Moisture Control

Its not the humidity....

It's The Dew Point Stupid!

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Matching great technology to market need!

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Topics

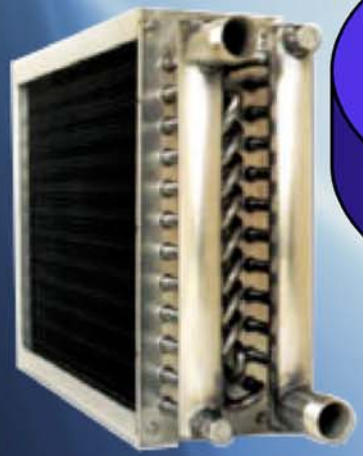
- SHR of Buildings vs Equipment
- Why Dew Point Is Important
- New Developments In DP Sensing

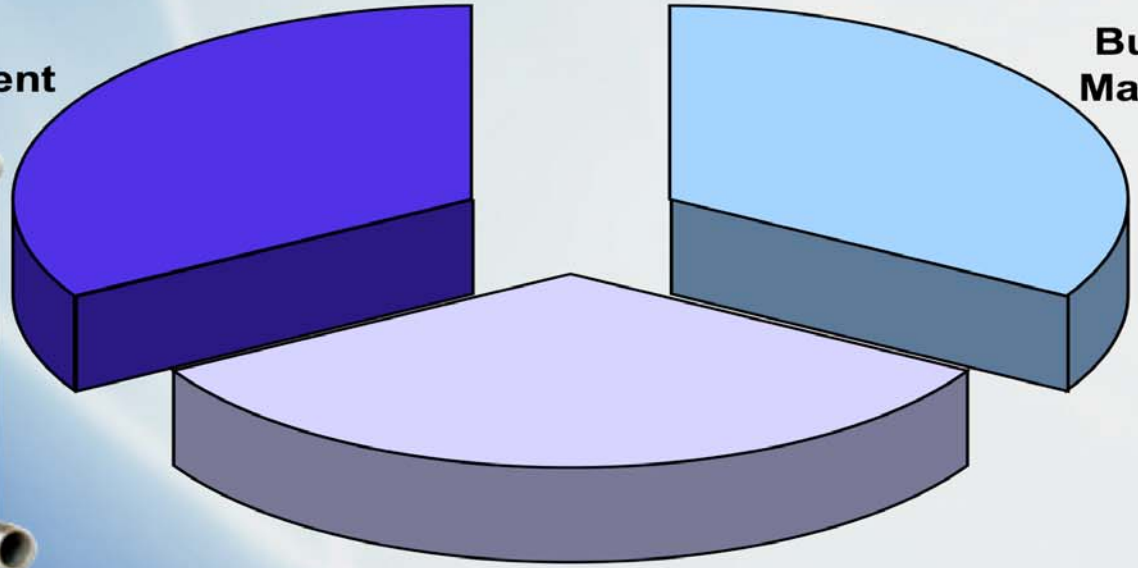
Question…

Why have reports of mold in buildings increased over the past 5-7 years?

Answer

HVAC Equipment





Building Materials

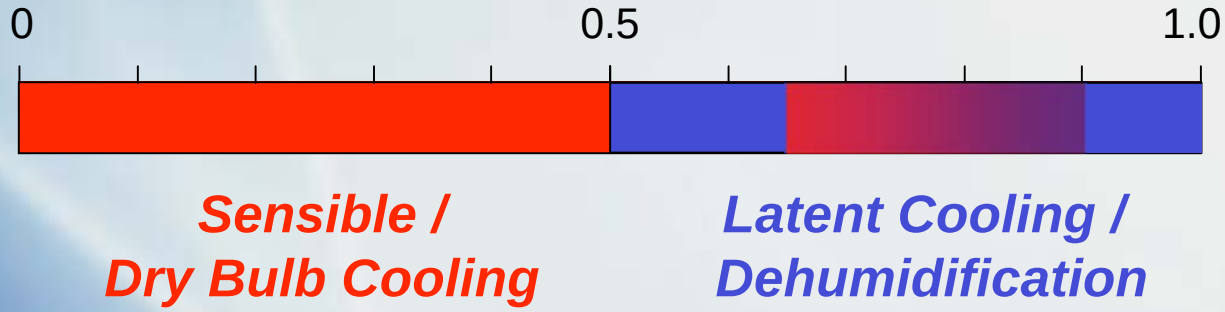
Construction Details

HVAC Equipment

- AC Systems
- Economizer Control
- Dehumidification Control
- Humidification Control
- No Control Of Ventilation (OA is a major source of moisture in cooling seasons)

Sensible Heat Ratio

A Rating Of Air Conditioning Equipment



Ratio of sensible cooling to total cooling capacity

Typically controlling temp would control humidity!

20 Years of Energy Conservation…

- Lighting Retrofits
- Windows/Window Films
- Lower Energy Appliances
- Higher Thermal Performance Of Walls
- Setback Controls

All Reduce Sensible Load!

SHR Of Buildings Vs Equipment

At Sensible Design Conditions:

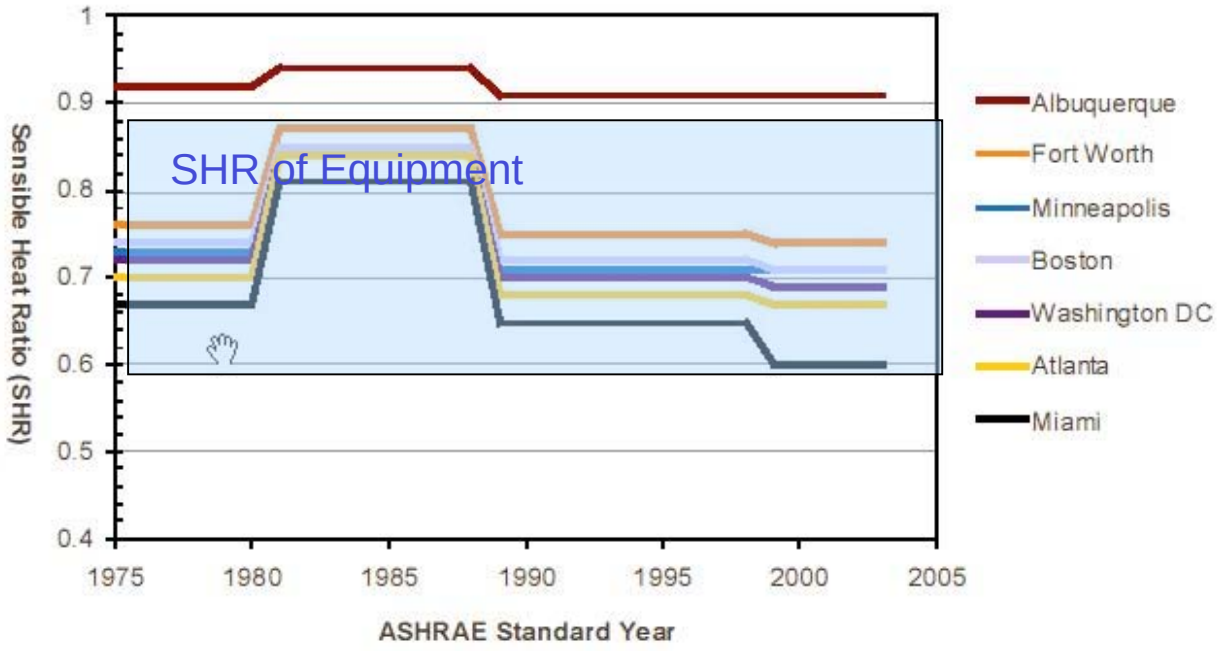


Figure E-1: Building Load SHR from 1975 – Present, at Sensible Design Condition (High Outdoor Temperature)

