PSYCHROMETRIC CHART & AIR CONDITIONING PROCESS

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PROPERTIES OF DRY AIR AND ITS RELATION TO PSYCHROMETRIC CHART

- DRY BULB (db) TEMPERATURE
- WET BULB (wb)TEMPERATURE
- DEWPOINT (dp)TEMPERATURE
- RELATIVE HUMIDITY (rh)
- SPECIFIC HUMIDITY (HUMIDITY RATIO)

ADDITIONAL INFORMATION ON PSYCHROMETRIC CHART

- ENTHALPHY
- SENSIBLE HEAT FACTOR (SHF)
- ALIGNMENT CIRCLE

ENTHALPHY

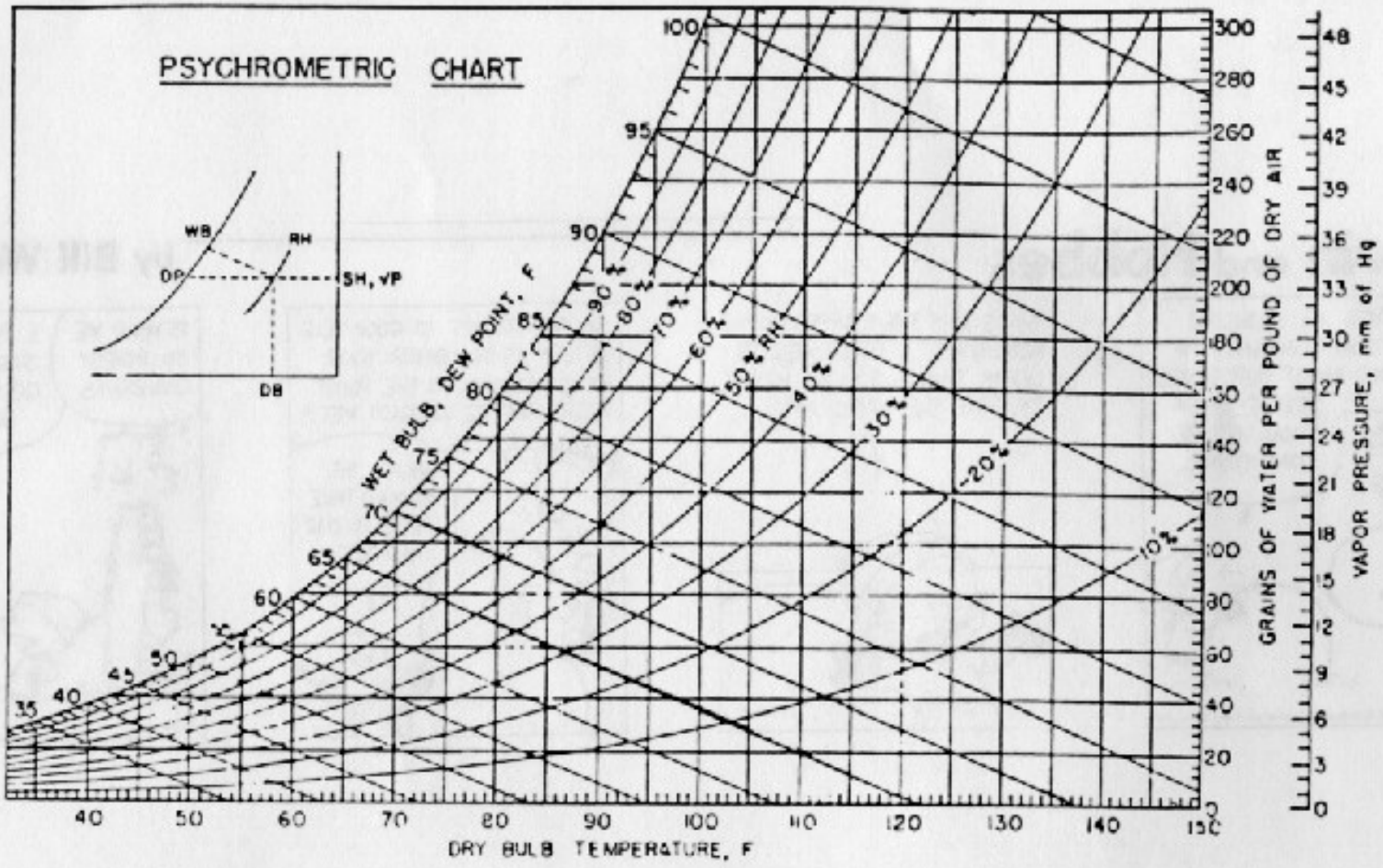
- A thermal property indicating the quantity of heat in the air above arbitrary datum, in Btu/pound of dry air. The datum of dry air is 0°F and, for moisture content, 32°F water

SENSIBLE HEAT FACTOR

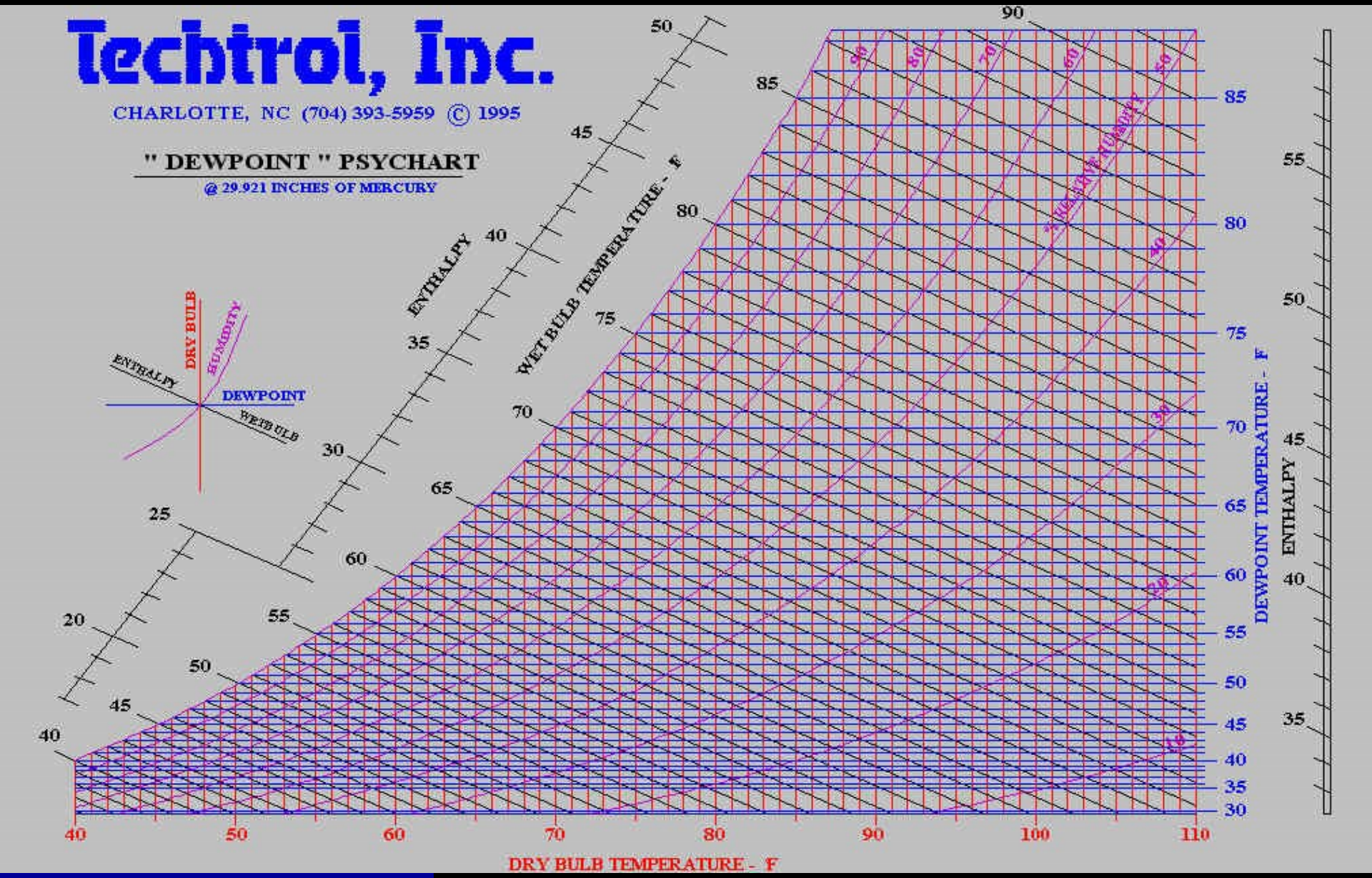
- RATIO OF SENSIBLE TO TOTAL HEAT

ALIGNMENT CIRCLE

- LOCATED AT 80°F db AND 50% rh AND USED IN CINJUNCTION WITH THE SENSIBLE HEAT FACTOR TO PLOT THE VARIOUS AIR CONDITIONING PROCESS LINES



source: *The Industrial Environment - Its Evaluation and Control, 3rd Edition, NIOSH, 1973*



