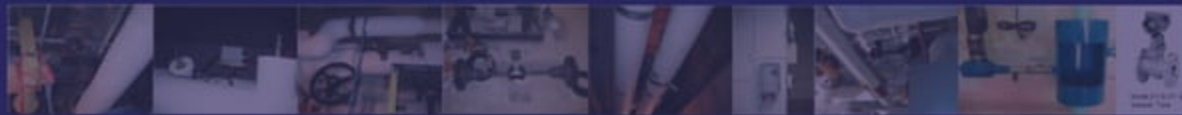


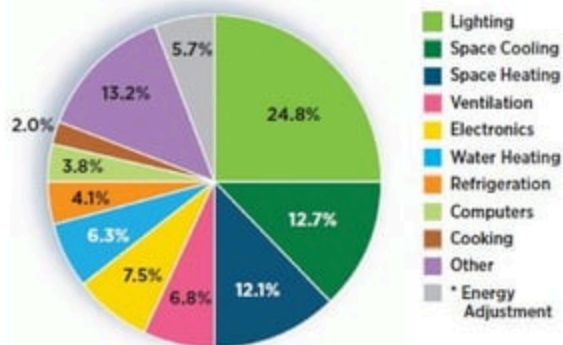
# HVAC Basics



**Bin Yan**

**HVAC – Heating, Ventilation, Air-conditioning**

# HVAC Energy Consumption



Source: 2009 Buildings Energy Data Book, U.S. Department of Energy, Table 3.1.4  
<[http://buildingsdatabook.eere.energy.gov/docs/xls\\_pdf/3.1.4.pdf](http://buildingsdatabook.eere.energy.gov/docs/xls_pdf/3.1.4.pdf)>

**32%**

*DOE numbers*

## Annual Energy Use



Cooling **642 kWh/m<sup>2</sup>**



Heating **623 kWh/m<sup>2</sup>**



Electricity **414 kWh/m<sup>2</sup>**

**>60%**

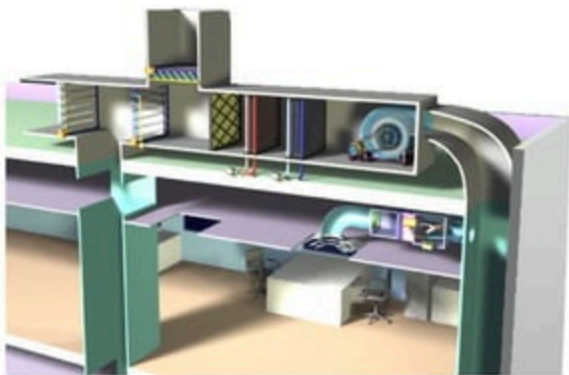
*A lab building on campus*

## HVAC – Heating, Ventilation, Air-conditioning

|   |                    |                                                                         |
|---|--------------------|-------------------------------------------------------------------------|
| ● | <b>Temperature</b> | <i>68°F (20°C) and 75°F (25°C)</i>                                      |
| ● | <b>Humidity</b>    | <i>30% relative humidity (RH) and 60% RH</i>                            |
| ● | <b>Pressure</b>    | <i>A slightly positive pressure to reduce outside air infiltration.</i> |
| ● | <b>Ventilation</b> | <i>Rooms typically have several complete air changes per hour</i>       |

Diagram of mechanical system on the blackboard

# Where?



Mechanical Room: Boilers, chillers, pumps, heat exchangers...