Source: TIAX, Matching The SHR of AC Equipment With Building Load SHR

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SHR Of Buildings Vs Equipment

At Latent Design Conditions:

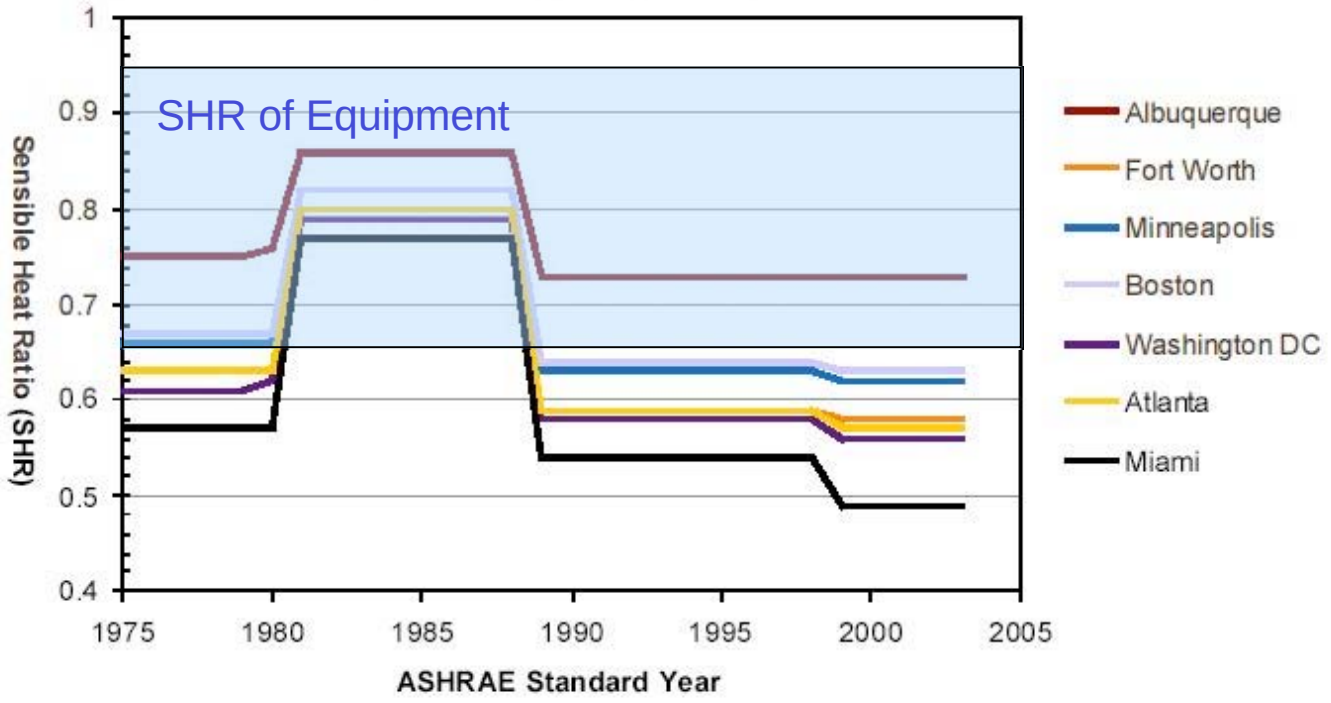

Figure E-2: Building Load SHR from 1975 – Present, at Latent Design Condition (High Outdoor Humidity)

Source: TIAX, Matching The SHR of AC Equipment With Building Load SHR

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SHR Of Buildings Vs Equipment

At Part Load Conditions (High RH Low Temp):

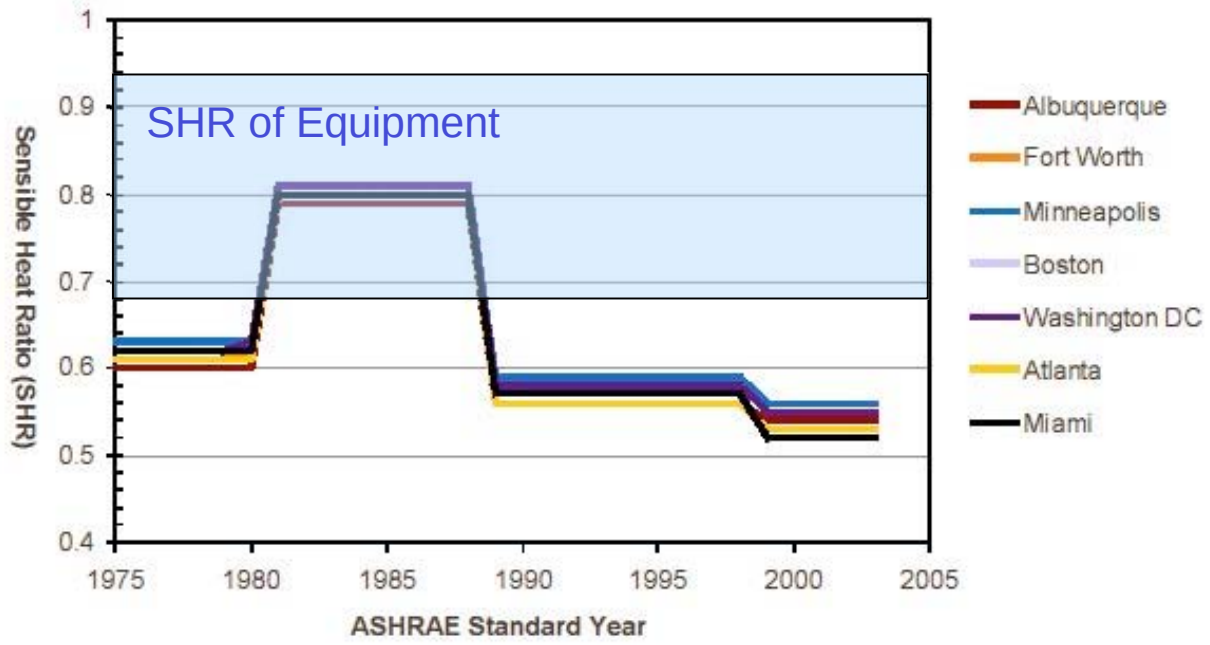

Figure E-3: Building Load SHR from 1975 – Present, at Shoulder or Part Load Condition (High Outdoor Humidity, Moderate Temperature)

Source: TIAX, Matching The SHR of AC Equipment With Building Load SHR

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What Does This Mean?