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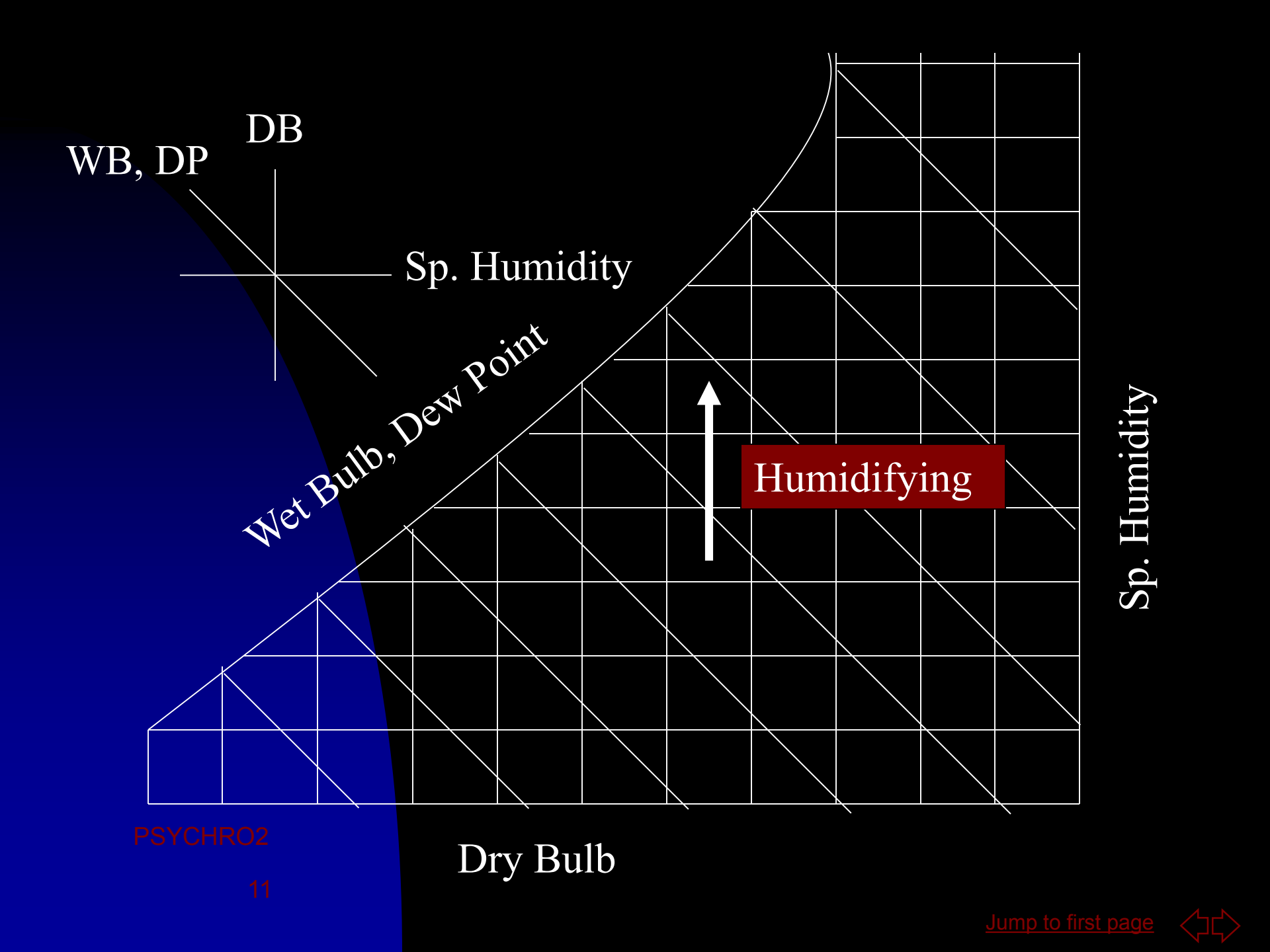
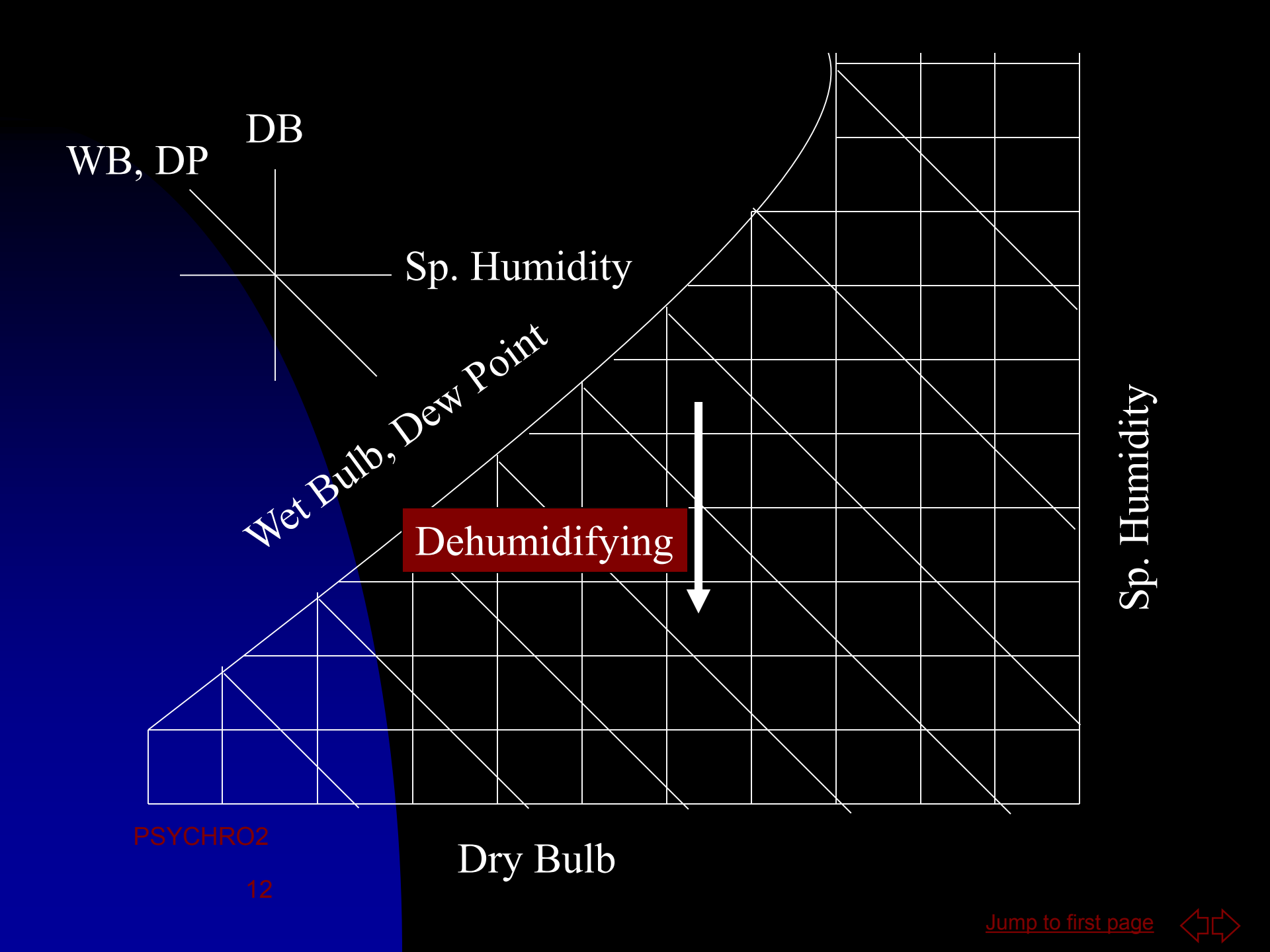
PSYCHROMETRY AND AIR CONDITION

- LATENT HEAT
- SENSIBLE HEAT
- HUMIDIFICATION
- DEHUMIDIFICATION
- SENSIBLE HEAT FACTOR (SHF)

LATENT HEAT (LH)

