Fundamentals of Psychrometrics

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Let's Start with Air

- Air is Made up of Two Main Gases
  - Nitrogen (77%)
  - Oxygen (23%)
- If that is all there was HVAC Calculations would be easy
  - Cooling BTU's = $(T_2-T_1)*1.085*CFM$
- But there is One other element
  - Water Vapor
- How do we account for Water Vapor?
  - Psychrometric Chart

PSYCHROMETRIC CHART

Normal Temperature

I-P Units

5000 FEET

BAROMETRIC PRESSURE: 24.896 in. HG

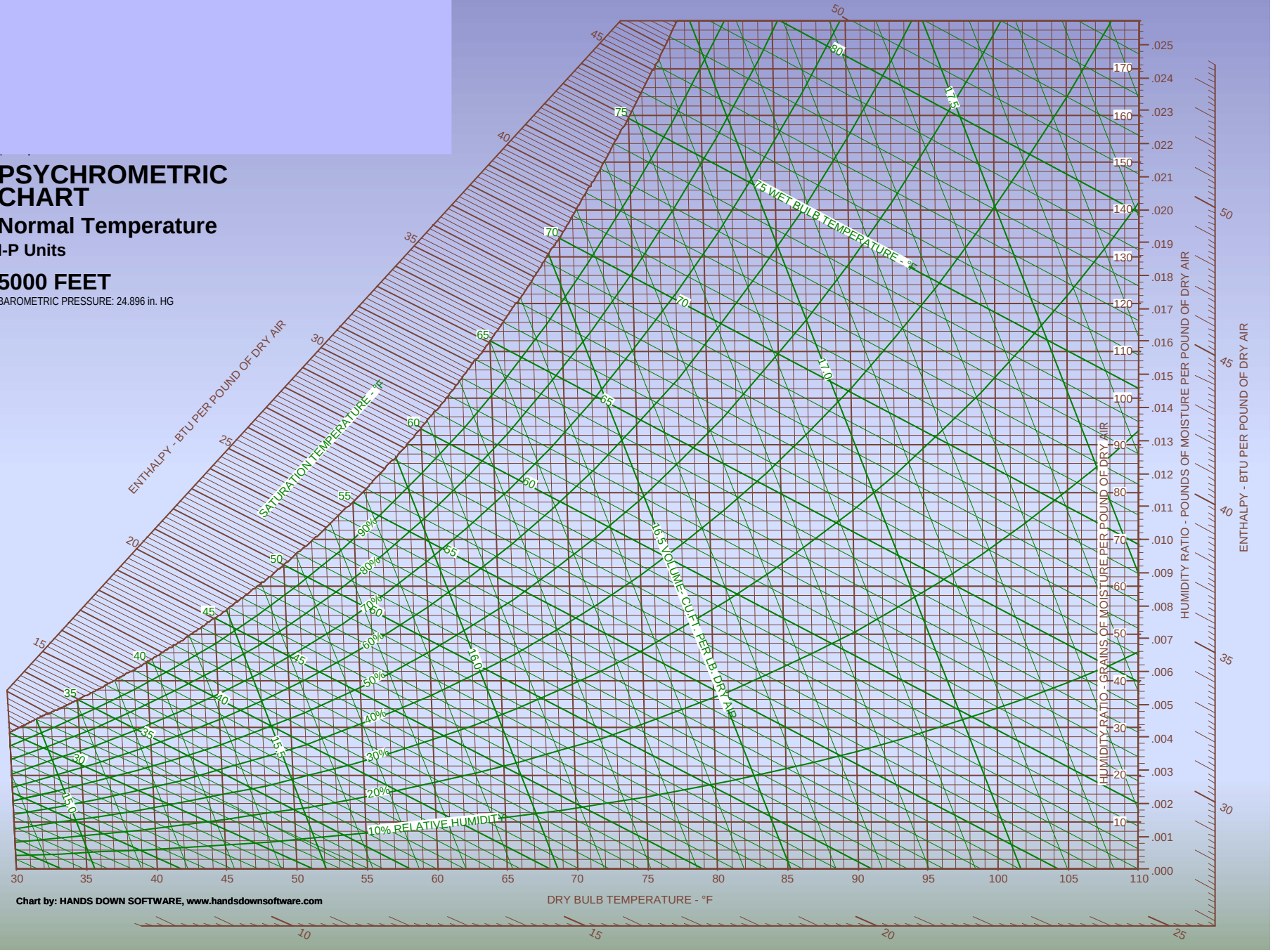
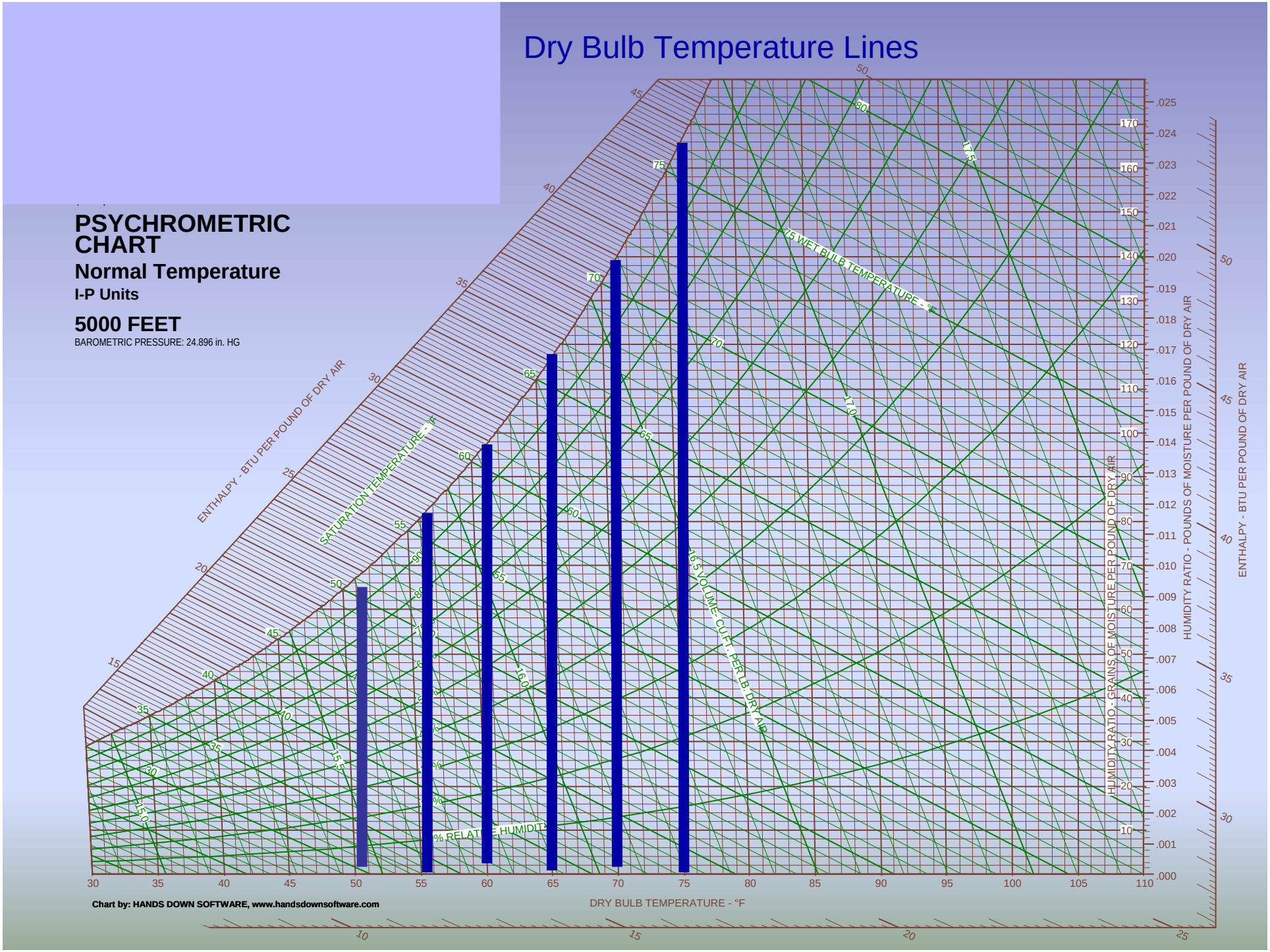
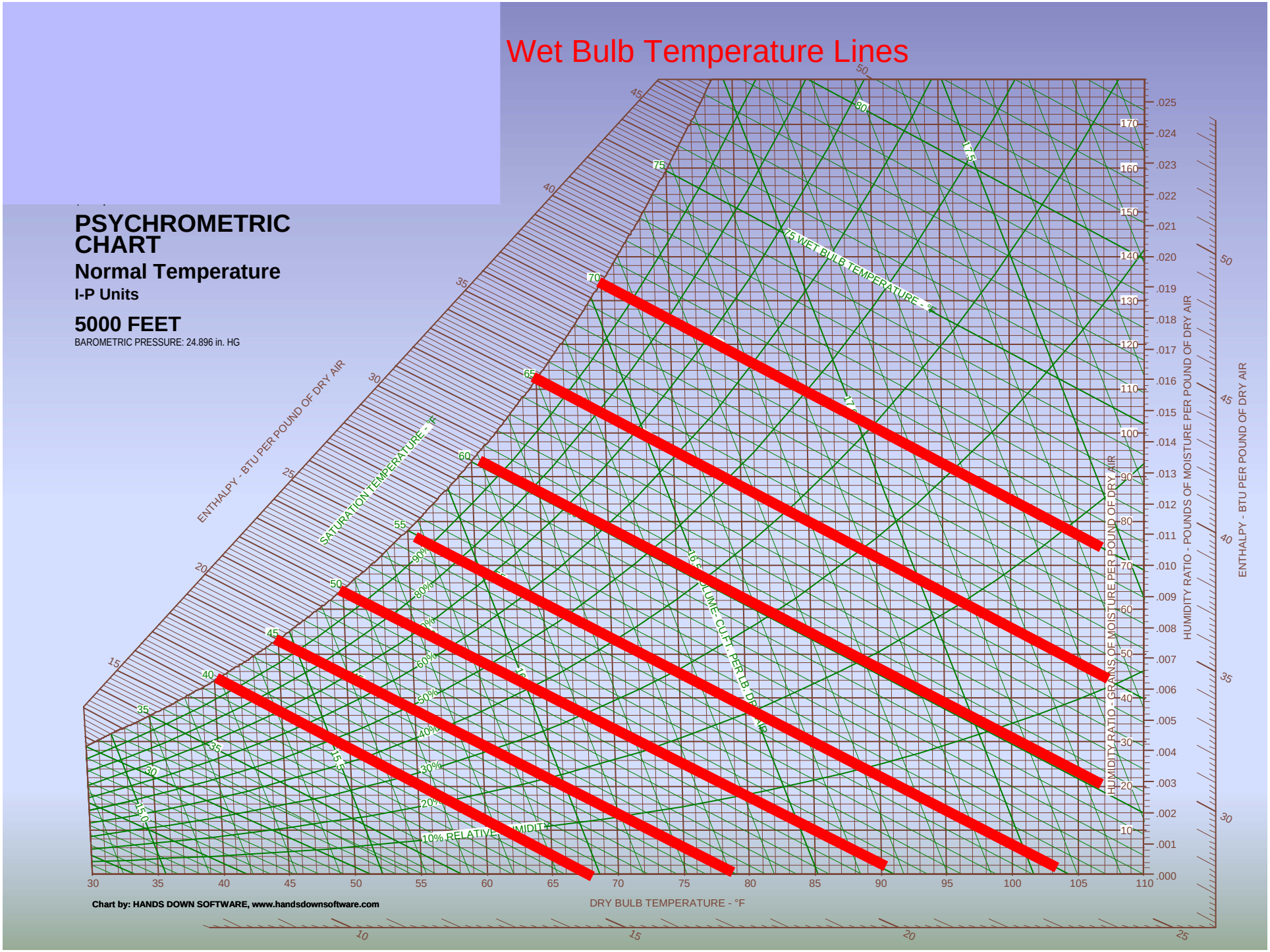