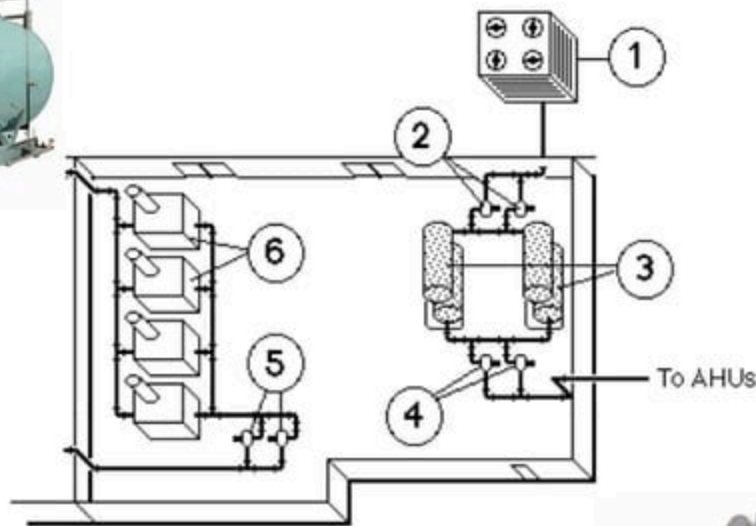
Air Handling Units (AHUs): heat, cool, humidify, dehumidify, ventilate, filter and distribute the air.

