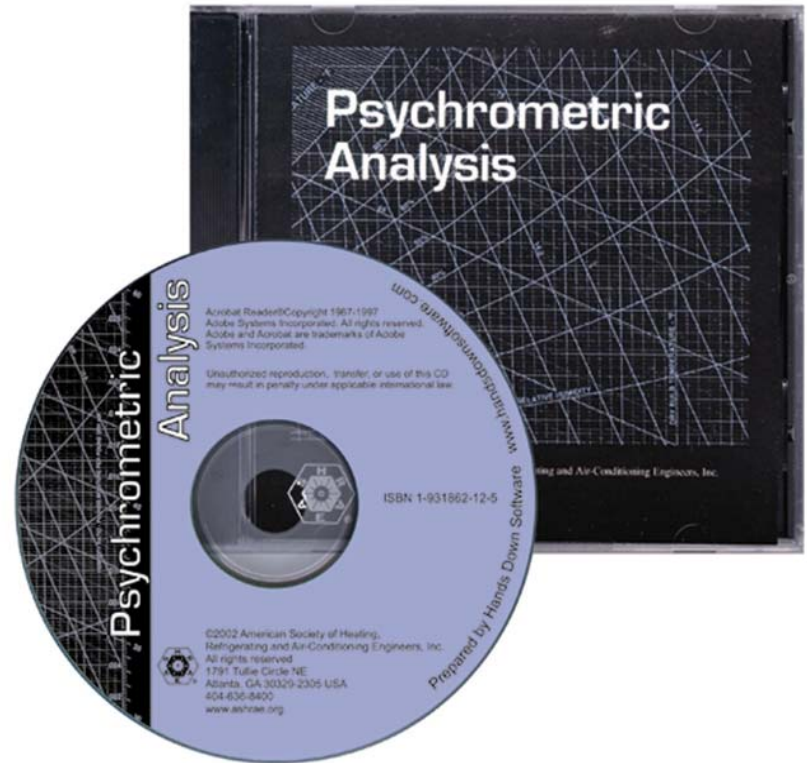
ASHRAE Standards and Publications

- ❑ Available from ASHRAE in Atlanta
- ❑ Design Data for Weather
- ❑ **Weather Data Viewer**
- ❑ **ASHRAE Design Weather Sequence Viewer**



ASHRAE Standards and Publications

- ❑ Psychrometric Analysis CD
- ❑ Available at ASHRAE Book Store Long Beach, California



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