Chart by: HANDS DOWN SOFTWARE, www.handsdownsoftware.com

Dry Bulb Temperature Lines



Wet Bulb Temperature Lines



Relative Humidity Lines

PSYCHROMETRIC CHART

Normal Temperature

I-P Units

5000 FEET

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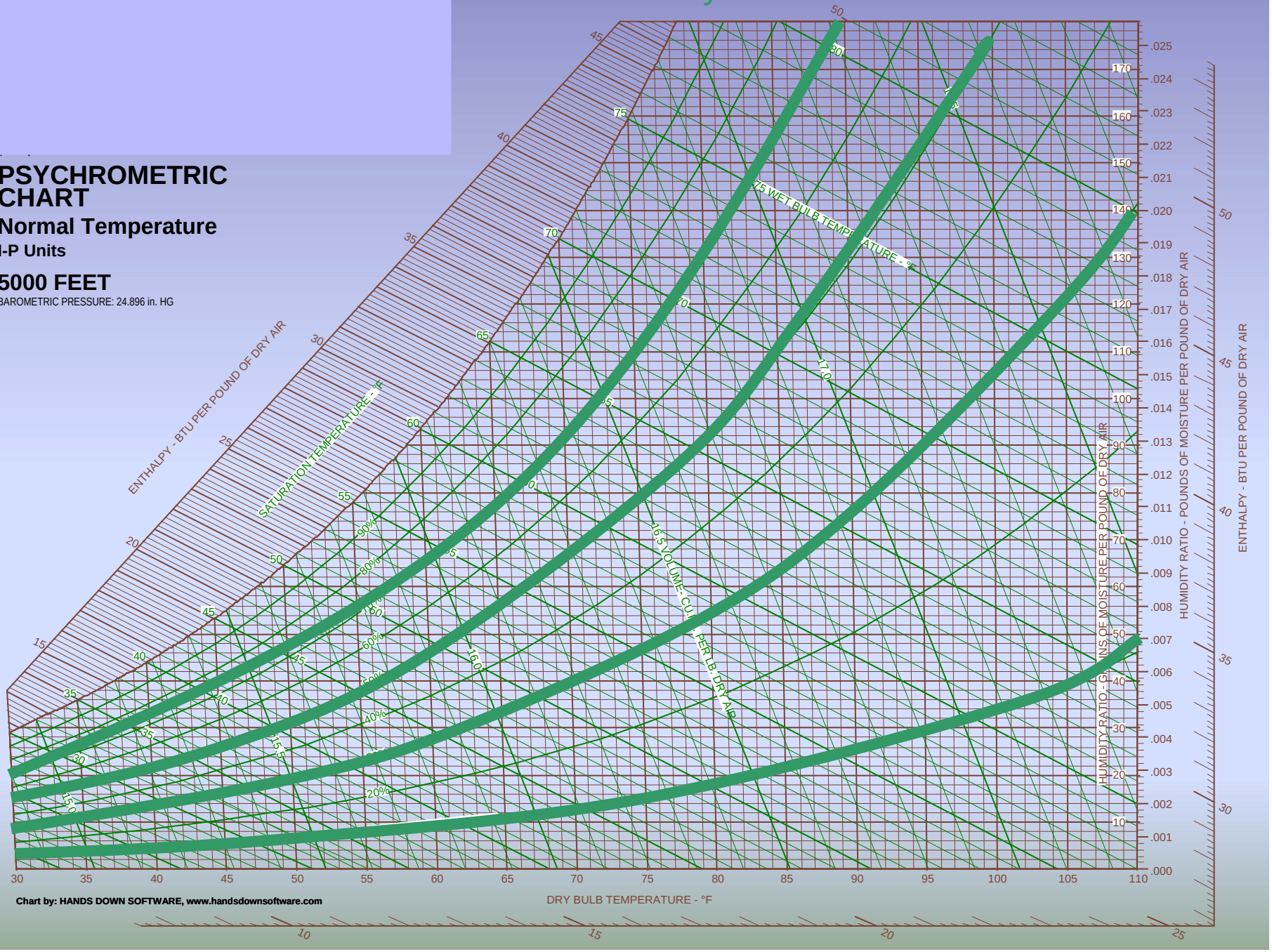