We can no longer assume that controlling temperature also controls humidity.

… some of the moisture problems we are seeing in buildings are a result of this disconnect.

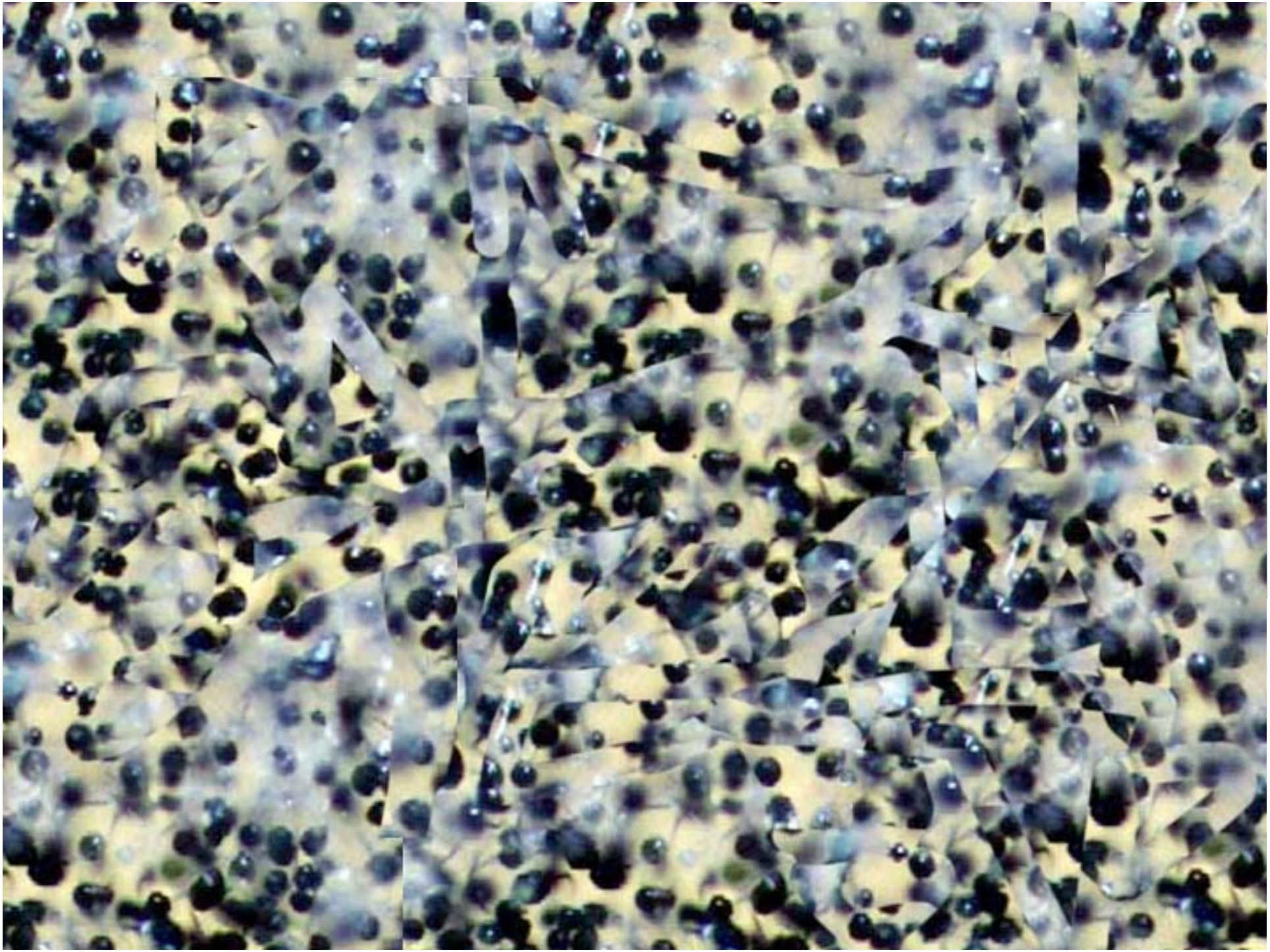
… Some Further Complications

- AC systems that are oversized
- Finding of ASHRAE Research 2003… If cooling systems run for less than 15 min:
  - Water has no time to run off coils
  - With coil off, water is re-evaporated into space as air moves over coil
  - No moisture is removed from the air
  - Moisture removal capability of coil is nullified

