Humidity Control & Psychrometrics

Iowa Chapter of ASHRAE
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Humidity Control & Psychrometrics …

Designing for Absolute Humidity Control

Why do we “air-condition” our buildings?

- Control Temperature
- Control Humidity/Moisture
- Control Air Movement
- Control Air Quality

- **CONTROL** the environment!

Why is it so hard to control HUMIDITY?

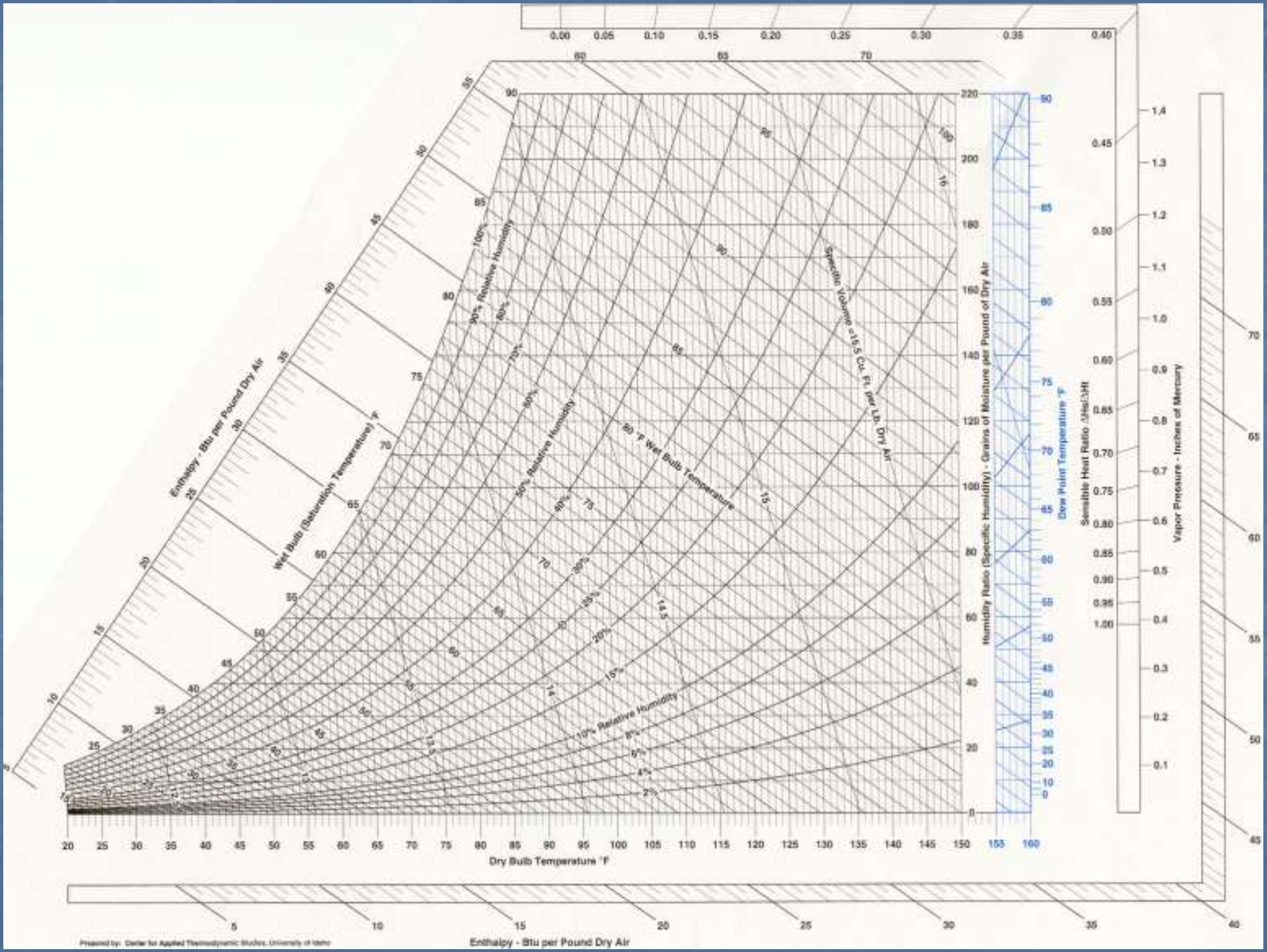
- Lack of understanding of PSYCHROMETRICS
- Unaware of published ASHRAE Weather data (since 1997 *Fundamentals Handbook)*
- Installing inappropriate equipment for the task (selection type and/or capacity)

PSYCHROMETRICS

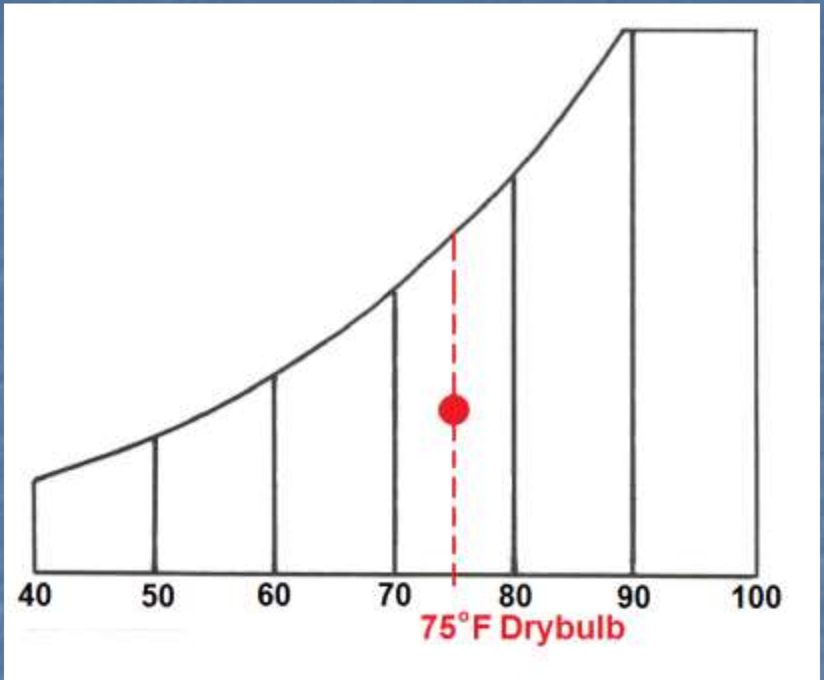
Definition: Is the study of the physical and thermodynamic properties of air and water vapor mixtures.

All the air we breathe contains some amount of moisture.

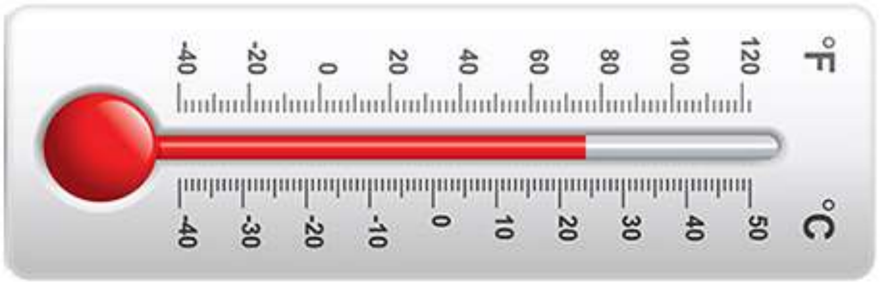
Psychrometric Chart



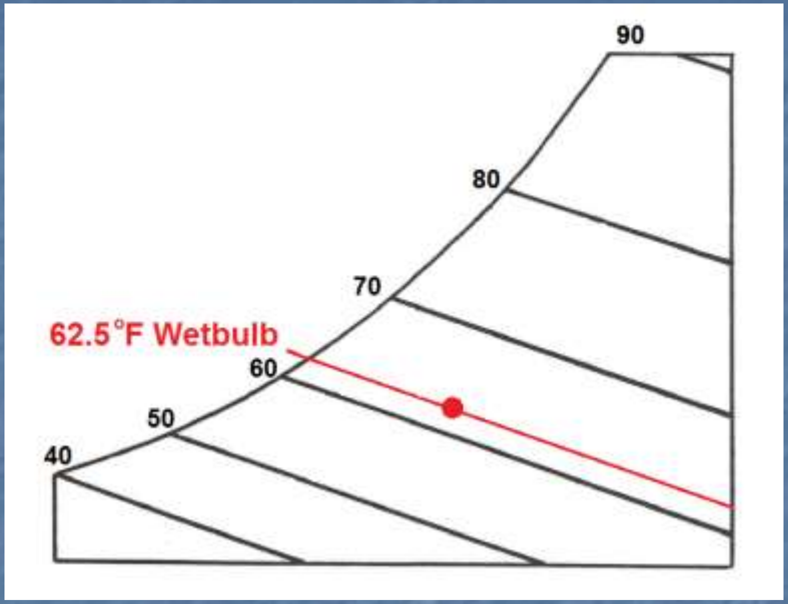
Dry Bulb Temperature



The temperature of air as measured by a thermometer with a dry sensing bulb

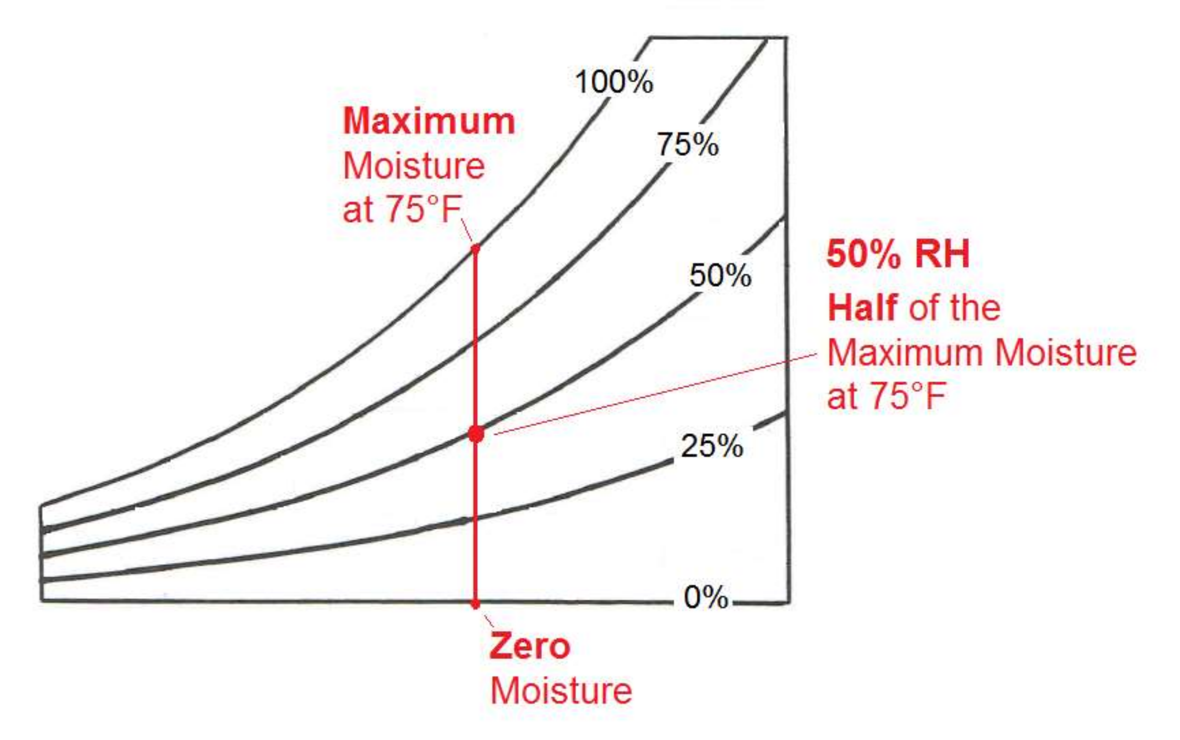


Wet Bulb Temperature



- The temperature at which water will evaporate into the air sample.
- Physically… the temperature of air when measured by a thermometer with a wetted wick over the sensing bulb.

Relative Humidity



- The amount of water vapor in the air, compared to its maximum capacity at that specific dry bulb temperature
- *Relative* measurement… not *absolute*

Why is Understanding “Relative Humidity” Beneficial?

Many charts, tables and standards use “Relative Humidity” as a reference or guideline.

ASHRAE Human Comfort Zone

(2013 ASHRAE Handbook – Fundamentals, Ch. 9)

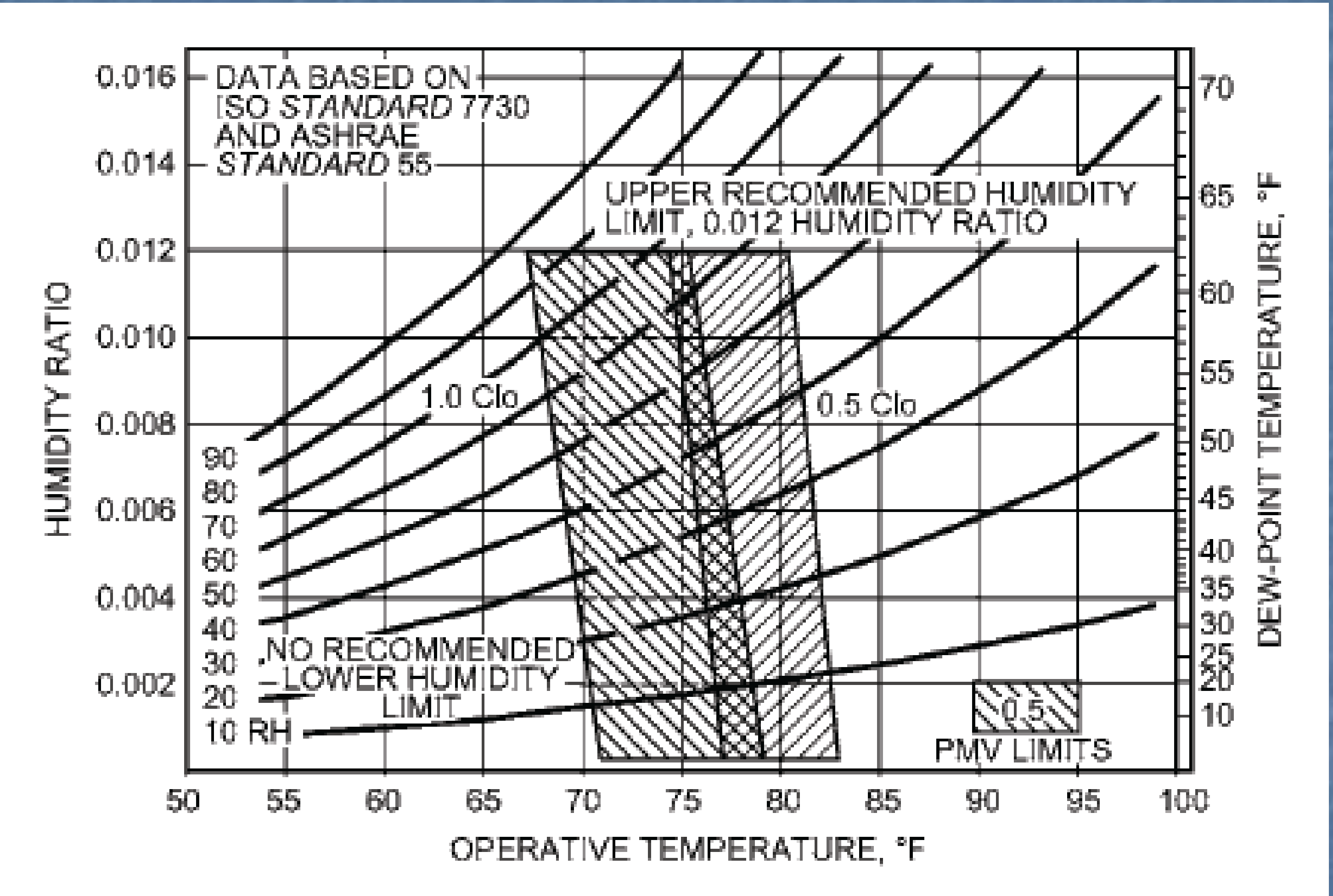
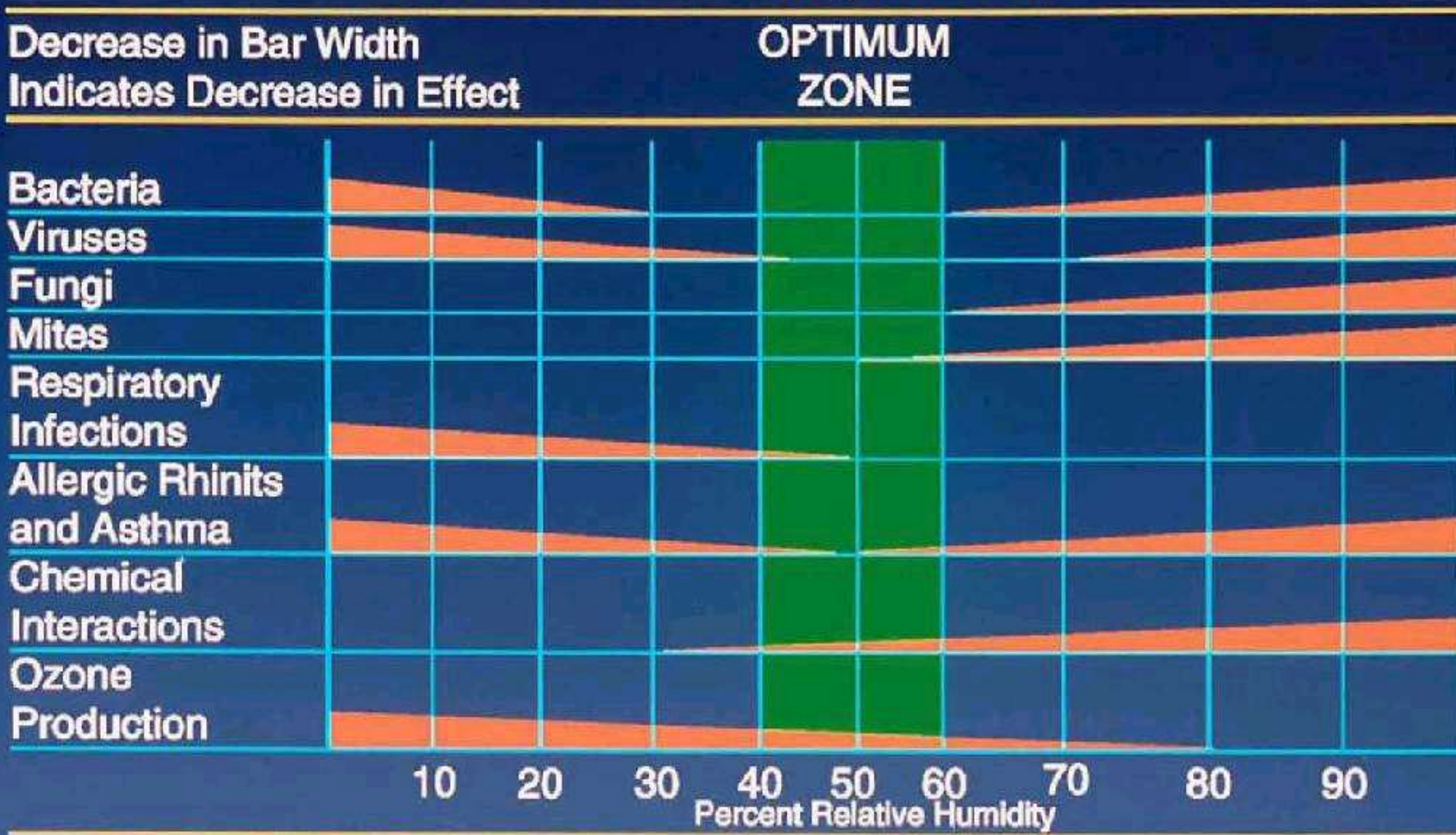