PSYCHROMETRIC CHART

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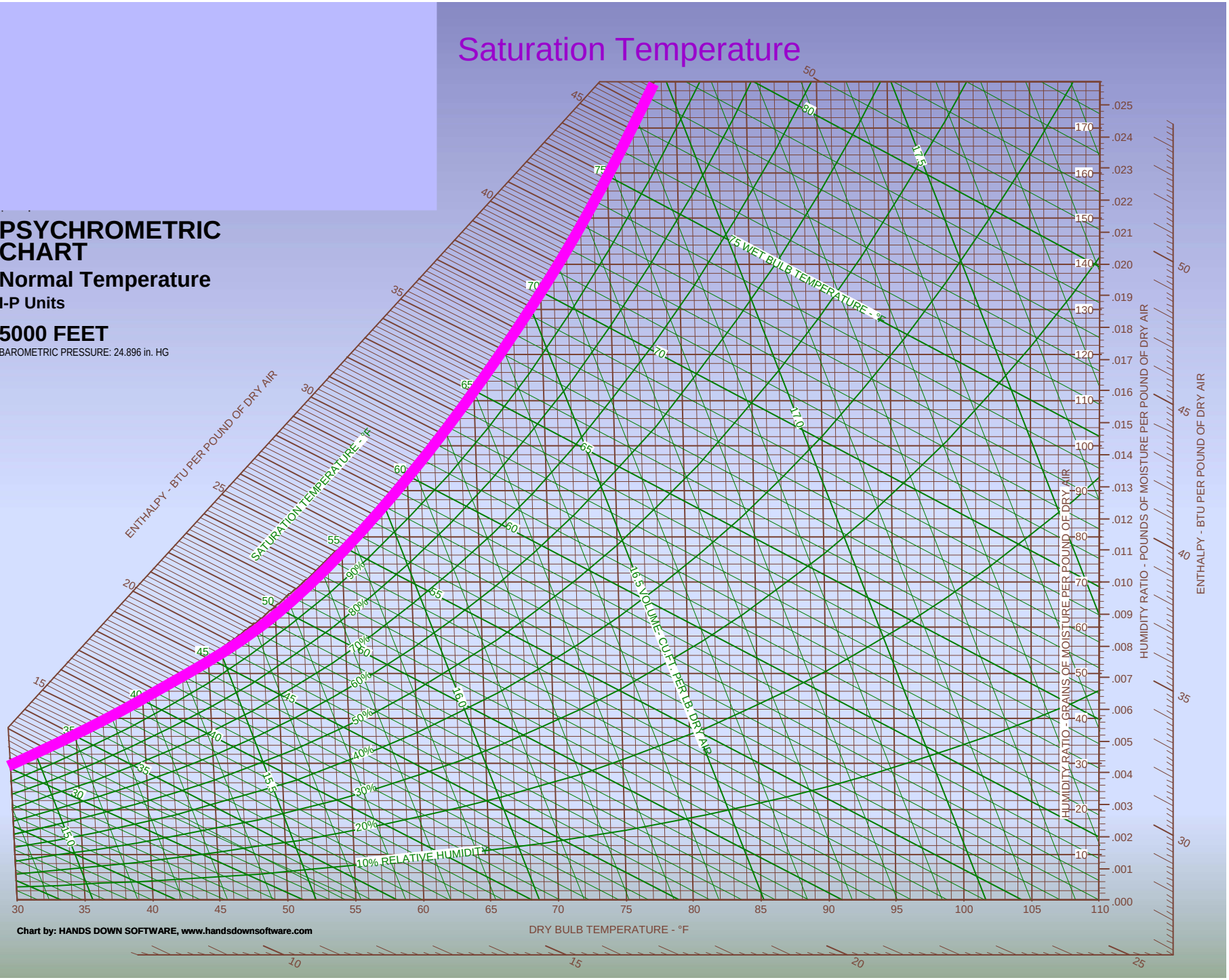
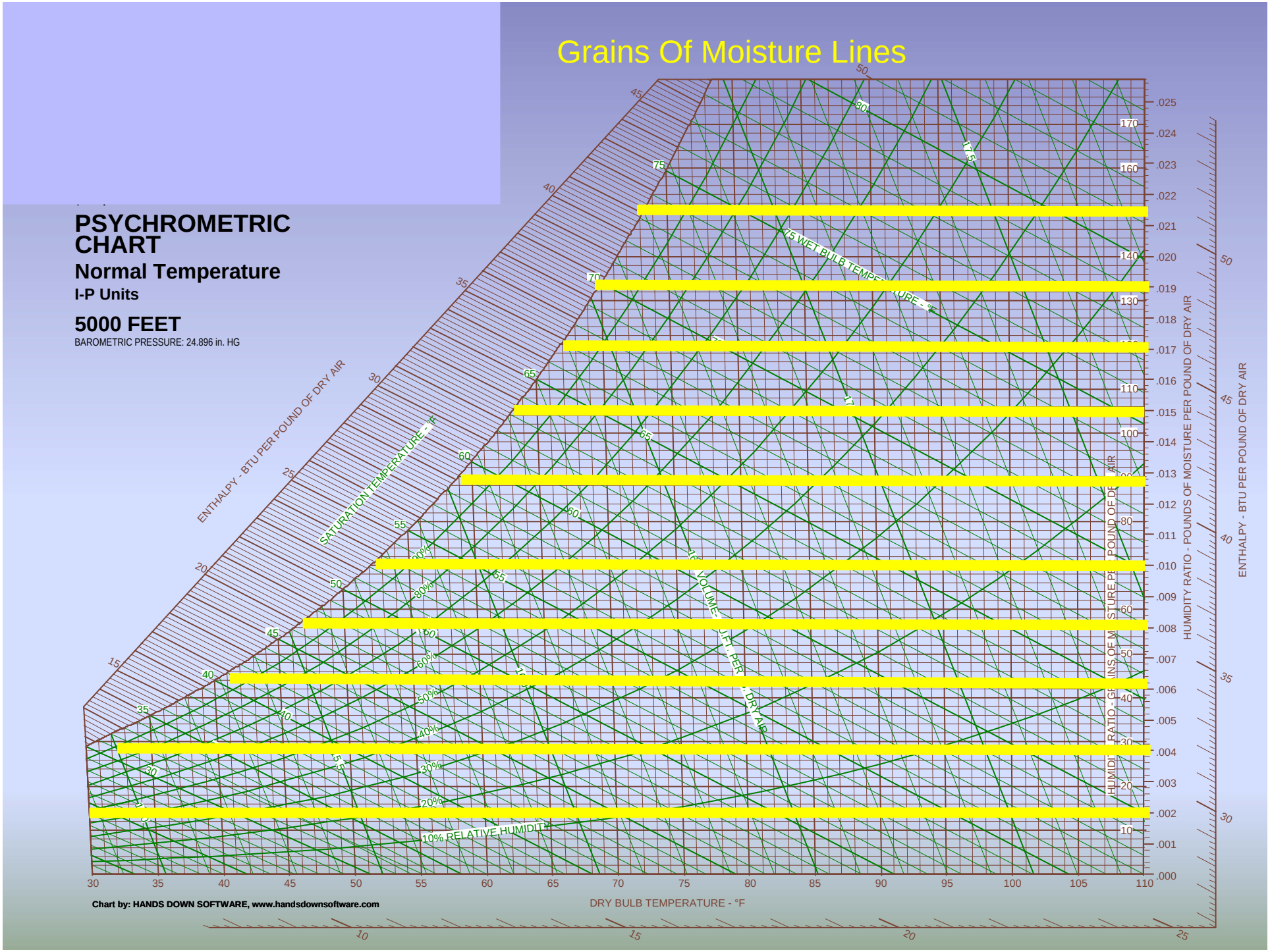
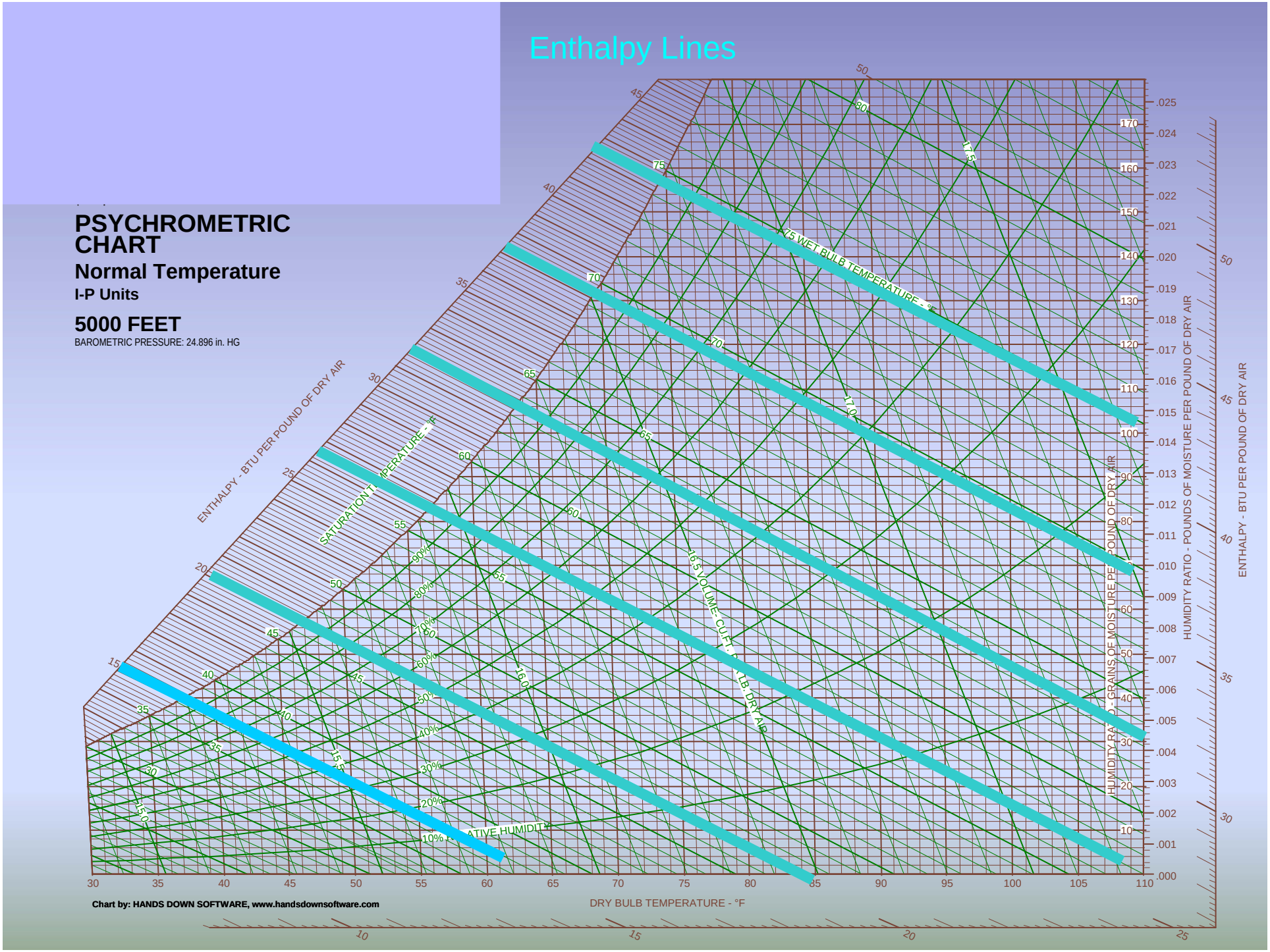


