Aim High: Good Mechanicals

HVAC Objectives

- Safety
  - Combustion, explosion, scalding
- Health
- Comfort
  - Temperature, humidity, air speed, noise, light
- Reliability
  - Maintainable, long term performance,
- Efficiency
  - Meet the needs imposed by occupants and enclosure with a minimum of additional energy

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Common Problems

- Poor comfort
  - Poor control of temperature and/or humidity,
  - Noise, drafts from high velocity air (at 55 or 95 F)
- Health
  - Air based systems act as distribution for outdoor pollutants, mold grown in coils/ducts
  - Chilled water pipes collect condensation leading to mold
  - Insufficient ventilation/mixing common issue
- Energy
  - Systems are often very inefficient
- Maintainability / Controllability
  - Systems are complex, difficult to trouble shoot, maintain etc

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Functions

Five Critical functions are needed

- Ventilation
  - "fresh air"
  - Dilute / flush pollutants
- Heating
- Cooling
- Humidity Control
- Air filtration / pollutant Removal
  - Remove particles from inside and outside air
  - Remove pollutants in special systems

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What do you need to deliver?

Type	Temperature	Humidity	Pressure	Examples
I a	●			Heated house, warehouse
I b	●	○		Heating and normal A/C
I c	●		○	Heating + exhaust fans
I d	●	○	○	Heating+ A/C + exhaust fans
II a	●	●		Museum, fruit storage
II b	●	●	○	Pressurized + controlled
III	●	●	●	Special labs, chip fabrication
IV	●		●	Dust controlled manufacturing
V		●	●	
VI			●	

Note: ● Directly controlled ○ - Incidental Implicit

All require metered deliver of fresh air, and some exhaust of polluted air

Indoor Air Quality

- Most HVAC re-circulates air
  - This takes pollutants from one space and moves to another
- HVAC can suck in pollutants from outdoors

- Filters and Interior Duct Insulation collect dirt
- If moisture (condensate) contacts, mold can grow
- Air flow distributes the problem smells and spores

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Common Air-based Sysems

- CAV systems
  - high energy consumers but provide outdoor air
- VAV
  - decent energy performance, but rarely supply desired ventilation (fresh) air rates
- DOAS: Dedicated Outdoor Air Systems
  - provide Ventilation (+ almost always dehumidification) only
  - separate terminal equipment does heating and cooling
  - Highest performance, easy to design & fix

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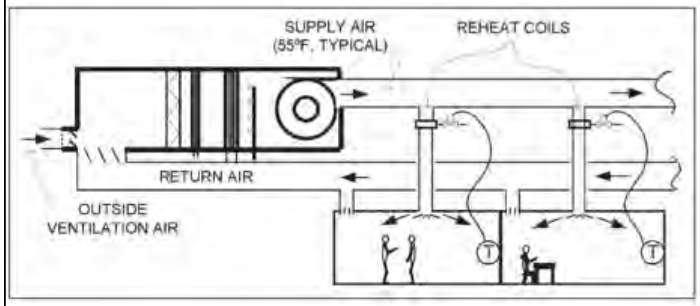
Constant Air Volume



Great RH & T control (Dewpoint of 55 all the time)
Terrible energy performance (reheating almost all the air, all the time)
Often no designed exhaust air: "pressurize" building

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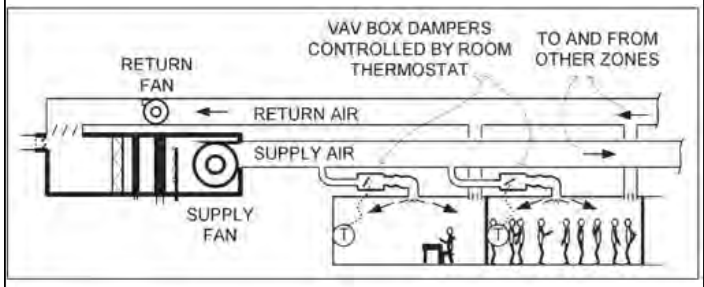
Variable Air Volume



Poor IAQ: ventilation controlled by thermostat
Poor/no RH control: depends on cooling coil operation
Either good energy performance /poor RH, or good RH / poor energy
Often no designed exhaust air: "pressurize" building

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Variations on VAV

- Spaces with low cooling load often under-ventilated
- Minimum flow setting at box can be imposed by clock or CO_2 and "reset" by temperature
- Reheat at box often needed, can be significant energy
- Outdoor air % can vary with return air CO_2 or clock
- Supply fan can be operated to provide constant static pressure (VFD)
- Flow can be measured at each box, with reheat, connected to central control to guarantee ventilation air (complex, $, works)