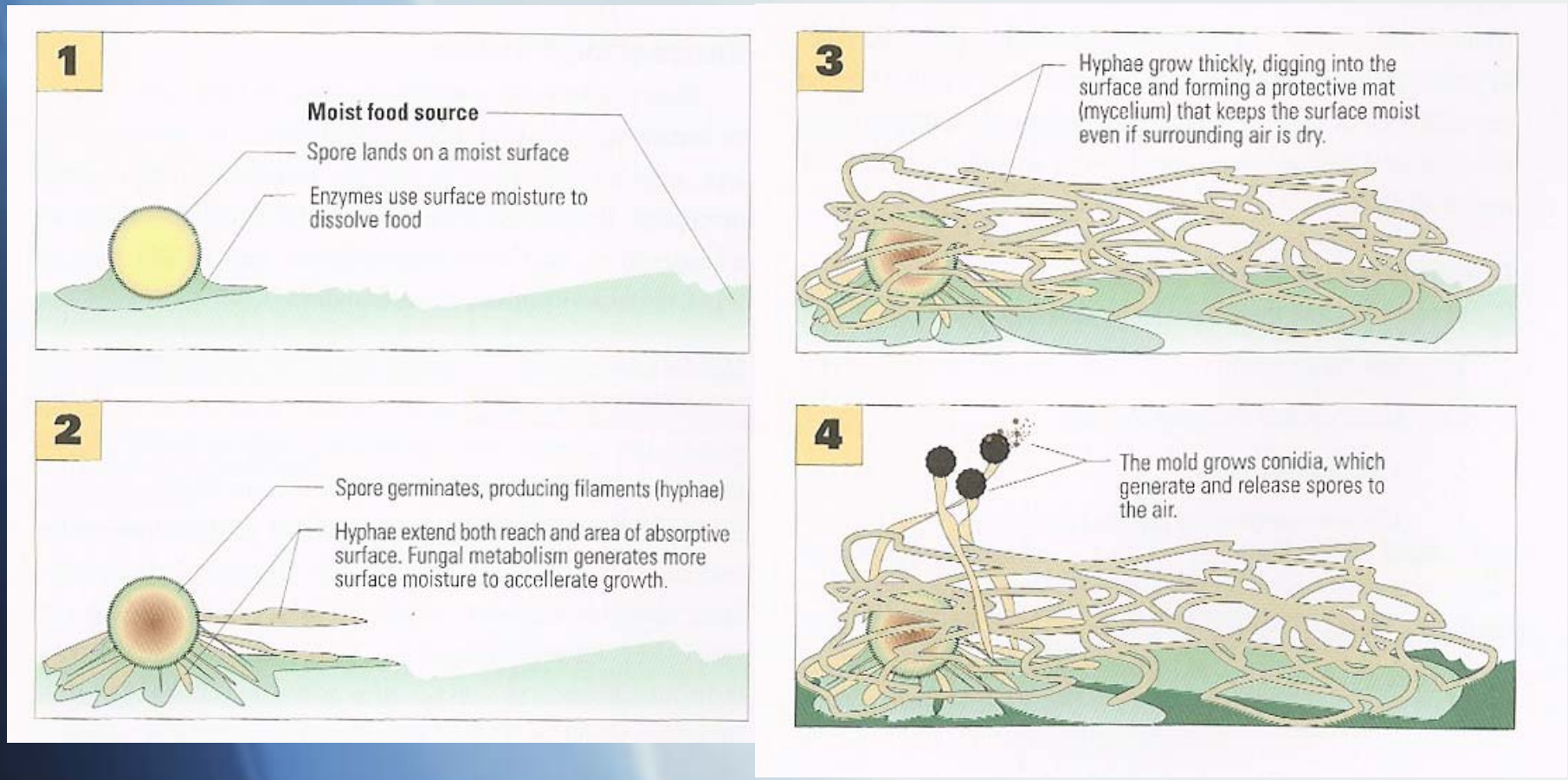
Dealing With The Latent Load

Solutions:

- CO_2 Control To Control OA To Minimum Required For Good Air Quality
- Latent Energy Recovery On OA
- Specialized Dehumidification Equipment
- Heat Pipes
- Cool-Reheat Strategies
- Eliminate Systems-Off Setback Schedule
- **Measure & Control The Right Thing**



Mold Growth Cycle



Source: ASHRAE Humidity Control Design Guide

Definitions

Relative Humidity

- The ability for air to hold moisture at a give temperature. (Will vary with temperature)

Dew Point

- The temperature at which water will condense from air. (Independent of Temperature)

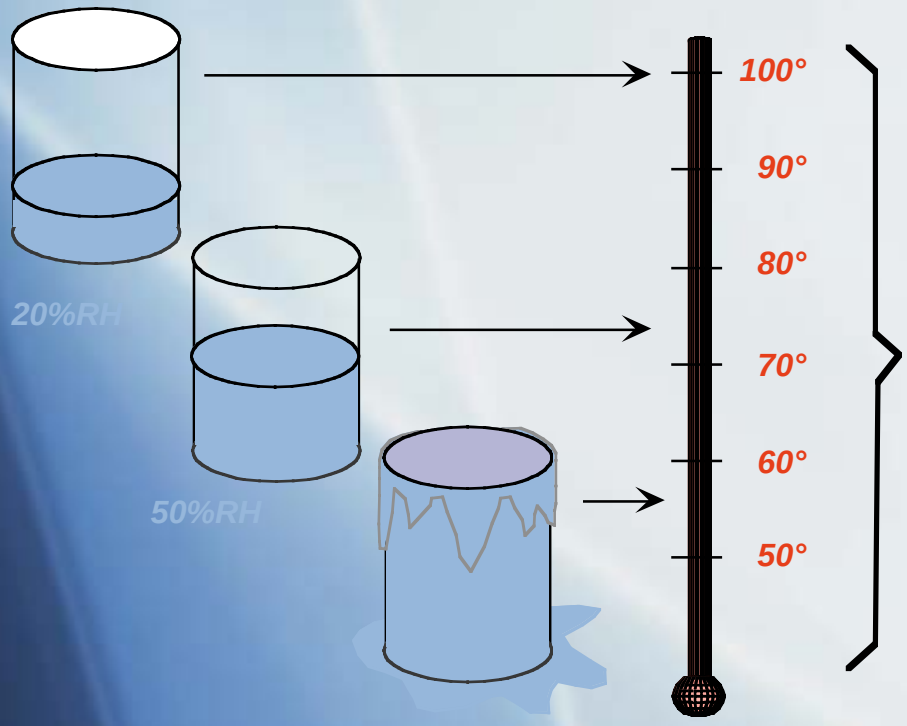
Grains/Lb of Dry Air

- The ratio of weight of water in air to weight of air. (Independent of temperature).