Room Controls: thermostats and Variable Air Volume (VAV) boxes

# In the mechanical room



Boiler

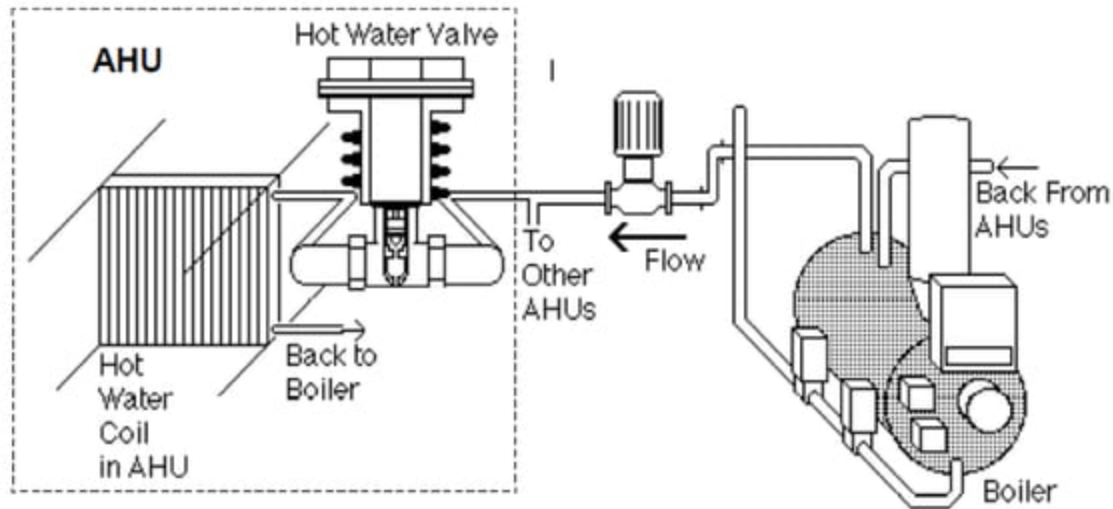


Mechanical Room

Chiller

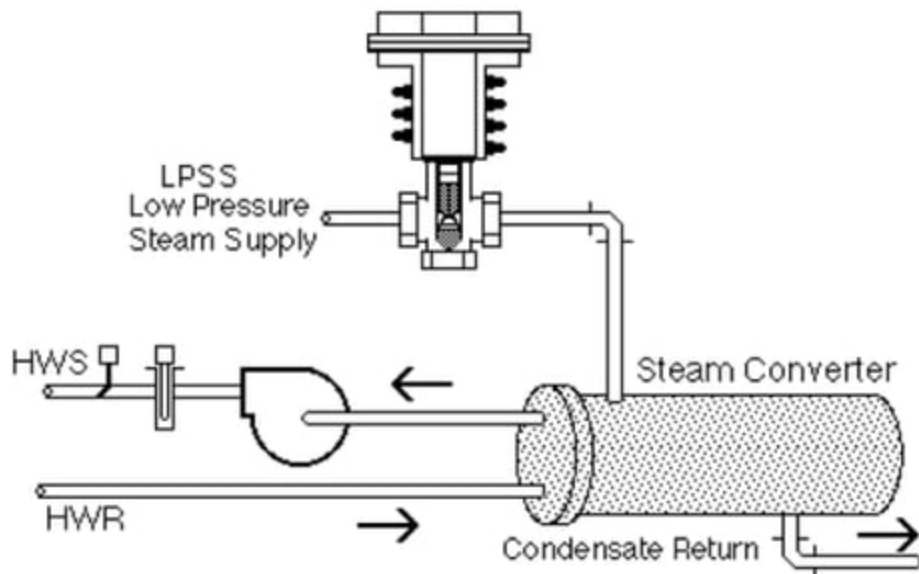


# Heating

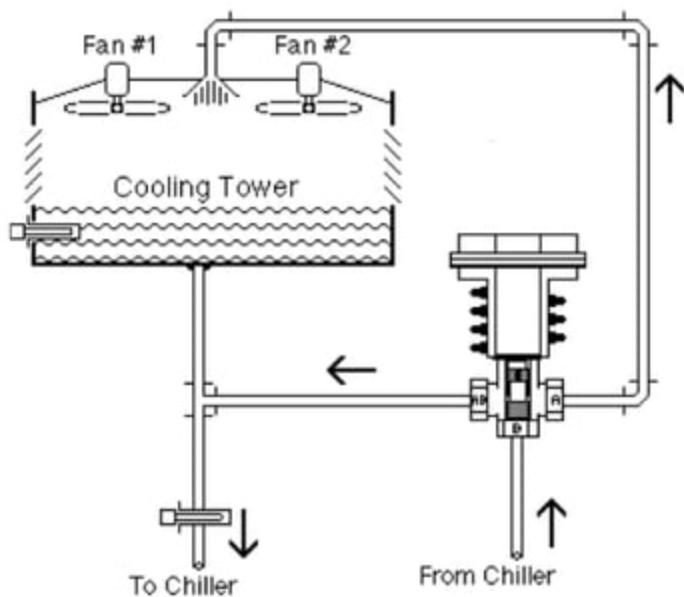


Also to radiators, terminal reheat, domestic hot water.