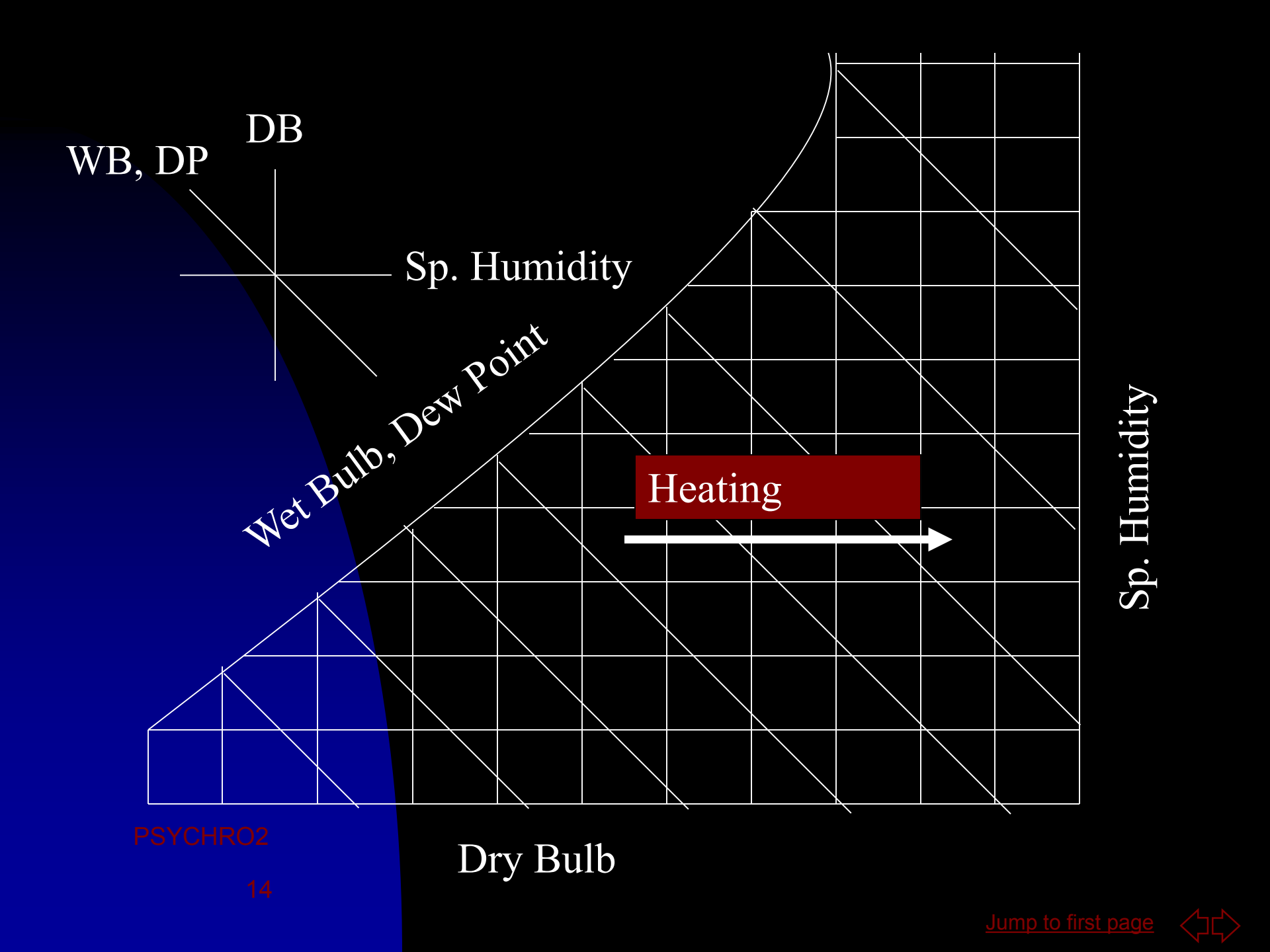
- Is the heat content due to the presence of water vapour in the atmosphere. It is the heat which is required to evaporate a given amount of moisture
- A latent heat change occurs when water is evaporated (humidifying) or condensed (dehumidifying) and the dry bulb temperature does not change.
- The change is shown as vertical line on the chart

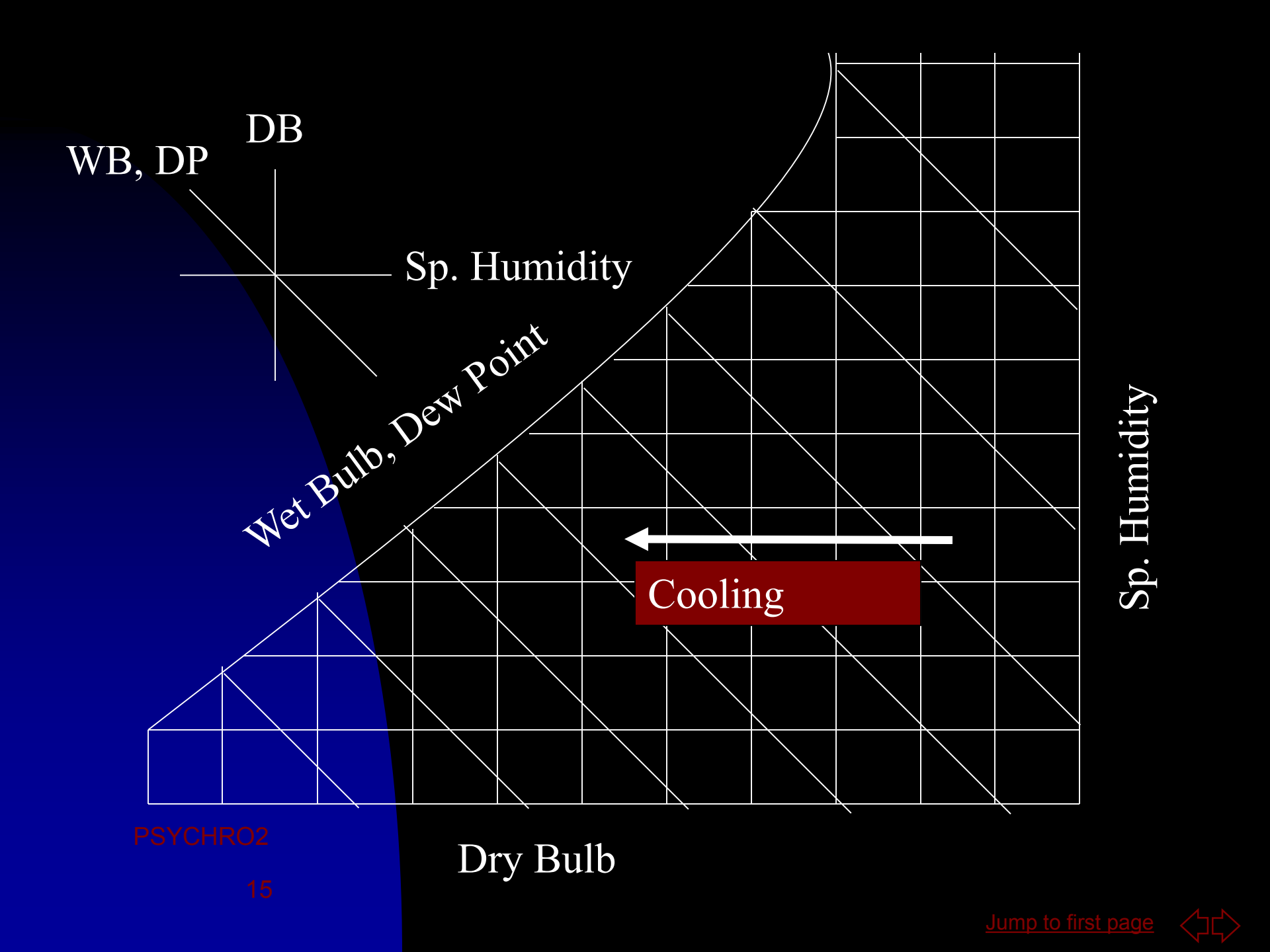

DB
WB, DP
Sp. Humidity
Wet Bulb, Dew Point
Humidifying
Sp. Humidity
Dry Bulb


DB
WB, DP
Sp. Humidity
Wet Bulb, Dew Point
Dehumidifying
Sp. Humidity
Dry Bulb

SENSIBLE HEAT

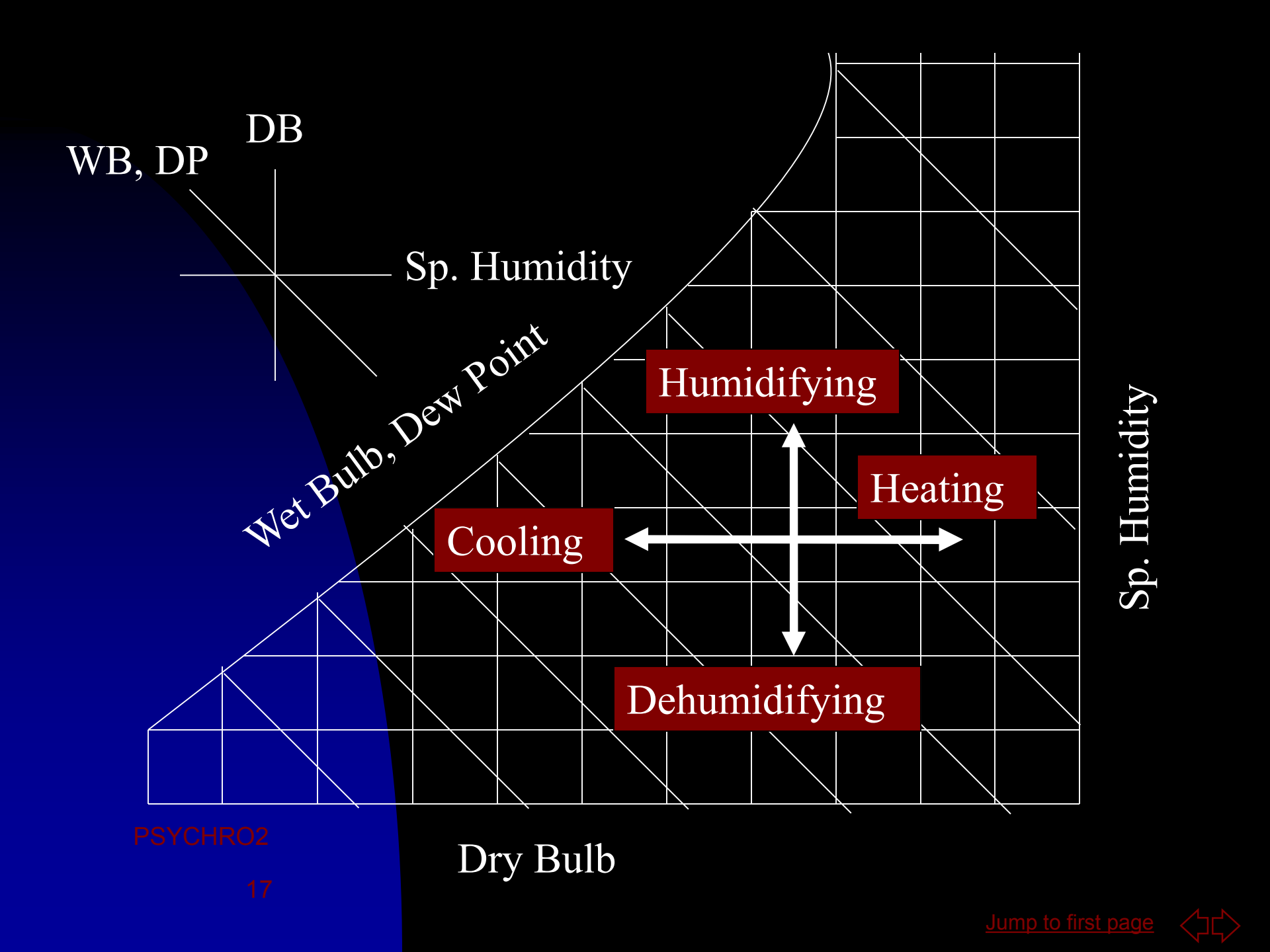
- Is the heat content causing an increase in dry-bulb temperature.
- Is heat that when added or subtracted from a substance changes the measurable temperature of the substance.
- Shown as the horizontal line on the chart


