Mechanical Systems and Controls for Institutional Building

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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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Common Multi-zone Systems

- CAV Constant Air Volume
  - high energy consumers but provide outdoor air
- VAV Variable Air Volume
  - decent energy performance, but rarely supply desired ventilation (fresh) air rates
  - Often heat and cool simultaneously or loose control of comfort/humidity

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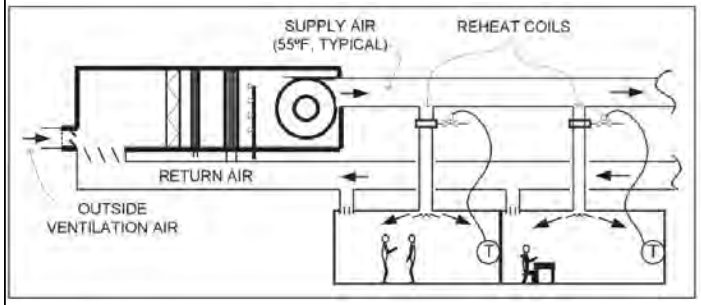
Constant Air Volume



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

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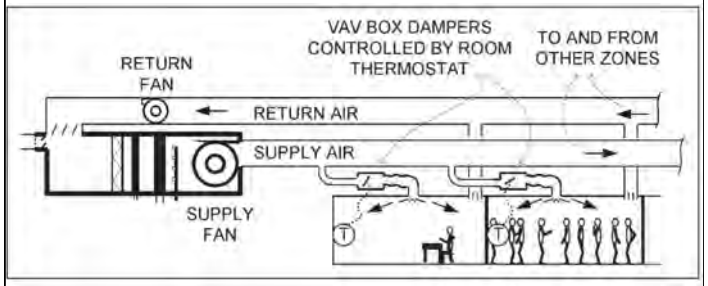
Variable Air Volume



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

VAV Challenges

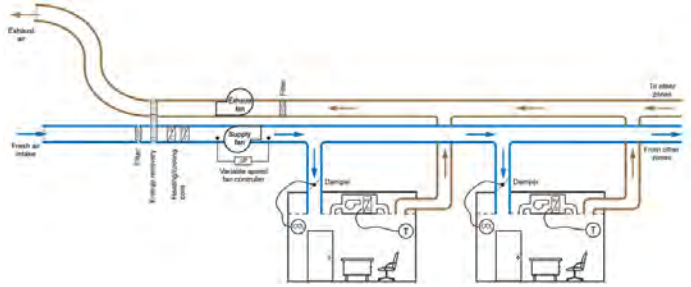
- "Rainy day"
  - How to deliver fresh air and control RH when it is raining and 68 F outside
- Demand ventilation
  - How do we
    - control fresh air rate and
    - not impact air temperature
    - all without reheat?

DOAS

DOAS: Dedicated Outdoor Air Systems

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

BuildingScience.com Perfect HVAC



Thermostat controls heating/cooling by zone (any system)
Ventilation rate controlled by occupancy (ideally CO_2)
All air is delivered dry (provides humdity control), neutral temperature
No re-circulated air (improved IAQ / less cross contamination)
No holiday schedule for ventilation. No under/over ventilation.

Retrofit and DOAS

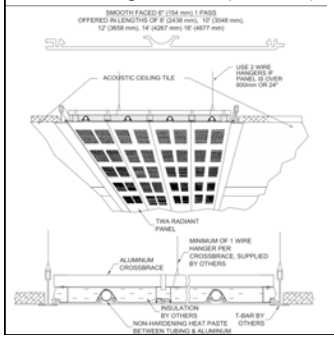
- Can Retrofit DOAS to CAV very easily
  - Change the diffuser
  - add modulating damper
- Easiest to retrofit if no ducts in building
  - E.g., old dormitories, offices, etc had no cooling and hence no ductwork
  - Small ducts can usually be fit into space easily

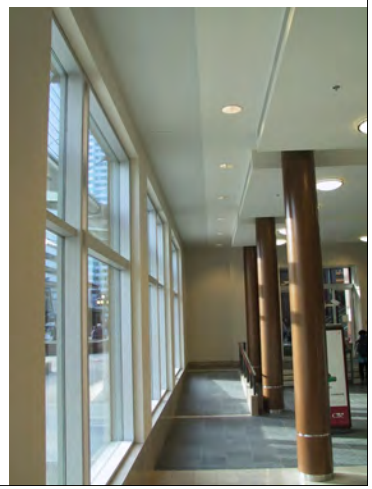
Convector / Radiator

- Hydronic terminal units often designed for high temperature (180F supply/160 return)
  - Can using condensing with outdoor reset

Radiant Panels

- Can replace hydronic baseboards
- Less heat output, low temperature
- Peak heating 150 W/m^2 (50 Btu/ft^2)
- Peak cooling 100 W/m^2 (33 Btu/ft^2)





Convector retrofit

Distributed Systems

- E.g., Local cooling, local HRV/ERV
- Avoids long complex ductwork
  - Typ VAV use 30% of AC energy to run fans
- Allows for better direct control of spaces
- Often less disruptive to install
- Often less expensive and more efficient

- Require maintenance nearer to occupied spaces, not in central plant rooms

Variable Refrigerant Volume (VRV)

- **Only run refrigerant lines for heating and cooling**
- **Capacities in the 25 ton + range now available**

Ductless Mini-split

- Many systems now variable speed to match load, increase dehumidification, and reduce energy use
- Need separate ventilation

Systems with SEER26 and HSPF=11 available

Room sized HRV/ERVs

- Capacities of 60-1200 cfm
- provide ventilation for small offices to classrooms of 100 students
- Simple and easy to add CO2 or occupancy sensors to operate at high speed.