Fig. 5 ASHRAE Summer and Winter Comfort Zones
(Acceptable ranges of operative temperature and humidity for people in typical summer and winter clothing during primarily sedentary activity.)

INDOOR AIR QUALITY

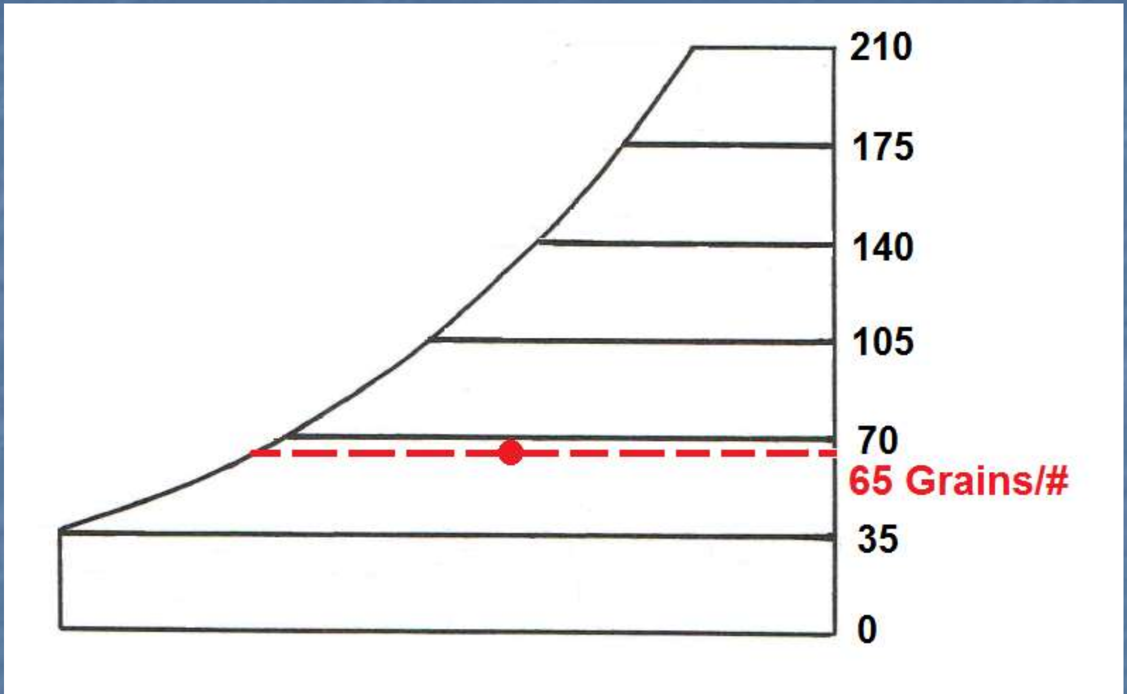
Effect of room humidity on selected human health parameters



Building Indoor Air Quality – The Mold Square

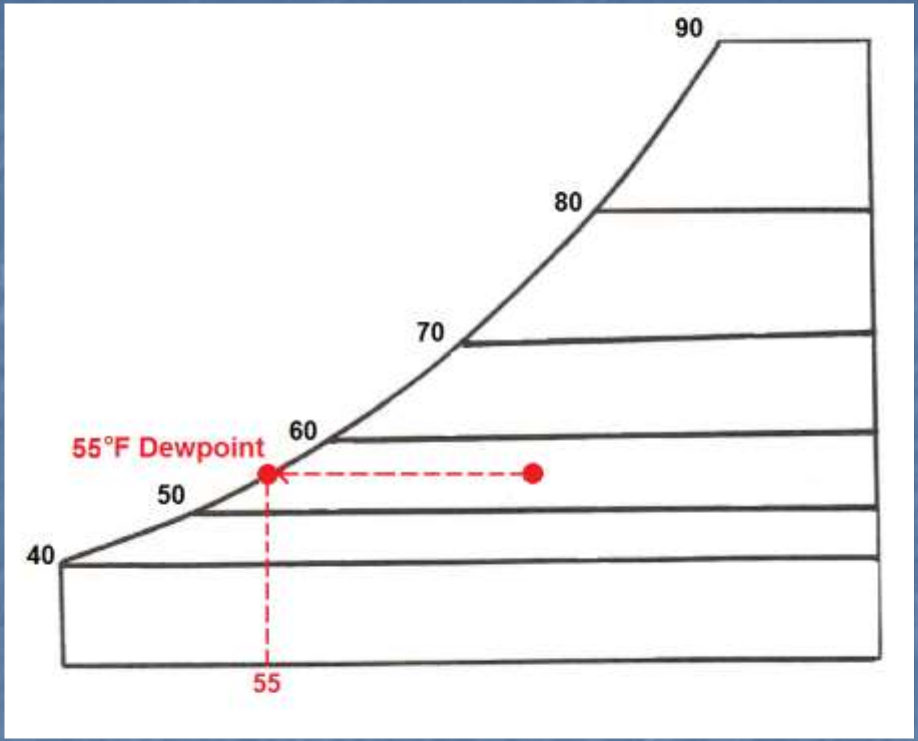
- Molds and mildew are fungi that grow on the surfaces of objects, in pores, and in deteriorated materials. They can cause discoloration and odor problems, deteriorate building materials, and lead to allergic reactions in susceptible individuals, and other health problems.
  - The following conditions are necessary for mold growth to occur on surfaces:
    - Temperature between 40°F and 120°F
    - Nutrient base (most surfaces contain nutrients)
    - **Moisture**
    - Mold spores

Absolute Humidity: Humidity Ratio



- The weight of water vapor divided by the weight of the dry air (lb_w/lb_a) - an ***absolute*** measurement
- lb_w/lb_a x 7000 = grains of water per lb of air

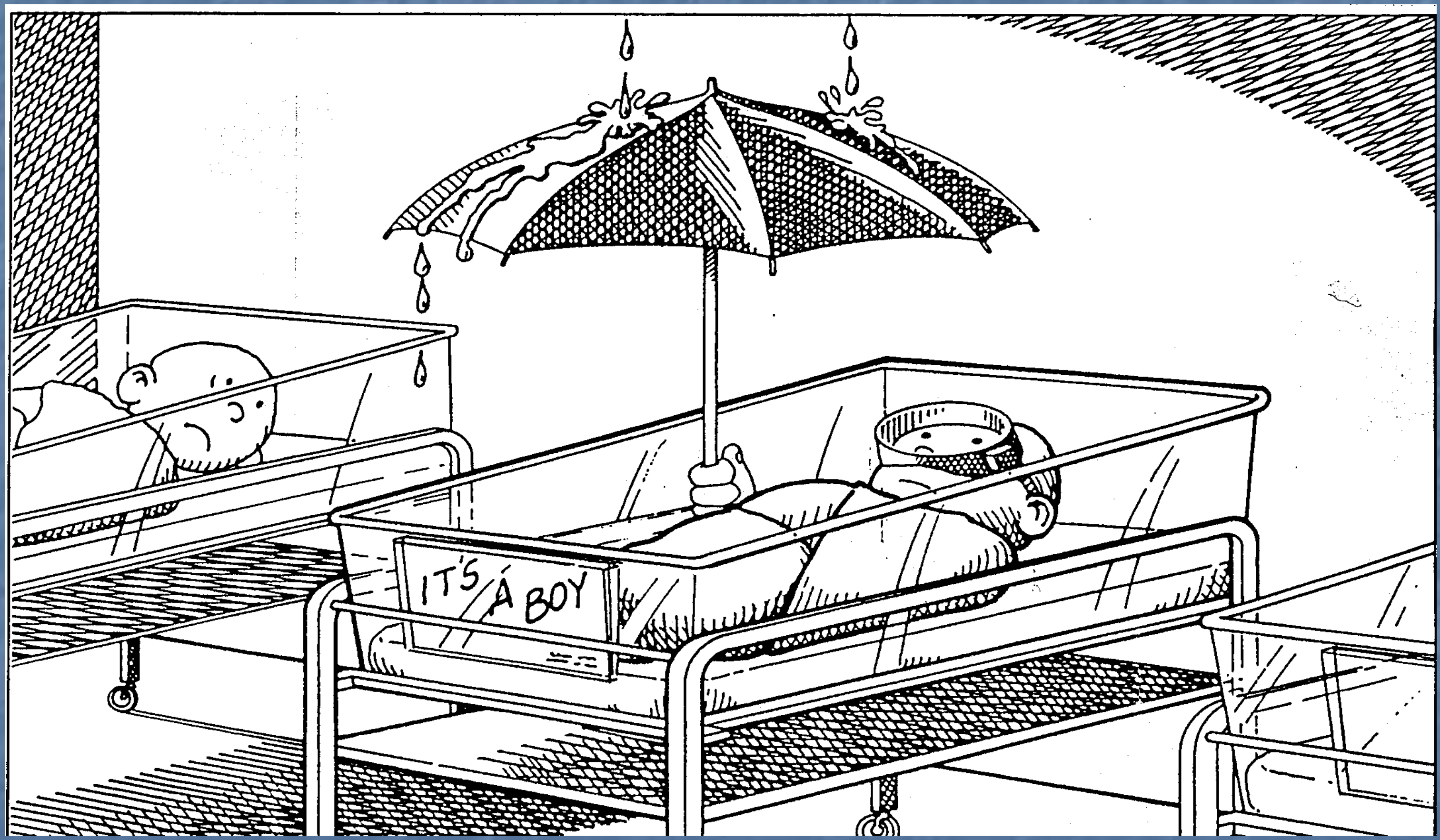
Dew Point

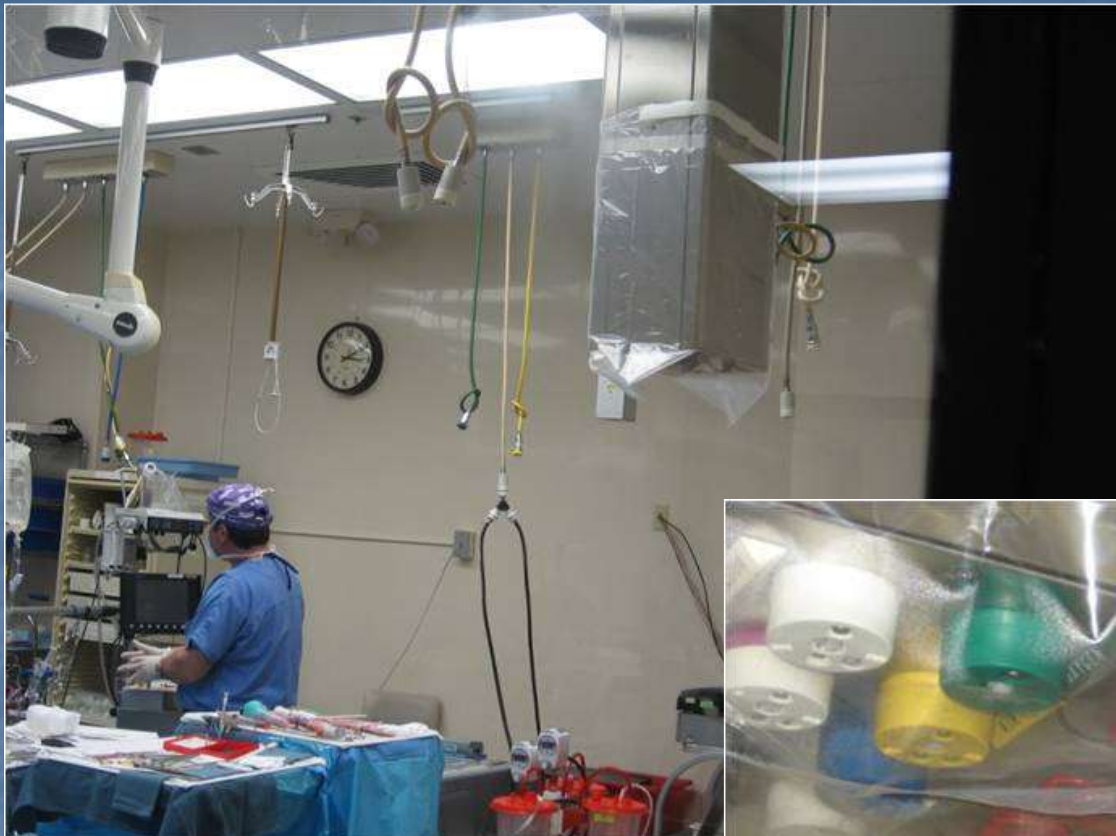


- The temperature at which the moisture contained in the air will begin to condense (i.e., the temperature at which the air sample would be 100% RH).
- Another *absolute* measurement of moisture