DB
WB, DP
Sp. Humidity
Wet Bulb, Dew Point
Heating
Sp. Humidity
Dry Bulb


DB
WB, DP
Sp. Humidity
Wet Bulb, Dew Point
Cooling
Sp. Humidity
Dry Bulb

COOLING AND DEHUMIDIFICATION

- When the heat and moisture changes are put together on one chart they show the direction the condition air will move when the heat and moisture is altered



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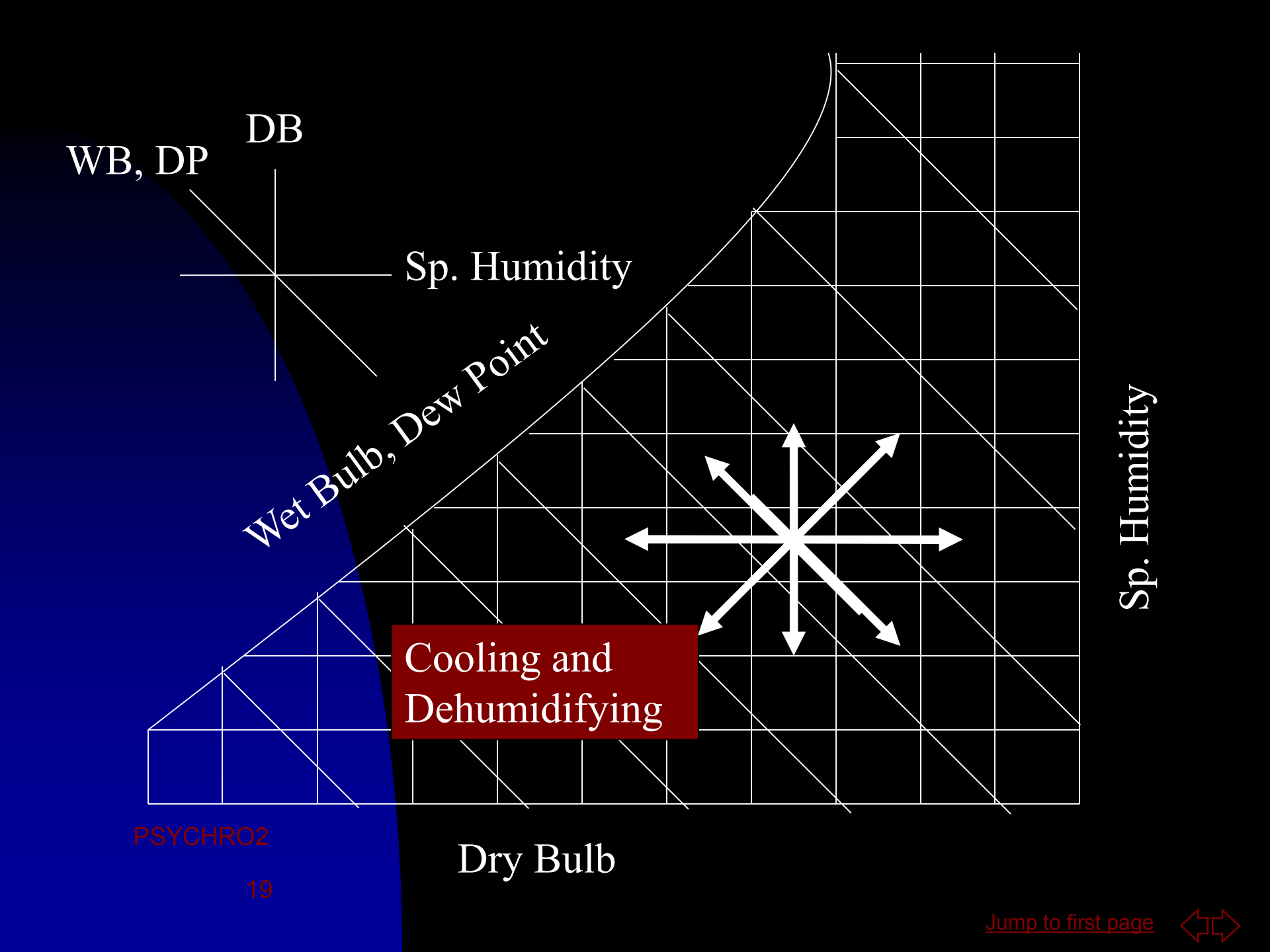
In practice, both the sensible heat and the moisture content (latent heat) of the air change simultaneously.

When this happens, the resulting air condition moves from point A at an angle which depends on the proportion of sensible and moisture added or removed.

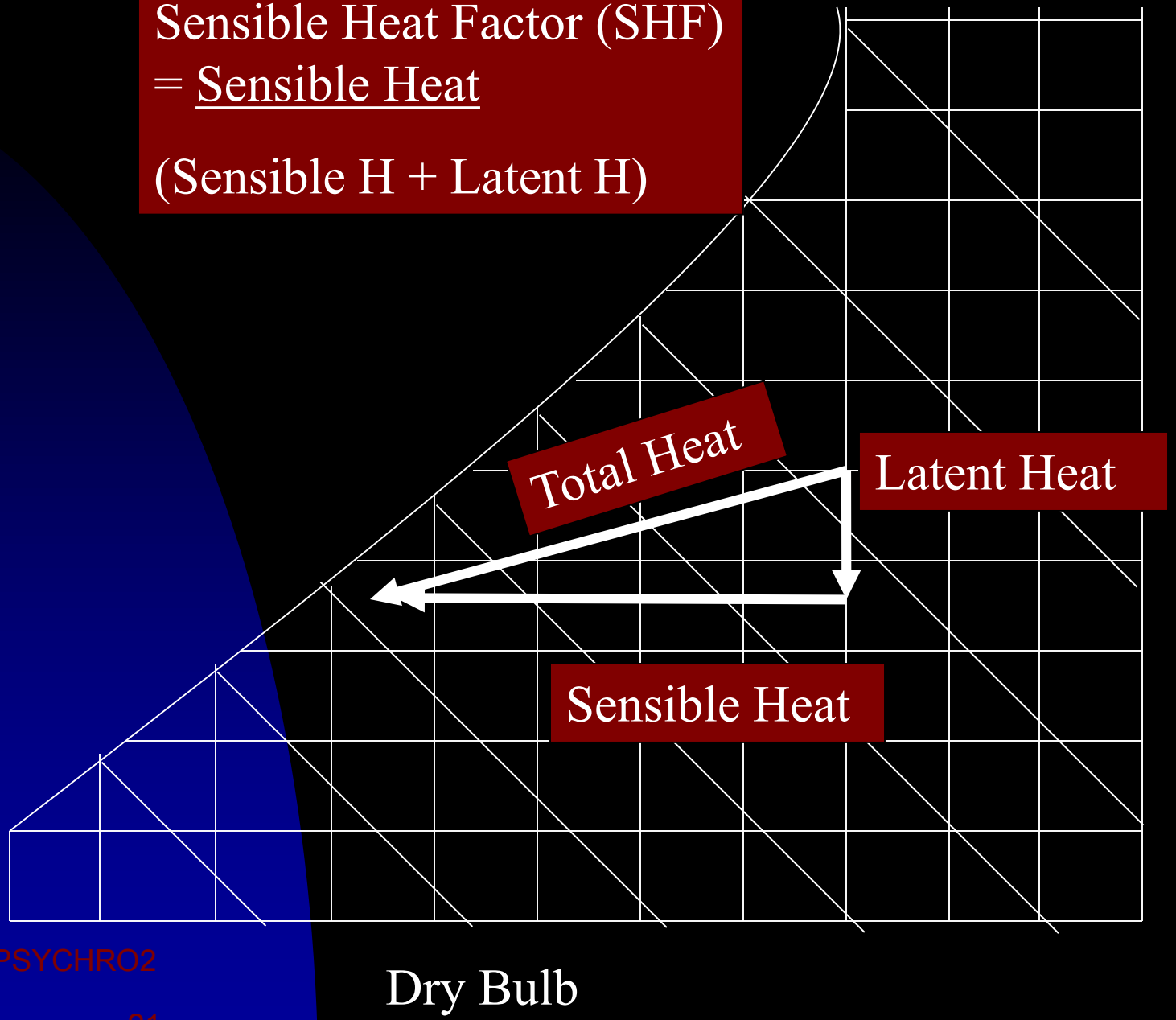

DB
WB, DP
Sp. Humidity
Wet Bulb, Dew Point
Sp. Humidity
Cooling and
Dehumidifying
Dry Bulb

To provide summer comfort, the air is cooled and dehumidified simultaneously, moving the air condition down words and to the left.