Grains Of Moisture Lines



Enthalpy

- What Is Enthalpy
  - The Total Heat Content of the air and water Vapor
- Why is it Important?
  - The more Heat Content in the air the Harder it is to cool
  - The Less Heat Content in the air the easier it is to cool


Enthalpy Lines
PSYCHROMETRIC CHART
Normal Temperature
I-P Units
5000 FEET
BAROMETRIC PRESSURE: 24.896 in. HG
ENTHALPY - BTU PER POUND OF DRY AIR
SATURATION TEMPERATURE - °F
RELATIVE HUMIDITY
DRY BULB TEMPERATURE - °F
HUMIDITY RATIO - POUNDS OF MOISTURE PER POUND OF DRY AIR
HUMIDITY RATIO - GRAINS OF MOISTURE PER POUND OF DRY AIR
ENTHALPY - BTU PER POUND OF DRY AIR
Chart by: HANDS DOWN SOFTWARE, www.handsdownsoftware.com

Plotting Points On the Psychrometric Chart

- Only need two of the following to Plot a point
  - DB Temp, WB Temp, RH%, Grains Of Moisture
- Once the Point is plotted, You can find all the other information

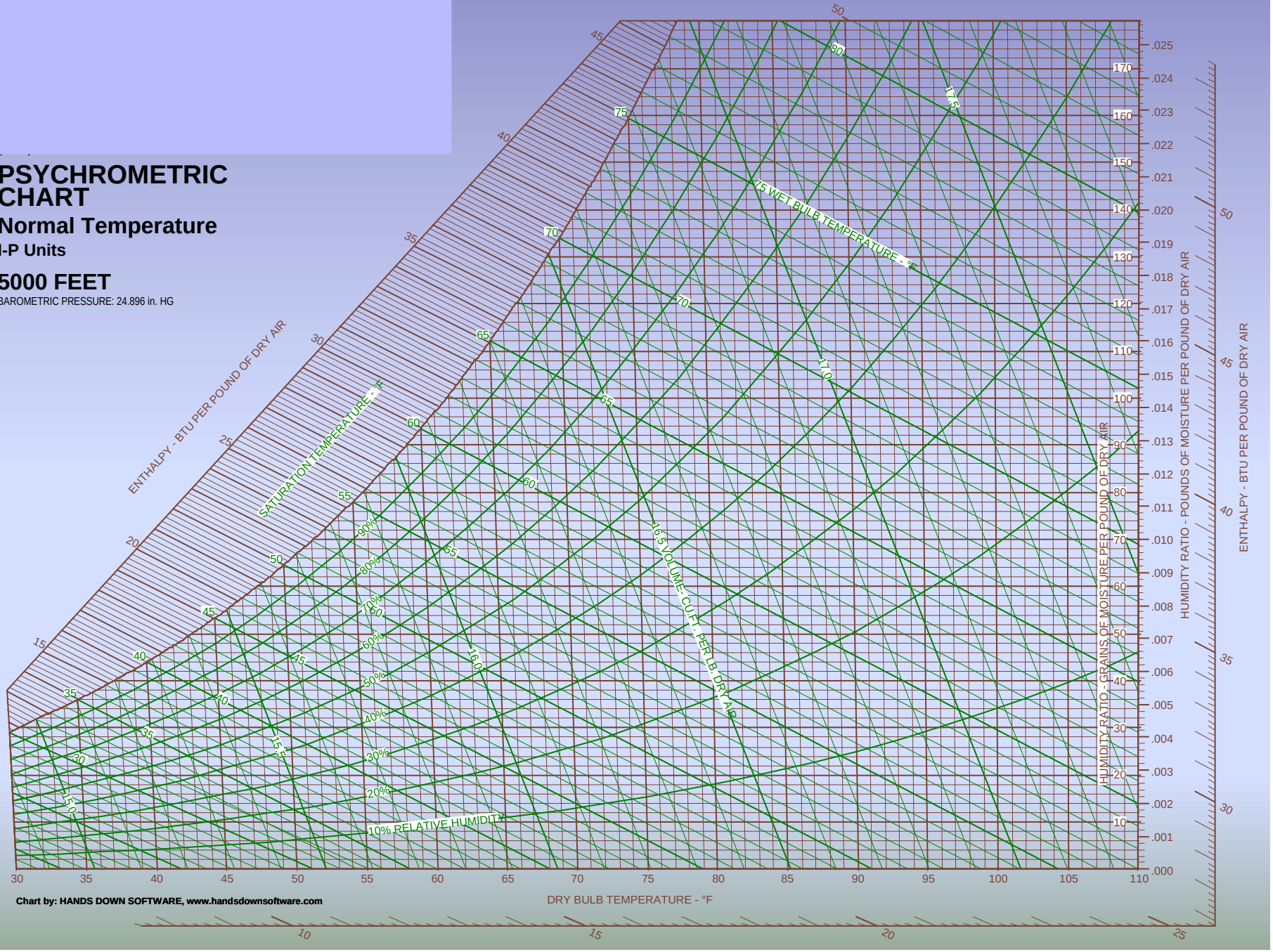
PSYCHROMETRIC CHART

Normal Temperature

I-P Units

5000 FEET

BAROMETRIC PRESSURE: 24.896 in. HG



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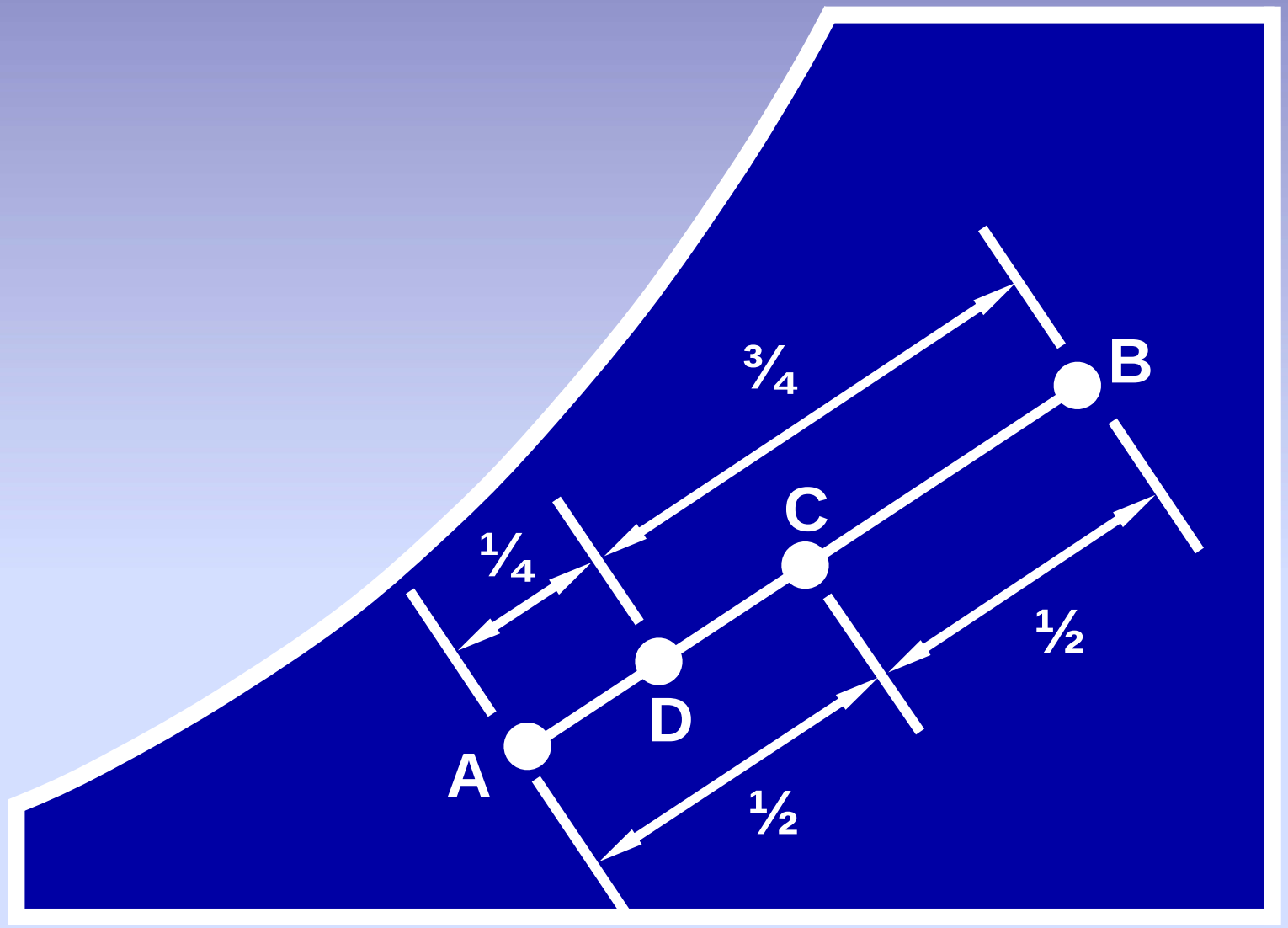
Mixed Air Temperatures

- Plot both Outdoor air and Return Air on Chart
- Draw a line between the two Points
- What ever the percentage of RA is, it is the same percentage down the line from RA to OA



