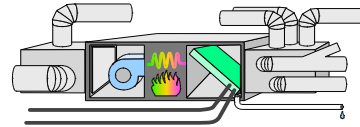# HVAC

Part 2: the details

HVAC

- Heating, Ventilation and Air Conditioning
- Provides *comfort* for people
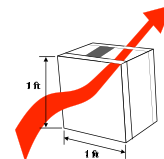- Allows humans to *exist* under adverse conditions.

Load Calculations

- Heating and Cooling
- Accuracy *important!*
- Design conditions
- Building shell load
- R, U value
- Internal load
- Ventilation load
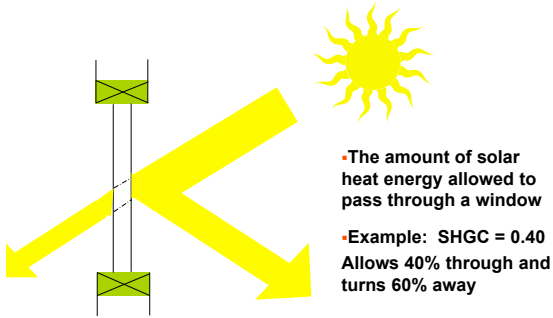- Infiltration
- Occupancy schedules

Heat Transfer

- Conduction
- Convection
- Radiation
- Resistance (R-Value)
- $U = 1 / R$
- $G_{heat} = U \times A \times \Delta T$

U-Value is the rate of heat flow in Btu/h through a one ft^2 area when one side is 1°F warmer

1

Solar Heat Gain Coefficient

▪ **The amount of solar heat energy allowed to pass through a window**

▪ **Example: SHGC = 0.40 Allows 40% through and turns 60% away**
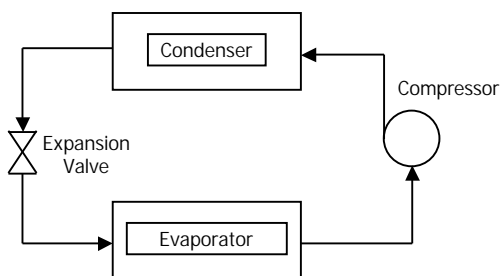
Psychrometrics

- Dry bulb temp.
- Wet bulb temp.
- Humidity
- Dew point
- Moisture content
- Heating
- Cooling
- Humidify
- De-Humidify
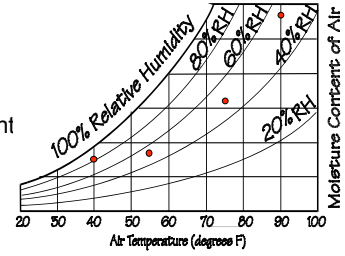
Psychrometric Chart
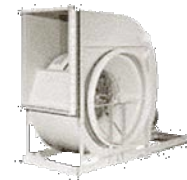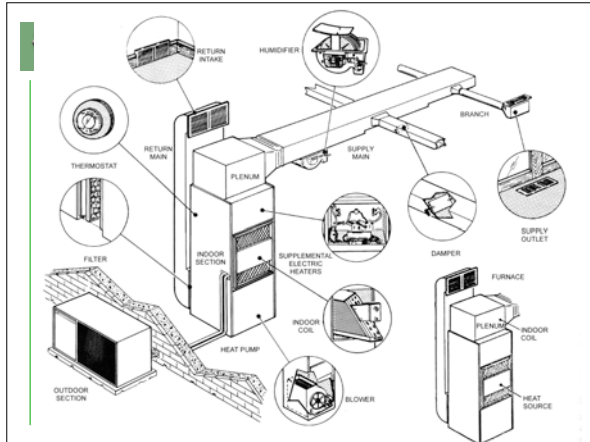
Basic Refrigeration Cycle

Condenser

Compressor

Expansion Valve

Evaporator

Basic HVAC Equipment

- Fans / Blowers
- Furnace / Heating unit
- Filters
- Compressor
- Condensing units
- Evaporator (cooling coil)
- Control System
- Air Distribution System
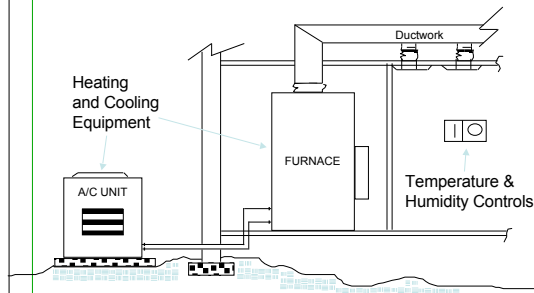
System Types and Common Terms

- Packaged Rooftop Unit
- Split System
- Heat Pump
- Geothermal
- Air to Air
- Hydronic (water)
- PTAC / PTHP

- Constant Volume
- Variable Volume
- Indoor Air Quality
- Direct Expansion
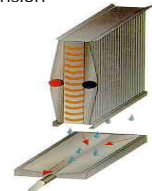
Packaged Rooftop Units

Split System

Heating and Cooling Equipment

Ductwork

A/C UNIT

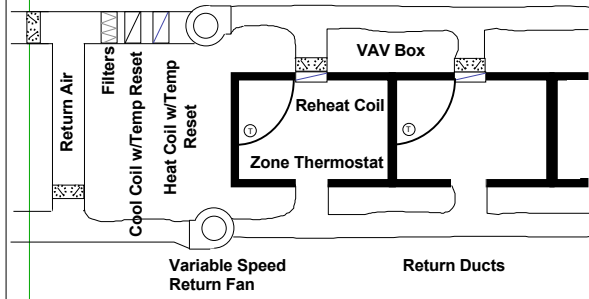FURNACE

Temperature & Humidity Controls

Heat Pump

- Operate on simple refrigeration cycle
- Reversing the cycle provides heating
- Temperature limitations
- Air to air
- Water source
- Geothermal
- Lake coupled