Relative Vs Absolute Humidity

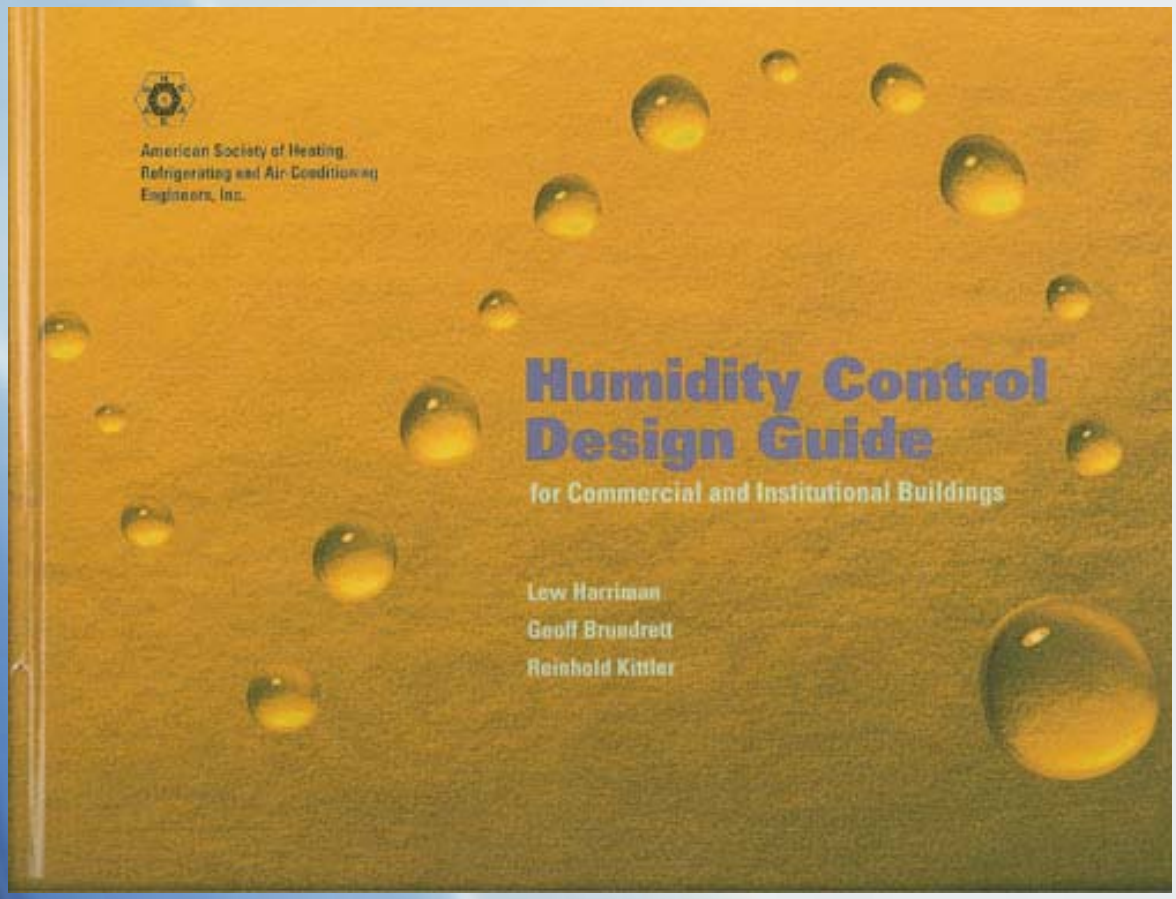
Relative Humidity

Absolute Humidity



60 grains per pound of dry air
53° Dewpoint

ASHRAE Design Guide



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Design Handbook

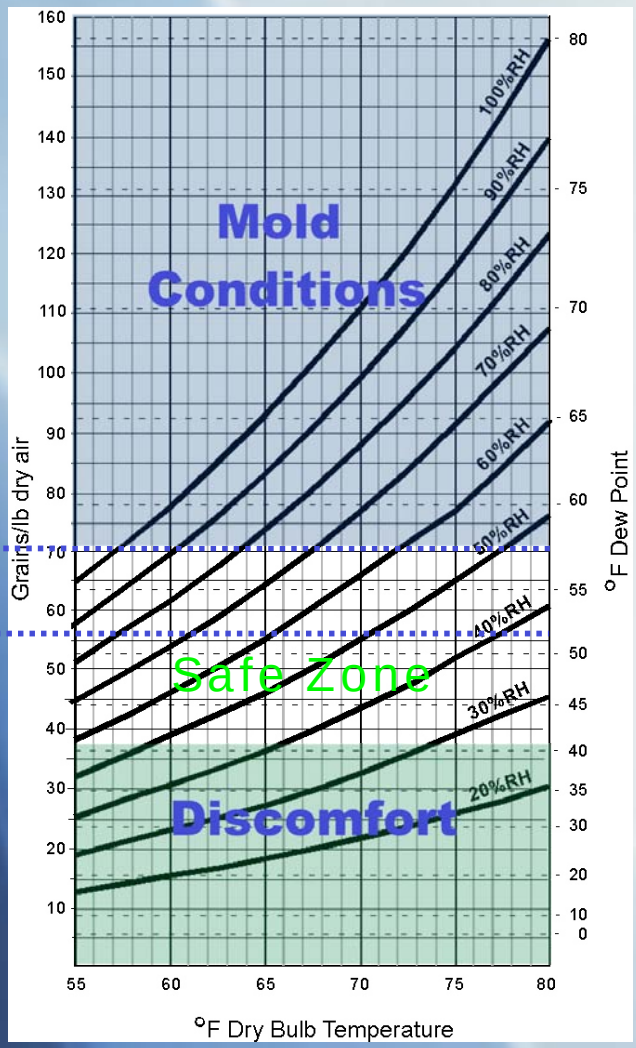
- RH Levels below 50% will not make a building safe from mold. What matters is the relative humidity at the source of the mold.

- Cold surfaces and high dew points combine to produce condensation, which creates more frequent and serious mold growth than simple high relative humidity.

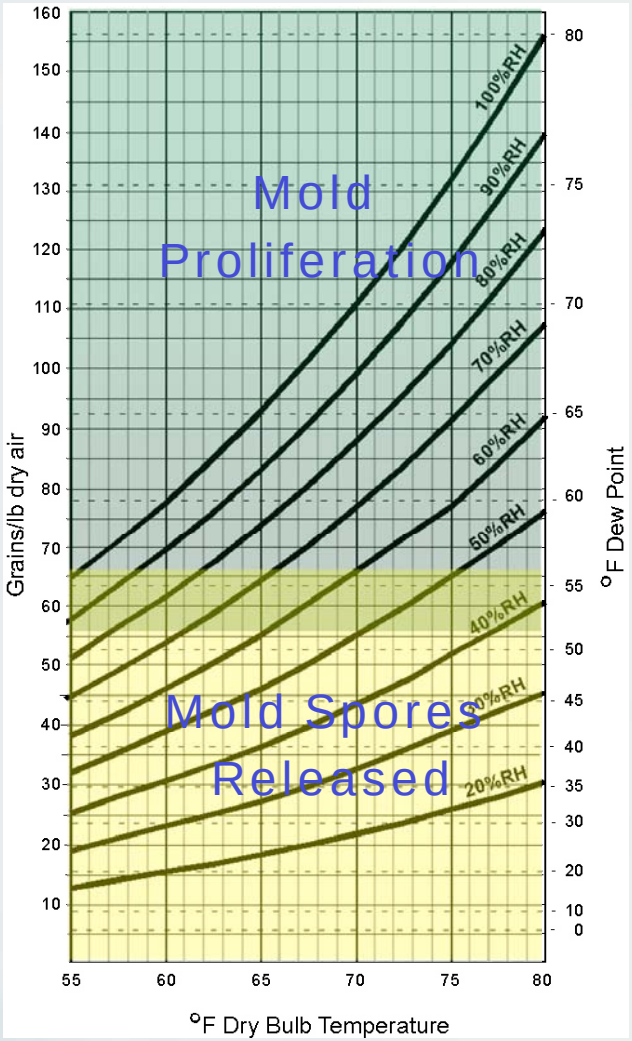
Source: ASHRAE Humidity Control Design Guide

Moisture Control Targets

Clean Building



Mold Present



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Problems With RH

- RH Varies With Temp
- A 1ºF change in temp will cause a 2% change in humidity
- Not An Efficient Control Measure Because Of Temperature Interference
- Accuracy/Durability/Quality
- Most People Are Familiar With This Measure

Summary

- Surface temperatures close to Dew Point conditions will result in mold growth
- Control strategies should ensure Dew Point never approaches temperature of cold surfaces
- Dew Point can be used to assess conditions in a building for mold… if temperature of exposed cold surfaces is know.
- Once mold appears it will thrive in a variety of conditions.
- Key strategy is to operate building to prevent liquid moisture that will support mold.

