Introduction to HVAC

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Agenda

- Psychrometrics
- Human Comfort
- Heat Transfer
- Refrigeration Cycle
- HVAC Terminology
- HVAC Systems

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Introduction to HVAC

Psychrometrics

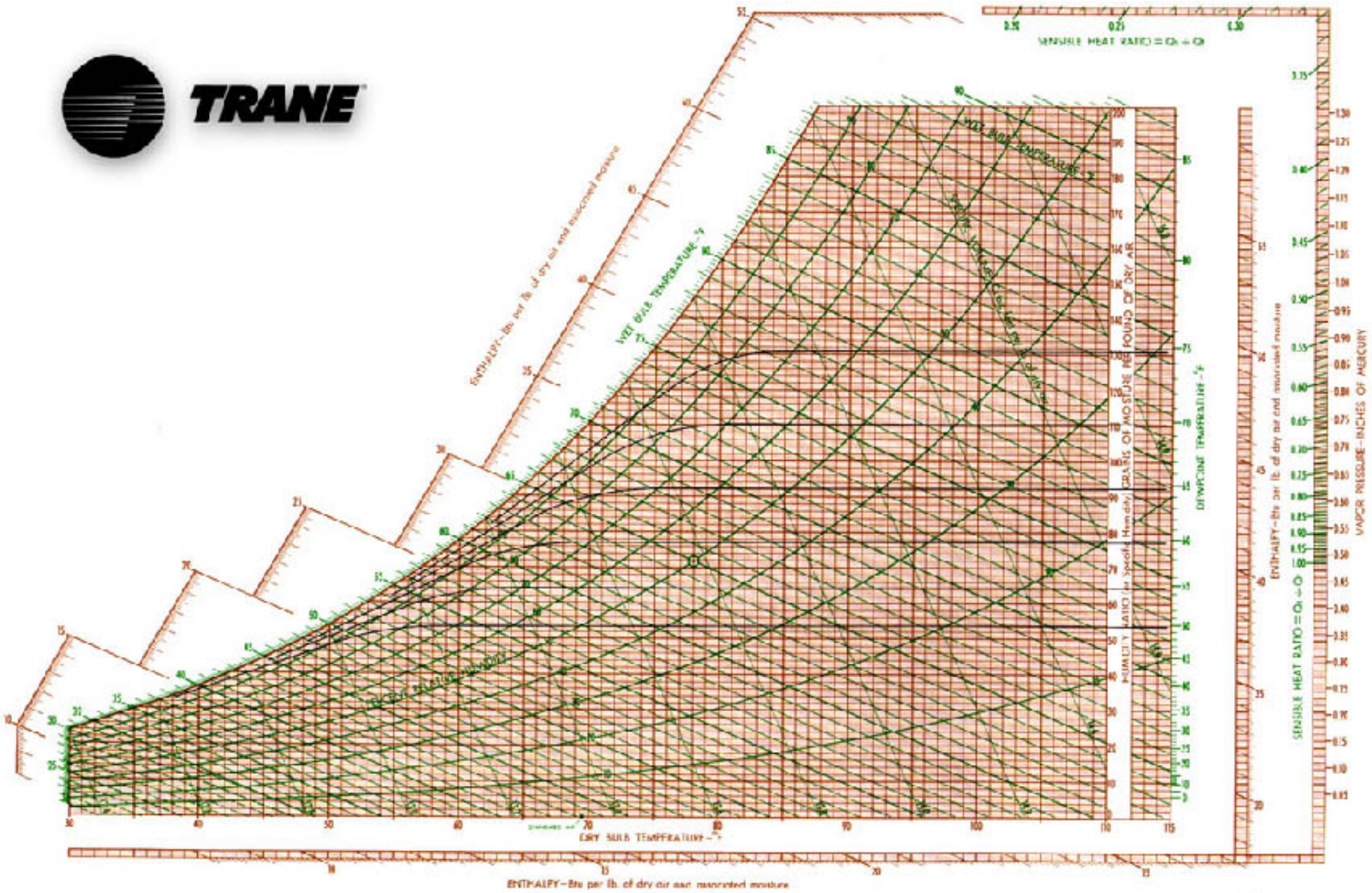
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Properties of Air

- Dry-bulb temperature
- Wet-bulb temperature
- Dew-point temperature
- Relative humidity
- Enthalpy

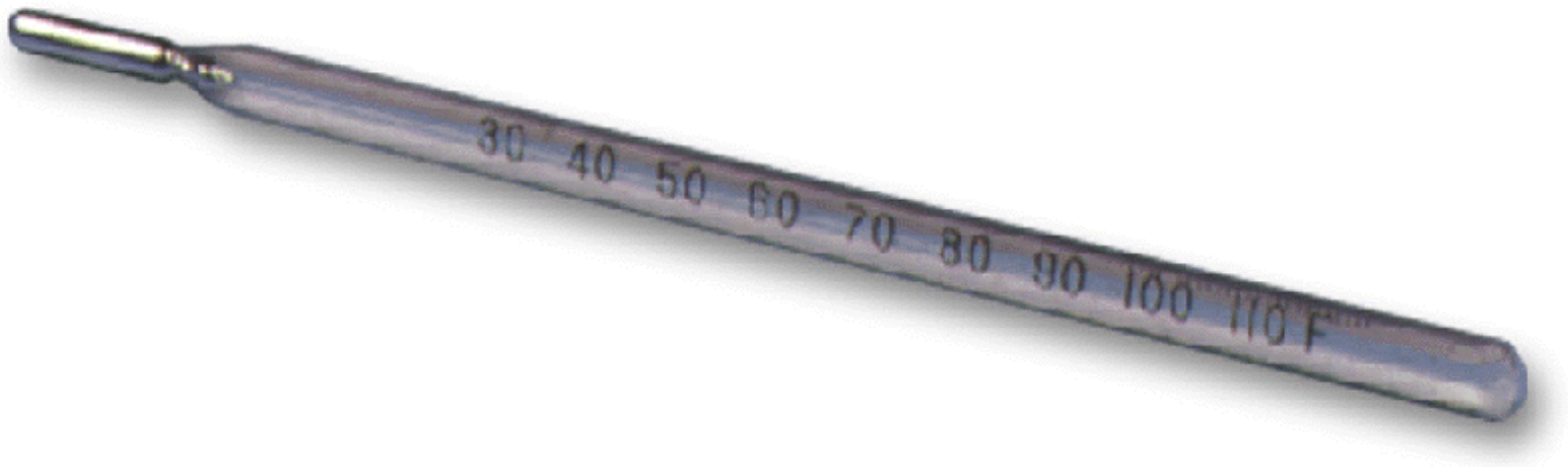


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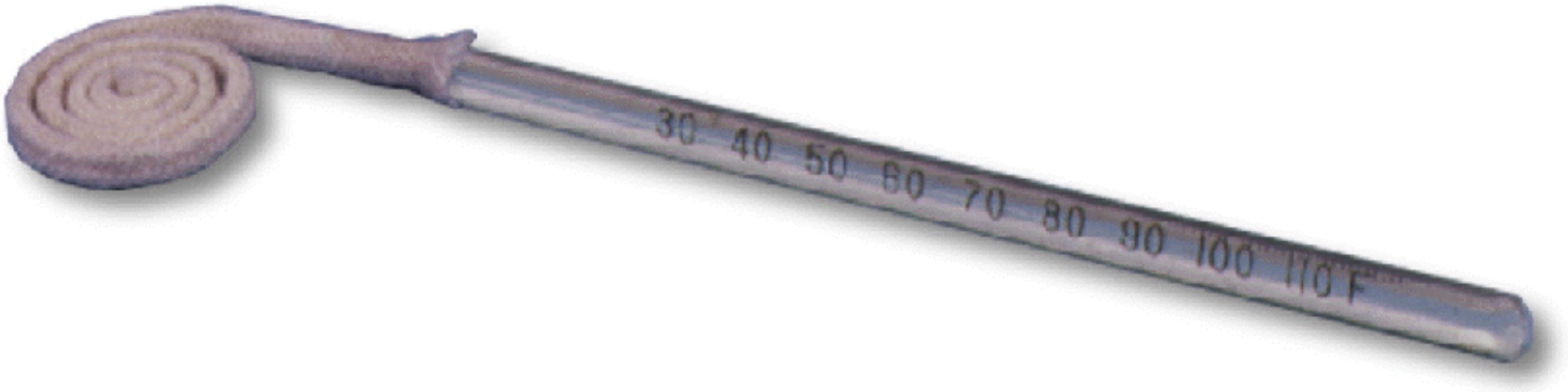
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Dry-Bulb Thermometer



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Wet-Bulb Thermometer



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Relative Humidity

$$\text{Relative Humidity} = \frac{\text{Amount of moisture that a given amount of air is holding}}{\text{Amount of moisture that a given amount of air can hold}}$$

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Enthalpy (h):

- **Definition: A measure of the total heat energy of an air mass in BTU per pound of dry air and associated moisture.**

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Human Comfort

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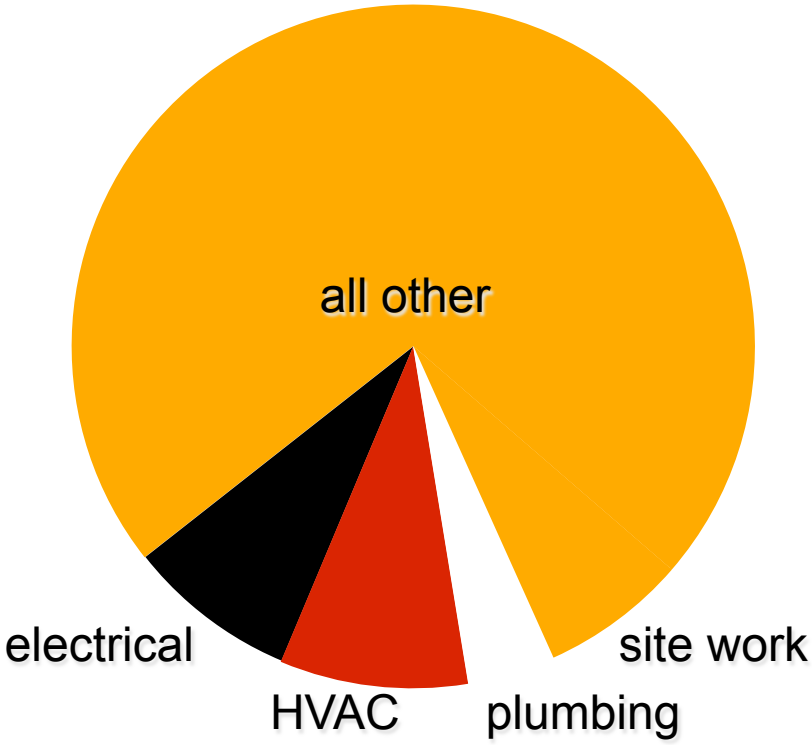
Impact of Comfort

Why is air conditioning a “big deal”?