AIR MIXING PROCESS

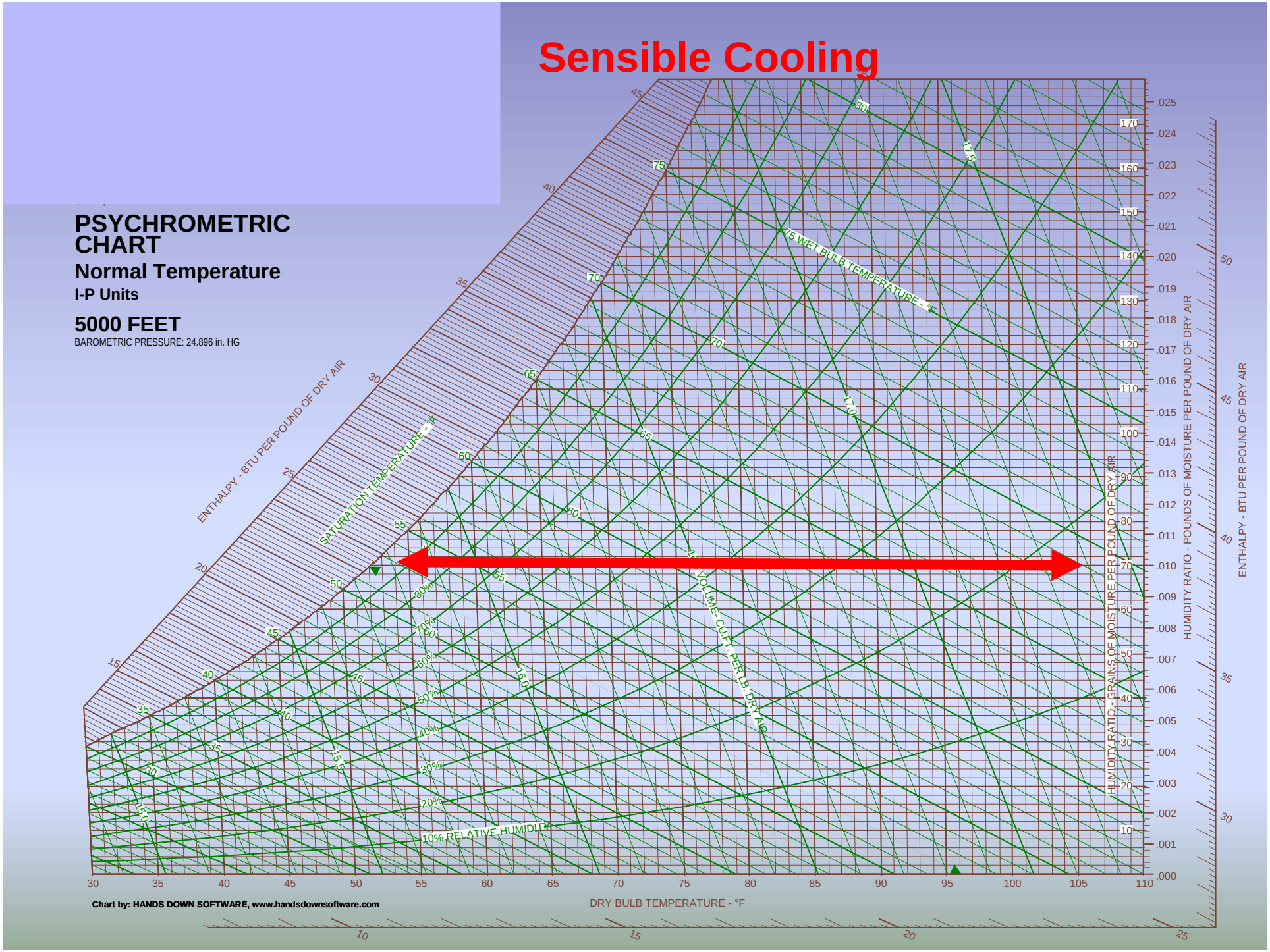
Heating and Cooling

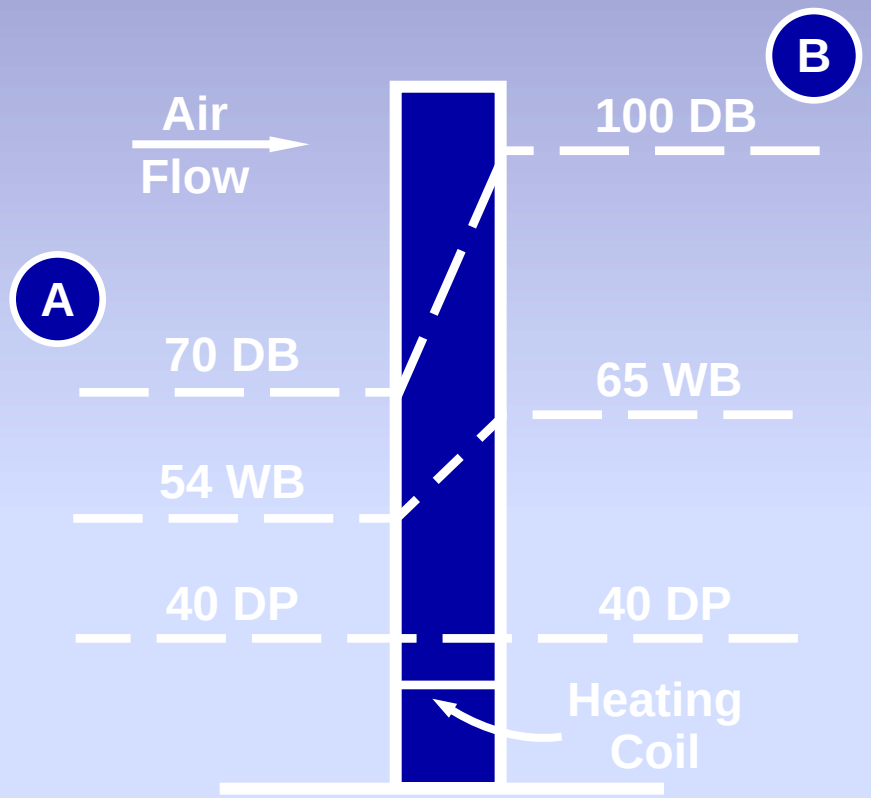
- Sensible Heating, Cooling
  - No moisture in the air Gained or Lost
  - Sensible Heat= 1.085*CFM(dT)