# Heating



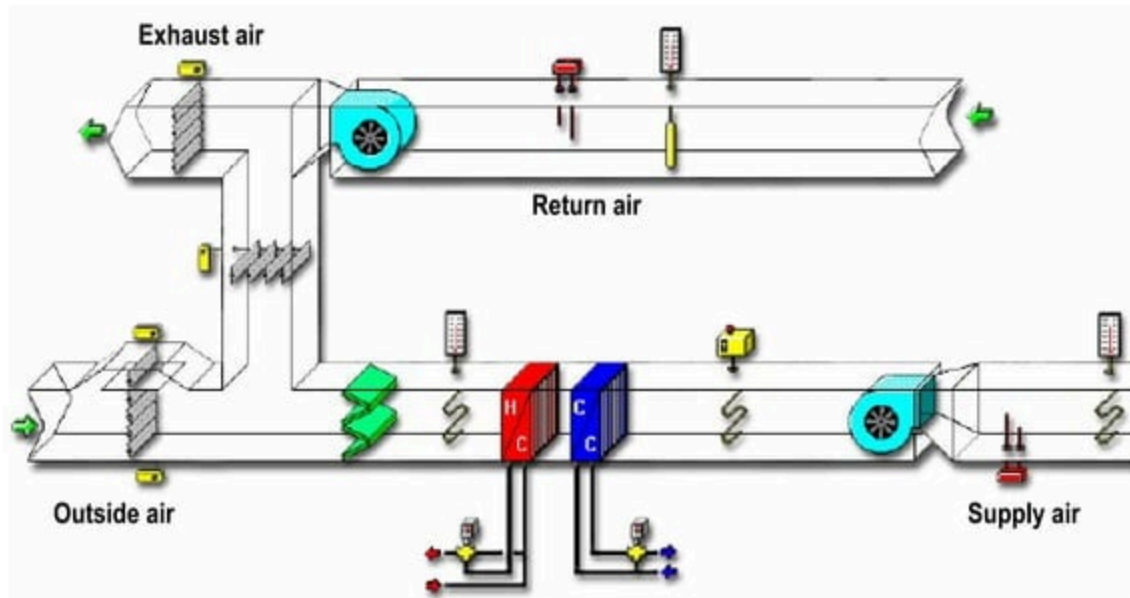
# Cooling





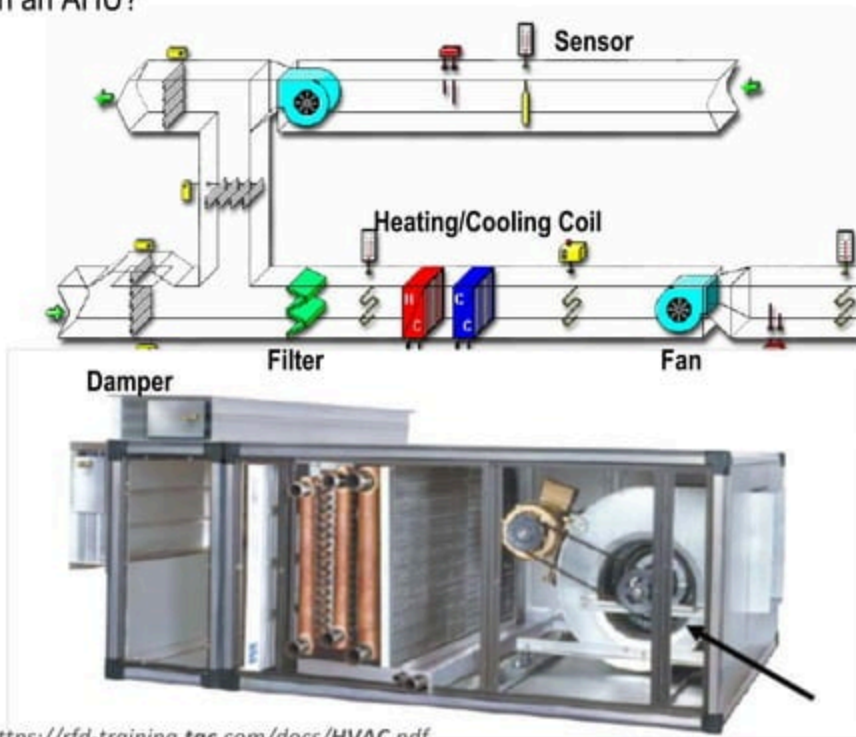
# AHU – Air Handling Unit

Where does air come from and go to?