Economizer Control

Outside Air For Free Cooling

- OA Temp Control Ignores High Latent Loads
- Differential Enthalpy
  - Low cost sensor are not accurate or do not work
  - Can increase latent/cooling load in buildings under some conditions
- ASHRAE Design Guide Solution: Dew Point And Temperature
  - **55ºF Dew Point, lower OA than RA temp.**

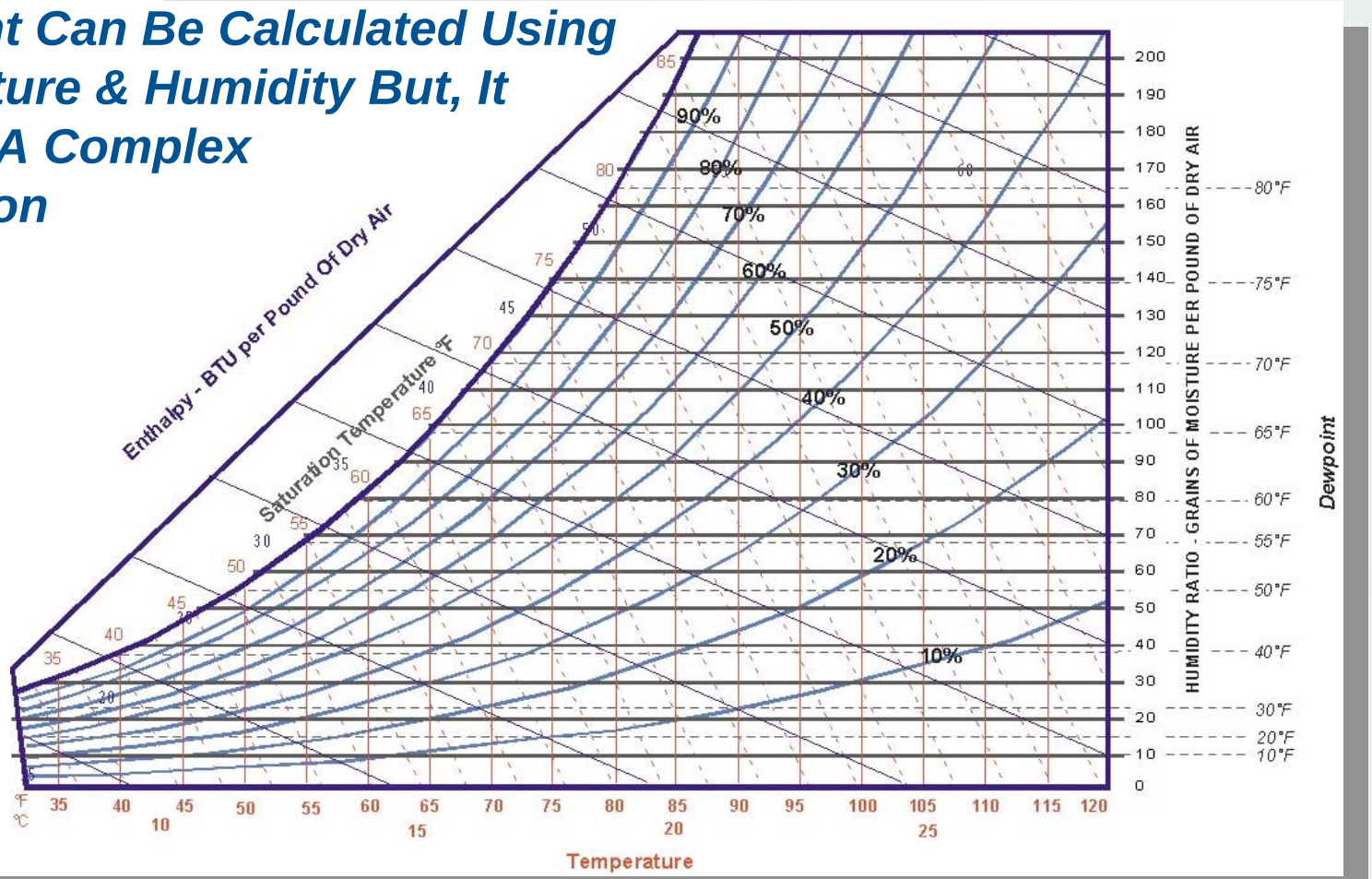
Dew Point Rule

The Dew Point should not exceed the temperature of the coldest surfaces in the space.

Where are the coldest surfaces?

The Dew Point Challenge

Dew Point Can Be Calculated Using Temperature & Humidity But, It Involves A Complex Calculation



The Dew Point Challenge

Chilled Mirror Instrumentation the Measures Dew Point Directly Is Priced More For Laboratory Applications

But, proliferation of low cost microprocessors is making Dew Point easier to measure …

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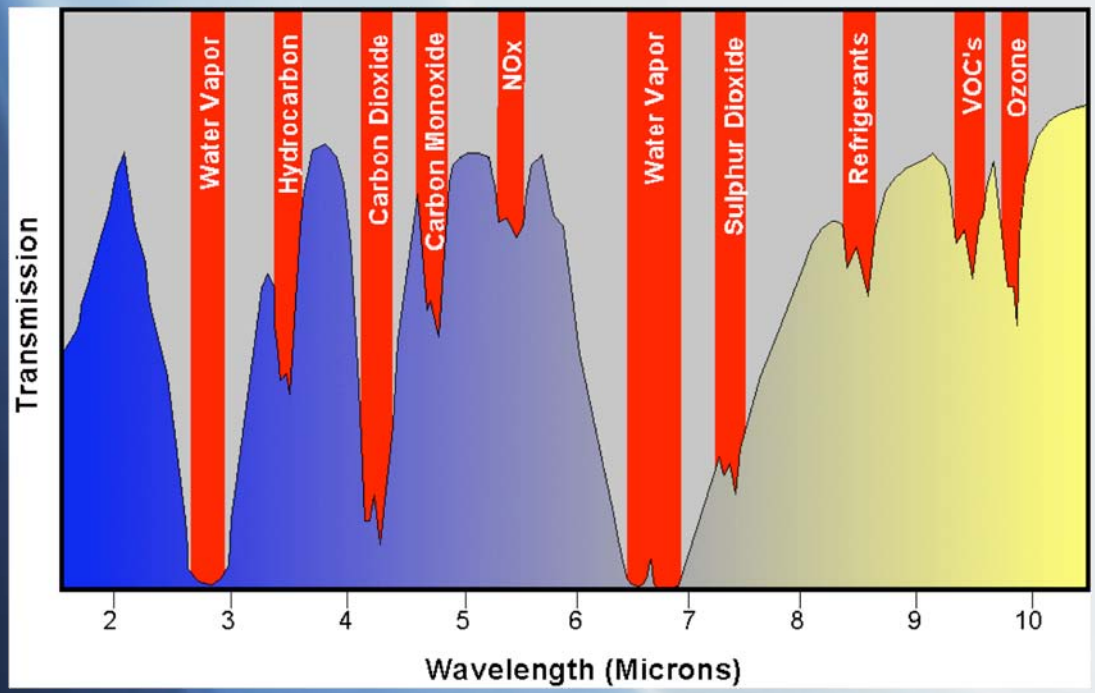
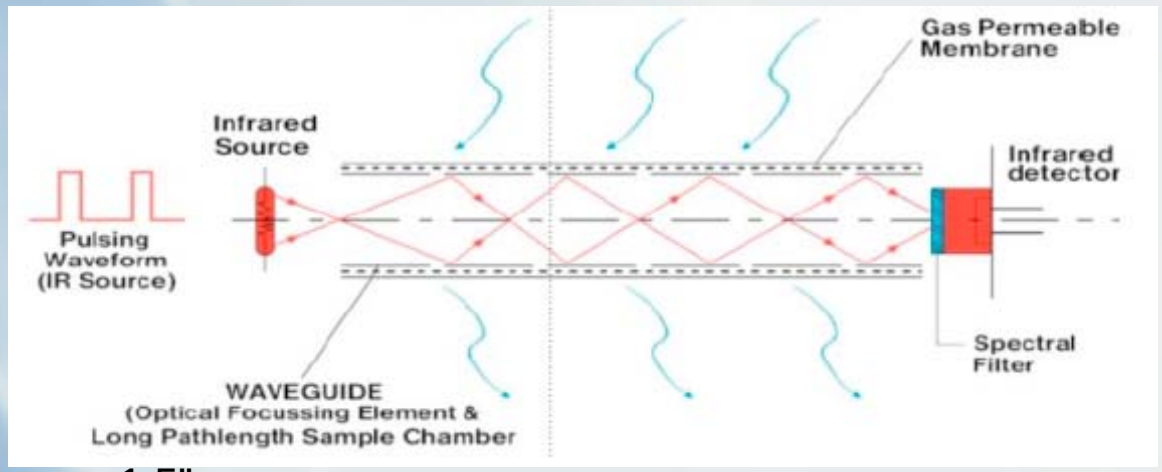
Infrared Sensors