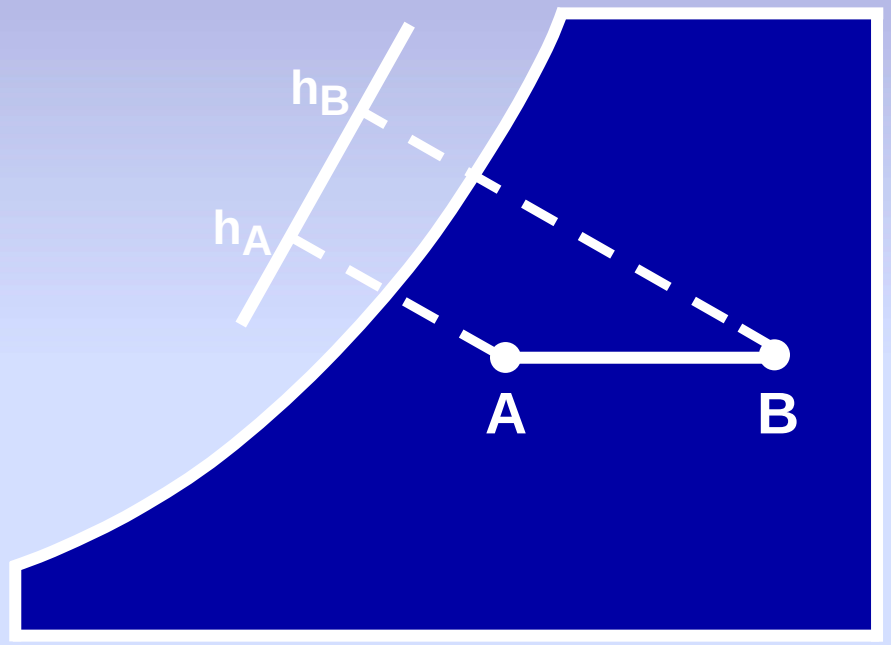
  OR

  - Sensible Heat = $4.5*CFM*(Enthalpy_1-Enthalpy_2)$
    - Enthalpy = H

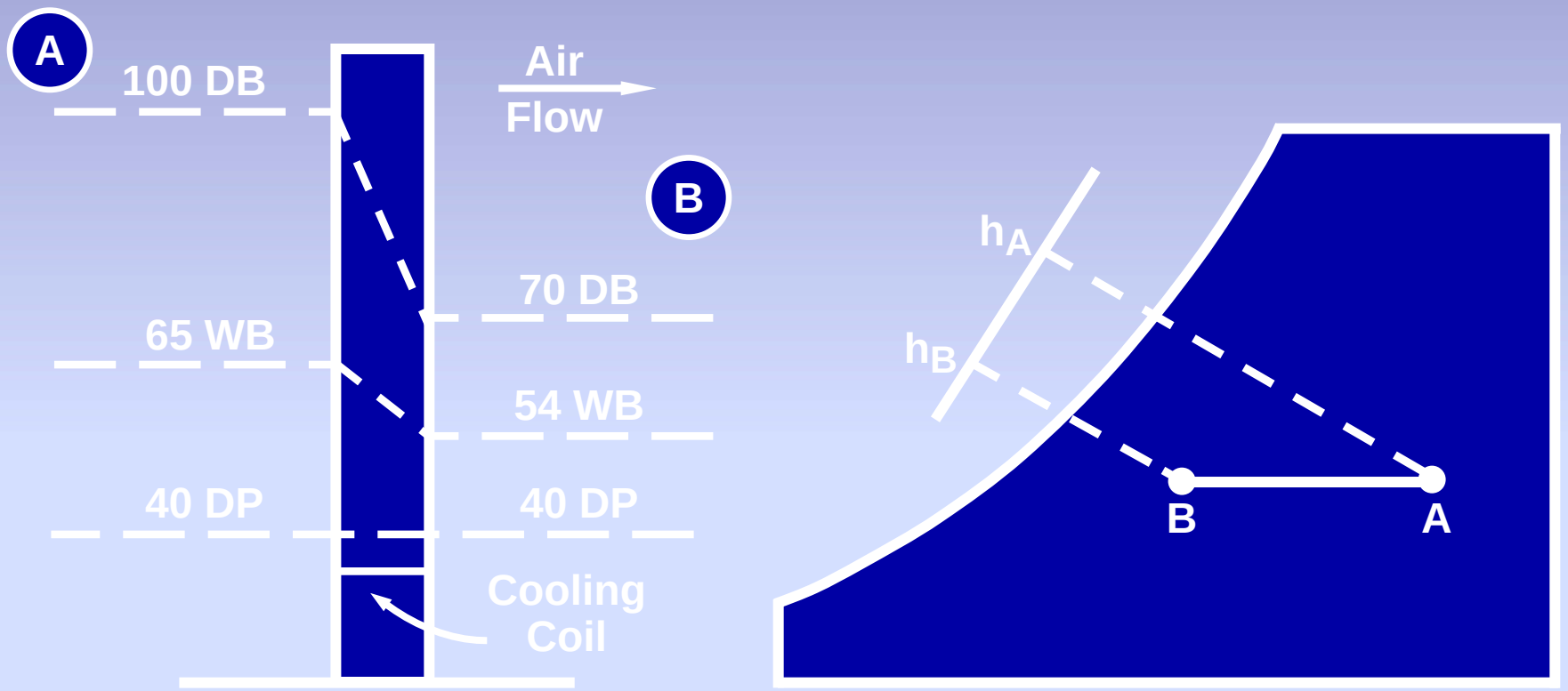
Sensible Cooling







SENSIBLE HEATING

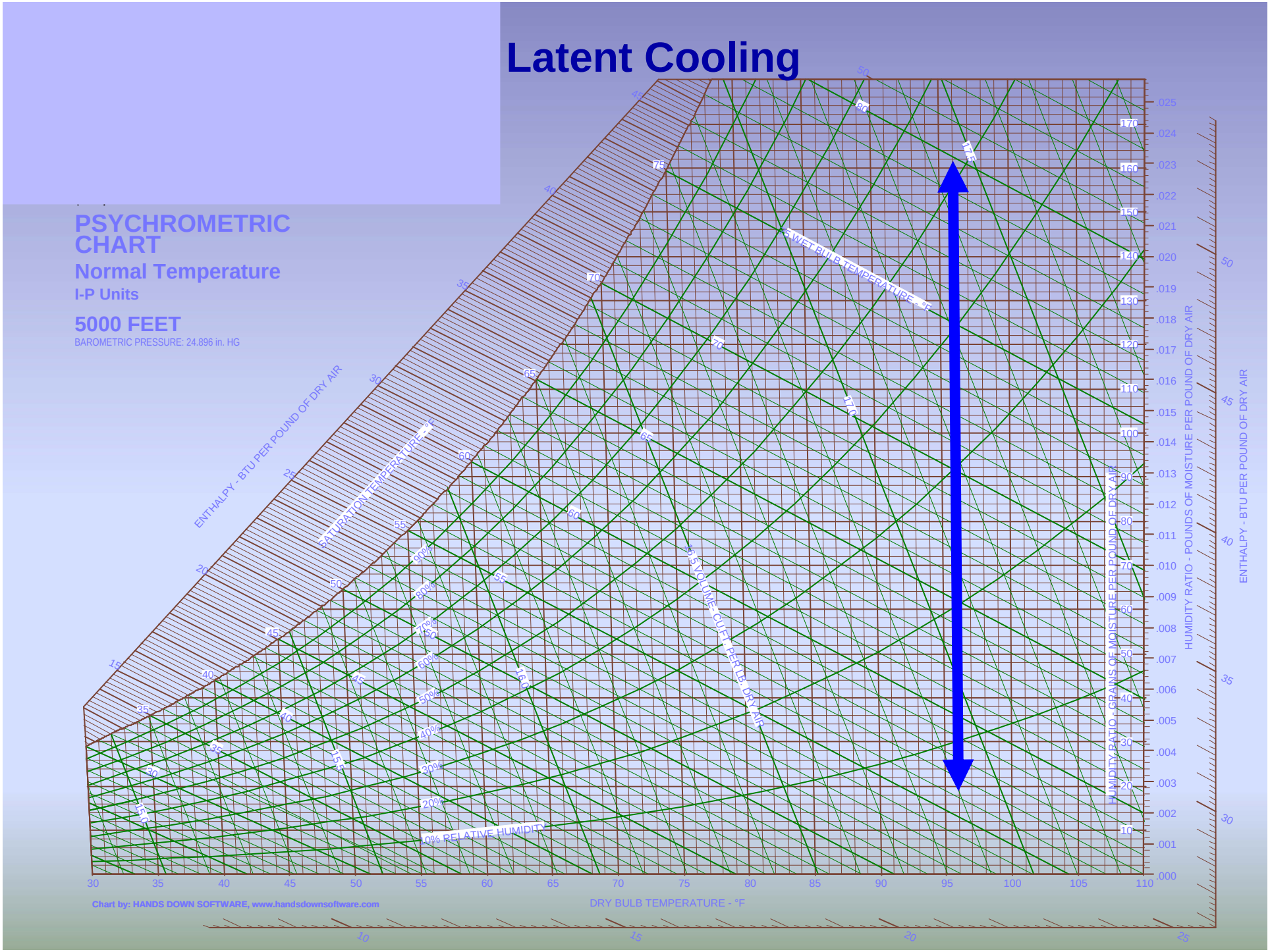


SENSIBLE COOLING

Latent Heat

- Occurs when Water is evaporated or Condensed and the dry bulb temperature does not change
- Adds to cooling needed to produce the dry bulb