This combination of sensible and latent removal occurs so frequently in air conditioning that the slope of the line has been named **SENSIBLE HEAT FACTOR**

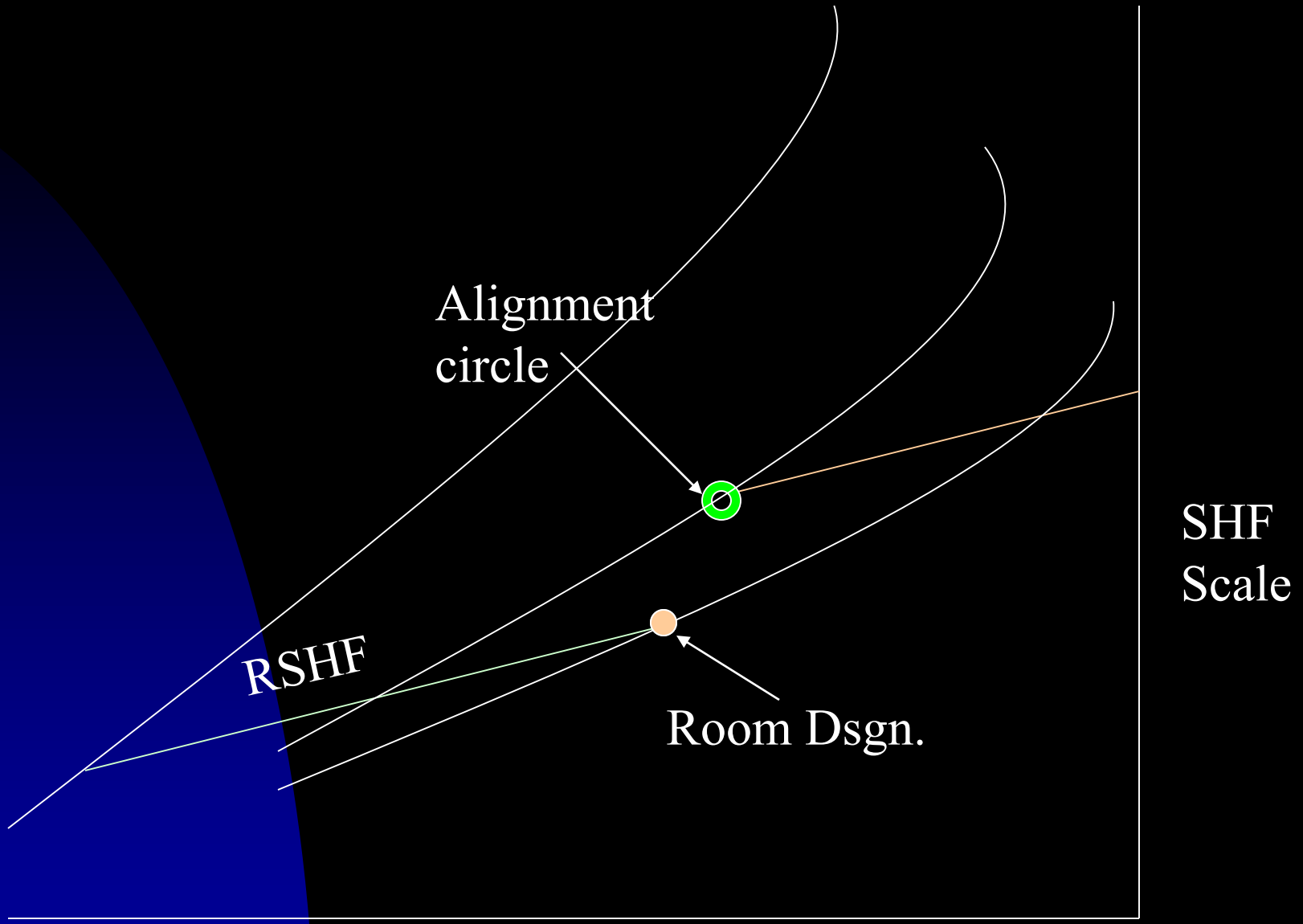
Sensible Heat Factor (SHF)
= Sensible Heat

(Sensible H + Latent H)



ROOM SENSIBLE HEAT FACTOR (RSHF)

- IS THE RATIO OF ROOM SENSIBLE HEAT TO TOTAL HEAT (SENSIBLE + LATENT HEAT)
- $RSHF = \frac{RSH}{RSH + RLH} = \frac{RSH}{RTH}$

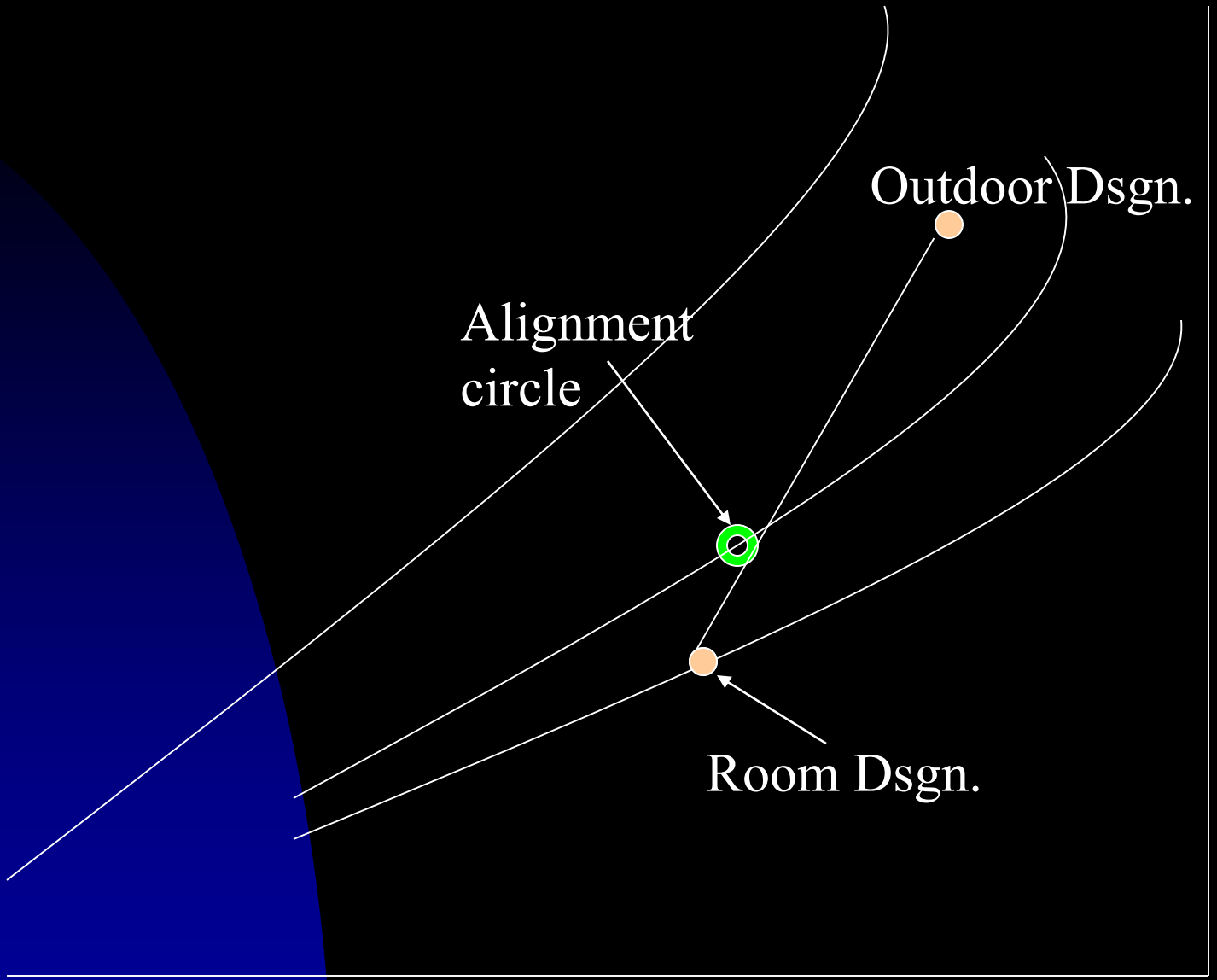

Alignment
circle
SHF
Scale
RSHF
Room Dsgn.