Variable Air Volume
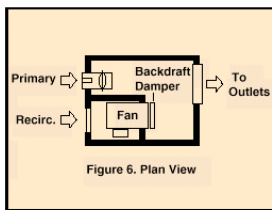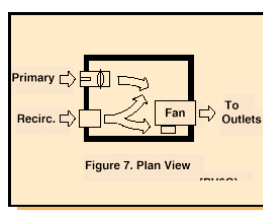

Variable Speed Supply Fan

Supply Ducts

Return Air

Filters

Cool Coil w/Temp Reset

Heat Coil w/Temp Reset

VAV Box

Reheat Coil

Zone Thermostat

Variable Speed Return Fan

Return Ducts

HVAC-14

Terminal Units

Variable volume:
Parallel

Constant volume:
Series

Primary
Recirc.
Backdraft Damper
Fan
To Outlets

Figure 6. Plan View

Primary
Recirc.
Fan
To Outlets

Figure 7. Plan View

Hydronic systems

- Pumps
- Piping
- Valves

Control Devices

- Thermostats
  - Manual
  - Programmable
- Optimum Start
- DDC Systems
- Variable Speed Drives
- Automatic Valves and Dampers
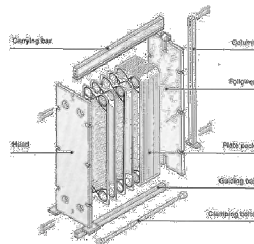- Outdoor Sensors

Major Equipment

- Chillers
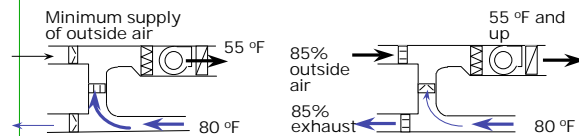- Boilers
- Cooling Towers

Economizers

Air Side

Water Side

Economizers

Free cooling source: When available, use cool outdoor air instead of mechanically cooled air.

Minimum supply of outside air

55 °F

85% outside air

55 °F and up

80 °F

85% exhaust

80 °F

Normal Operation
Outside air dampers are positioned to provide the minimum outside air
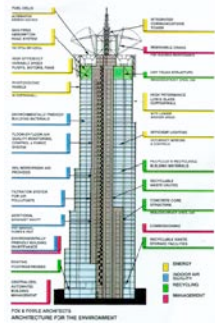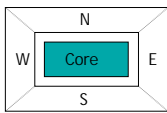
Economizer Operation
Outside air dampers are fully open. Maximum outside air is provided
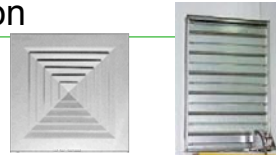
HVAC-20

Zoning and Economizers

- Economizers provide "free cooling" when outdoor conditions are optimal
- Proper orientation & zoning yields comfort & efficiency

Air Distribution

- Ductwork
  - Metal
  - Flexible
  - Ductboard
- Grilles, Louvers, & Registers
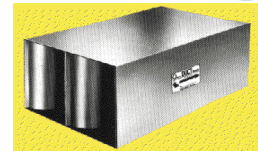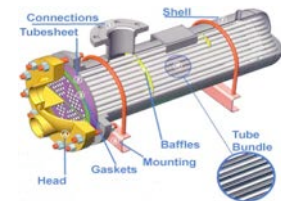- Dampers
  - Shut off
  - Fire
  - Smoke
- Sealants
- Supports

Additional Equipment

- Energy Recovery Units
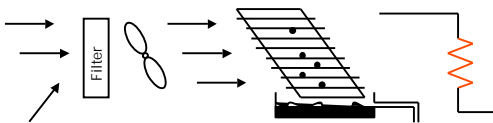- Desiccant Systems

Additional Equipment

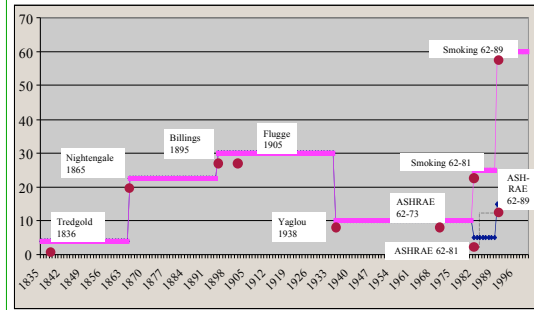- Heat Exchangers
- Humidifiers
- Silencers

Mechanical Dehumidification

- Return air is mixed with ventilation air

- Cold coil condenses moisture

- Heat is added back (electric or gas) so that room air is not over cooled- *Reheat*

Historical Minimum Ventilation Rates (cfm/person)

Improved Ventilation Effectiveness

- Effective mixing of ventilation air within space

- Vary ventilation based on the number of occupants and process loads - changes in occupancy can be measured by CO_2 sensors

- Consider designs that separate ventilation and space conditioning

- Utilize heat recovery systems to reduce system size energy costs

- Avoid: loading docks, exhaust vents, plumbing stacks, waste collection & stagnant water