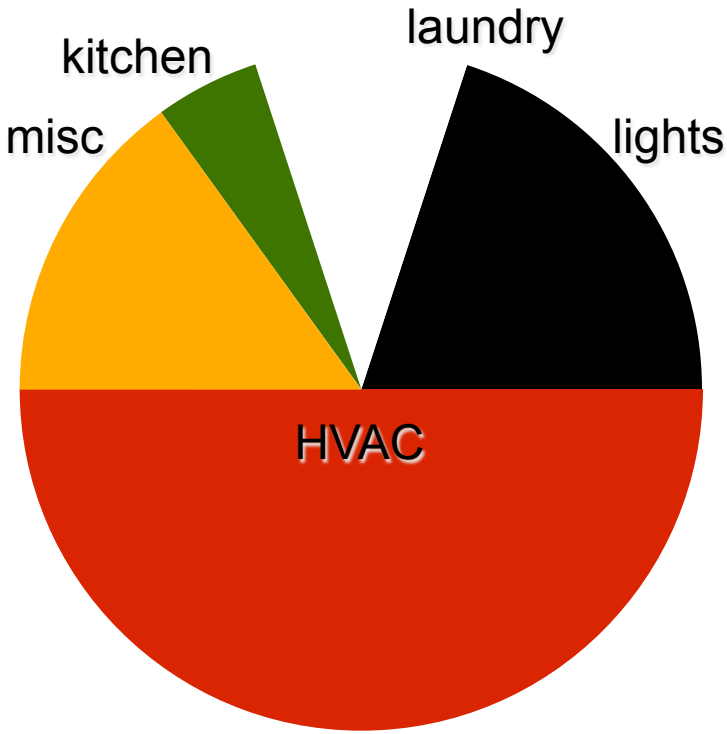
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“Home” Economics

Construction Costs



Operating Costs

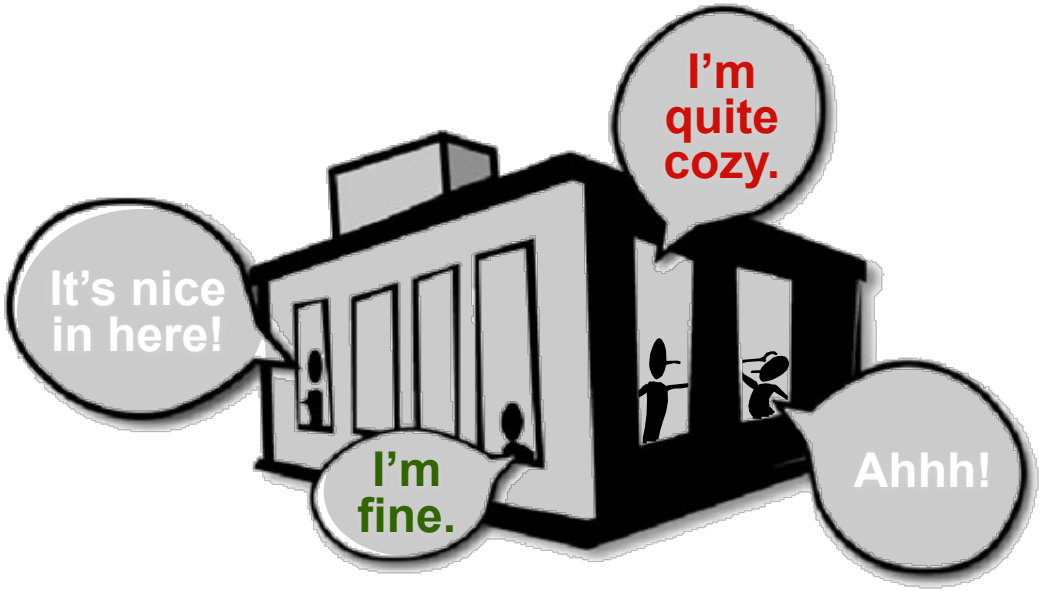


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Effects of Comfort

A comfortable indoor environment enhances:

- **Tenancy**
- **Productivity**
- **Health**
- **Profitability**



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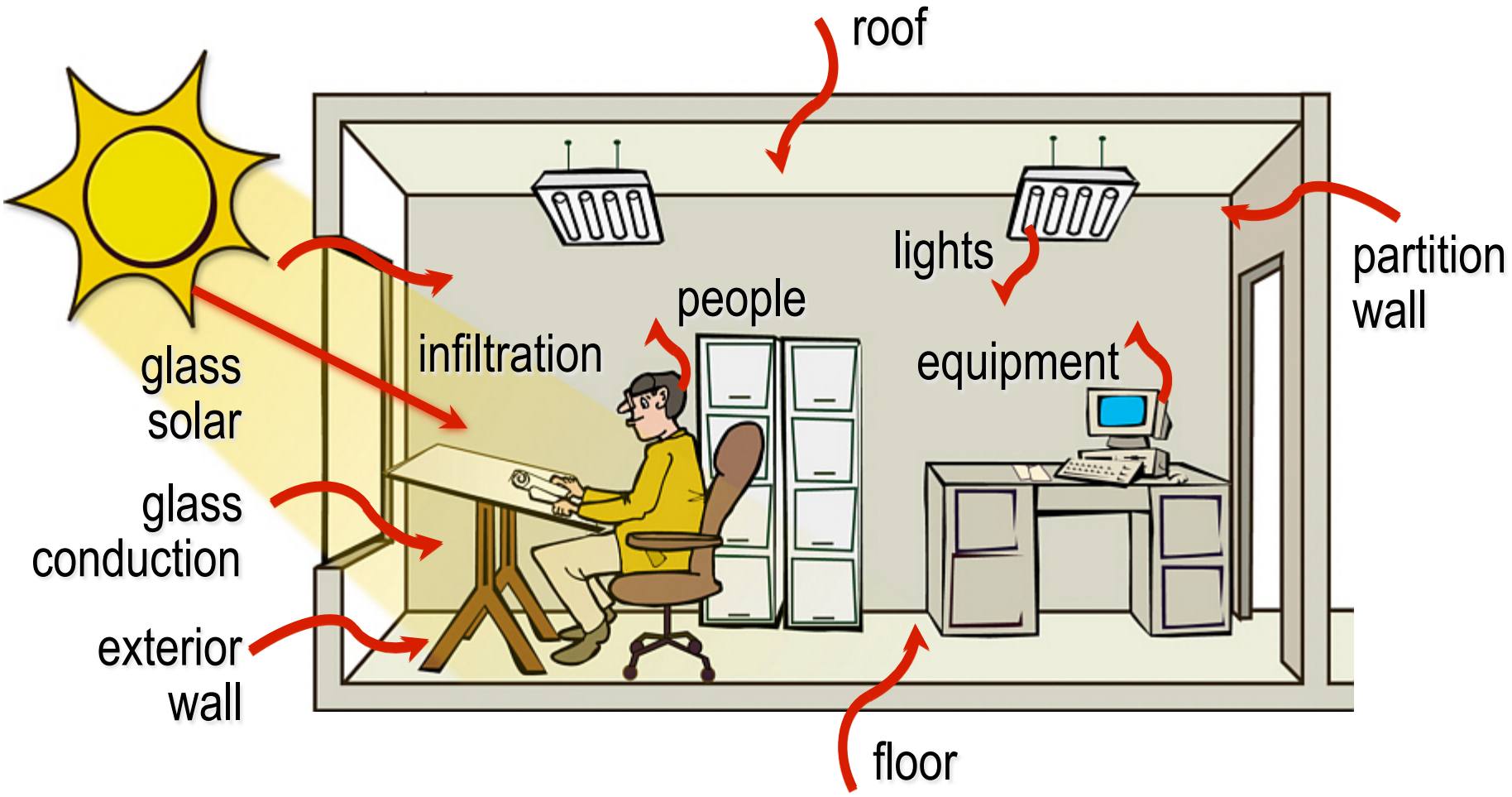
Factors Affecting Human Comfort

- Dry-bulb temperature
- Humidity
- Air movement
- Fresh air
- Clean air
- Noise level
- Adequate lighting
- Proper furniture and work surfaces



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Cooling Load Components



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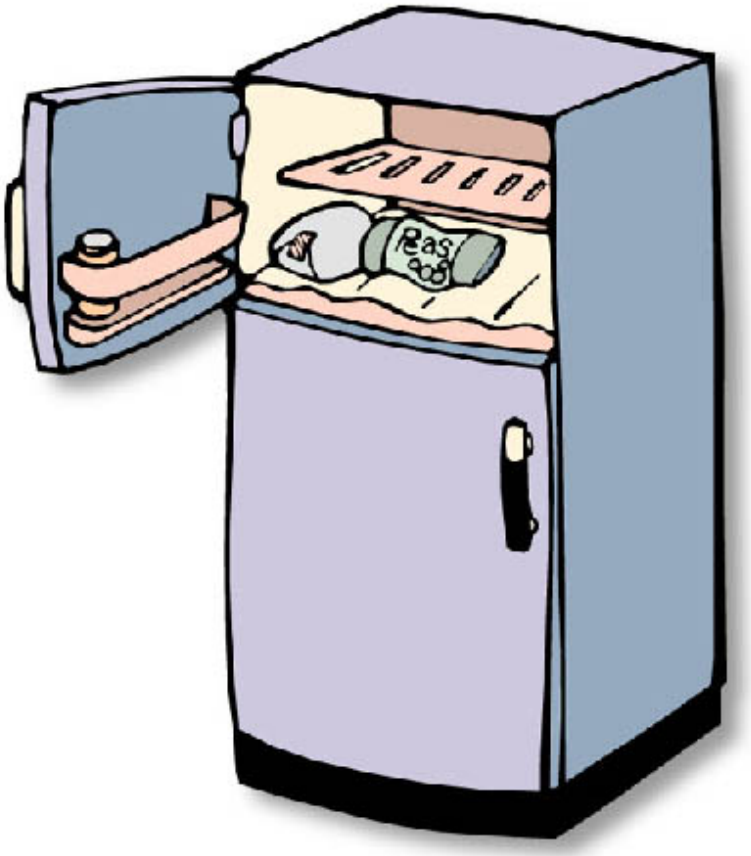
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Heat Transfer

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What is Refrigeration?

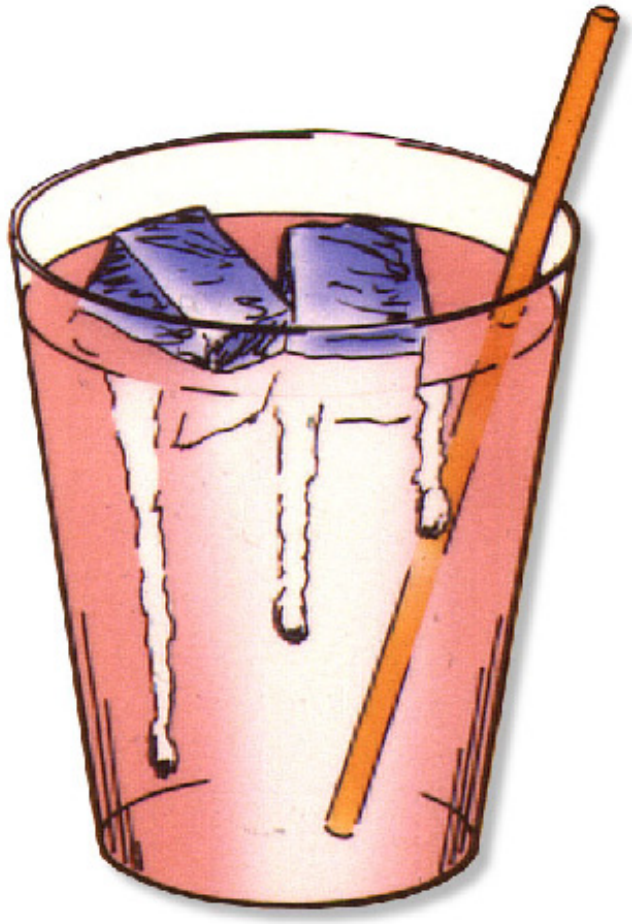
Refrigeration is the process of removing heat from one substance and transferring it to another substance.