QUESTION

- Room condition 75°F DB, 55 % RH
- Calculated RSHF = 0.93
- Plot RSHF line

MIXTURE CONDITION (t_{mix})

- T_{mix} can only be determine by trial and error
- It is the temperature of the return air + the outdoor air.
- For 100% outdoor air system, the T_{mix} equals the outdoor air temperature.
- Simpler method is as follows,

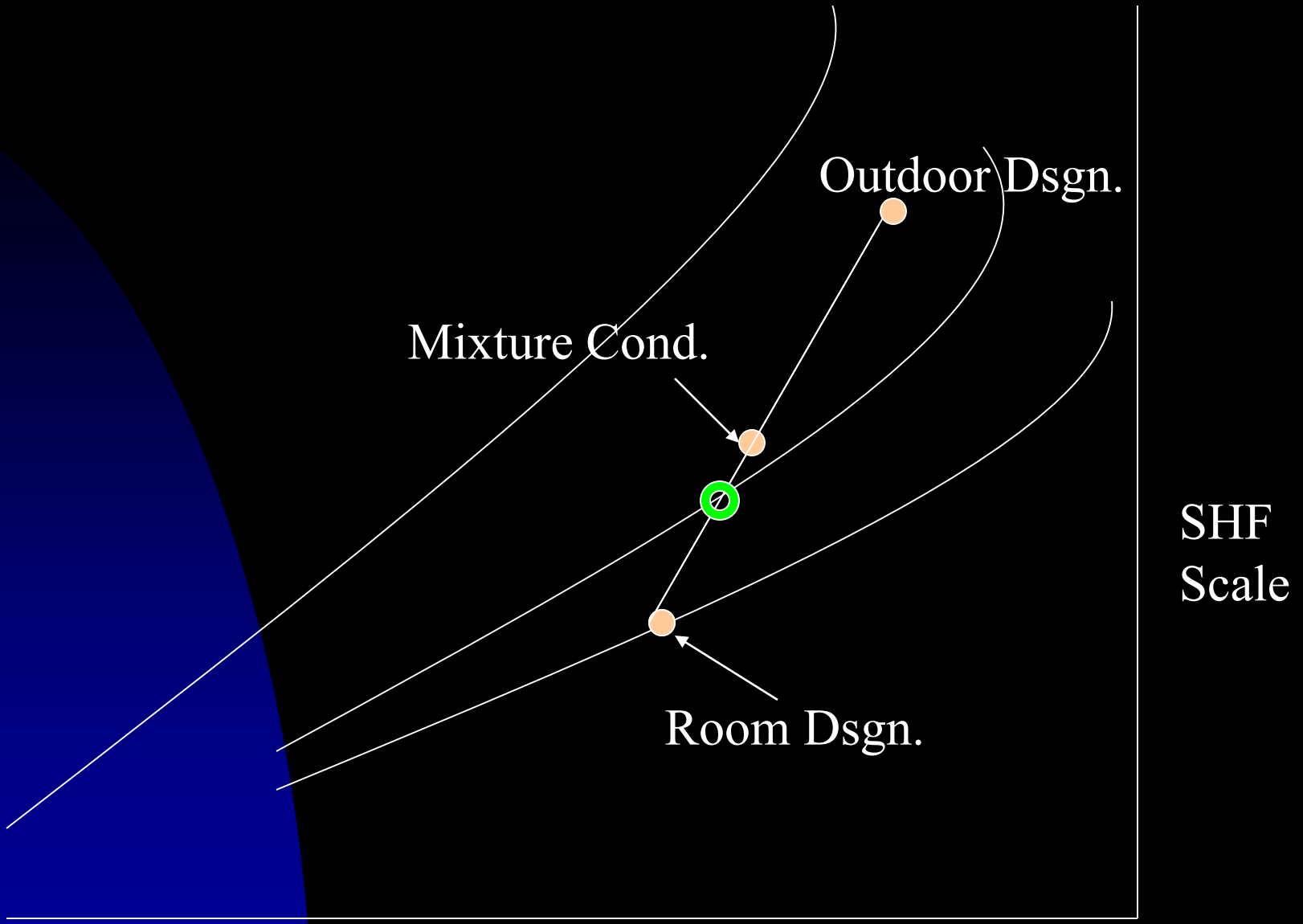

Outdoor Dsgn.
Alignment
circle
SHF
Scale
Room Dsgn.

MIXTURE CONDITION (t_{mix})

- For equal volume of Return Air (RA) and Outdoor Air (OA)
- RA + OA = Mixture volume
- 1000 cfm + 1000 cfm = 2000 cfm
- 80°F + 92°F = 86°F
- For unequal volume, then

MIXTURE CONDITION (t_{mix})

- For unequal volume, then
- RA cfm + OA cfm = Mixture cfm
- 3000 cfm + 1000 cfm = 4000 cfm
- $80°x\frac{(3000)}{(4000)} + 92°x\frac{(1000)}{(4000)} = t_{mix}$
- $t_{mix} = 83°F$


Outdoor Dsgn.
Mixture Cond.
SHF
Scale
Room Dsgn.

QUESTION?

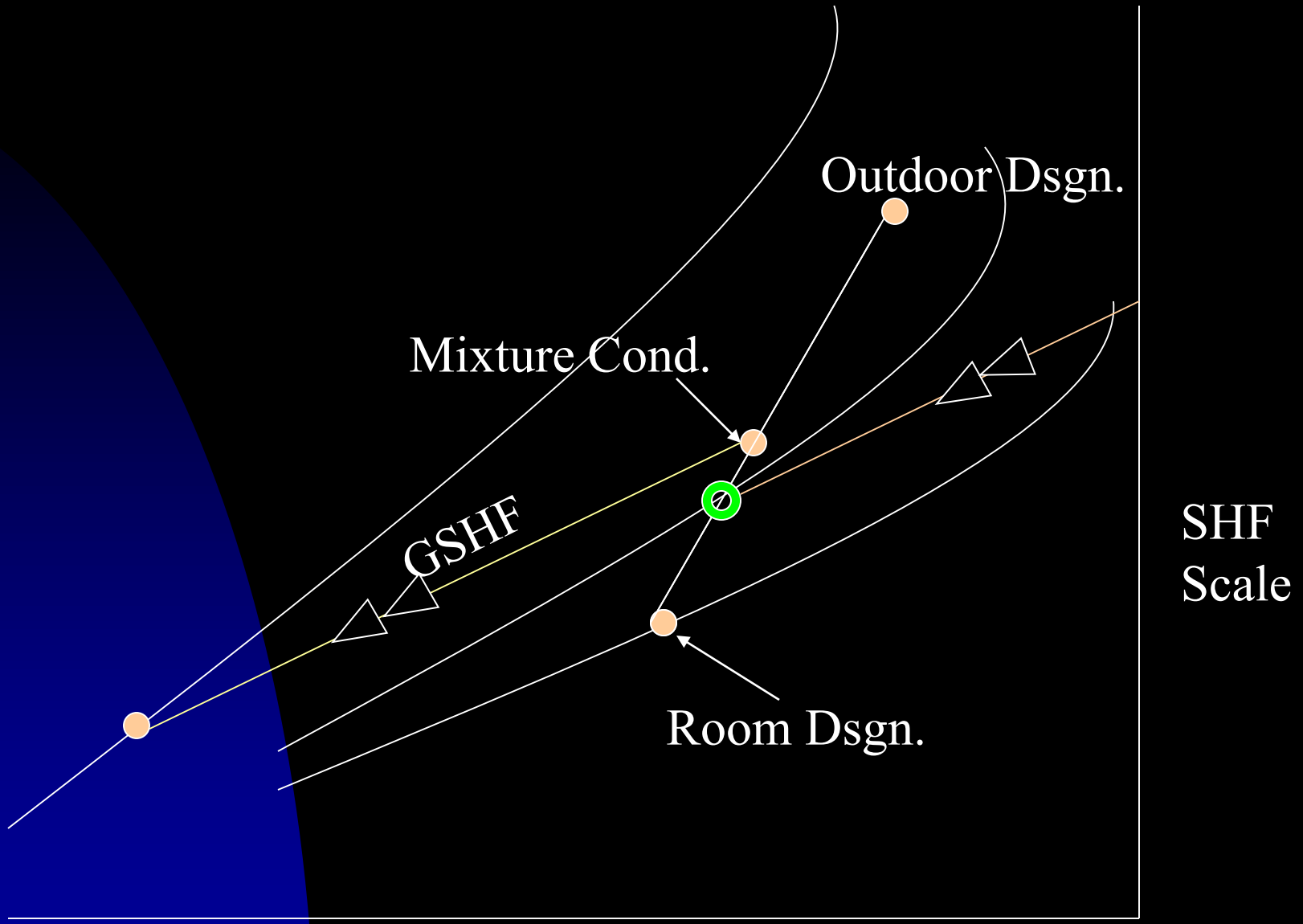
- Outdoor air at 92 DB and 80 WB is to be mixed with room air at 75DB 55RH. The final mixture consist of 12.5% outdoor air and 87.5% return air. Find the resulting dry and wet bulb temperatures of the mixture?