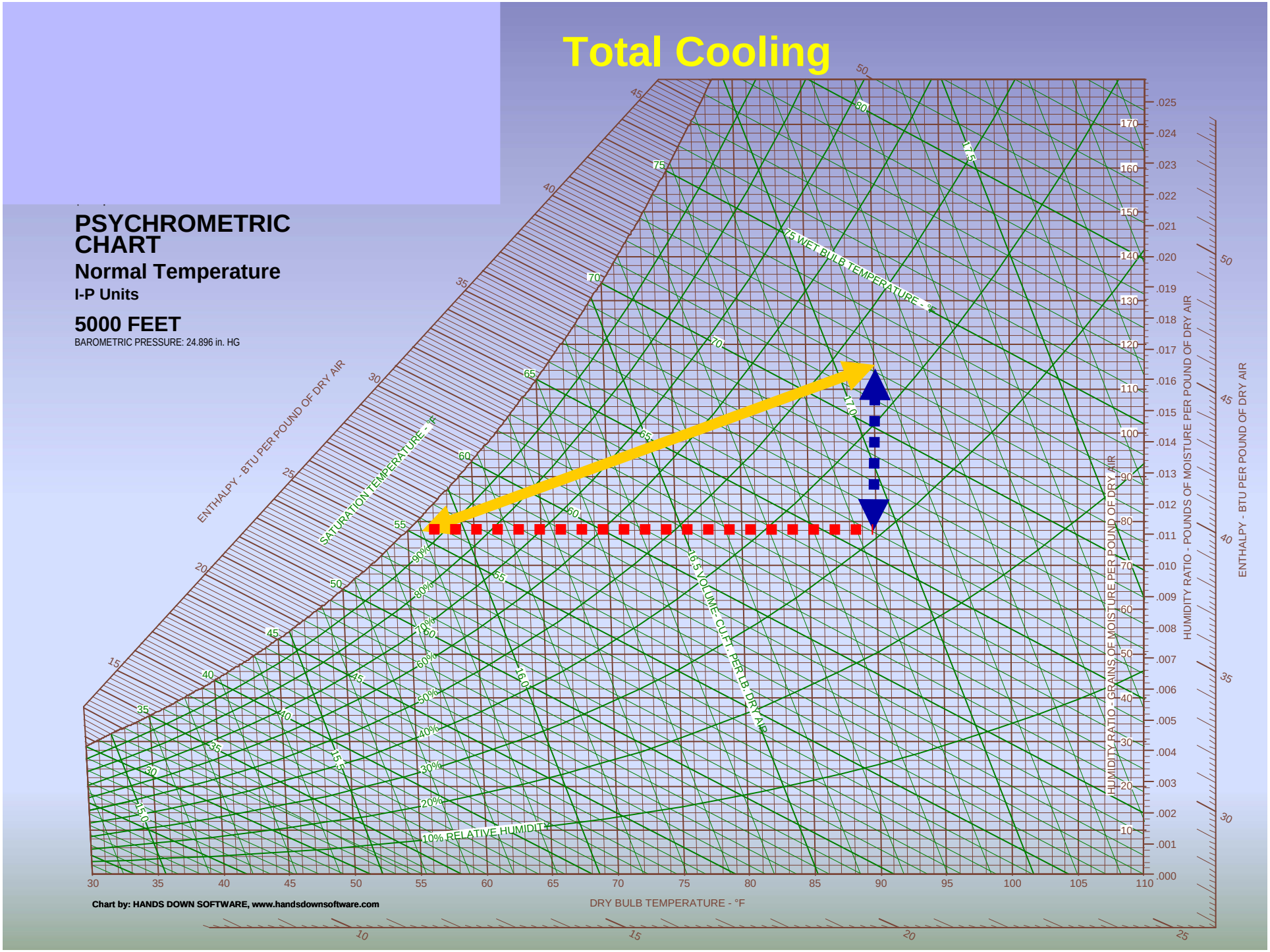
Latent Cooling

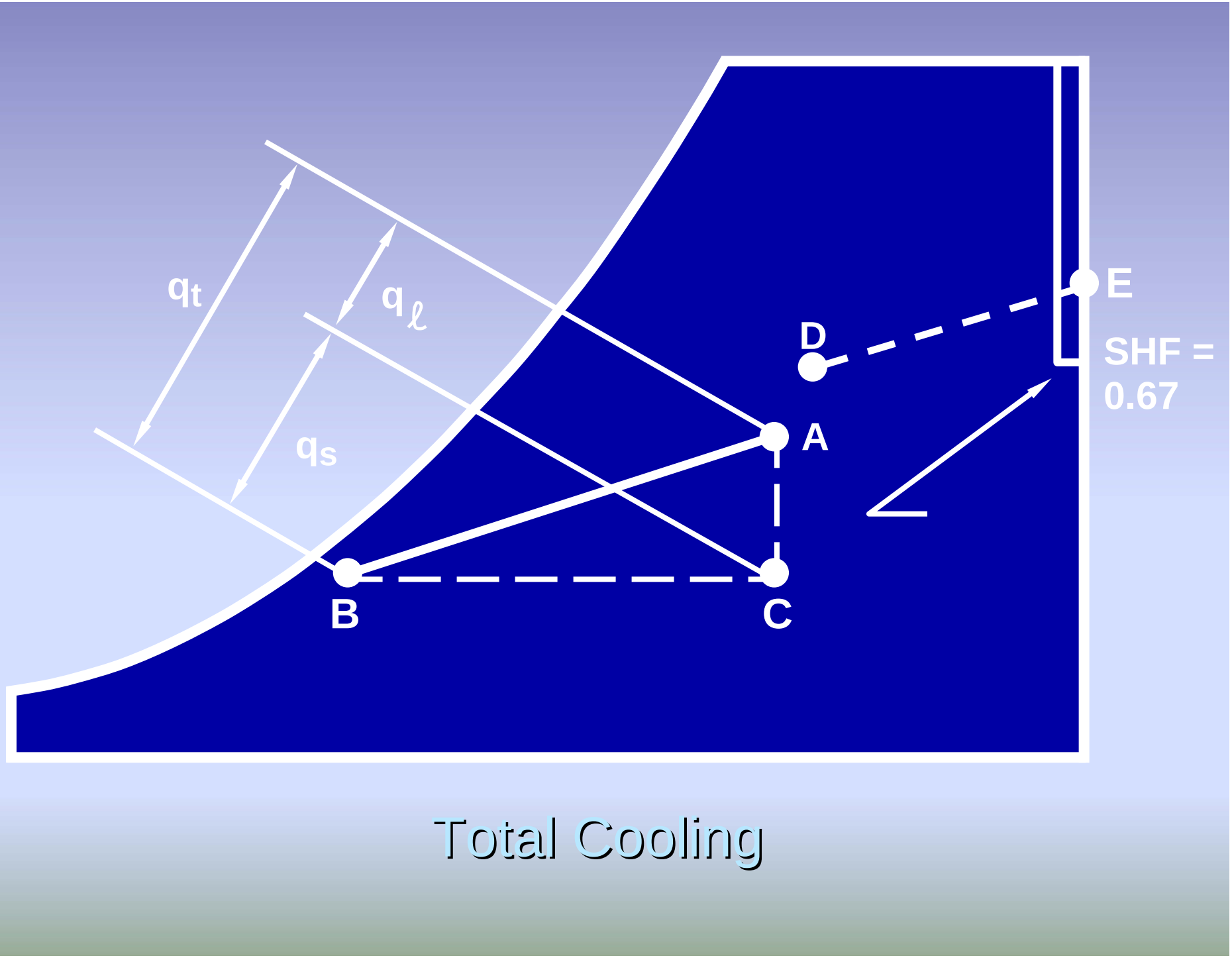


Total Heating, Cooling

- Sensible + Latent = Total
- Total = $4.5*CFM*(H_1-H_2)$

Total Cooling





Total Cooling

Why is the Psychrometric Chart useful

- Let's Say an Engineer's Schedule calls for a cooling coil to cool 1000 CFM from 80 degrees dry bulb and 67 degrees wet bulb to 55db degrees and wants 42 MBH Total Cooling at 5000' Altitude. Why is this a problem?
- Total Cooling=(60/16.5)*1000*(35-24.6)=38.4 MBH

Why is the Psychrometric Chart useful

- Let's Say an Engineer wants to put a humidifier in the duct work of a VAV unit down stream of the VAV box. The air is supplied at 55 degrees and the space needs to be kept at 80 degrees and 60% RH Why is this a problem?