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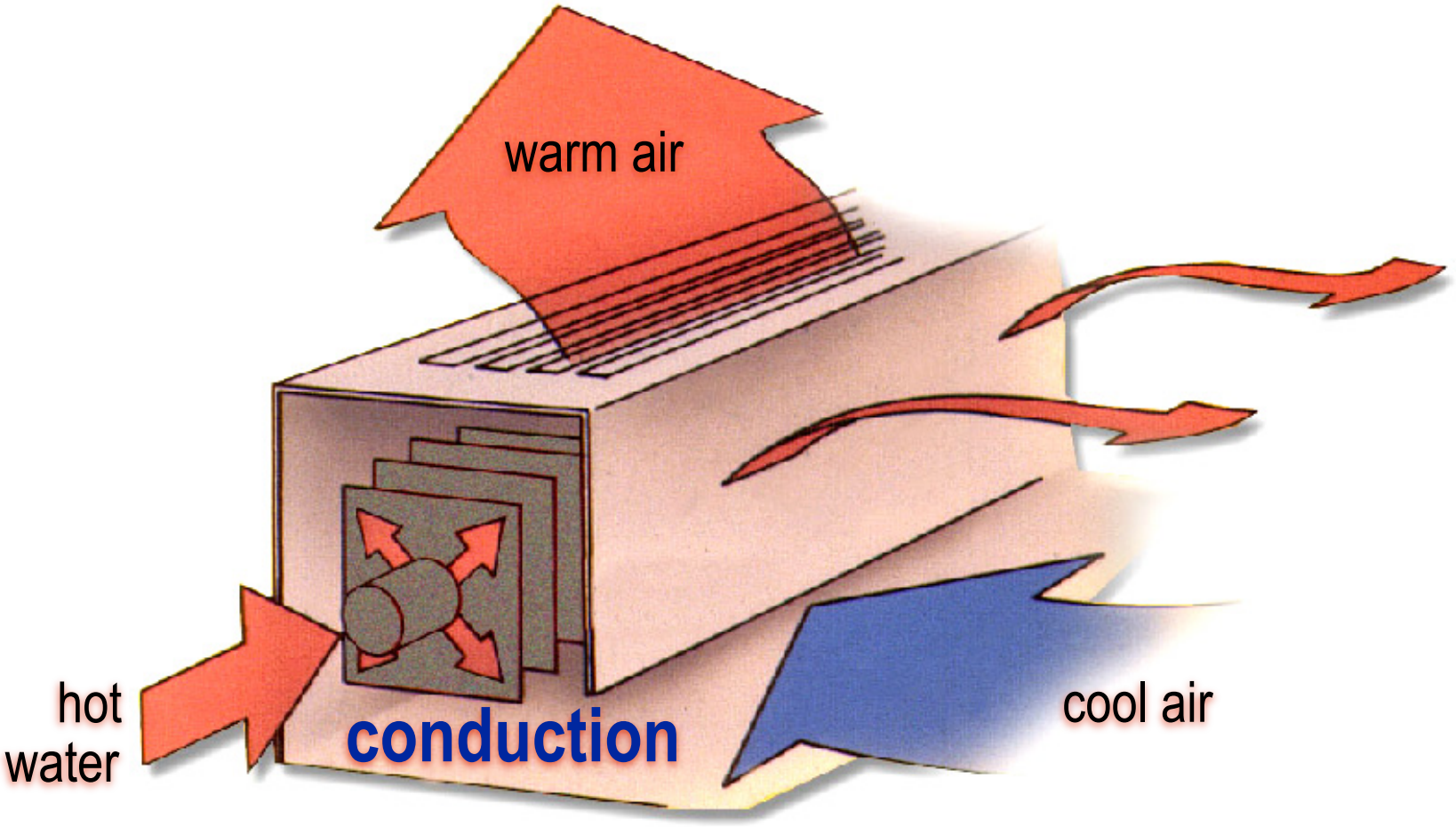
Principles of Heat Transfer

- Heat energy cannot be destroyed
- Heat always flows from a higher temperature substance to a lower temperature substance
- Heat can be transferred from one substance to another



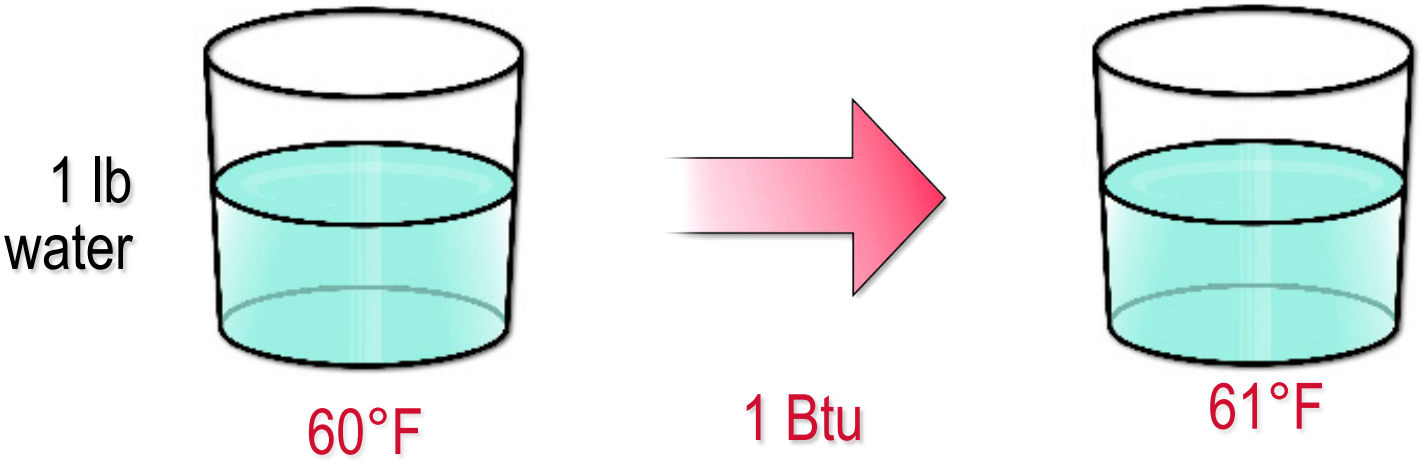
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Methods of Heat Transfer



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Measuring Heat Quantity



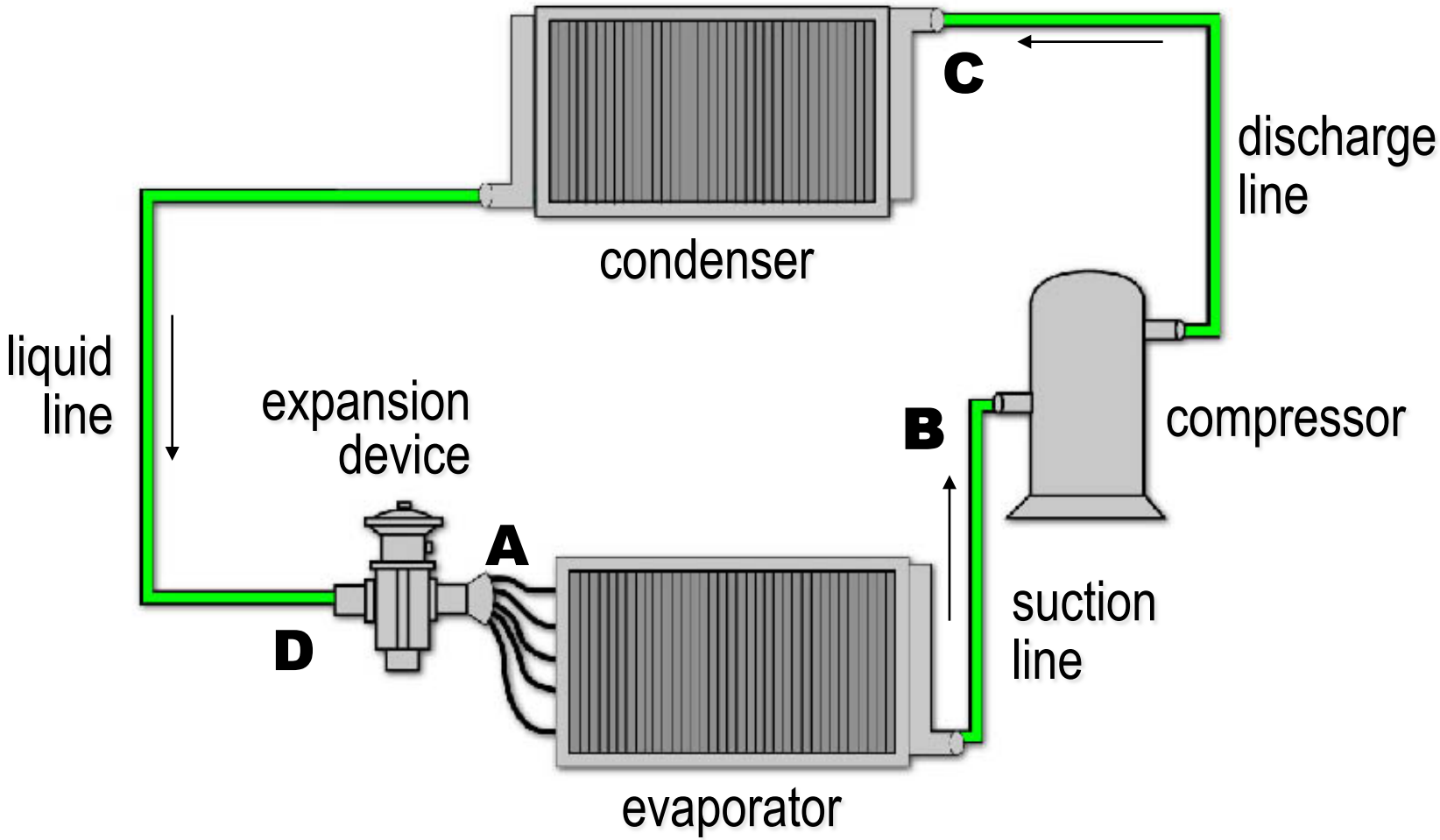
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Refrigeration Cycle

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Basic Refrigeration System



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HVAC Terminology

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HVAC Terminology
Topics of Discussion:

- CFM, ESP, TSP
- Enthalpy
- Sensible, Latent, Total Heat
- BTU, BTUH, MBH, Ton
- dB, dBA

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HVAC Terminology
CFM:

- **Definition: Cubic Feet per Minute**
- **Typical values:**
  - 1 cfm/square foot airflow
  - 400 cfm/ton
  - 20-cfm per person ventilation air

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HVAC Terminology
ESP (External Static Pressure):

- **Definition: External Static Pressure is the sum of the losses (both straight run frictional & dynamic fitting) that occur outside of the air handling system.**
- **Static Pressure in our industry has a unit of measure equivalent to inches water gauge. Typical values would be in the 1” to 3” range for ESP.**

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HVAC Terminology
TSP (Total Static Pressure):