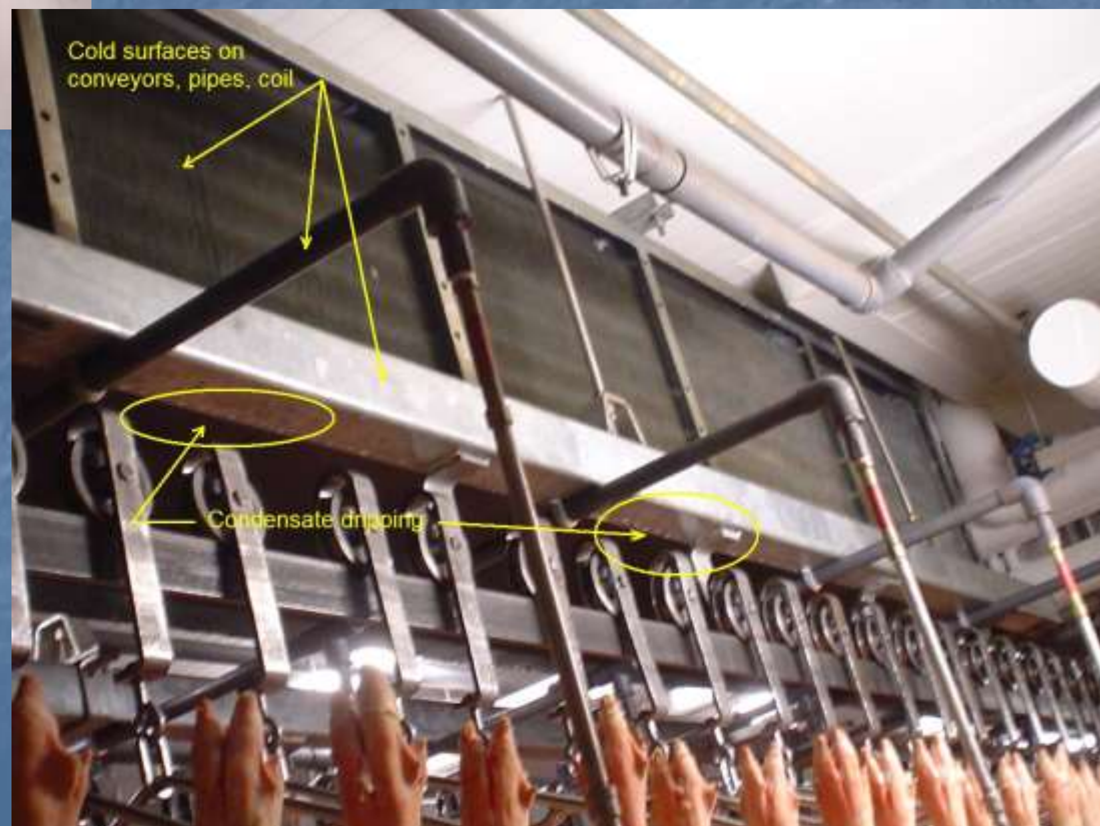
Why is it important to understand “dewpoint”?

"Raining" in the Operating Rooms!



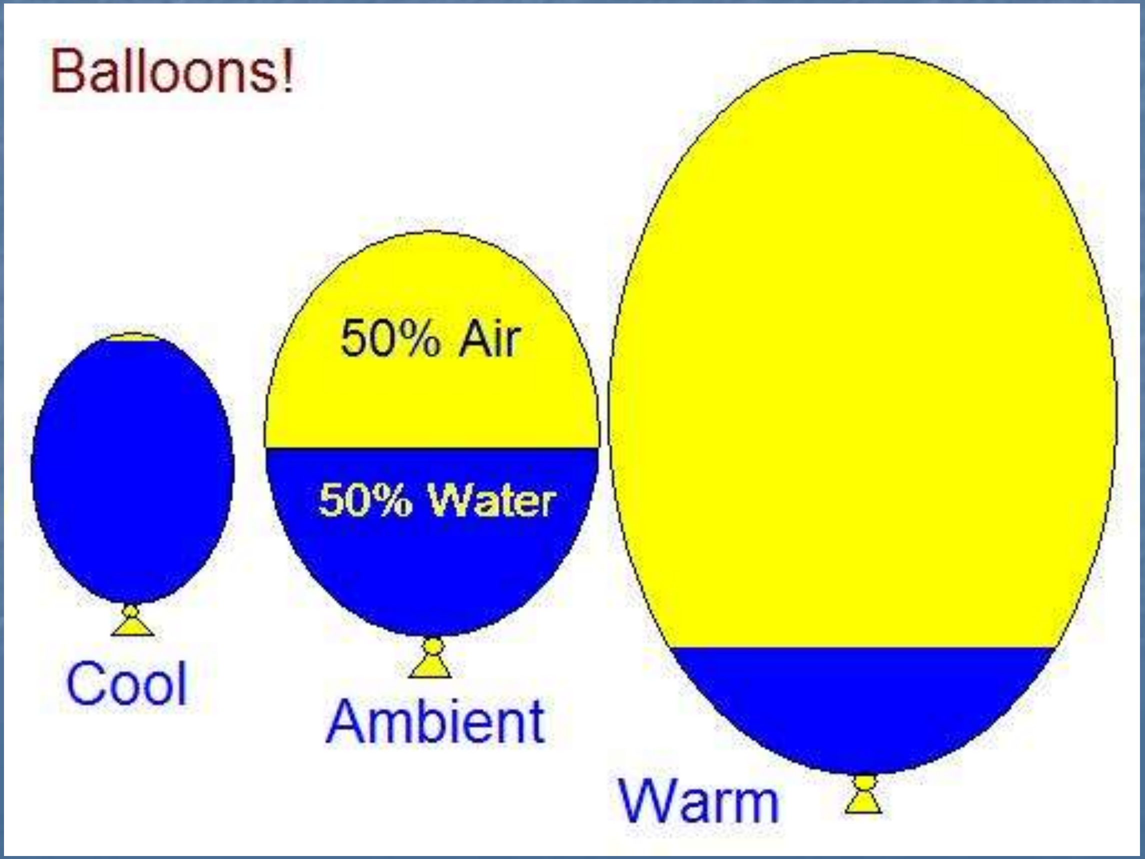



What happens when the dewpoint temperature of the air is greater than the surrounding surfaces' temperature?

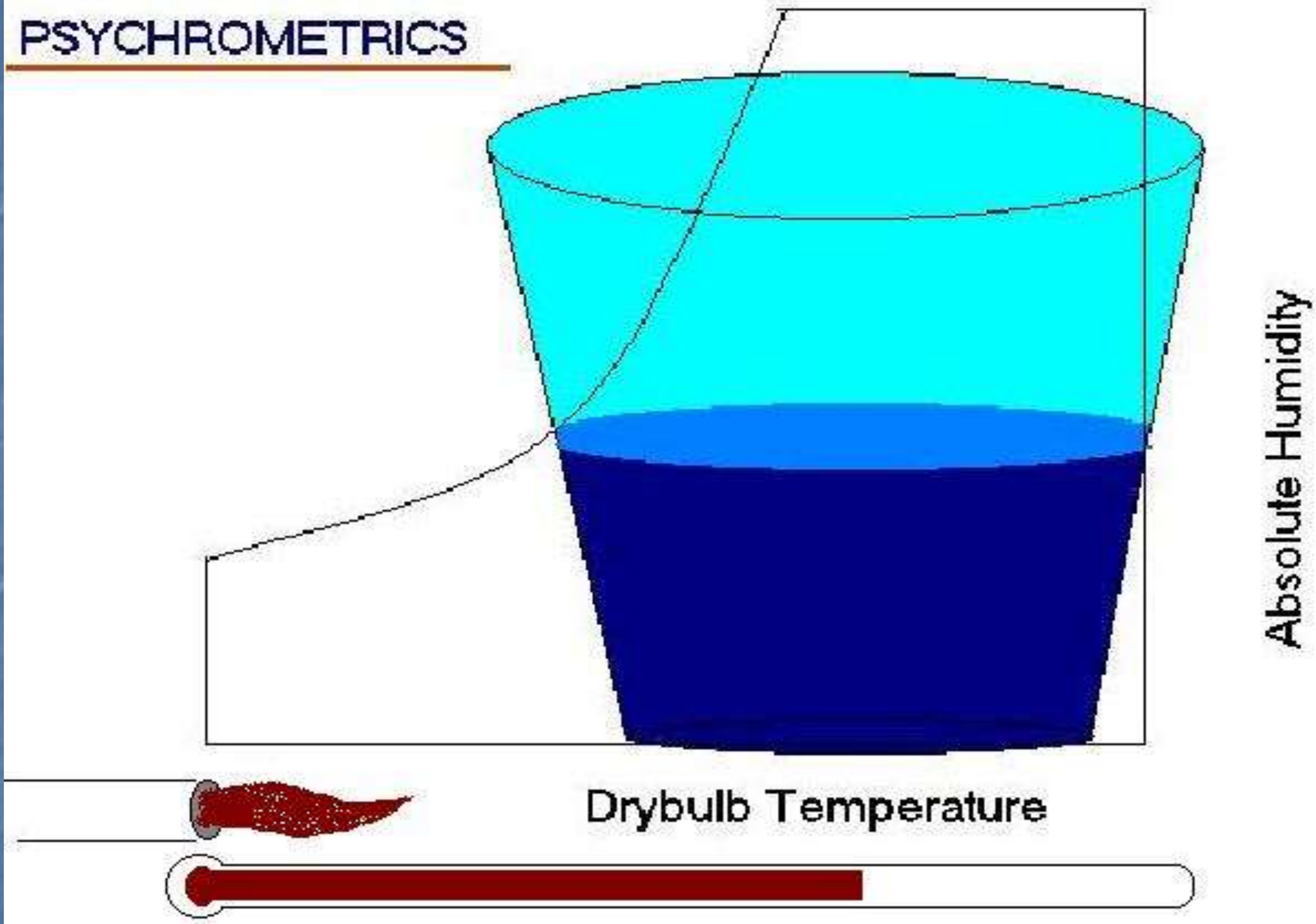


Absolute Humidity vs. Relative Humidity

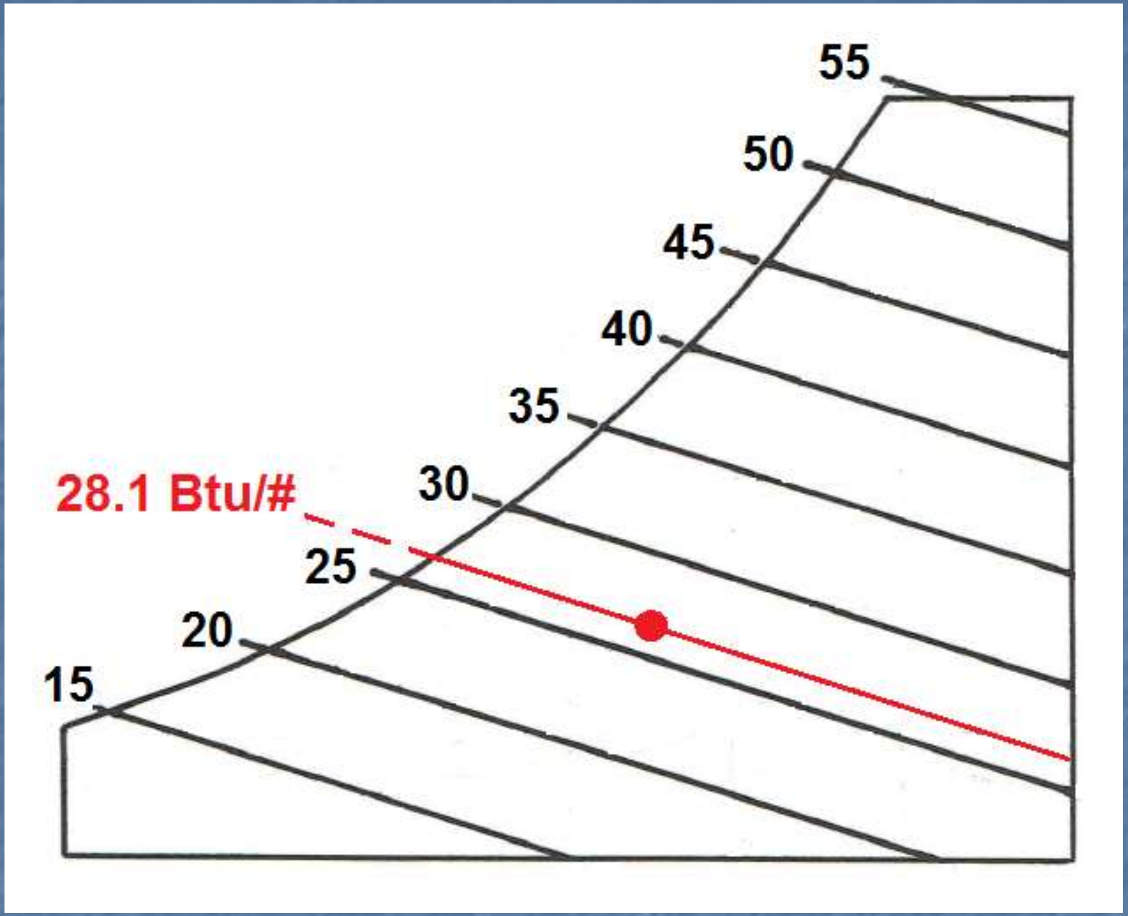
Consider the balloon of 1 Ft^3 volume at ambient temperature with an absolute amount of water of 1 gallon. What happens when the balloon is either heated or cooled? What is the new "relative" volume of water? What is new "absolute" volume of water?



PSYCHROMETRICS



Enthalpy



- Total Amount of Energy in the air
- BTU/# Dry Air

Heat Load Formulas

- **Total Load (i.e., Sensible + Latent)**

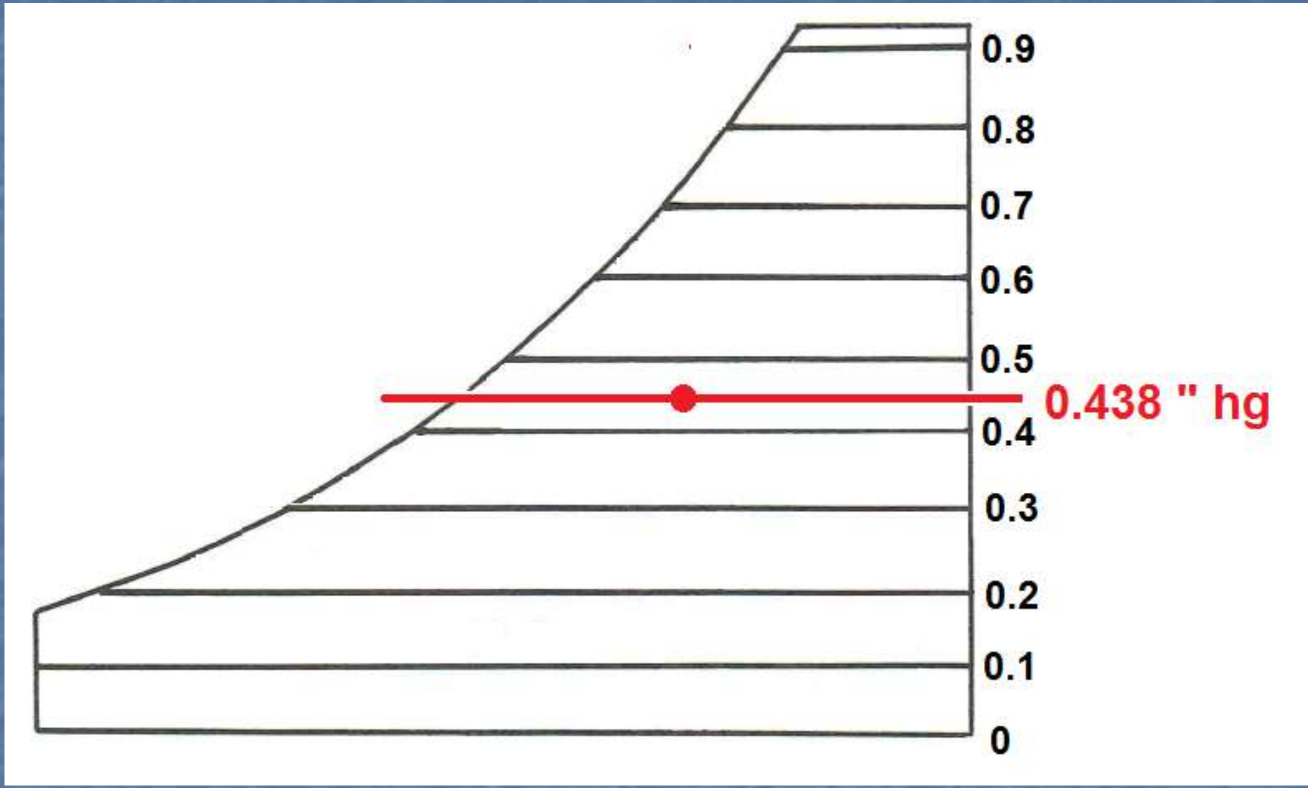
  QT = 4.5 x (Enthalpy Difference) x cfm
- **Sensible Load**