Infrared Sensor Can Be Used To Measure The Number Of Water Molecules In Air… Which Is A Direct Dew Point Measurement



Infrared Measurement Principals



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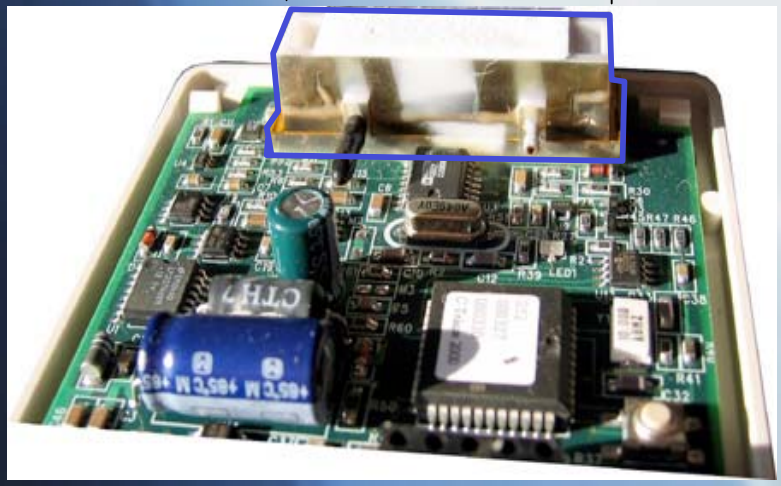
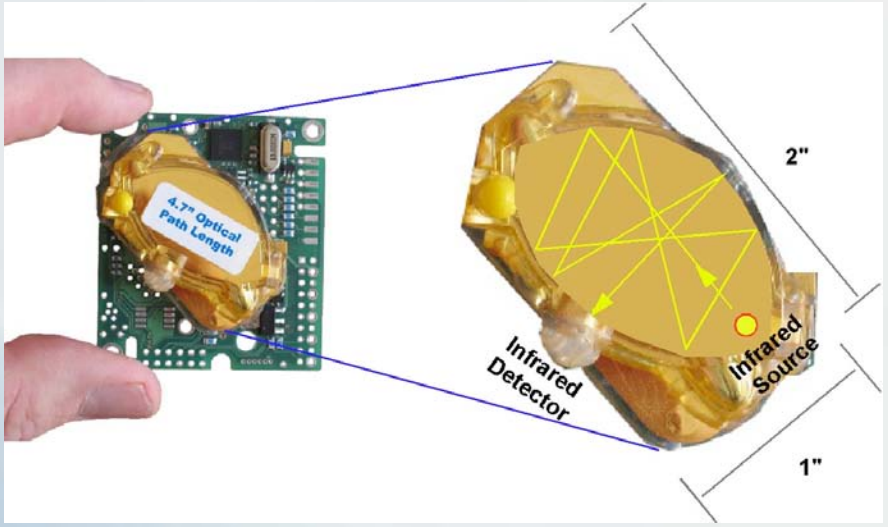


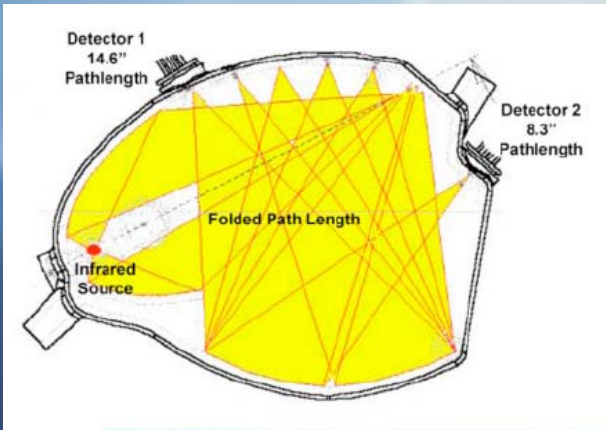


Water Vapor Measurement

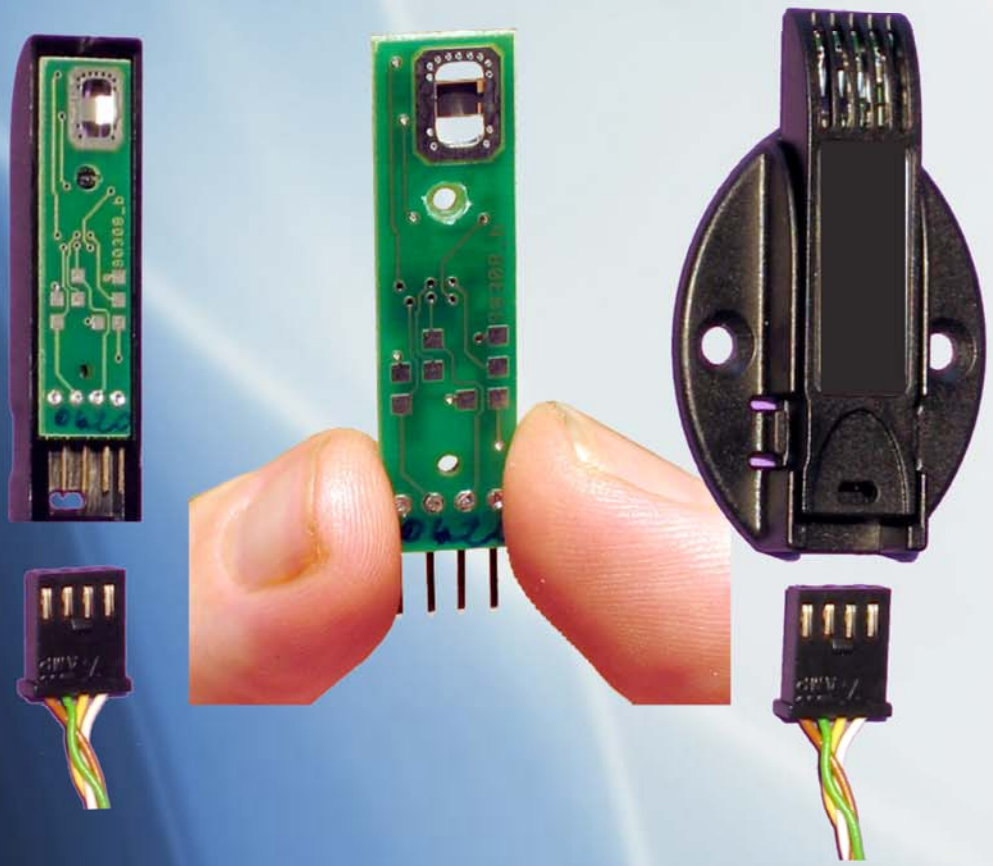
Grains/lb	PPM (Vol)	DP	Hg VP
HVAC Range			
200	45,935	87.36	1.30909
180	41,342	84.20	1.18346
140	32,155	76.77	0.92879
120	27,560	72.30	0.79973
100	22,966	67.10	0.66948
80	18,373	60.86	0.53804
60	13,780	53.01	0.40539
40	9,186	42.36	0.27150
20	4,593	25.93	0.13625
Instrument Range			
10	2,295	11.64	0.06827
8	1,836	7.21	0.05464
6	1,377	1.62	0.04100
4	918	(6.04)	0.02734
3	688	(11.32)	0.02051
2	458	(18.56)	0.01367
1	228	(30.42)	0.00684
0.8	183	(34.10)	0.00547
0.6	136	(38.75)	0.00410
0.4	92	(45.15)	0.00273
0.2	45	(55.64)	0.00137
0.1	22	(65.61)	0.00068
0.05	11	(75.03)	0.00034
0.025	4	(84.08)	0.00017