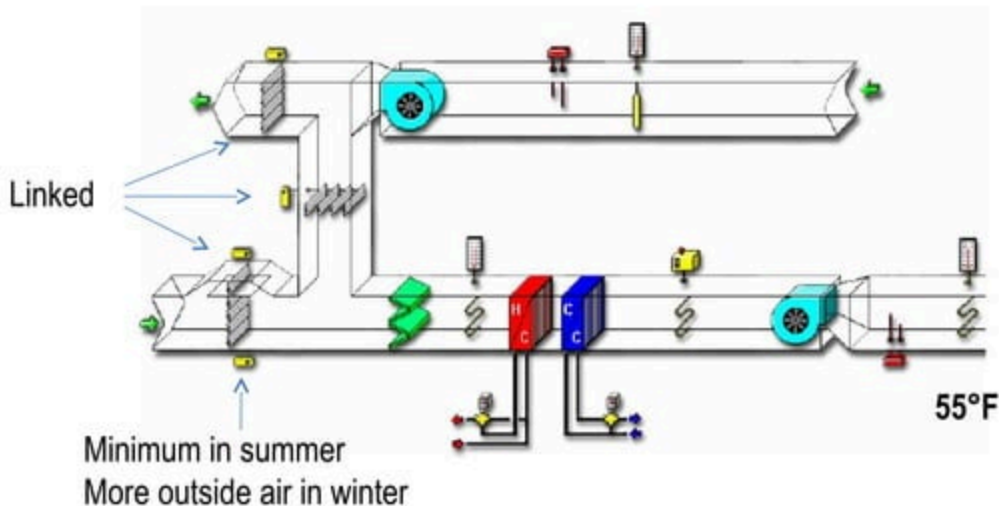


# AHU

What's in an AHU?