ANSWER

- OA > 0.125 x 92 = 11.50
- RA > 0.875 x 75 = 65.63
- T_{mix} = 77.13°DB
- T_{mix} = 66°WB

GRAND SENSIBLE HEAT FACTOR (GSHF)

- IS THE RATIO OF THE TOTAL SENSIBLE HEAT TO THE GRAND TOTAL HEAT LOAD THAT THE CONDITIONING APPARATUS MUST HANDLE
- $GSHF = \frac{TSH}{TSH + TLH} = \frac{TSH}{GTH}$



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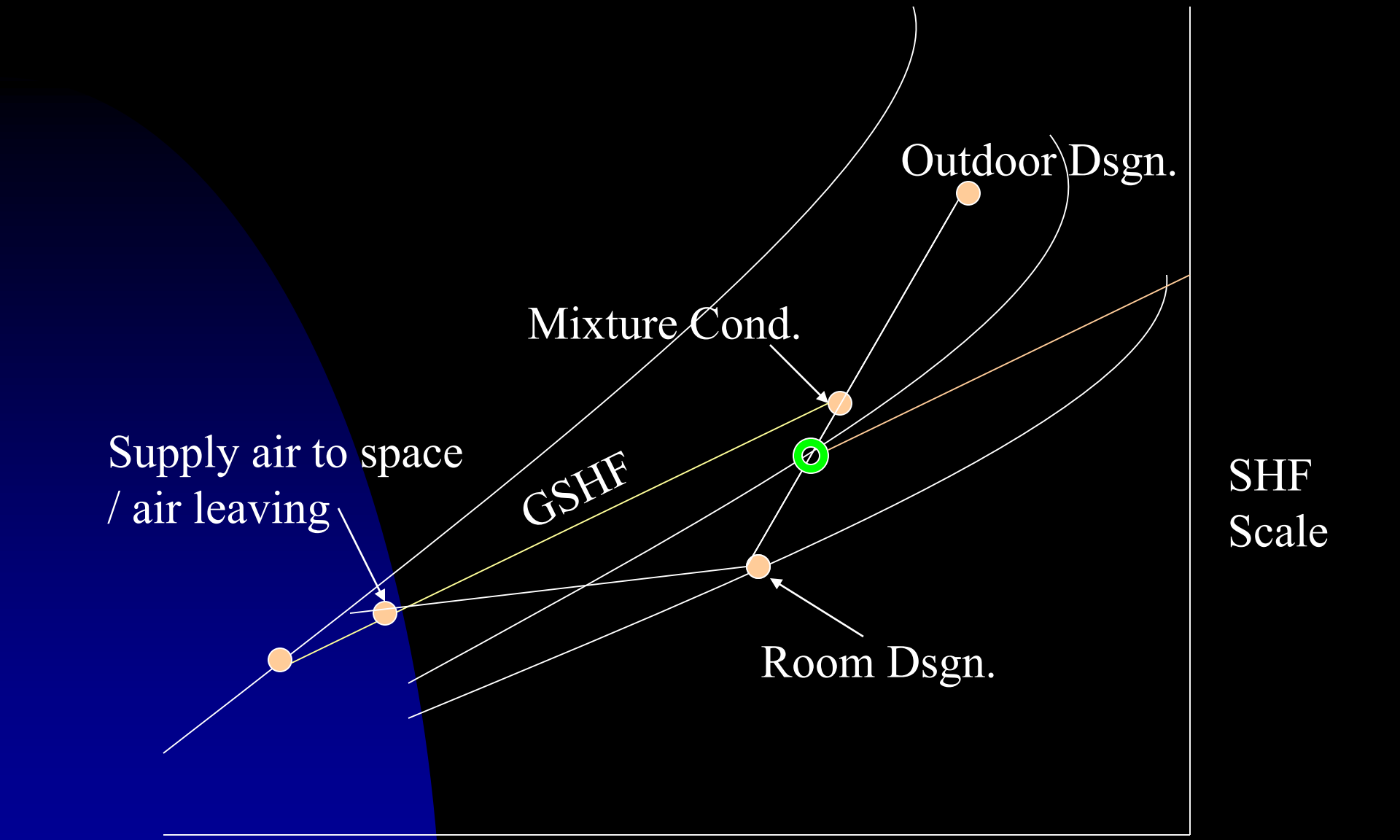

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QUESTION - Find and Plot GSHF

- Outdoor air = 92db / 80wb
- Room air = 75db / 55%rh
- T_{mix} = 77db
- ERSH = 114 000
- ERTH = 130 000
- OA heat sensible = 12 000
- OA heat latent = 30 000

ANSWER

- ERSH + OA Sensible = 126 000
- GTH = ERTH + OA (S) + OA (L)
- = 172 000
- GSHF = 126 000/172 000
- = 0.733

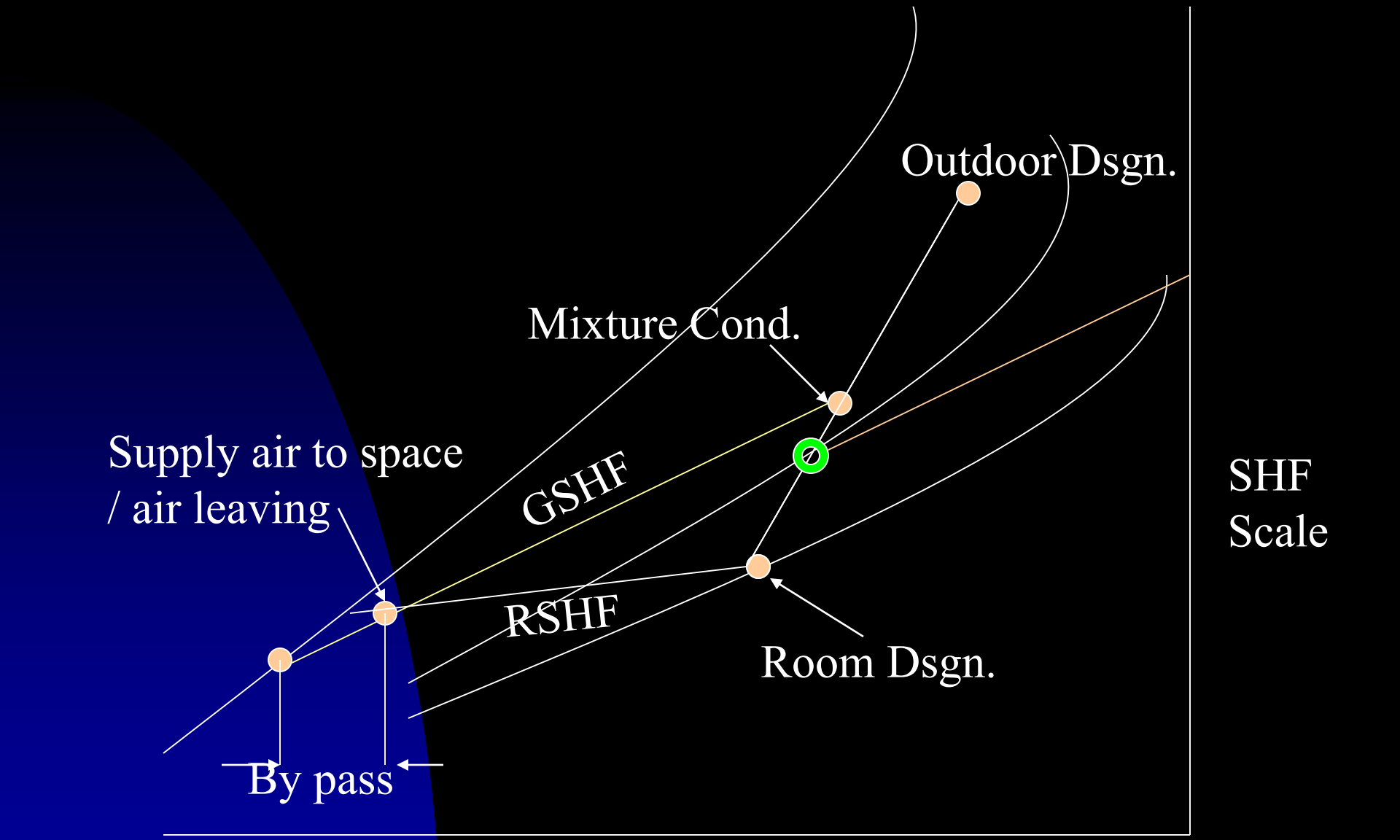
BYPASS FACTOR (BF)

- By pass is a function of the physical and operating characteristics of the conditioning apparatus
- It represents that portion of the air which is considered to pass through the conditioning apparatus completely unaltered

BYPASS FACTOR

- $BF = \frac{\text{Lvg. Temp - ADP}}{\text{Entering Temp. - ADP}}$

- Lvg. T = BF x (Ent. T - ADP) +ADP


Outdoor Dsgn.
Mixture Cond.
Supply air to space
/ air leaving
GSHF
SHF
Scale
RSHF
Room Dsgn.
By pass

BF DEPENDS UPON COIL CONSTRUCTION

- Size of tube
- Size and type of fin
- Spacing of tube and fin
- Velocity of air

TYPICAL BF FOR VARIOUS APP.