- **Definition: Total Static Pressure is the sum of the ESP and the SP losses of that occur in the air handling system itself. This is the actual SP that the Fan must develop.**

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HVAC Terminology
Sensible Heat:

- **Definition: That heat when increased or decreased to a previously steady state environment, will increase or decrease the Dry Bulb temperature of that space.**

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HVAC Terminology
Latent Heat:

- **Definition: That heat when increased or decreased to a previously steady state environment, will not change the Dry Bulb temperature of that space. It only effects the amount of moisture in the space.**

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HVAC Terminology
Total Heat:

- **Definition: The sum of both the Sensible & Latent heat.**

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HVAC Terminology
BTU:

- **Definition: The amount of heat necessary to raise one pound of water one deg F**

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HVAC Terminology
Ton:

- **Definition: The rate of heat transfer necessary to melt 1-ton of ice at 32 deg F in 24 hours**

  = 2,000 lbs x 144 BTU/lb / 24 hrs

  = 288,000 BTU / 24 hrs

  = 12,000 BTU/hour or BTUH

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HVAC Terminology
dB:

- **Definition: A measurement used to describe the amplitude of Sound.**
- **A healthy young human ear can detect sound pressures in the range of:**
  - 20 millionths of a Pascal to
  - 20 Pascals
  - This range is too difficult to manage, so we put it on a logarithmic scale
  - Which works out to: 00-dB to 140-dB

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HVAC Terminology
dBA:

- **Definition: The ‘A’ weighting scale is used to better estimate how the human ear hears sound pressure.**
- **Some acoustical rules of thumb:**
  - 3-dB represents doubling of sound power
  - 6-dB represents doubling of sound pressure
  - 10-dB represents perceived doubling of sound to human ear
  - Average human can’t distinguish a difference less than 3-dB

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HVAC Systems

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The Five System Loops


Airside


Heat rejection

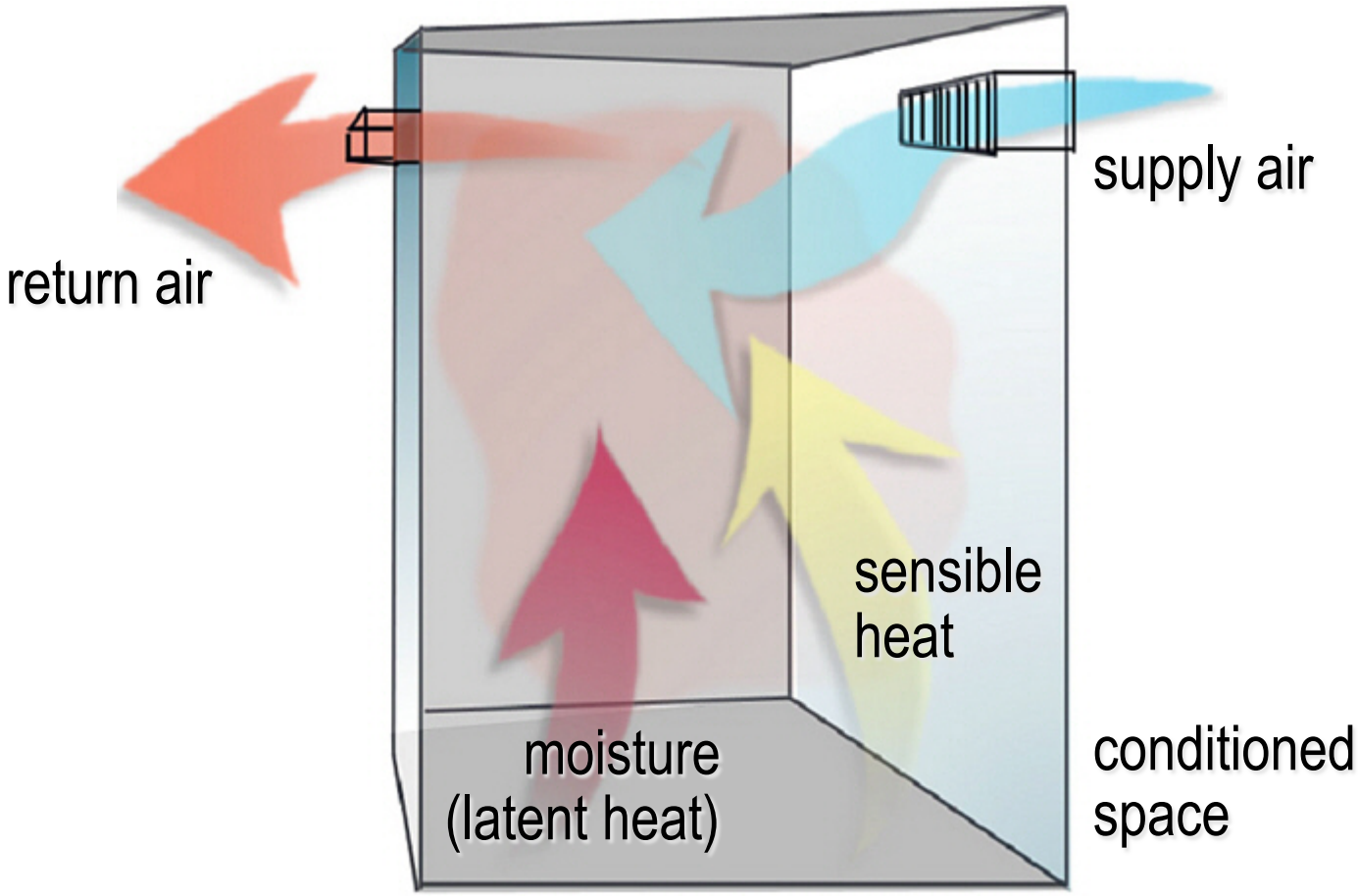

Chilled water


Controls


Refrigeration

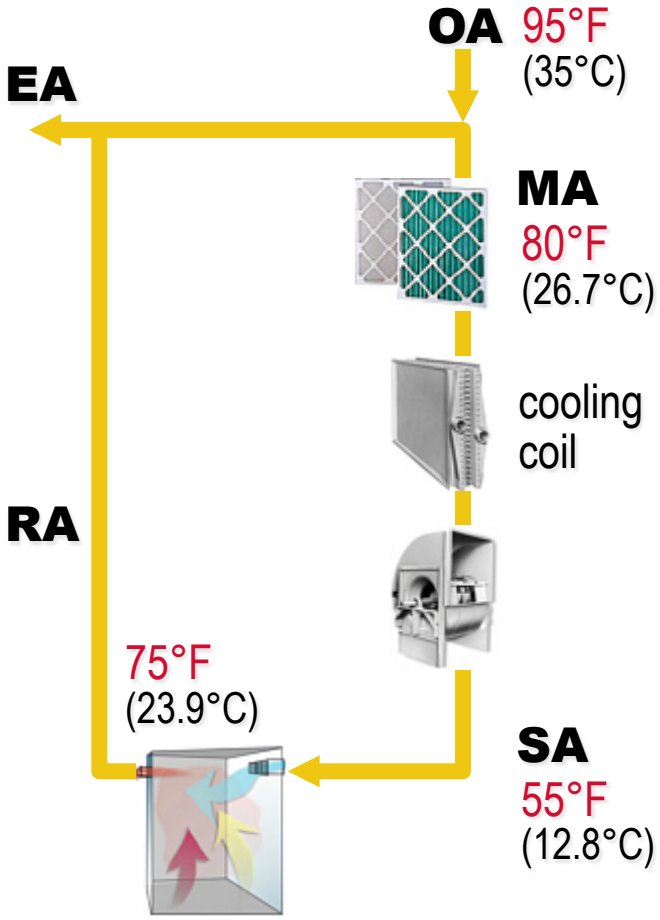
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Airside Loop



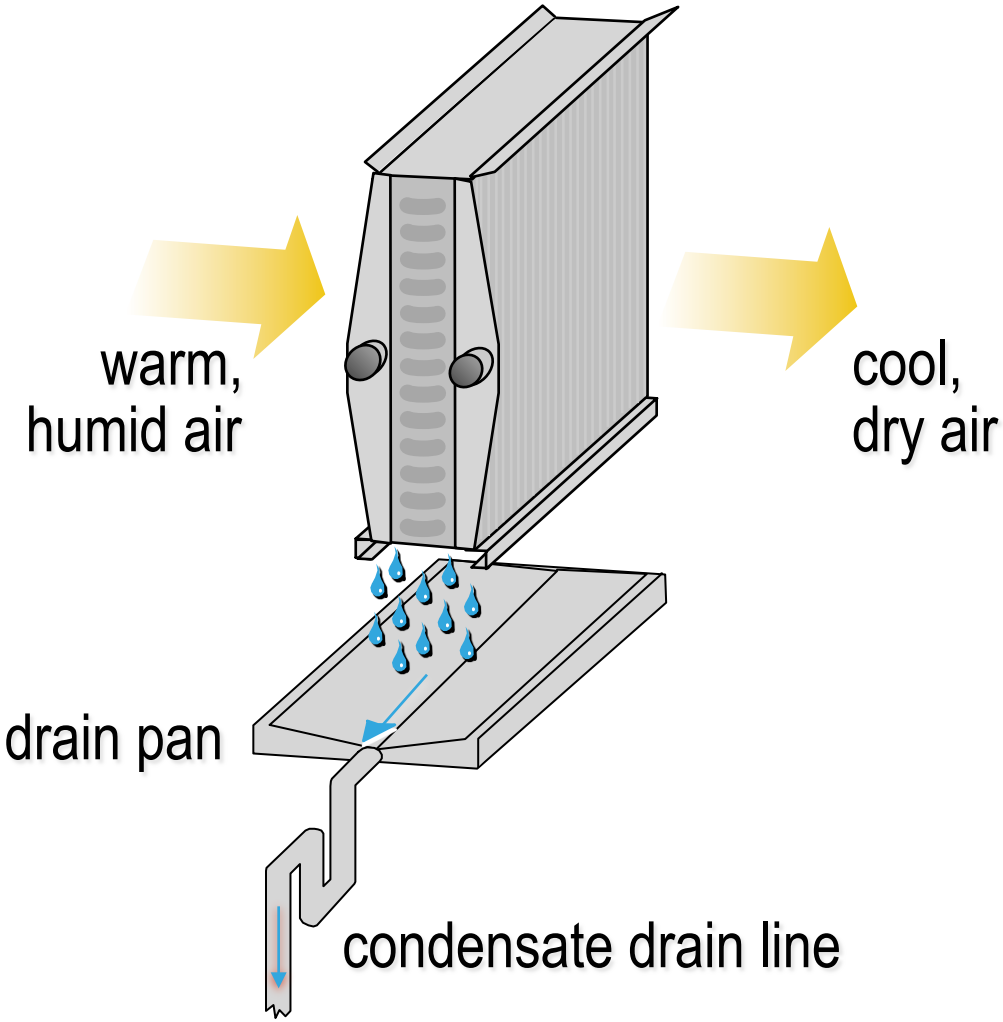
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Airside Loop