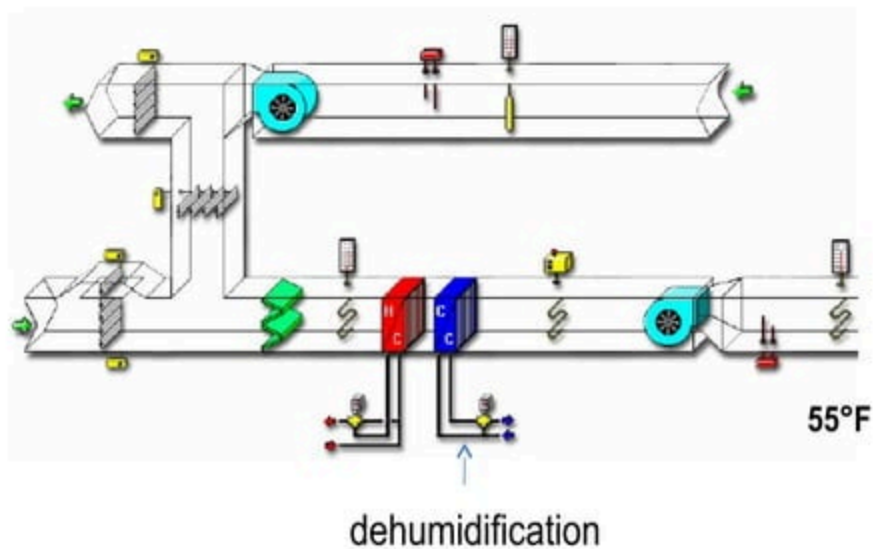


# AHU - Economizer

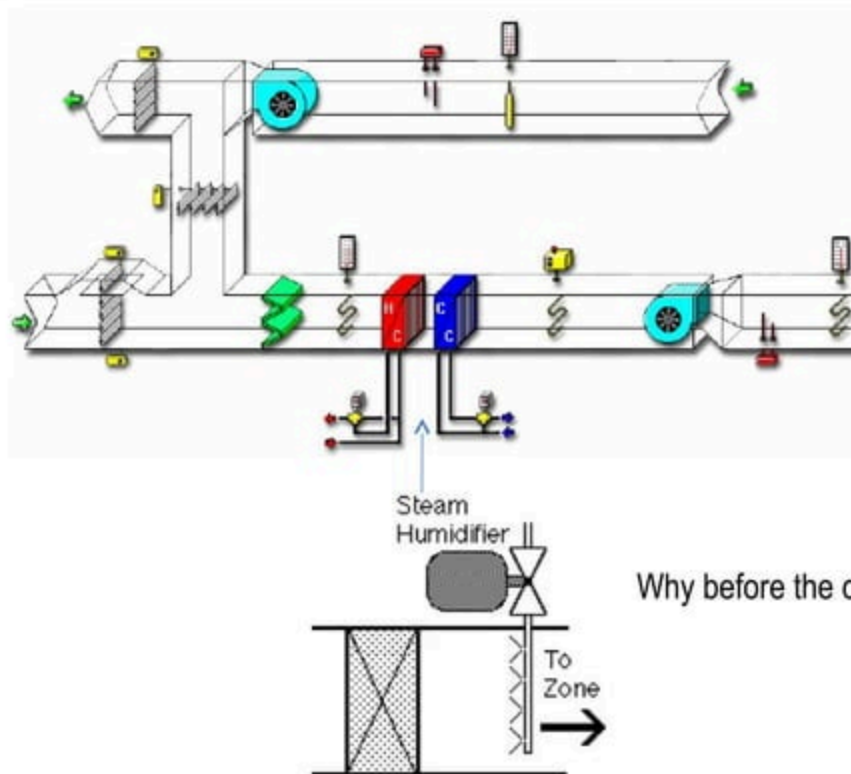


Economizer mode: Using outside air for cooling rather than mechanical cooling.

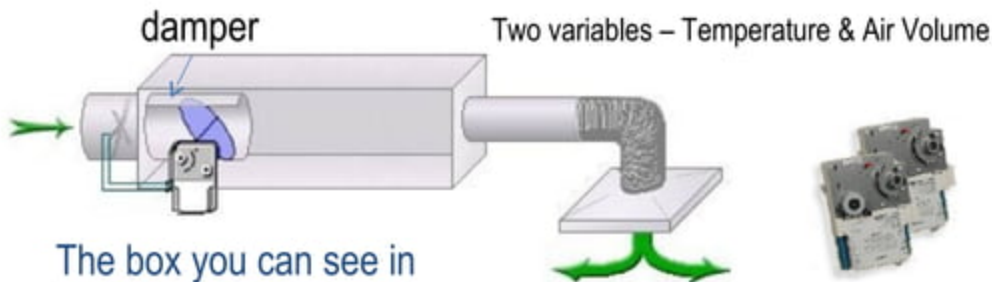
# AHU – Heating and Cooling



# Humidification



Why before the cooling coil?



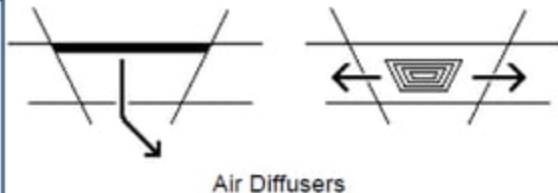
The box you can see in the hallway.

IF temperature too high

First reduce reheat till fully closed  
Then increase air volume

IF temperature too low

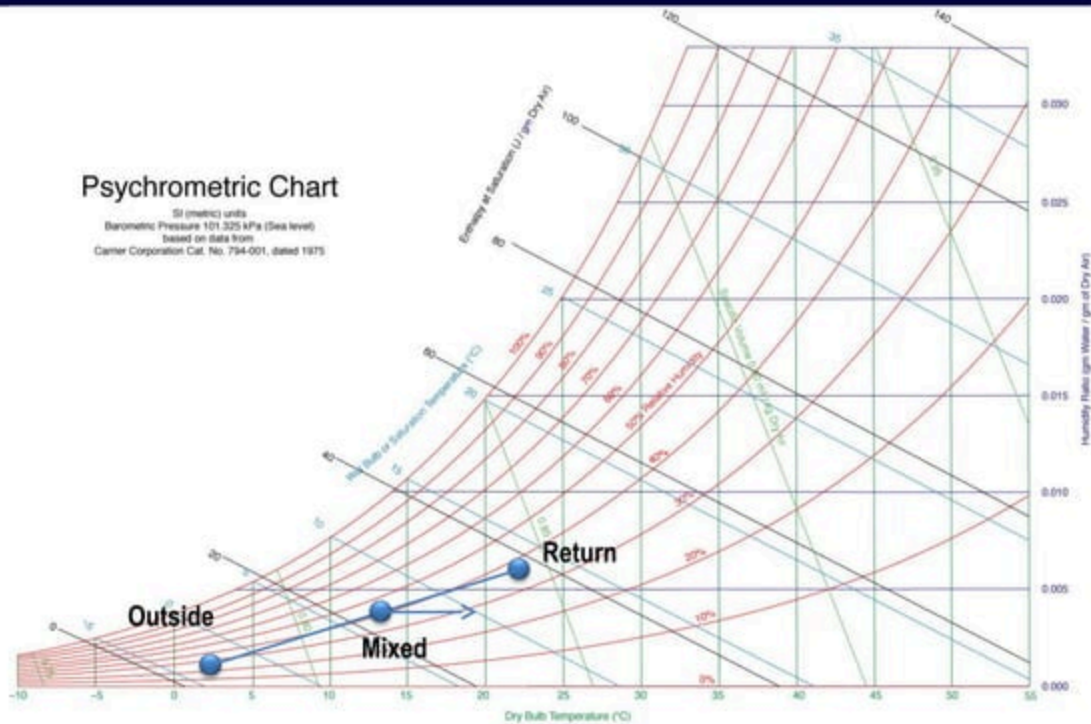
First reduce air volume till minimum  
Then start reheat