  QS = 1.08 x (Temperature Difference) x cfm
- **Latent Load**

  QL= 0.68 x (Humidity Ratio Difference) x cfm

$$Q_T = Q_S + Q_L$$

Vapor Pressure



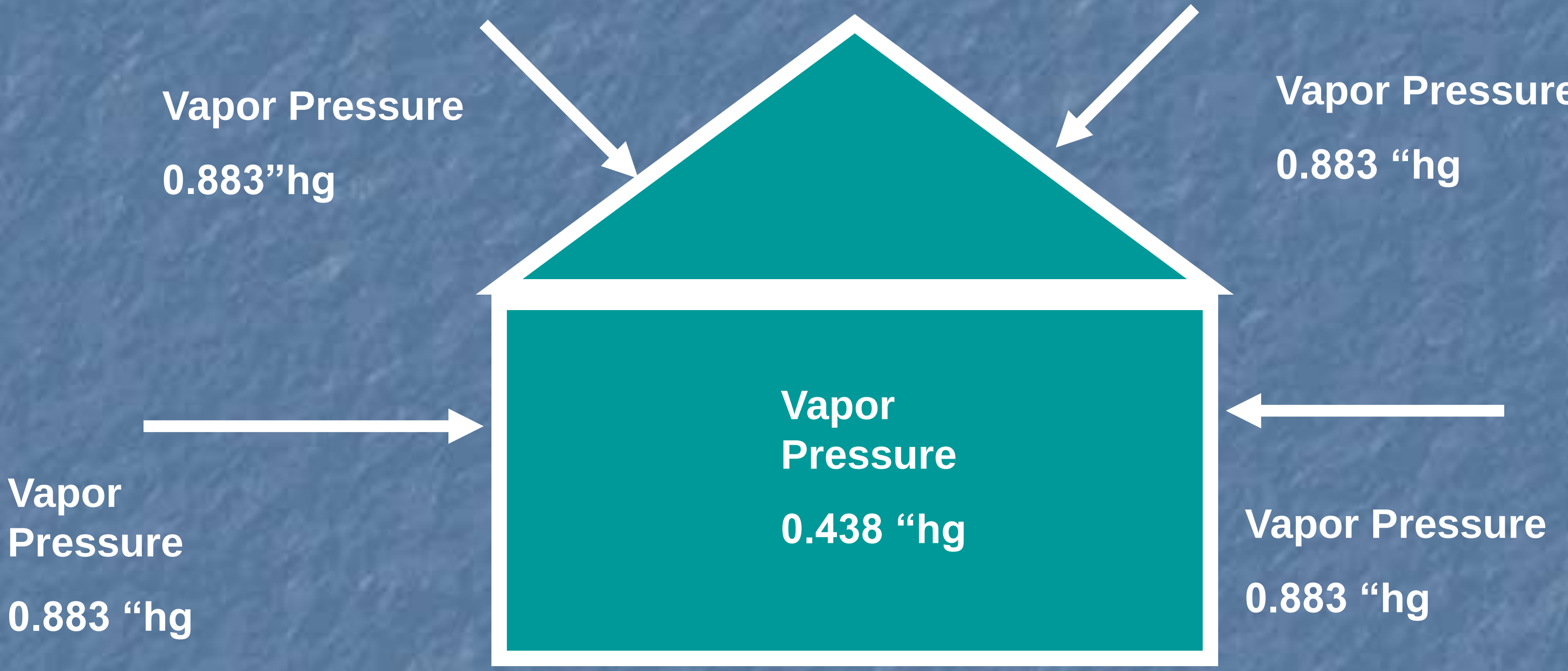
- A measure of how high the water vapor can lift a column of mercury due to its pressure.

Moisture travels from the HIGHER Vapor Pressure to the LOWER Vapor Pressure. The difference in Vapor Pressure is the driving force behind moving water vapor.

Applied Psychrometrics

- What is the Vapor Pressure of the air inside a building at the conditions of 75°F drybulb and 50% RH? 0.438" HG
- What is the Vapor Pressure of the air outside a building at the conditions of 82°F drybulb and 77°F wetbulb? 0.883"HG
- Vapor Pressure Differential of 0.445"HG (x 13.596 = 6.052" WG)

Influence of Vapor Pressure



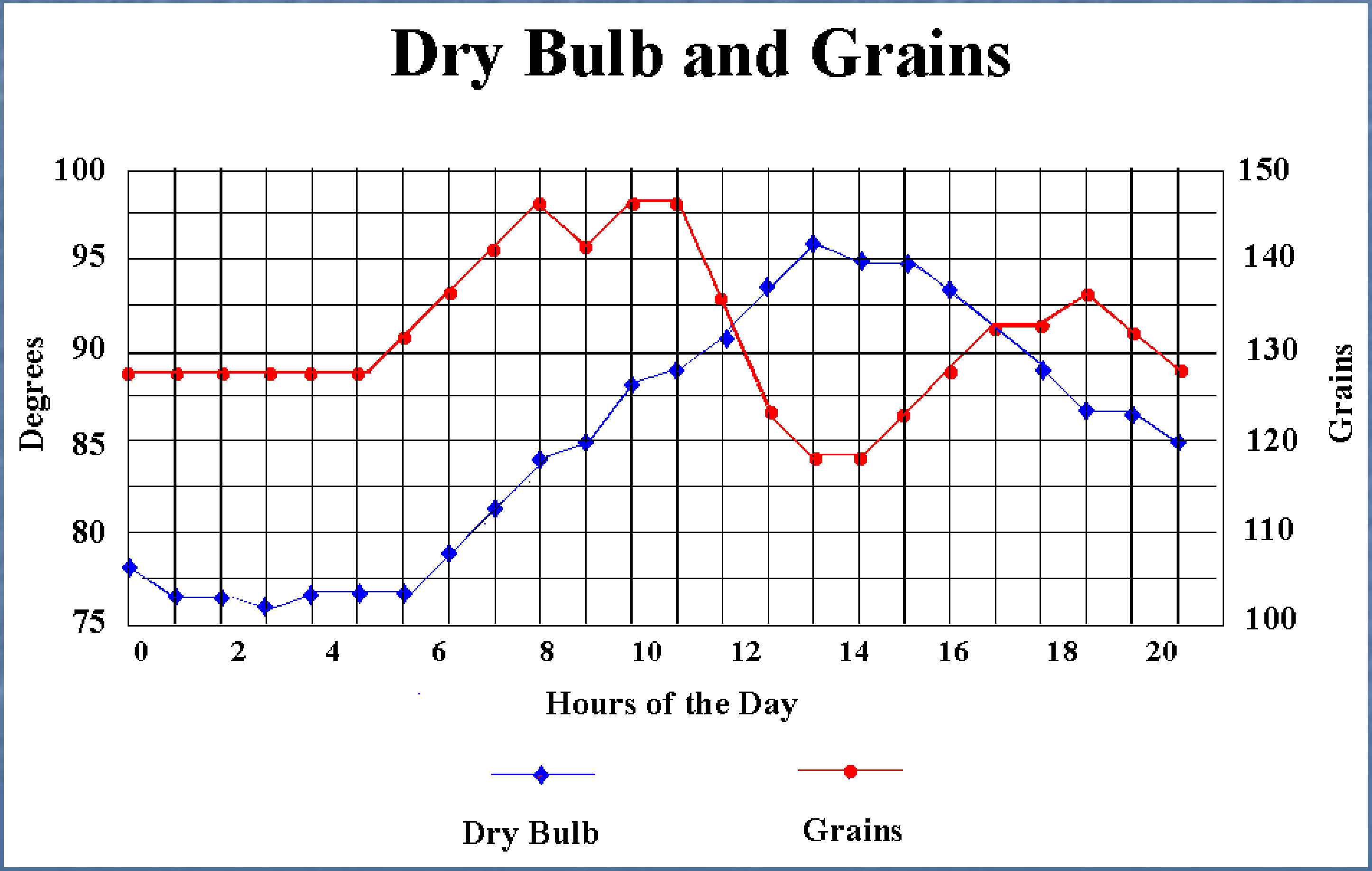
(0.883-0.438) X 13.596 = 6.052" wg

Bernoulli's Equation: Dynamic Velocity Rate=4005 $\sqrt{6.052}$ = 9,852.6 FPM = 112 MPH

Outside Air Design Conditions

Understanding ASHRAE Weather Tables

Typical Ambient Conditions



2013 ASHRAE Fundamentals Handbook – Climatic Conditions

DES MOINES INTL, IA, USA

WMO#: 726460

Lat: 41.54N Long: 93.67W Elev: 965 StdP: 14.19 Time Zone: -6 (NAC) Period: 86-10 WBAN: 14933

Annual Heating and Humidification Design Conditions

	Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		
				99.6%			99%			0.4%		1%				
		99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	
(1)	1	-6.3	-0.2	-13.1	2.8	-4.2	-8.7	3.6	0.8	30.2	13.3	26.9	20.9	9.8	310	(1)

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

	Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB		
			0.4%		1%		2%		0.4%		1%		2%				
			DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(2)	7	17.9	92.6	76.4	89.8	76.1	86.9	73.3	78.6	88.5	77.1	86.8	75.6	84.1	12.2	180	(2)

	Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Hours 8 to 4 & 55/69	
	0.4%			1%			2%			0.4%		1%		2%			
	DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(3)	76.6	138.7	84.7	74.1	131.9	83.4	72.6	126.0	81.6	42.8	88.8	41.2	86.8	39.7	84.6	821	(3)

Extreme Annual Design Conditions

	Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB								
					Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years		
	1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(4)	25.4	22.3	19.6	86.1	-11.4	96.8	6.2	3.1	-16.1	99.0	-18.2	100.8	-21.1	102.6	-24.8	104.9	(4)

Monthly Climatic Design Conditions

				Annual (d)	Jan (e)	Feb (f)	Mar (g)	Apr (h)	May (i)	Jun (j)	Jul (k)	Aug (l)	Sep (m)	Oct (n)	Nov (o)	Dec (p)	
(5)	Temperatures, Degree-Days and Degree-Hours		Tavg	50.9	23.2	27.3	39.4	51.8	62.2	71.7	76.8	73.8	65.5	53.0	39.3	26.8	(5)
(6)			Sd		12.23	12.38	11.78	9.99	7.93	6.38	5.44	5.98	7.87	9.51	10.51	11.50	(6)
(7)			HDD50	3085	832	638	367	96	6	0	0	0	2	78	348	722	(7)
(8)			HDD65	6172	1297	1067	796	416	160	17	1	7	90	388	770	1186	(8)
(9)			CDD50	3421	0	1	39	144	383	662	801	737	487	170	26	1	(9)
(10)			CDD65	1034	0	0	2	14	63	219	337	279	106	16	0	0	(10)
(11)			CDH74	9260	0	0	22	166	560	1868	3178	2388	867	141	3	0	(11)
(12)			CDH80	3231	0	0	4	38	124	679	1260	861	249	26	0	0	(12)
(13)	Precipitation		PrecAvg	33.1	1.0	1.1	2.3	3.4	3.7	4.5	3.8	4.2	3.6	2.8	1.8	1.3	(13)
(14)			PrecMax	44.6	4.3	2.9	6.0	7.8	7.2	11.4	9.2	13.7	9.6	6.2	3.3	2.6	(14)
(15)			PrecMin	22.7	0.2	0.1	0.4	0.9	1.8	1.1	0.0	1.1	0.8	0.3	0.0	0.1	(15)
(16)			PrecSD	6.3	0.9	0.8	1.3	1.7	1.6	2.4	2.2	3.2	2.6	1.6	1.0	0.7	(16)
(17)	Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures	0.4%	DB		56.0	61.8	76.6	85.0	87.5	93.9	96.9	96.6	90.3	83.6	72.7	58.8	(17)
(18)			MCWB		46.7	51.1	59.2	64.9	70.6	76.4	77.7	76.6	71.9	67.2	59.3	52.3	(18)
(19)		2%	DB		48.8	54.9	69.2	79.0	83.6	89.7	93.2	91.3	88.2	78.1	65.4	51.7	(19)
(20)			MCWB		41.8	46.2	56.9	62.3	67.3	73.9	76.8	76.7	71.1	64.0	57.0	46.1	(20)
(21)		5%	DB		43.3	48.6	63.2	73.3	80.3	87.0	90.1	88.0	82.6	73.0	60.0	48.1	(21)
(22)			MCWB		38.1	41.7	54.0	58.9	65.7	72.2	76.3	75.3	69.2	61.1	52.2	40.7	(22)
(23)		10%	DB		38.4	43.4	57.5	68.4	76.6	83.9	86.8	84.5	79.1	68.4	56.1	41.4	(23)
(24)			MCWB		34.6	38.3	48.4	55.8	63.5	70.6	74.6	73.0	67.4	58.9	48.3	38.9	(24)
(25)	Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperatures	0.4%	WB		48.2	52.0	62.3	68.1	74.4	78.4	81.2	80.2	75.9	71.1	62.1	54.6	(25)
(26)			MCDB		53.3	57.1	71.3	81.1	83.8	88.8	92.4	90.4	85.6	79.5	67.8	57.2	(26)
(27)		2%	WB		42.0	46.4	58.8	64.3	71.3	76.5	79.0	78.2	73.6	66.6	58.2	48.1	(27)
(28)			MCDB		48.1	56.0	66.4	75.2	79.6	86.5	89.3	88.0	82.3	74.2	64.4	49.8	(28)
(29)		5%	WB		38.2	42.0	54.5	61.1	68.4	74.6	77.5	76.7	71.6	63.4	53.2	40.8	(29)
(30)			MCDB		43.2	47.9	63.6	70.8	76.6	84.0	87.5	85.8	79.5	70.7	58.5	45.7	(30)
(31)		10%	WB		34.8	38.3	49.4	57.6	65.7	72.6	76.0	75.0	69.4	58.9	48.8	37.1	(31)
(32)			MCDB		37.9	42.9	57.3	66.6	73.7	81.4	84.7	83.1	76.4	67.1	54.5	40.7	(32)
(33)	Mean Daily Temperature Range		MDBR		15.8	16.5	18.8	20.4	19.2	18.4	17.9	17.8	20.2	19.5	16.9	15.2	(33)
(34)		5% DB	MCDBR		22.1	23.6	26.7	27.4	23.1	21.3	21.0	20.8	22.9	26.1	23.9	21.7	(34)
(35)			MCWBR		16.3	18.0	18.0	15.0	12.1	9.8	9.2	9.5	11.2	13.7	15.4	18.0	(35)
(36)		5% WB	MCDBR		21.0	22.4	24.2	23.7	19.7	18.9	18.9	18.6	19.8	21.3	20.6	20.3	(36)
(37)			MCWBR		16.7	16.8	16.1	14.4	11.7	10.4	9.6	9.8	11.2	13.9	16.3	16.8	(37)
(38)	Clear Sky Solar Irradiance	taub			0.282	0.294	0.324	0.341	0.346	0.377	0.389	0.372	0.360	0.320	0.302	0.289	(38)
(39)		taud			2.480	2.389	2.429	2.384	2.380	2.297	2.280	2.376	2.440	2.650	2.620	2.667	(39)
(40)		Ebn,noon			279	291	294	296	294	284	279	281	281	280	271	268	(40)
(41)		Edh,noon			23	30	32	37	38	41	41	38	32	26	21	20	(41)