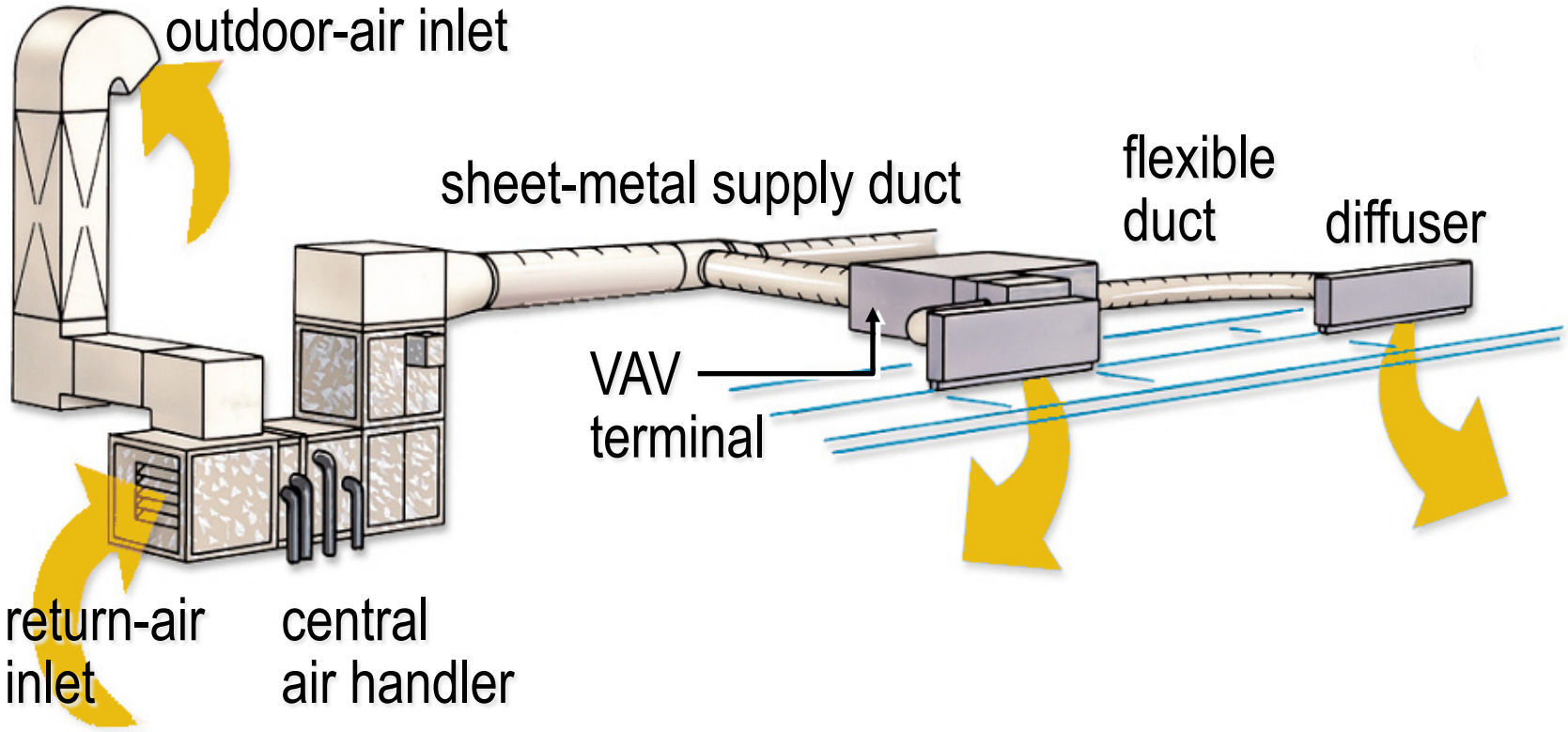
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Chilled-Water Cooling Coil



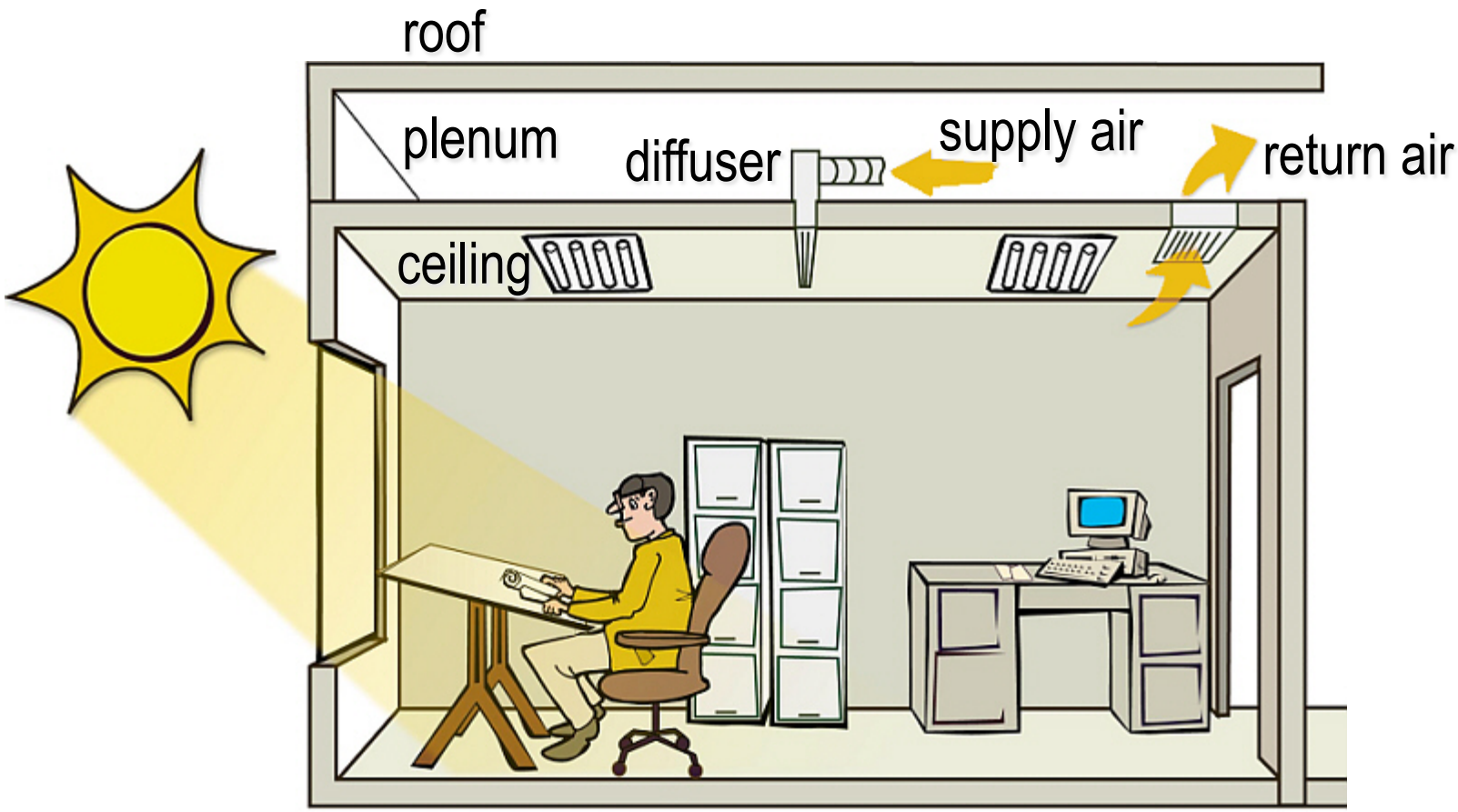
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Supply-Air Distribution System



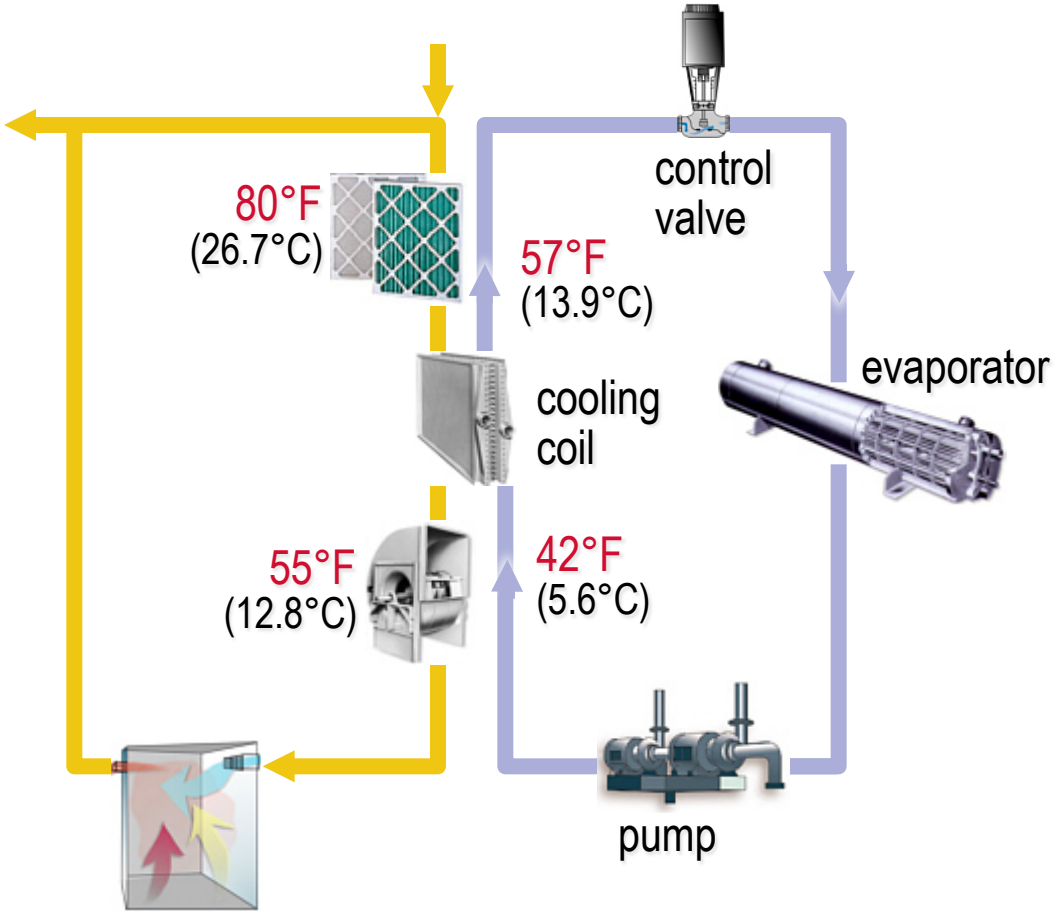
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Ceiling Plenum Return