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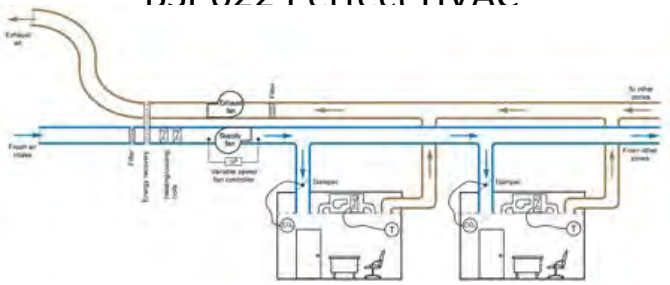
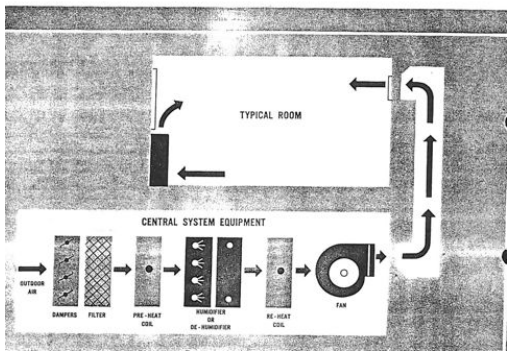
BSI-022 Perfect HVAC



Thermostat controls heating/cooling by zone
Ventilation controlled by occupancy (CO2)
All air is delivered dry (humdity control)
No recirculated air (improved IAQ)



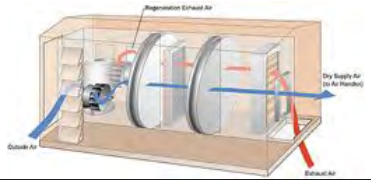
From Trane Co., 1951

DOAS

- Most reliable means of delivering ventilation air to people without over ventilating
- Excellent humidity control, no extra reheat
- No cross-contaminated air from different zones
- Small ducts (ventilation only, no cooling)
- Works well with hybrid ventilation
- Disadvantage: economizer flow is limited, so free *air* cooling capacity is limited by 2-3X

Energy recovery ventilation

- Reduces equipment peak capacity (saves capital $)
- Reduces load on heating/cooling/ dehumidification (saves energy/operating $)
- Usually makes sense for any large mechanical ventilation flow



Underfloor Air Distribution

- A “green” technology. Why?
- Higher temperature air delivery (55F vs 65)
  - High T required for ankle comfort,
  - allows higher chilled water temp (saves energy)
- Large airflow volumes required for cooling
  - More airflow= more fan energy, but . . .
  - Allows economizer at higher outdoor T
  - Requires large “ducts” to reduce fan energy

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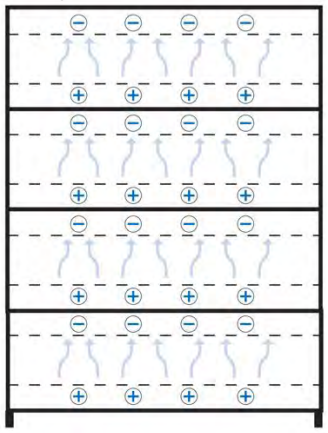
Displacement Ventilation



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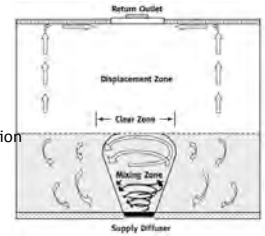
Ventilation

- Displacement (DV) ≠ UFAD
- Many UFAD are not DV
- Low supply Velocity = DV

Swirl diffuser
UFAD ventilation



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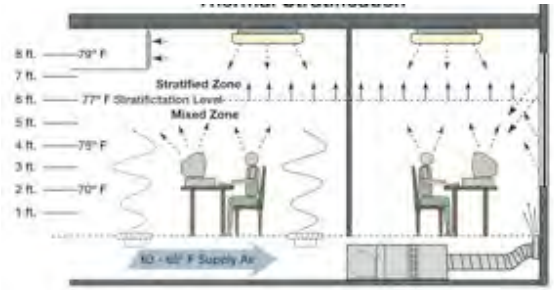
Cooling dominates, not ventilation

- Perimeter zones



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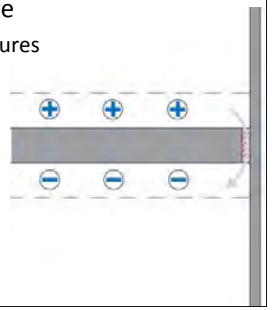
UFAD Leakage

- Underfloor plenum is a duct
  - Ducts leak
  - Field reports of 20-30% leakage
    - Into partitions walls, into enclosures
- Loss of control & cooling



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Other "Issues"

- Dirt Collection & IAQ
  - •During construction
  - •Operation
- Furniture
  - •Need to coordinate heavy furniture with filters, access

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