Nomenclature: See separate page

Ambient Design Conditions, 2013 *ASHRAE 0.4% Occurrences – Des Moines, IA*

2013 ASHRAE Handbook - Fundamentals (IP)

DES MOINES INTL, IA, USA

WMO#: **725460**

Lat: **41.54N** Long: **93.67W** Elev: **965** StdP: **14.19** Time Zone: **-6 (NAC)** Period: **86-10** WBAN: **14933**

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB	
		0.4%		1%		2%		0.4%		1%		2%			
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD
7	17.9	92.5	76.4	89.6	75.1	86.9	73.3	78.5	88.5	77.1	86.8	75.5	84.1	12.2	180

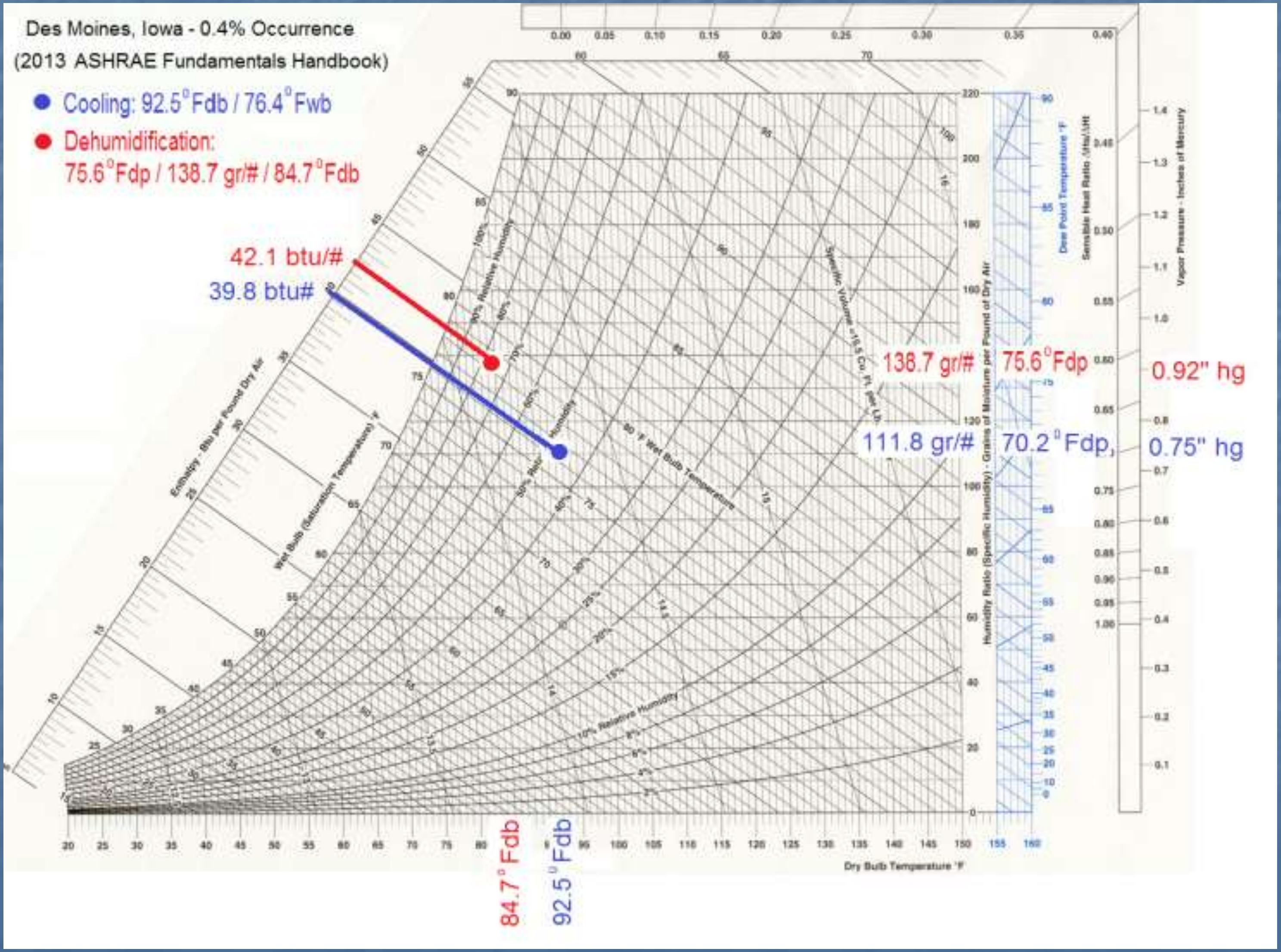
Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Hours 8 to 4 & 55/69
0.4%			1%			2%			0.4%		1%		2%		
DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB	
75.6	138.7	84.7	74.1	131.9	83.4	72.6	125.0	81.6	42.8	88.8	41.2	86.8	39.7	84.6	621

Ambient Design Conditions, 2013

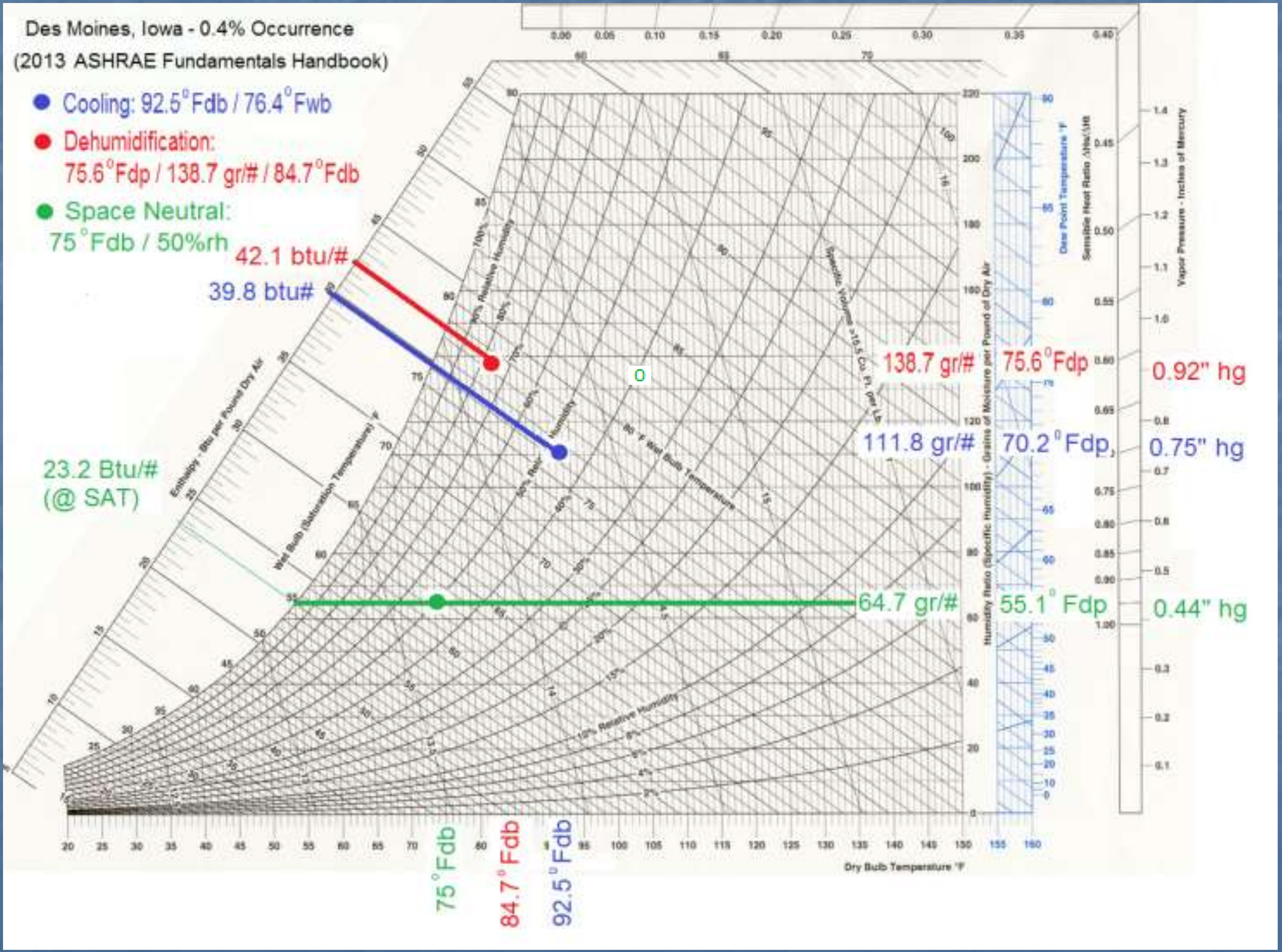
ASHRAE 0.4% Occurrences – Des Moines, IA

	Cooling	**Dehumidification**
Drybulb	92.5 °F	84.7 °F
Wetbulb	76.4 °F	78.6°F
Hum. Ratio	111.8 gr/#	138.7 gr/#
Dewpoint	70.2°F	75.6 °F
Enthalpy	39.8 Btu/#	42.1 Btu/#
Vapor Pressure	0.7459” hg	0.92” hg

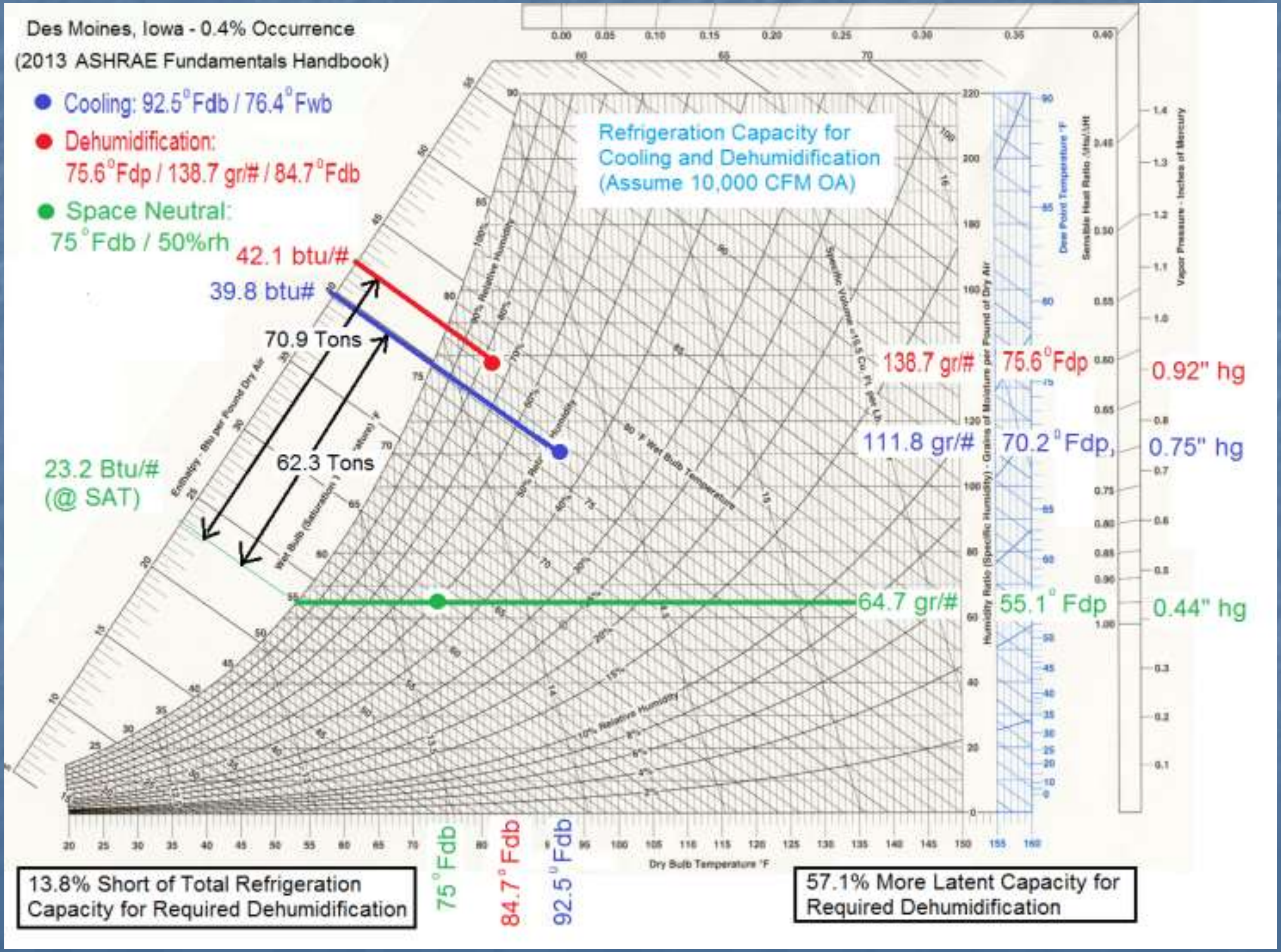
0.4% ASHRAE Ambient Design Conditions 2013 (*Des Moines, IA)*



0.4% ASHRAE Ambient Design Conditions 2013 (*Des Moines, IA) and Space Design Condition*



0.4% ASHRAE Ambient Design Conditions 2013 (*Des Moines, IA) and Refrigeration Capacity Required of Outside Air (Example)*