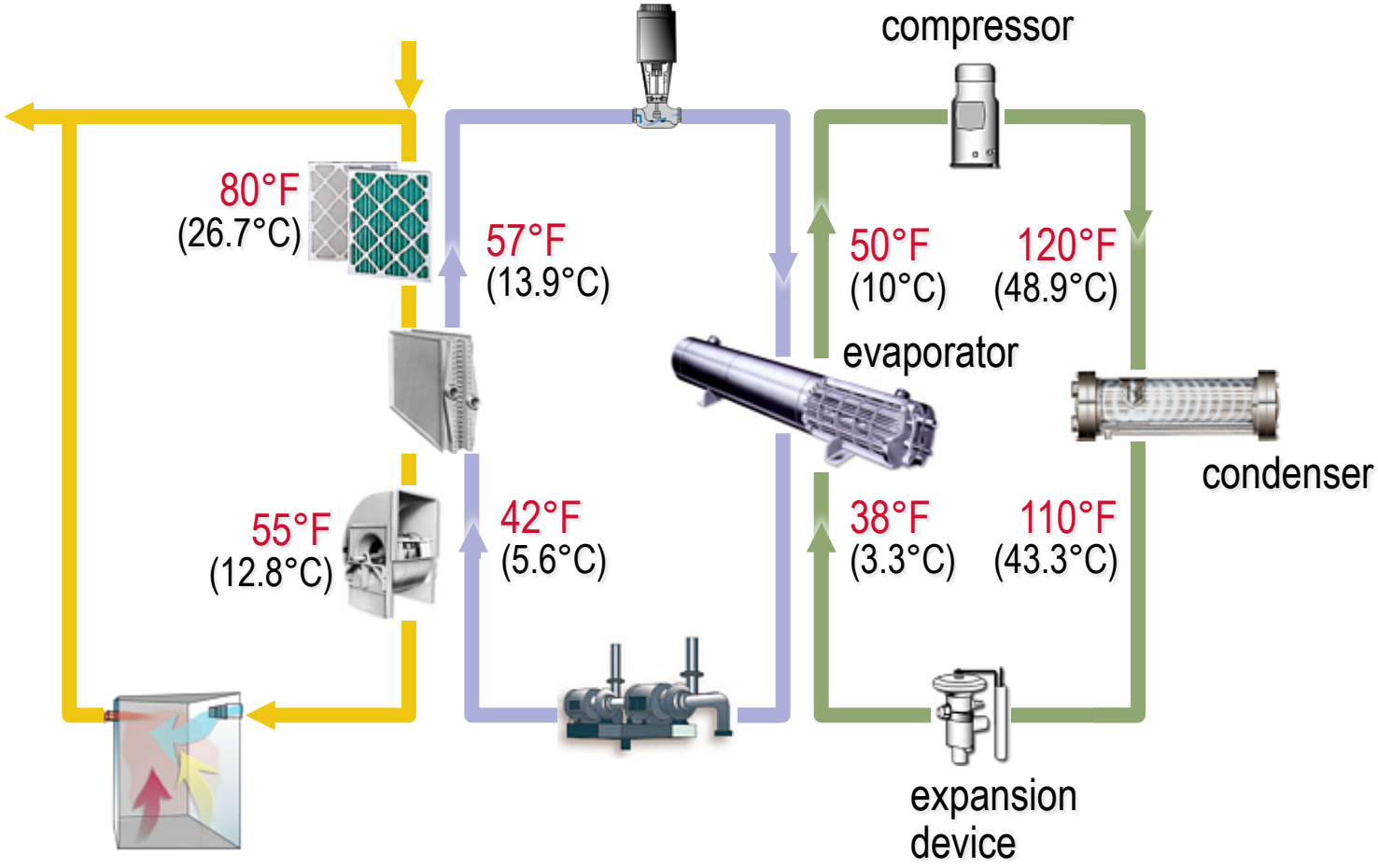
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Chilled-Water Loop



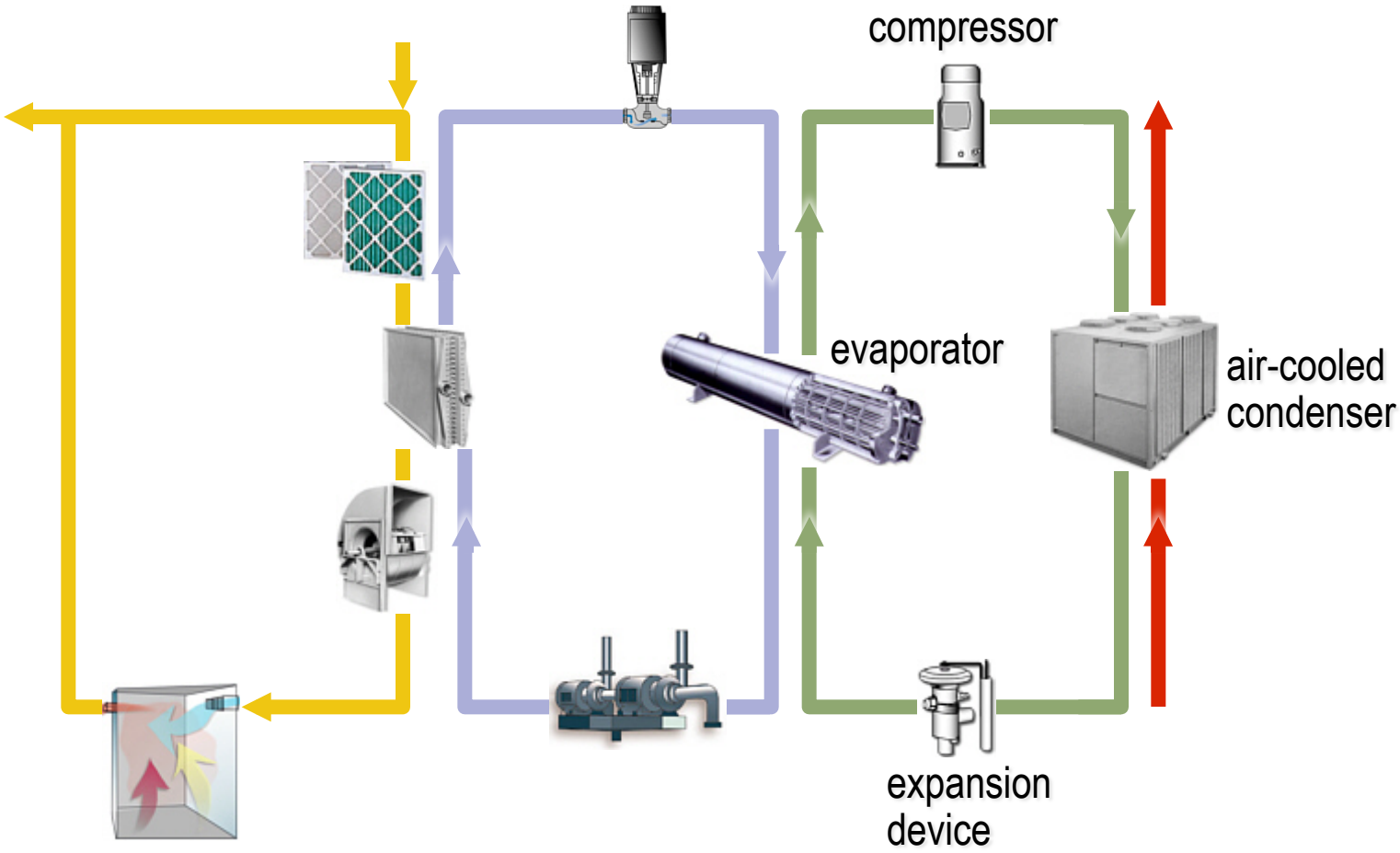
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Refrigeration Loop



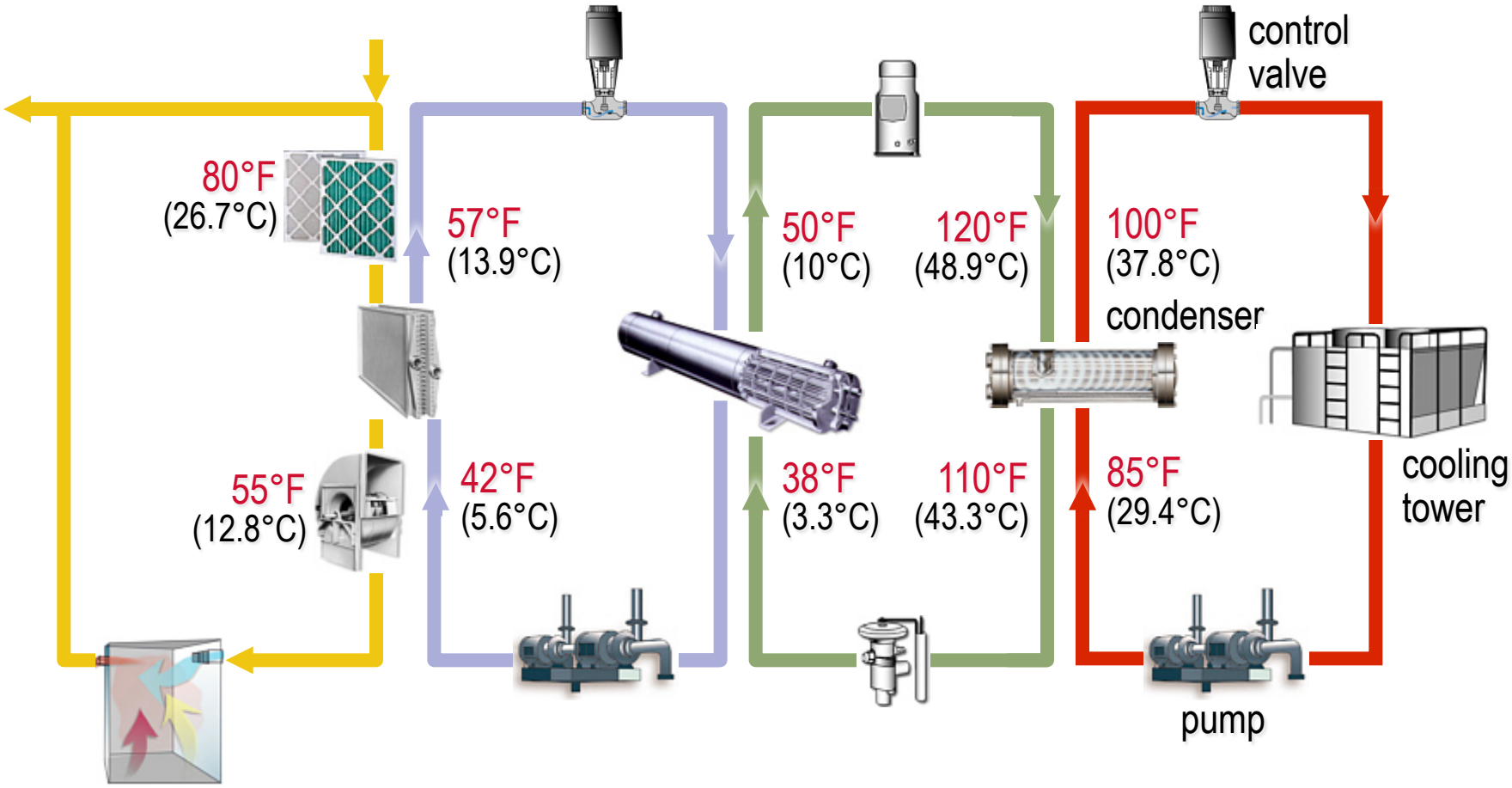
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Packaged Air-Cooled Chiller