Based On Sea Level Pressures

Path Length Improvements

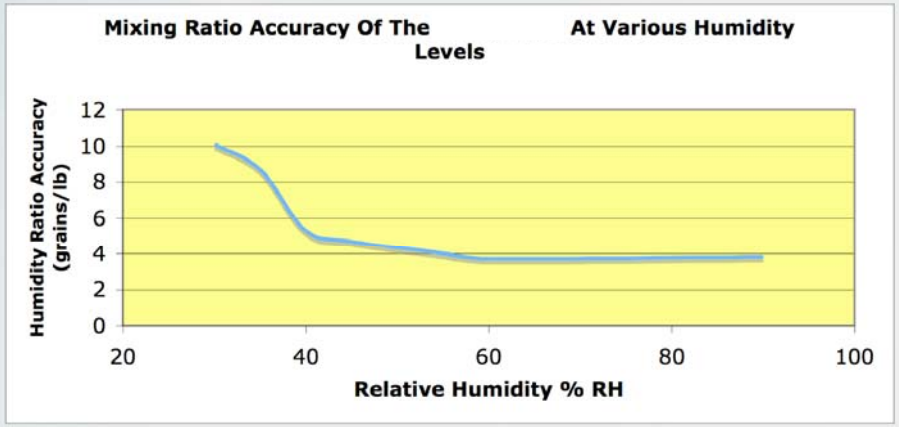


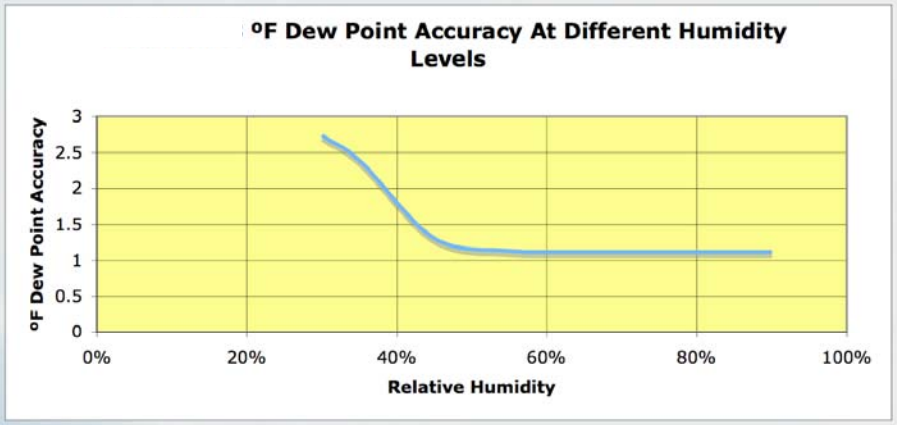
Surface Humidity Measurement



Space Sensing

On Board Calculation Of
Dew Point /Mixing Ratio
± 2% RH, ± 0.45ºF





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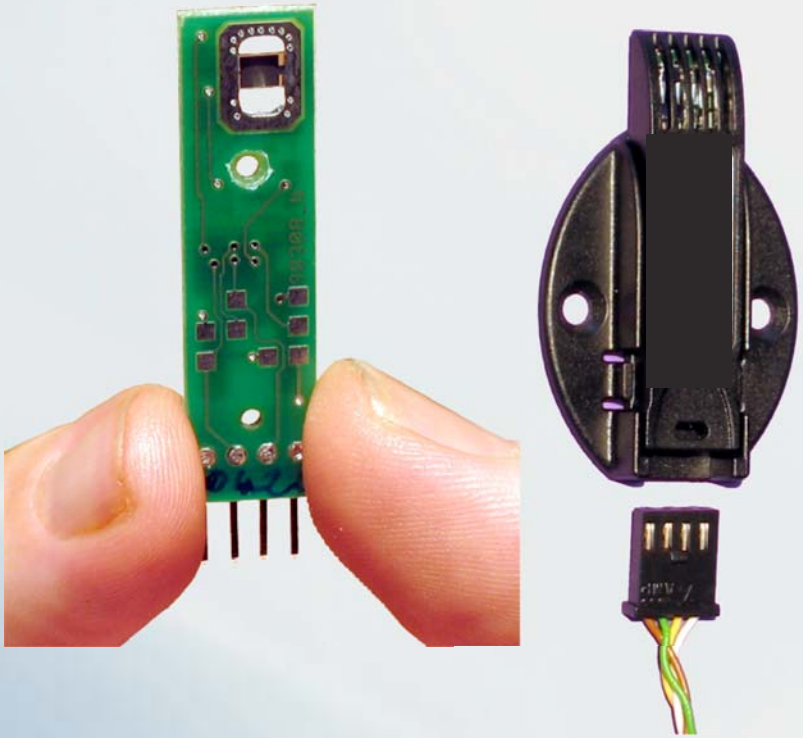
Example: Higher Quality OA Sensors

Choice RH, Enthalpy, Dew Point
One Sensor Controls # Of Units

OEM Sensors For Equipment
Microprocessor Based
Accurate Temp, RH, Dew Point
Environmental Coating For Long Life



Conclusion

- Using Dew Point as a humidity control parameter will allow separate control of latent and sensible components of cooling.
- Dew Point/Mixing Ratio measurements are becoming much more affordable