# Winter

## Psychrometric Chart

SI (metric) units  
Barometric Pressure 101.325 kPa (Sea level)  
Based on data from  
Carrier Corporation Cat. No. 794-001, dated 1975

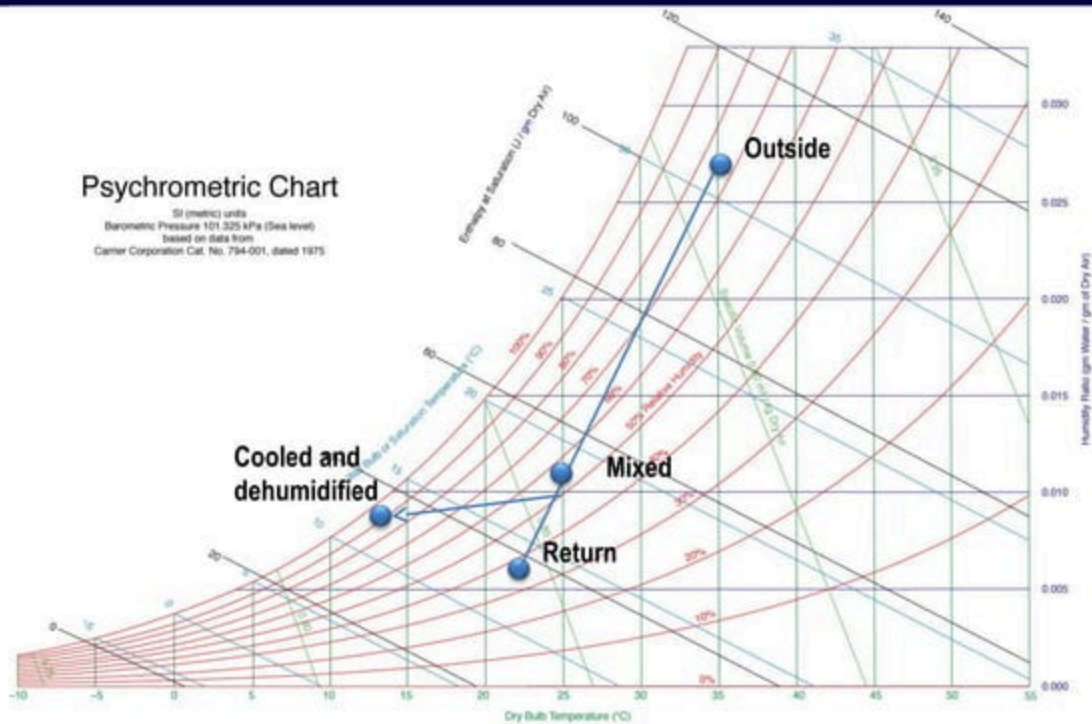




# Summer

## Psychrometric Chart

SI (metric) units  
Barometric Pressure 101.325 kPa (Sea level)  
based on data from  
Carrier Corporation Cat. No. 794-001, dated 1975