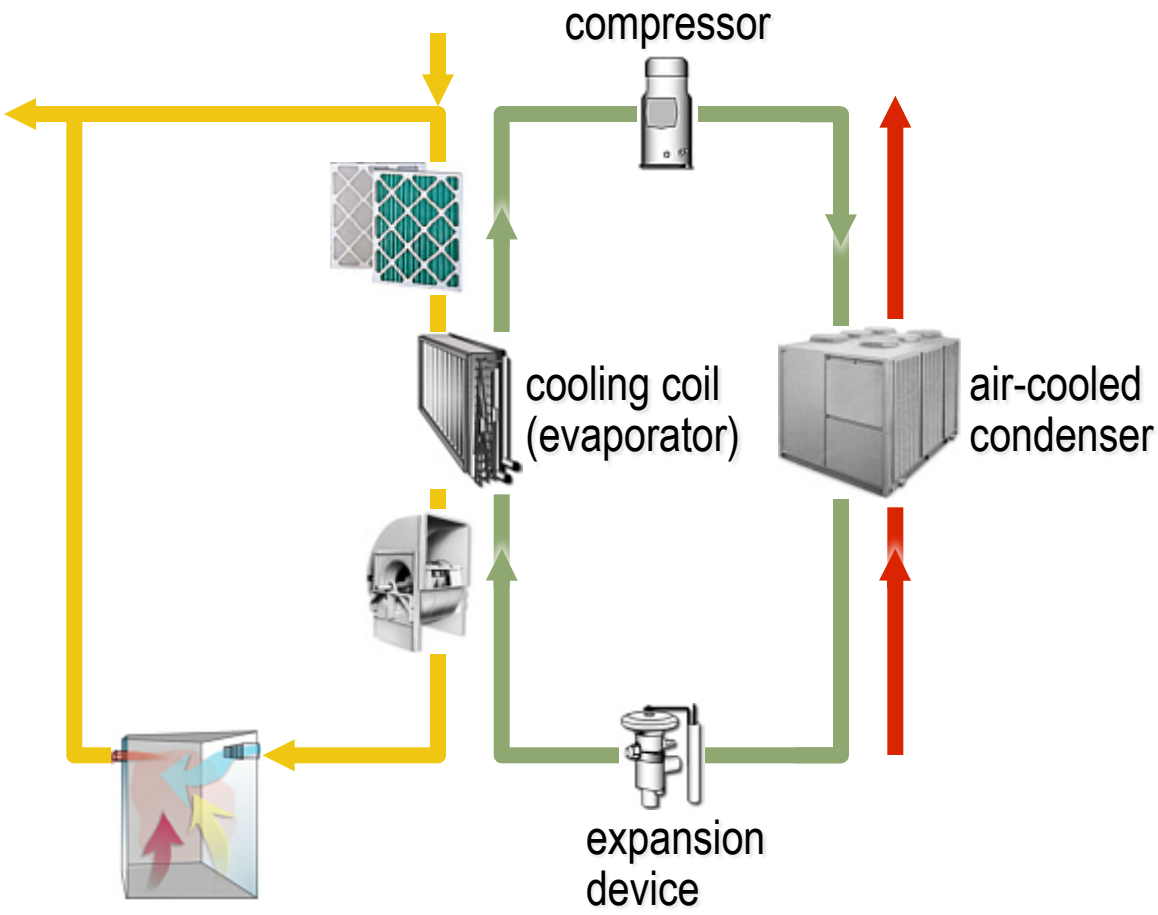
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Heat-Rejection Loop (water-cooled)



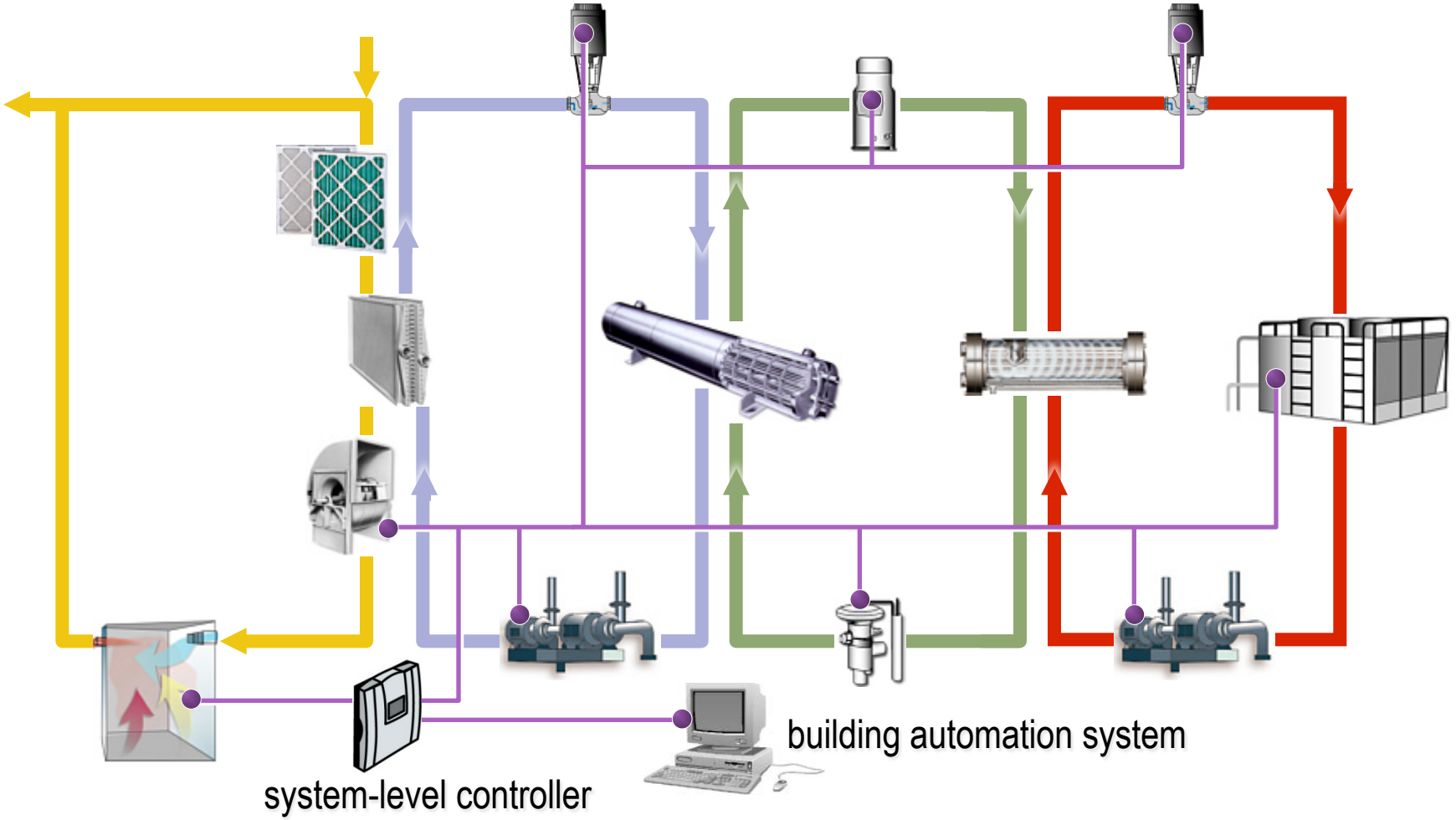
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No Chilled-Water Loop (RTU/Split System)



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Controls Loop



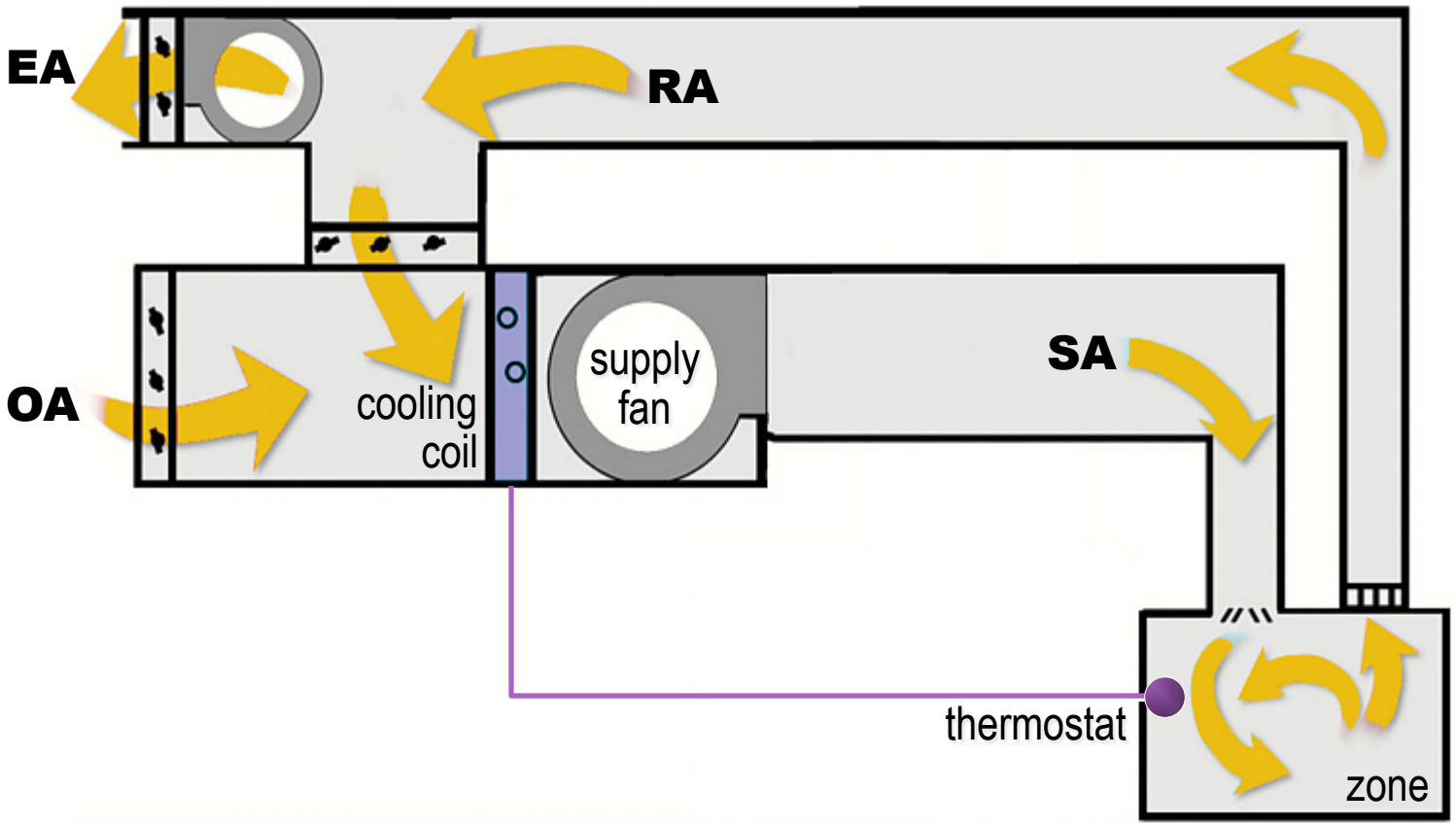
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Introduction to HVAC Systems