- At 55 degrees the max grains of moisture per lb of dry air is 65 grains. At 80 degrees at 60% RH the air has 93 Grains/Lb of Dry air

Real world applications

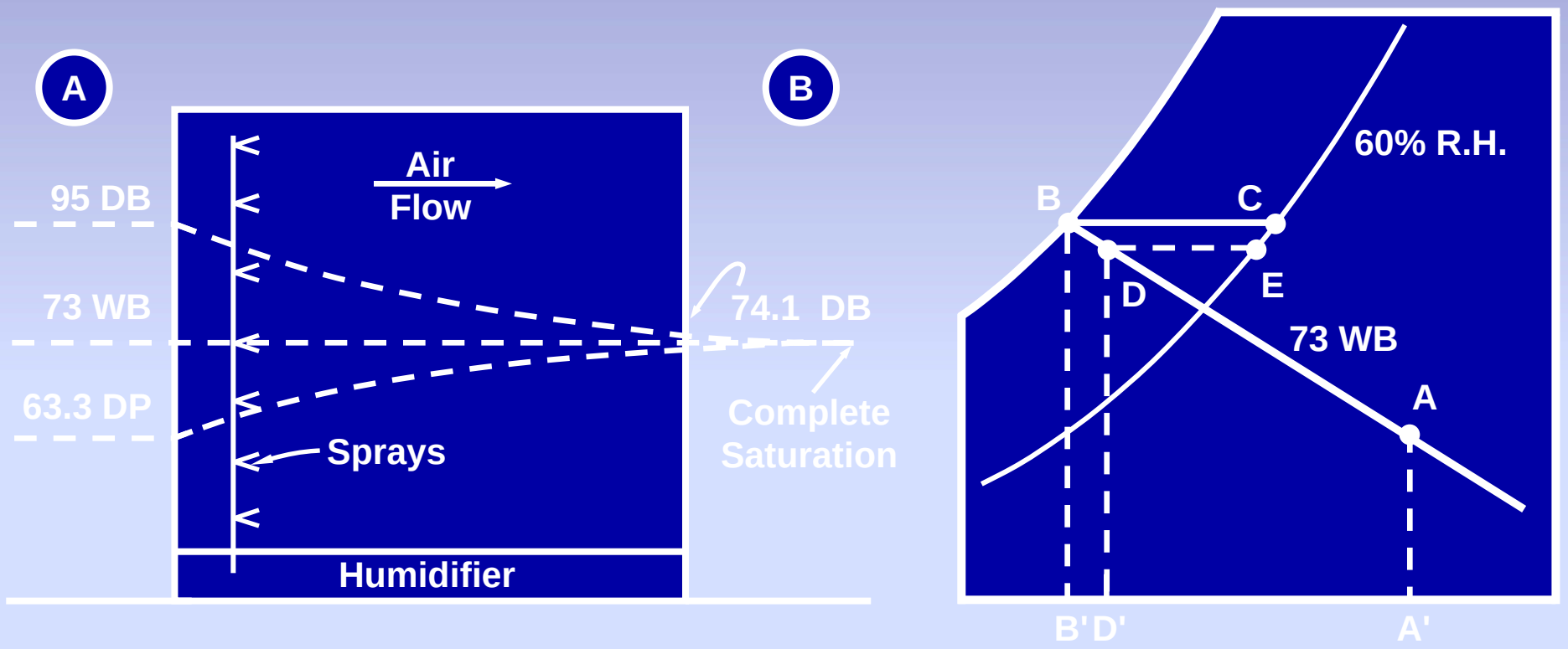
- Cooling coil
  - Total CFM = 10,000
  - OA =25% At 95/63
  - RA = 75% at 75/58
  - LA = 55
  - Find Mixed air Temp
  - Find LAT WB, RH%, LA Enthalpy
  - Find Sensible and Latent Load

Real World Aplication

- Direct Evap Cooling
  - Unit 1 is 100% OA in Denver, at 1000 CFM with a temperature of 95/63 and is 90% effective

    Find LAT
  - Unit 2 is 100% OA in Nashville, at 1000 CFM with a Temperature of 95/77 and is 90% effective

    Find LAT



Direct Evap Cooling

Real World Applications

- Indirect/Direct Evap Cooling
  - How can you get colder Temperatures out of this system
  - Lets do a rough plot to see