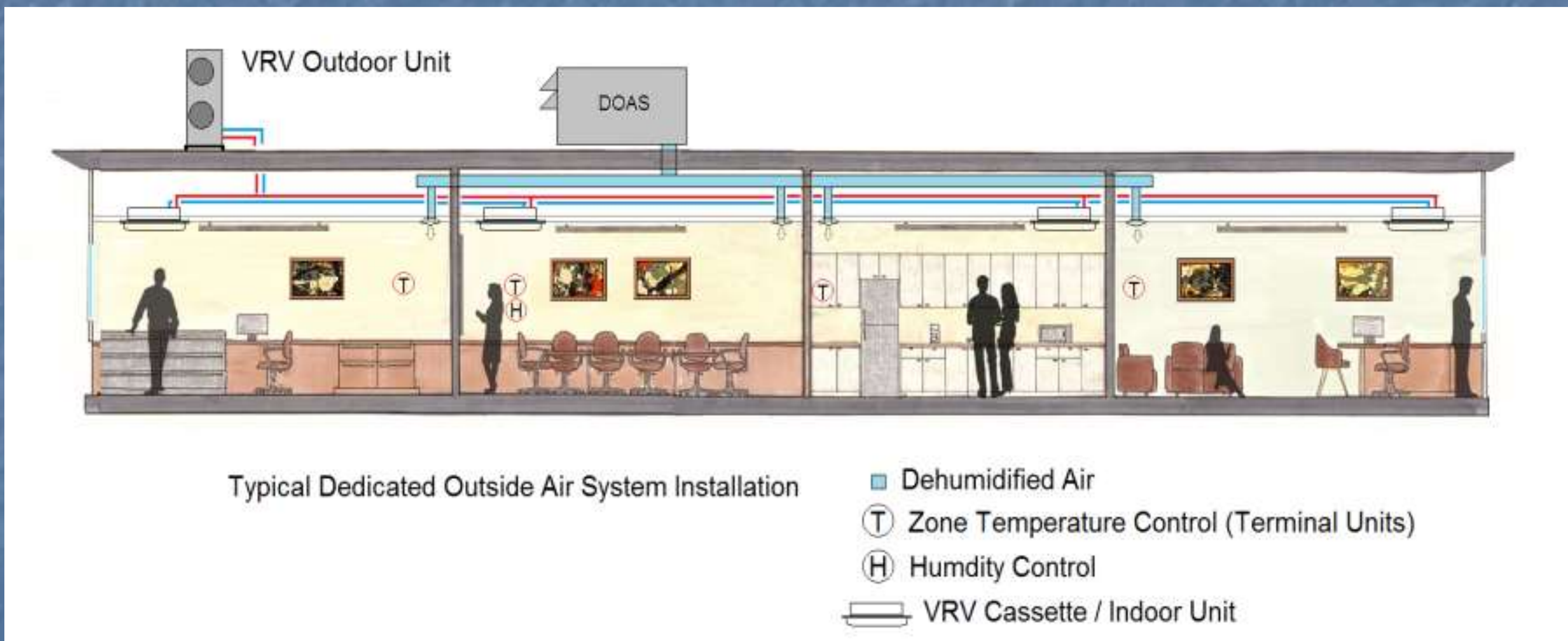


Divide and Conquer

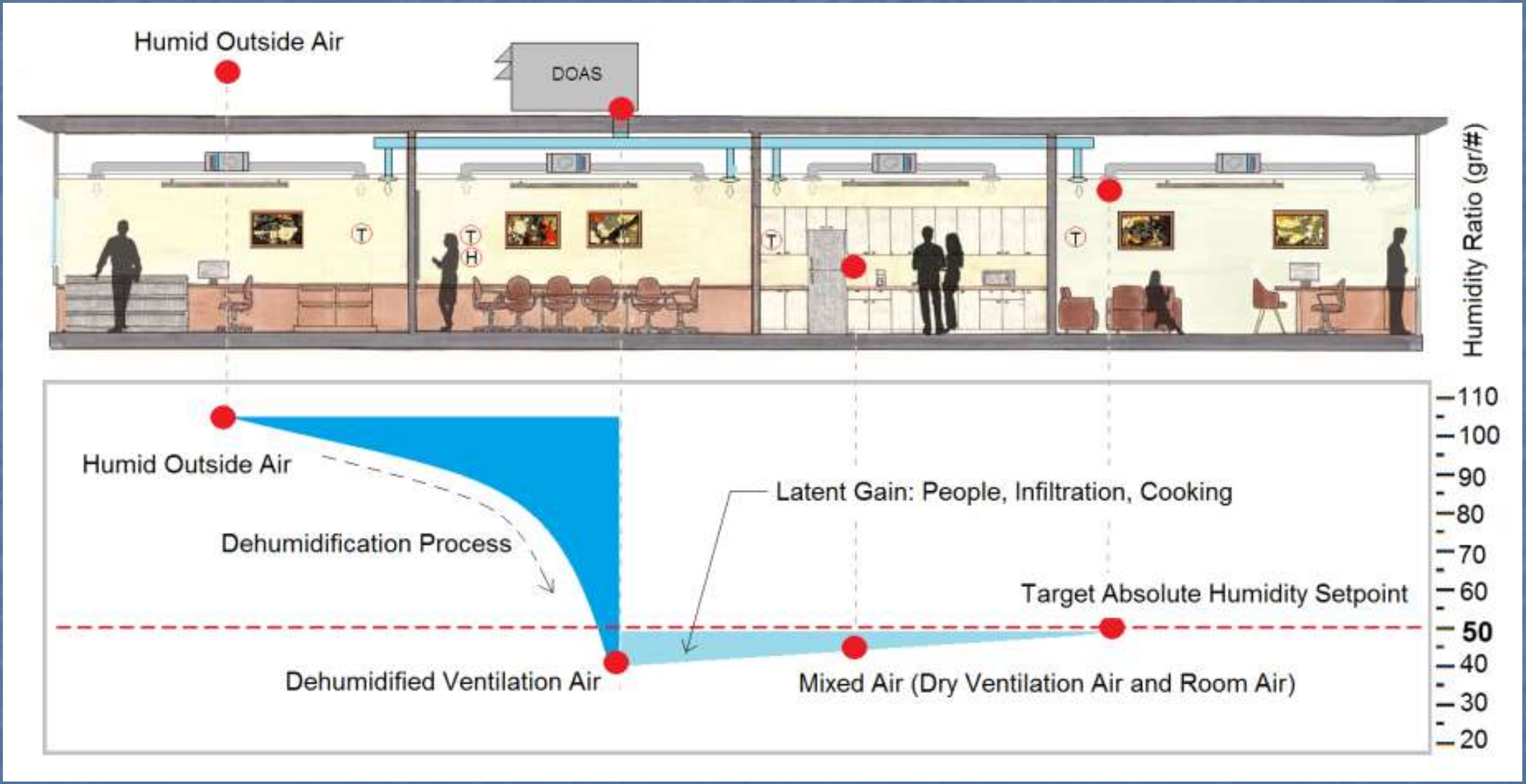
Typical Dedicated Outside Air System Installation

- Dehumidified Air
- (T) Zone Temperature Control (Terminal Units)
- (H) Humdity Control

Divide and Conquer



Dry Ventilation Air Dries The Building



What is Latent Heat Gain?

$$\underline{Lg = 0.68 \times (Wr - Ws) \times CFM}$$

Where:

Ws = Humidity Ratio Required of Supply Air (grains moisture / # dry air)

Wr = Humidity Ratio of Return Air (Space) (grains moisture / # dry air)

Lg = Latent Gain (total, or per person) (BTU/hr)

CFM = Ventilation Air Requirement (total, or per person) (cubic feet / minute)

Calculating for the Supply Air Humidity Ratio

$$\underline{Ws = Wr - Lg / (0.68 \times CFM)}$$

Where:

Ws = Humidity Ratio Required of Supply Air (grains moisture / # dry air)

Wr = Humidity Ratio of Return Air (Space) (grains moisture / # dry air)

Lg = Latent Gain (total, or per person) (BTU/hr)

CFM = Ventilation Air Requirement (total, or per person) (cubic feet / minute)

Example: Supply air requirement for an Office Building

Given:

- Design Space Condition of 73°Fdb/50% RH
- Latent Gain per employee of 200 BTU/hr
- Ventilation Rate of 20 CFM/person
- At 73°Fdb/50% RH, the Humidity Ratio (Wr) is equal to 60.6 grains moisture / # dry air

Ws = 60.6 – 200 / (0.68 x 20)

= 45.89 gr. moist. / # dry air

= <u>45.9°F dewpoint</u>

= 0.0066 # moisture / # dry air

Example: Supply air requirement for a School Building

Given:

- Design Space Condition of 73°Fdb/50% RH
- Latent Gain per student of 200 BTU/hr
- Ventilation Rate of 15 CFM/person
- At 73°Fdb/50% RH, the Humidity Ratio (Wr) is equal to 60.6 grains moisture / # dry air

Ws = 60.6 – 200 / (0.68 x 15)

= 40.99 gr. moist. / # dry air

= <u>43.0 °F dewpoint</u>

= 0.0059 # moisture / # dry air

Example: Supply air requirement for an Operating Room

Given:

- Design Space Condition of 60°Fdb/50% RH
- Latent Gain per person of 200 BTU/hr
- Ventilation Rate of 30 CFM/person
- At 60°Fdb/50% RH, the Humidity Ratio (Wr) is equal to 38.5 grains moisture / # dry air

Ws = 38.5 – 200 / (0.68 x 30)

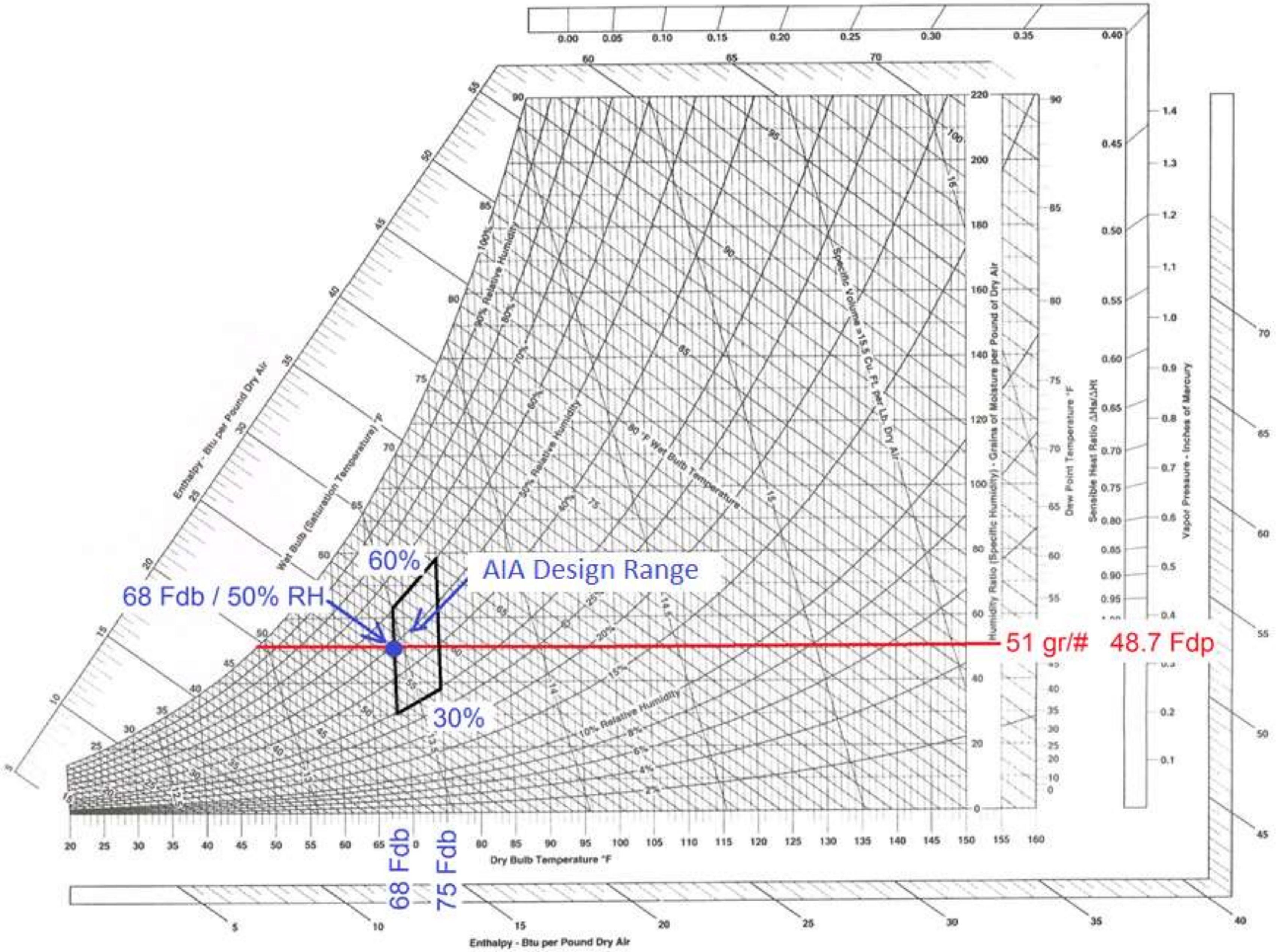
= 28.7 gr. moist. / # dry air

= <u>33.9 °F dewpoint</u>

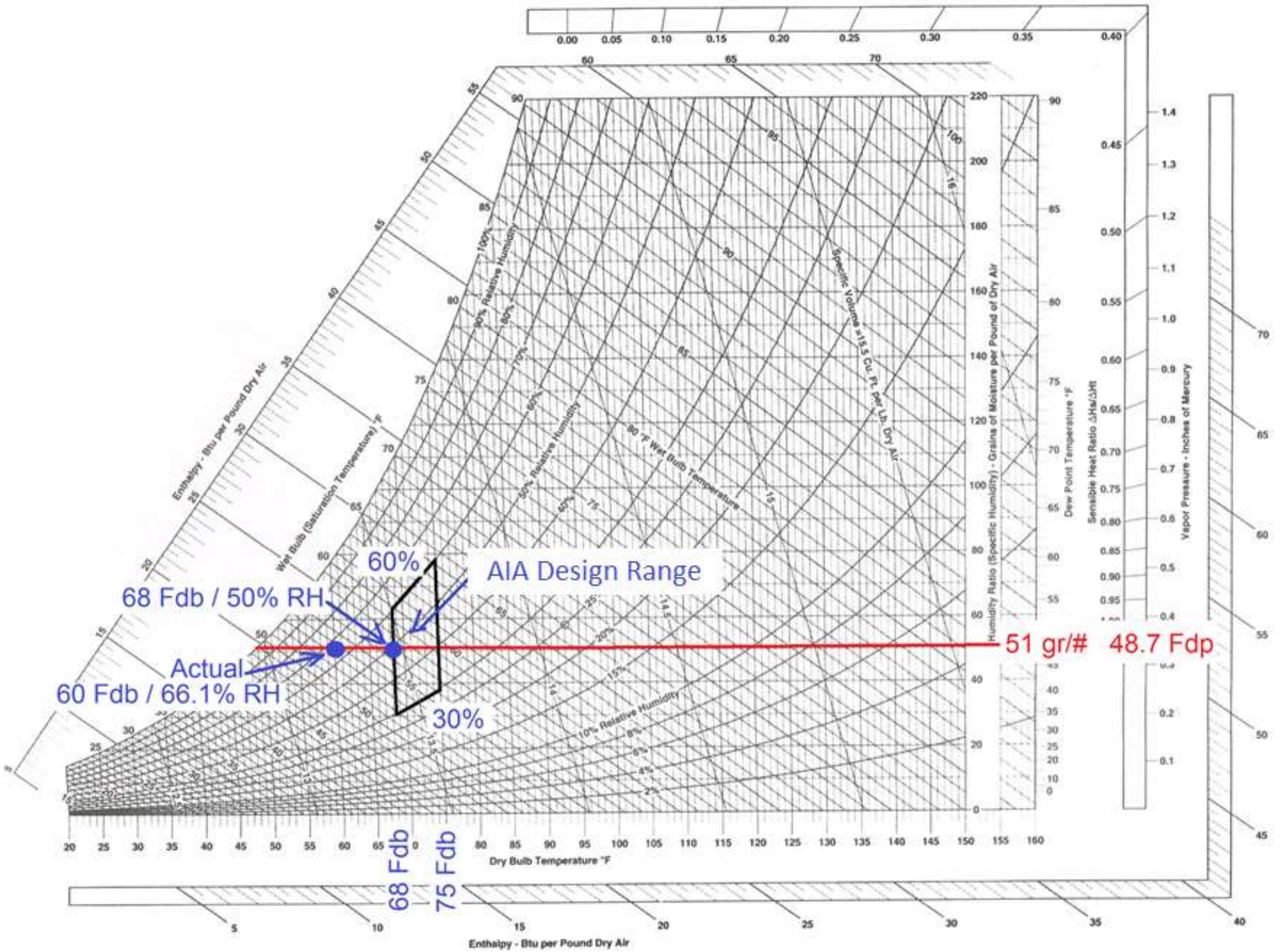
= 0.0041 # moisture / # dry air

Space Design Conditions

Comparison of Engineering Best Practice with AIA Guidelines and ASHRAE Handbook			
Function Space	**Operating Room (100% Outside Air System)**	**Operating Room (Recirculating Air System)**	**Operating Room Surgical Cystoscopic Rooms**
Minimum Air Changes of Outdoor Air / Hour			
Manual	*	5	5
ASHRAE Handbook	15	5	*
AIA Guideline	*	*	3
Minimum Total Air Changes / Hour			
Manual	*	25	25
ASHRAE Handbook	15	25	*
AIA Guideline	*	*	15
Relative Humidity, %			
Manual	*	30-60	30-60
ASHRAE Handbook	45-55	*	*
AIA Guideline	*	*	30-60
Design Temperature, °F			
Manual	*	68-75	68-75
ASHRAE Handbook	62-80	*	*
AIA Guideline	*	*	68-73
** No Value Given*			



60%
AIA Design Range
68 Fdb / 50% RH
30%
51 gr/#
48.7 Fdp
68 Fdb
75 Fdb
Dry Bulb Temperature °F
Enthalpy - Btu per Pound Dry Air
Wet Bulb (Saturation Temperature) °F
Humidity Ratio (Specific Humidity) - Grains of Moisture per Pound of Dry Air
Dew Point Temperature °F
Sensible Heat Ratio ΔHs/ΔHt
Vapor Pressure - Inches of Mercury



60%
AIA Design Range
68 Fdb / 50% RH
Actual
60 Fdb / 66.1% RH
30%
51 gr/#
48.7 Fdp
68 Fdb
75 Fdb
Dry Bulb Temperature °F
Enthalpy - Btu per Pound Dry Air
Wet Bulb (Saturation Temperature) °F
Humidity Ratio (Specific Humidity) - Grains of Moisture per Pound of Dry Air
Dew Point Temperature °F
Sensible Heat Ratio ΔHs/ΔHt
Vapor Pressure - Inches of Mercury
Specific Volume #15.5 Cu. Ft. per Lb. Dry Air
80 °F Wet Bulb Temperature
100% Relative Humidity
50% Relative Humidity
10% Relative Humidity