Common HVAC System Types

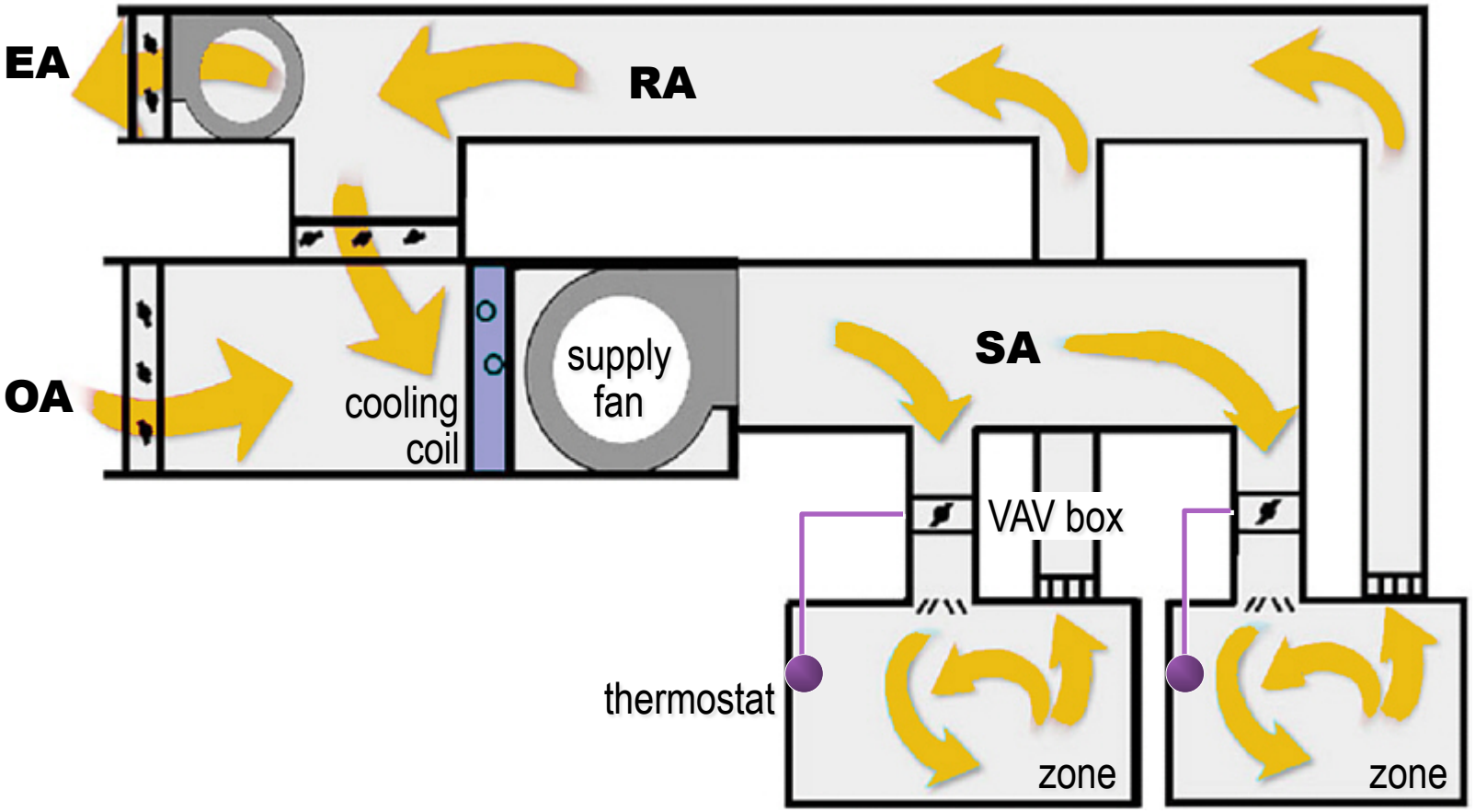
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Single Zone, Constant Volume



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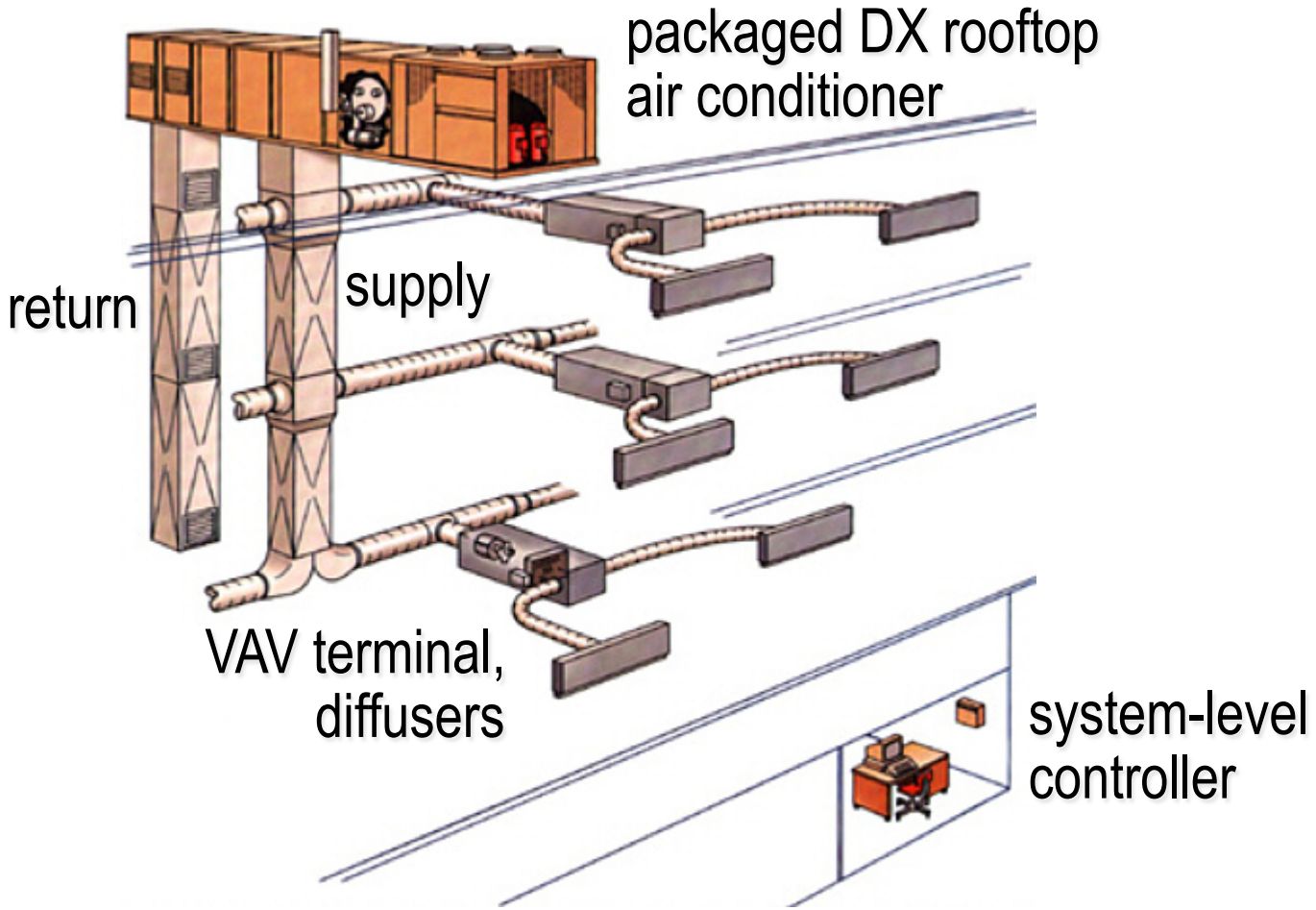
Multiple Zones, Variable Volume



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multiple zones, variable volume

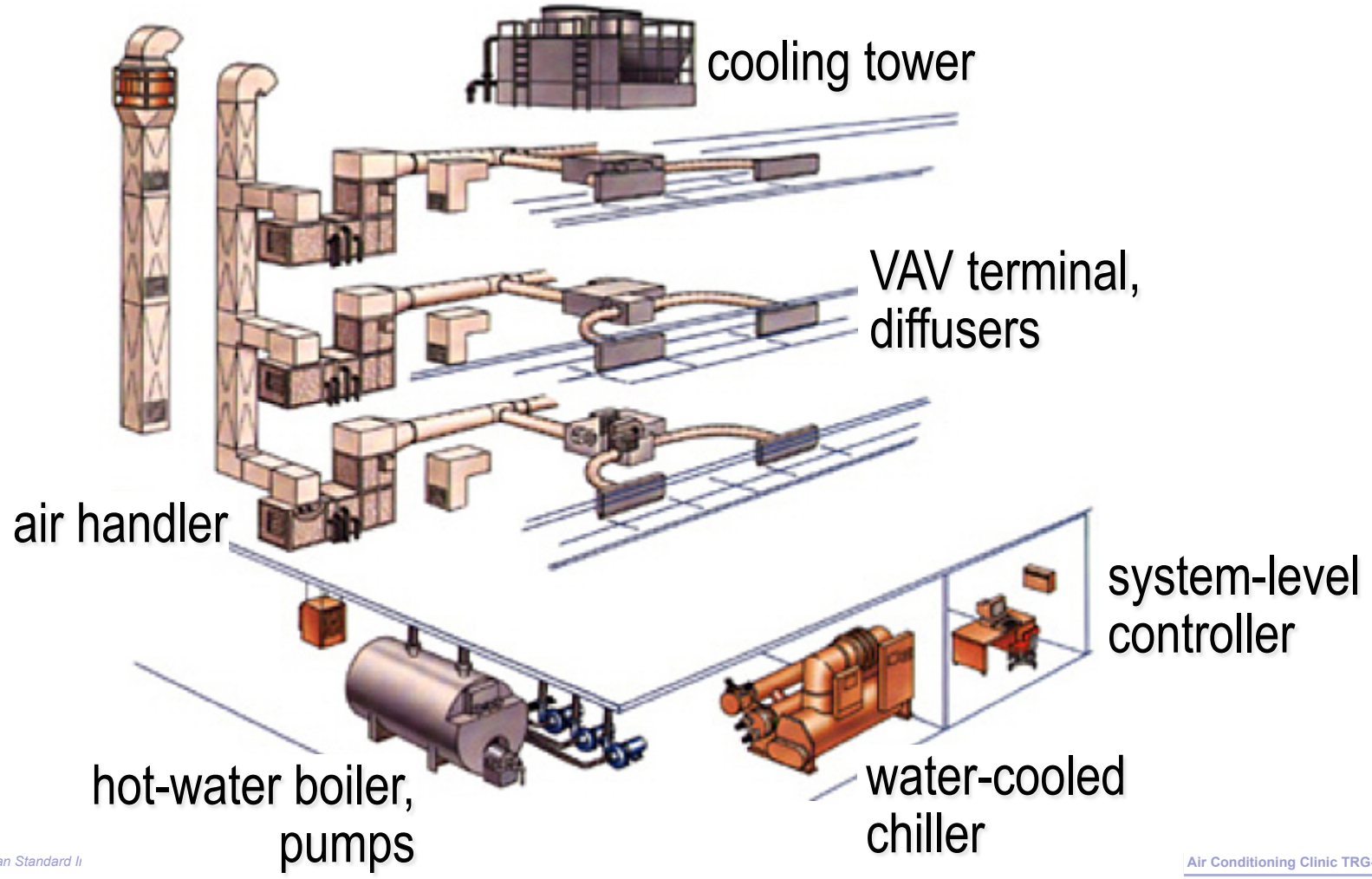
DX Rooftop VAV System



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multiple zones, variable volume

Central Chilled-Water VAV System



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Four-Pipe Versus Two-Pipe System

	4-pipe	2-pipe
Coils per terminal unit	2	1
Water distribution piping	2 sets	1 set
Heating and cooling	either or both simultaneously	mutually exclusive
Temperature control	direct	direct
Humidity control	direct (if heating coil downstream of cooling coil)	indirect

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Questions????

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