BF	APPLICATION	EX.
0.30 – 0.50	Small total load/low SHF	Residence
0.20 – 0.30	Typical comfort with small total load	Small shop
0.10 – 0.20	Typical comfort	Bank, Dept.
0.05 – 0.10	High Internal Sensible load/large outdoor air	Dept. Store
0 – 0.10	All outdoor air	Hospital OR

RELATIONSHIP BETWEEN ROWS AND BF

ROWS	BF
2	0.31
3	0.18
4	0.10
5	0.06
6	0.03

RELATIONSHIP BETWEEN VELOCITY AND BF

VELOCITY (fpm)	BF
300	0.11
400	0.14
500	0.18
600	0.20

SHOULD BF BE SMALL OR LARGE?

- NO EASY ANSWER
- SMALL BF MEANS
  - LOW AIR TEMPERATURE LEAVING THE COIL
  - HIGHER ADP
  - SMALLER REFRIGERATION MC
  - LESS AIR

SHOULD BF BE SMALL OR LARGE?

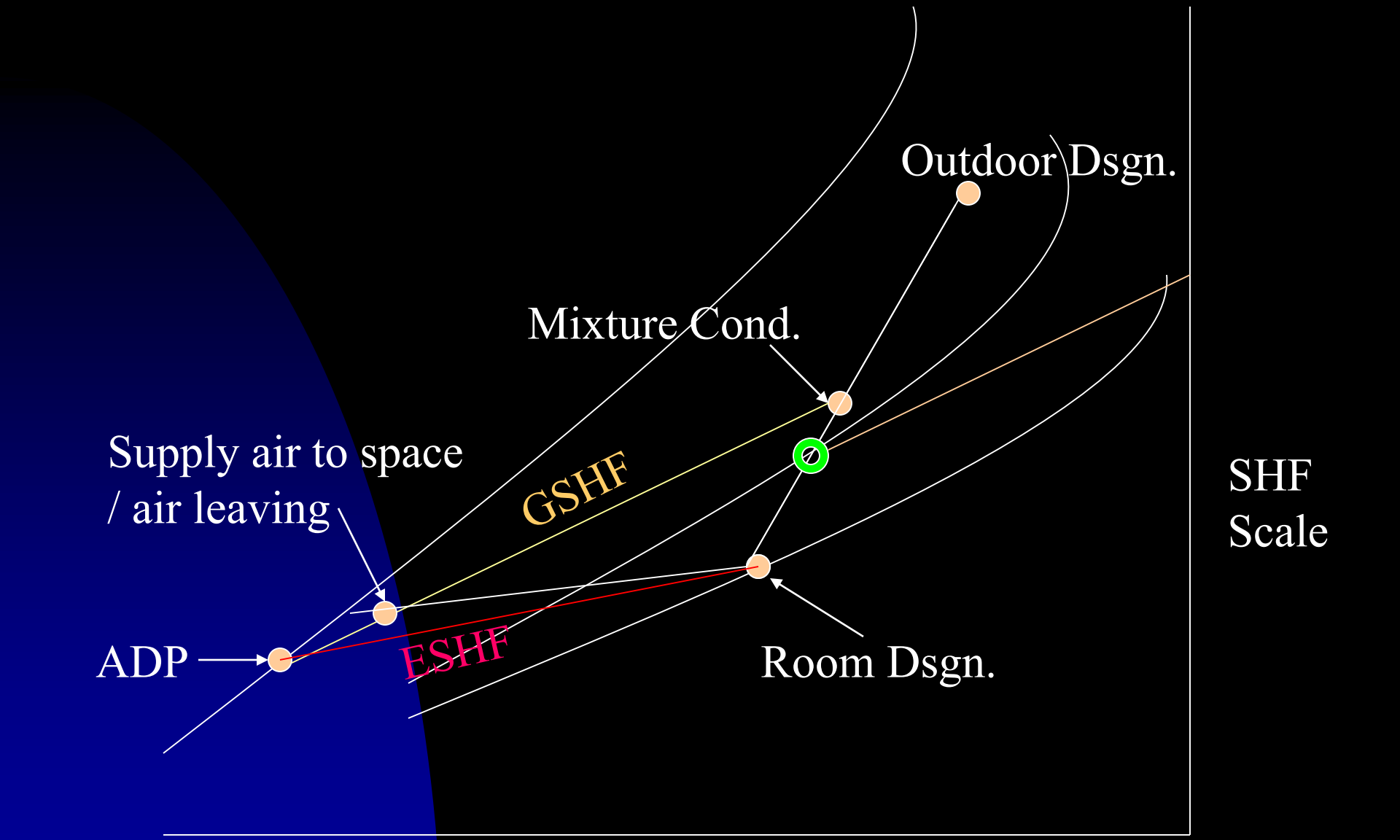
- LARGE BF MEANS
  - HIGH AIR TEMPERATURE LEAVING THE COIL
  - LOWER ADP
  - BIGGER REFRIGERATION MC
  - MORE AIR

APPARATUS DEW POINT (ADP)

- The name used for the final average surface temperature.

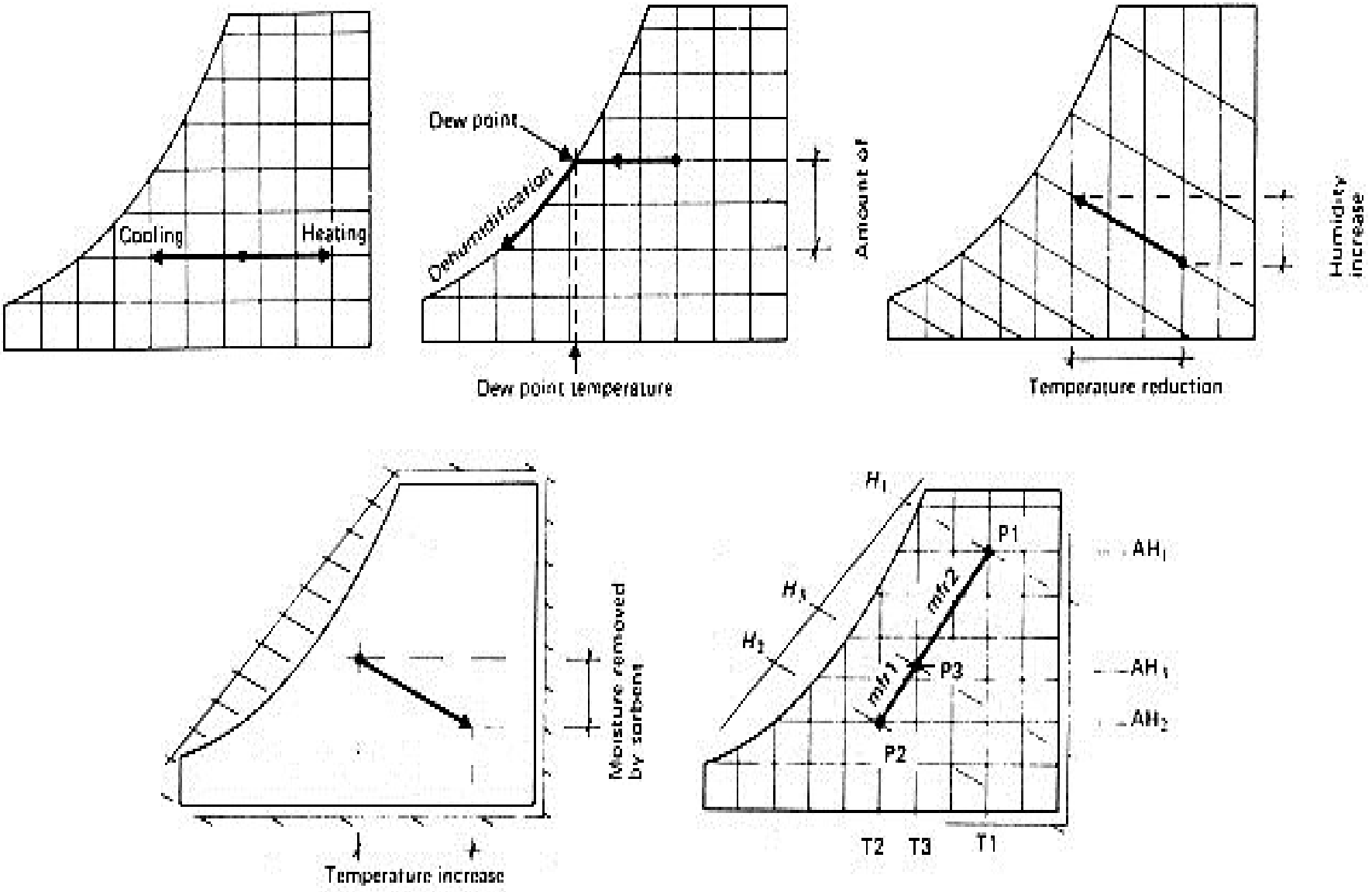
ADP

- Three ways to get the ADP
  - Knowing the ESHF and room condition, from table 65. Involve interpolation
  - Knowing ESHF and room condition, plot ESHF on chart.
  - Knowing GSHF and mix condition, plotting GSHF on chart


Outdoor Dsgn.
Mixture Cond.
Supply air to space
/ air leaving
GSHF
SHF
Scale
ADP
ESHF
Room Dsgn.

- Currently resulting Ent. And Lvg. Conditions at apparatus is the ONLY thing that is read from Psychrometric Chart
- Maybe now this can be change

THANK YOU



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