There are only 2 ways to remove moisture from the air …

- Adsorb / Absorb it out
- Condense it out

Dehumidification Technologies

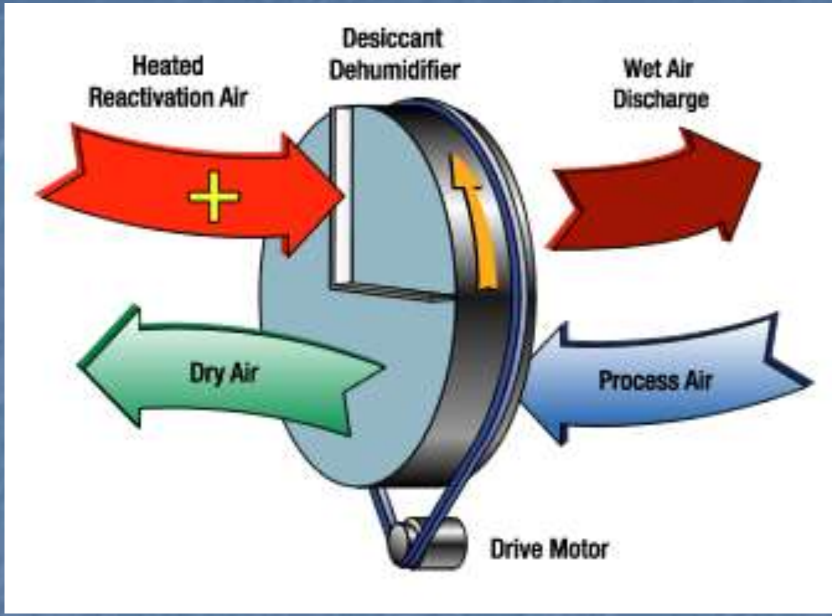
- Desiccant-based Systems: Adsorbs/Absorbs moisture out of the air
  - Solid Desiccants (i.e., wheels)
  - Liquid Desiccants
- Mechanical-based Systems: Condenses the moisture out of the air
  - Chilled Water
  - Direct Expansion (DX)

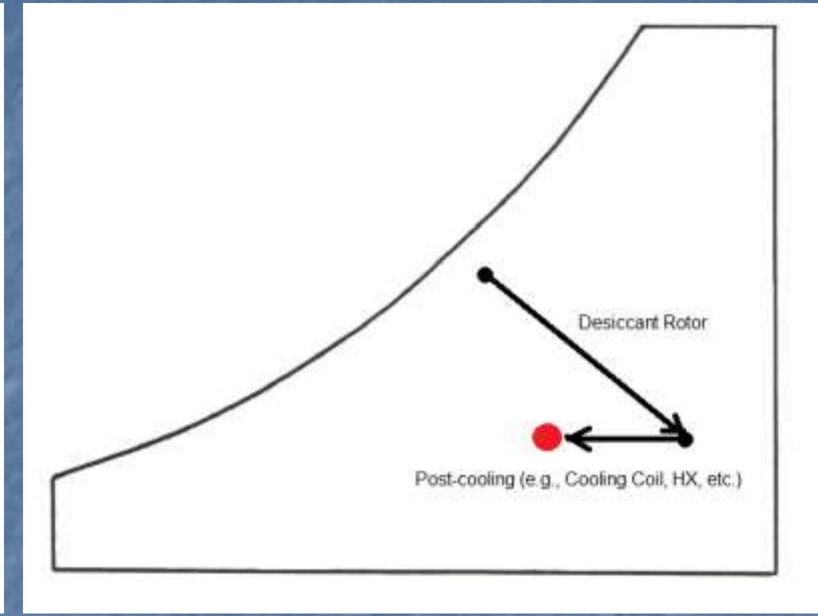
Choose the right equipment for the job!

What is a "Desiccant"?

A material that possesses an affinity for moisture vapor greater than that of the surrounding air.

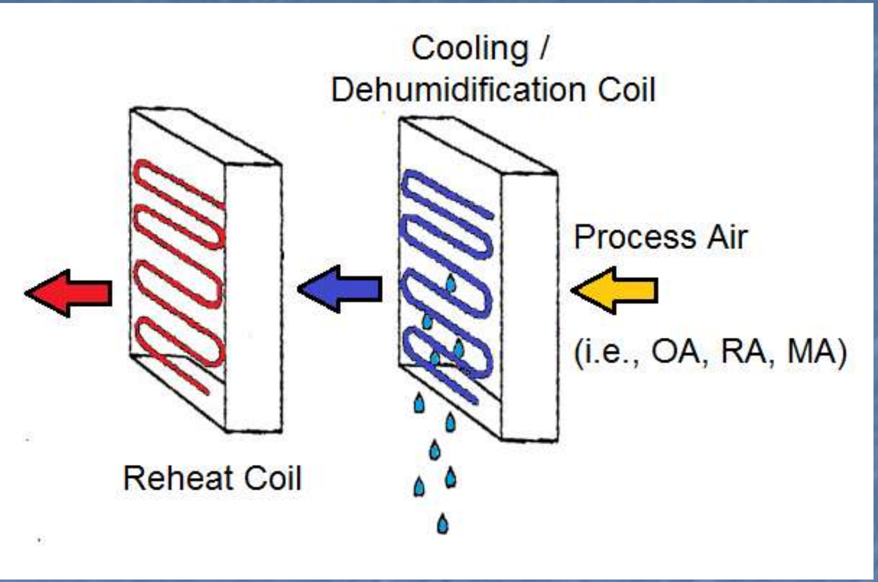
Adsorb / Absorb it out …

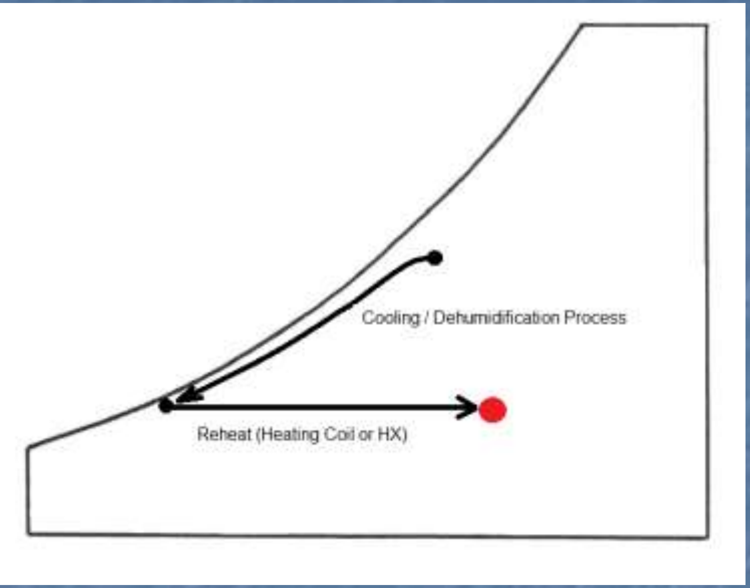




- Actively regenerated desiccant dehumidifier (solid rotor-type, or liquid-type)
- Desiccant material adsorbs (solid) or absorbs (liquid) water vapor from the process airstream.
- The heat from sorption is removed via cooling coils or heat exchanger after the desiccant rotor.

… or *Condense* it out



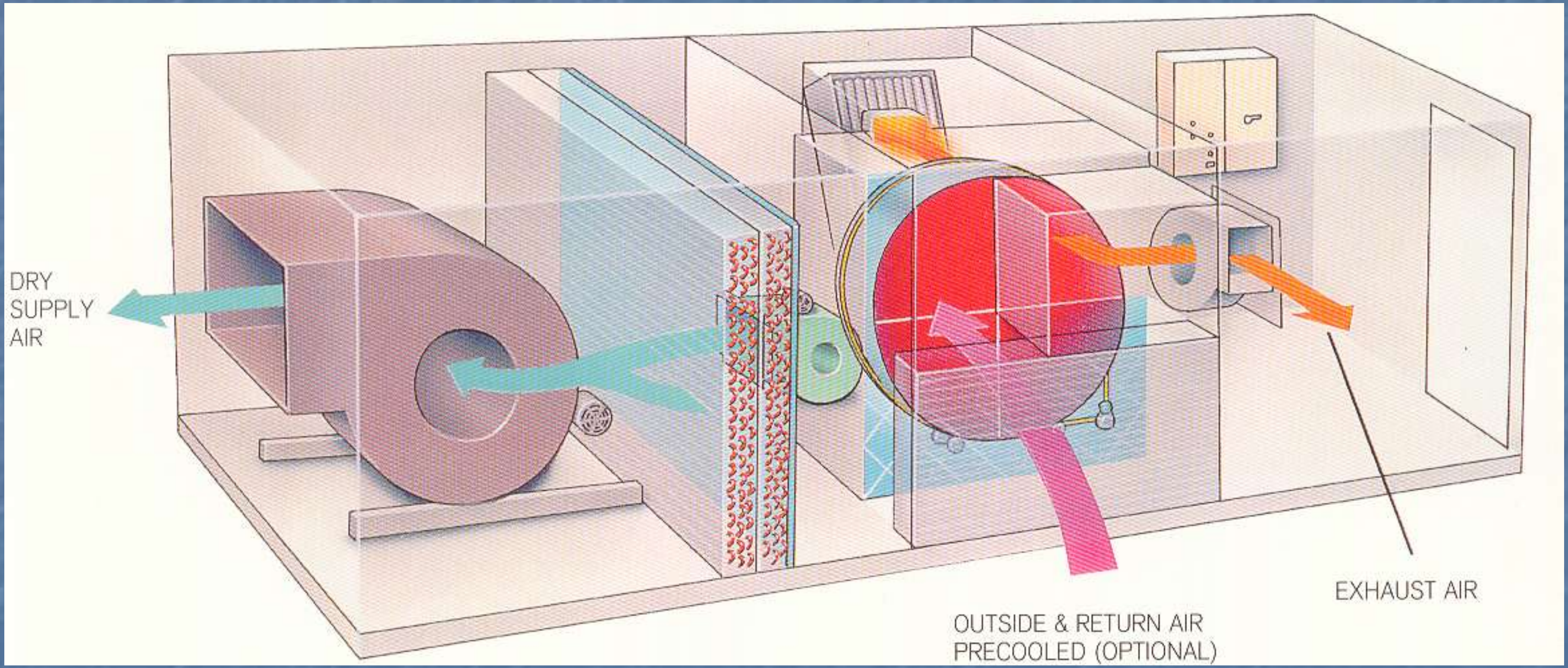


- Mechanical Dehumidification system
- The cooling coil cools the process airstream down to, or below, the air's Dewpoint temperature. Supply air Dewpoint dependent upon coil temperature.
- Any warming required (i.e., tempering) of this processed air is done after the cooling coil. This is done through a reheat coil (e.g., HW, Steam, Electric, HGRH, etc.) or HX.

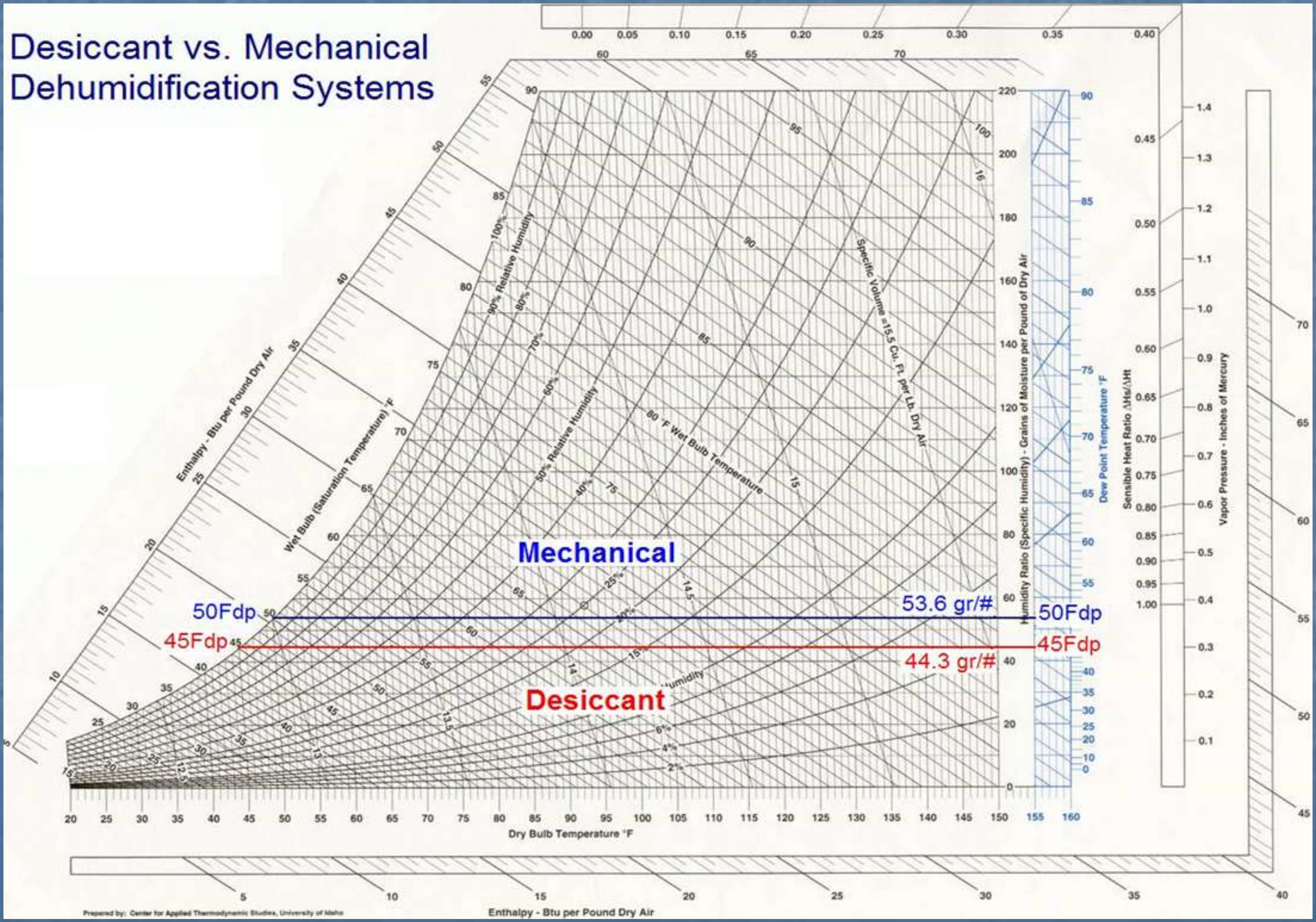
Mechanical-based

- Chilled Water
- Direct Expansion (DX)
- Heat Pipes
- Hot Gas Bypass
- Sub-cool Reheat
- Etc.