# The Real World

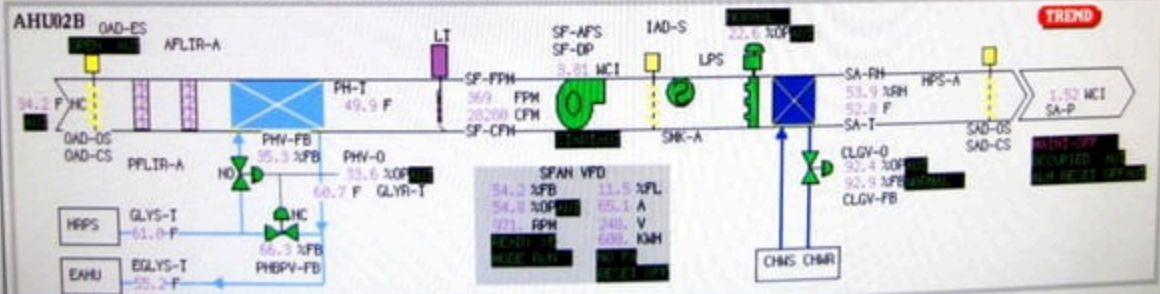
## LIFE SCIENCES BUILDING AIR HANDLING UNIT 2A AND 2B

OA CONDITIONS  
97.2 F  
43.0 %RH

TAG DISPLAY

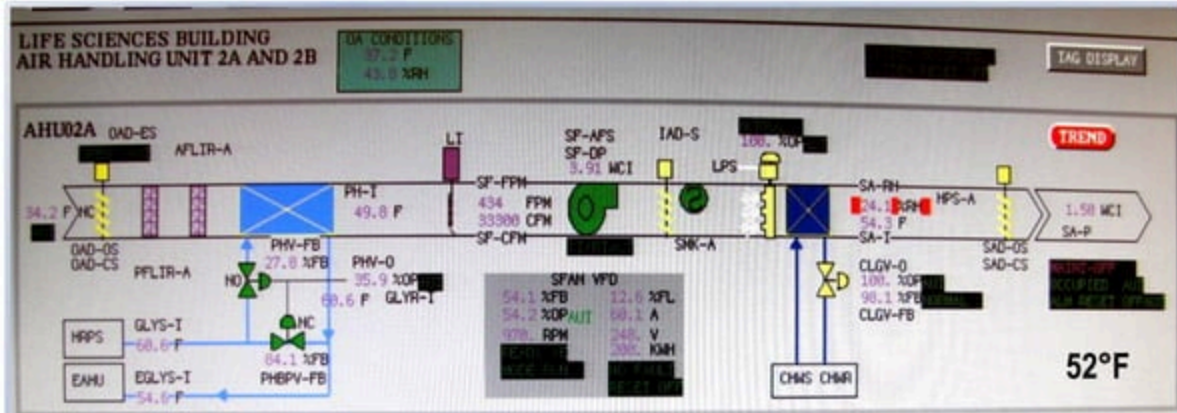


PHV-O = 100GPM = FULL FLOW TO COIL



Any difference? Anything wrong?

# The Real World



Chilled water is still used when outside air is far below 52F

Temperature increased after humidification.

Sensor error.

Separate control caused counteraction.

# What we have learned?

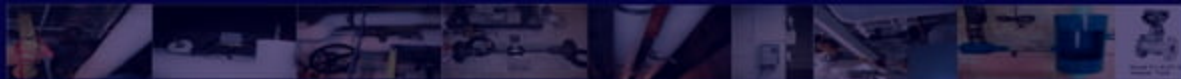
The system that ensures the thermal comfort.

What's in the mechanical rooms.

What happens in air handling unit.

How VAV works.

What can happen in the real world.



# Thanks!

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