Hybrid Desiccant Systems

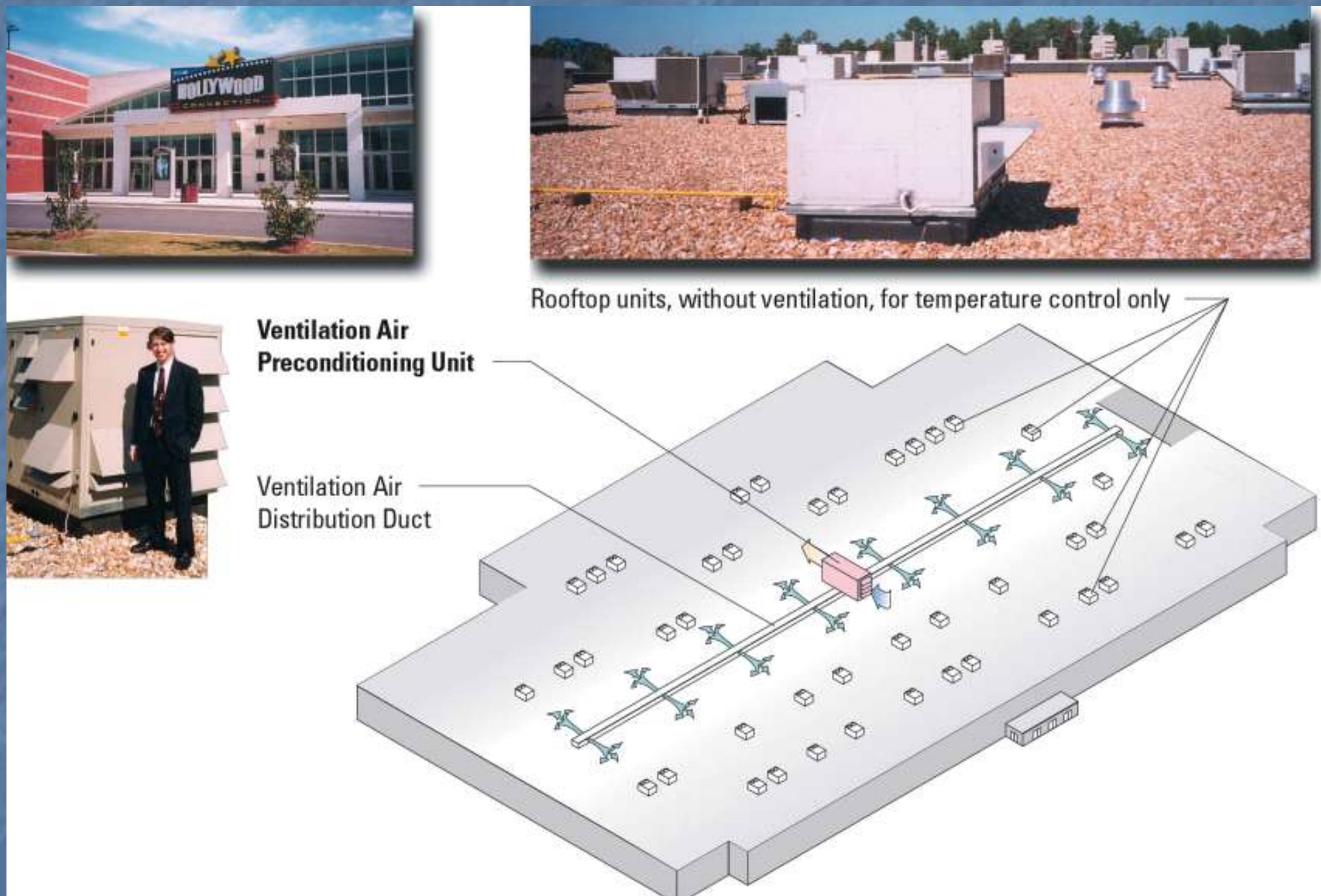


When to use Desiccant vs. Mechanical?
(personal opinion)



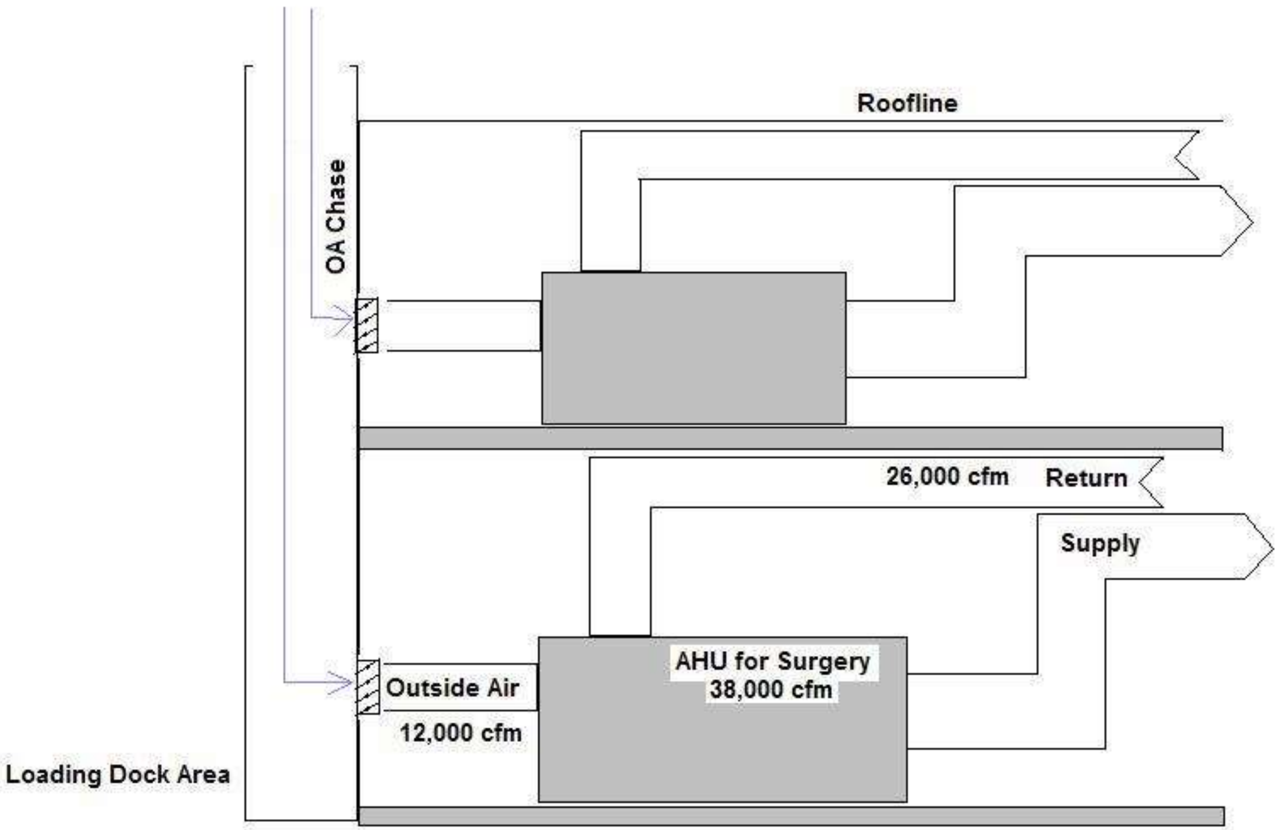
Applications for Humidity Control

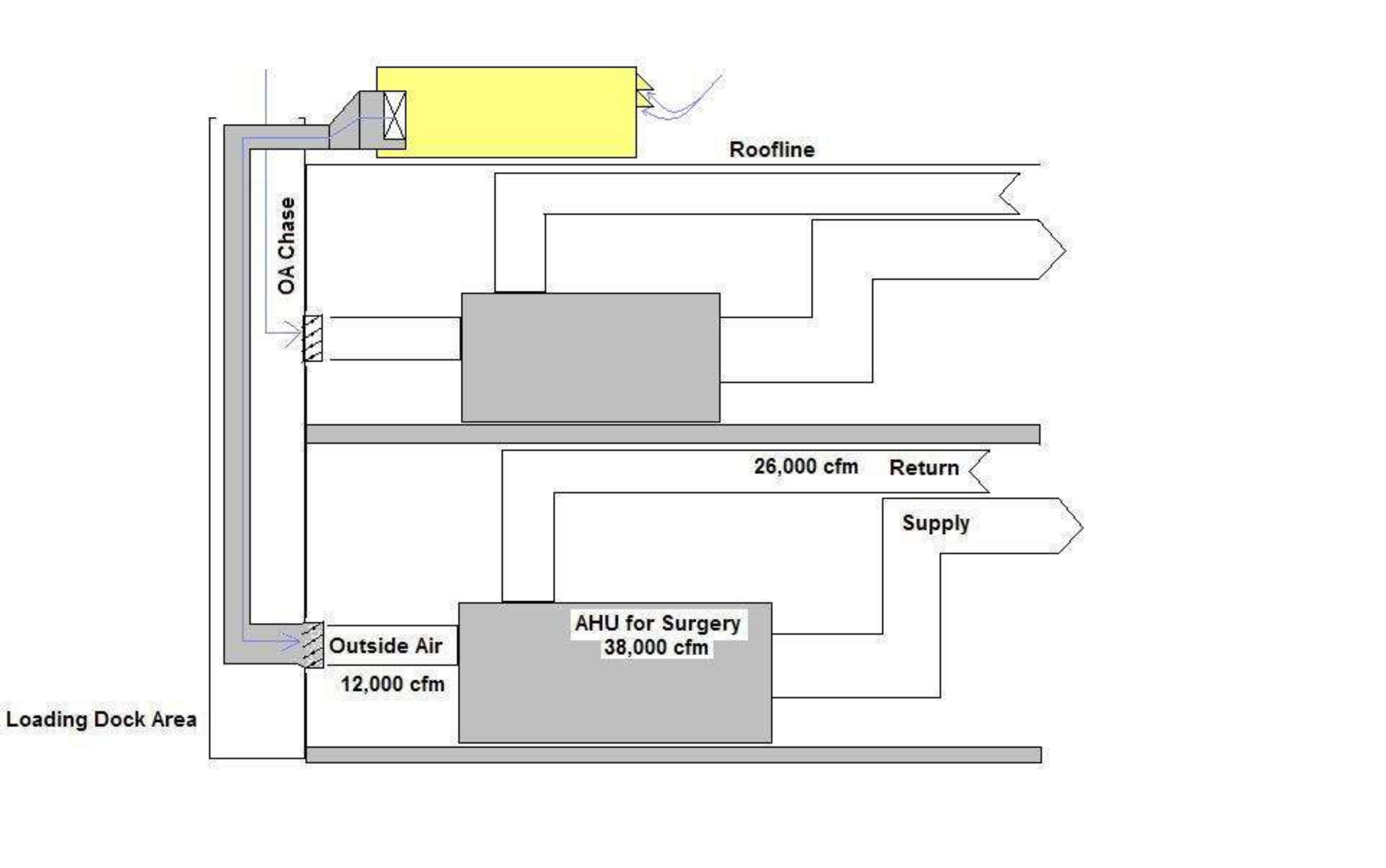
Typical System Application for Theaters & "Big Box" Retailers



Hospital Surgical Suites

Hospital Surgical Suite: 20°Fdp


Roofline
OA Chase
26,000 cfm
Return
Supply
AHU for Surgery
38,000 cfm
Outside Air
12,000 cfm
Loading Dock Area


Roofline
OA Chase
26,000 cfm
Return
Supply
AHU for Surgery
38,000 cfm
Outside Air
12,000 cfm
Loading Dock Area

Climate Controlled Distribution Center

Clean Room / Measurement Lab

68°Fdb / 35% RH / 39°Fdp

Cleanroom / Packaging Room 68Fdb / 25%RH / 31Fdp

Hotels / Motels

Schools

Example: Supply air requirement for a School Building

Given:

- Design Space Condition of 73°Fdb/50% RH
- Latent Gain per student of 200 BTU/hr
- Ventilation Rate of 15 CFM/person
- At 73°Fdb/50% RH, the Humidity Ratio (Wr) is equal to 60.6 grains moisture / # dry air

Ws = 60.6 – 200 / (0.68 x 15)

= 40.99 gr. moist. / # dry air

= <u>43.0 °F dewpoint</u>

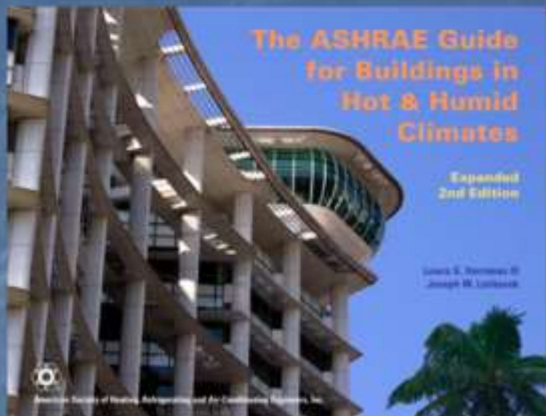
= 0.0059 # moisture / # dry air

School Building: 40°Fdp

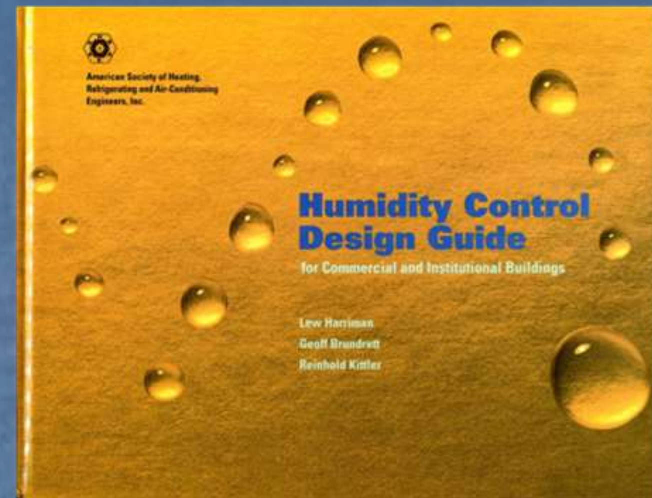



Cold Storage Ice / Snow

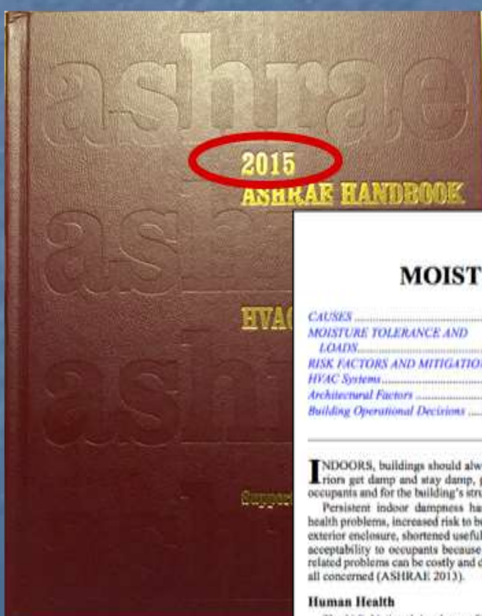
More detailed advice from ASHRAE …

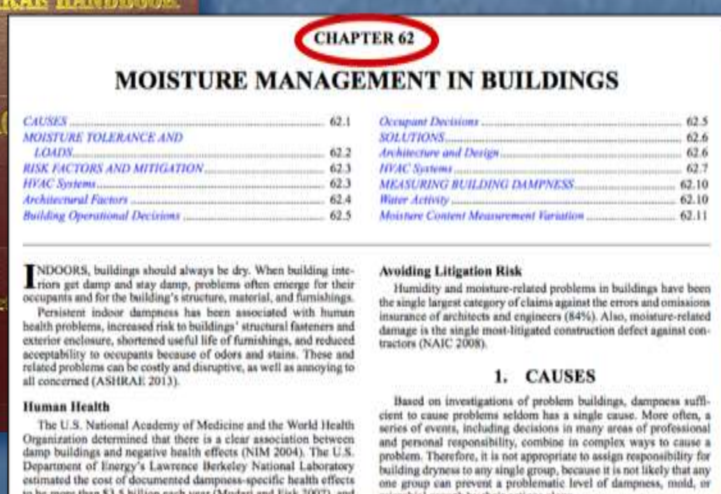


Guide for Buildings in Hot and Humid Climates



Humidity Control Design Guide





CHAPTER 62

MOISTURE MANAGEMENT IN BUILDINGS

INDOORS, buildings should always be dry. When building interiors get damp and stay damp, problems often emerge for their occupants and for the building's structure, material, and furnishings.

Persistent indoor dampness has been associated with human health problems, increased risk to buildings' structural fasteners and exterior enclosure, shortened useful life of furnishings, and reduced acceptability to occupants because of odors and stains. These and related problems can be costly and disruptive, as well as annoying to all concerned (ASHRAE 2013).

Human Health

The U.S. National Academy of Medicine and the World Health Organization determined that there is a clear association between damp buildings and negative health effects (NIM 2004). The U.S. Department of Energy's Lawrence Berkeley National Laboratory estimated the cost of documented dampness-specific health effects to be more than $3.5 billion each year (Mudari and Fisk 2007), and

Avoiding Litigation Risk

Humidity and moisture-related problems in buildings have been the single largest category of claims against the errors and omissions insurance of architects and engineers (84%). Also, moisture-related damage is the single most-litigated construction defect against contractors (NAIC 2008).

1. CAUSES

Based on investigations of problem buildings, dampness sufficient to cause problems seldom has a single cause. More often, a series of events, including decisions in many areas of professional and personal responsibility, combine in complex ways to cause a problem. Therefore, it is not appropriate to assign responsibility for building dryness to any single group, because it is not likely that any one group can prevent a problematic level of dampness, mold, or microbial growth by their actions alone.

Japanese Edition

Chinese Edition

It’s not the HEAT …

It’s the ***Humidity!***