Building Systems: HVAC

Committee on Microbiomes of the Built Environment
June 21, 2016
Washington DC

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Outline

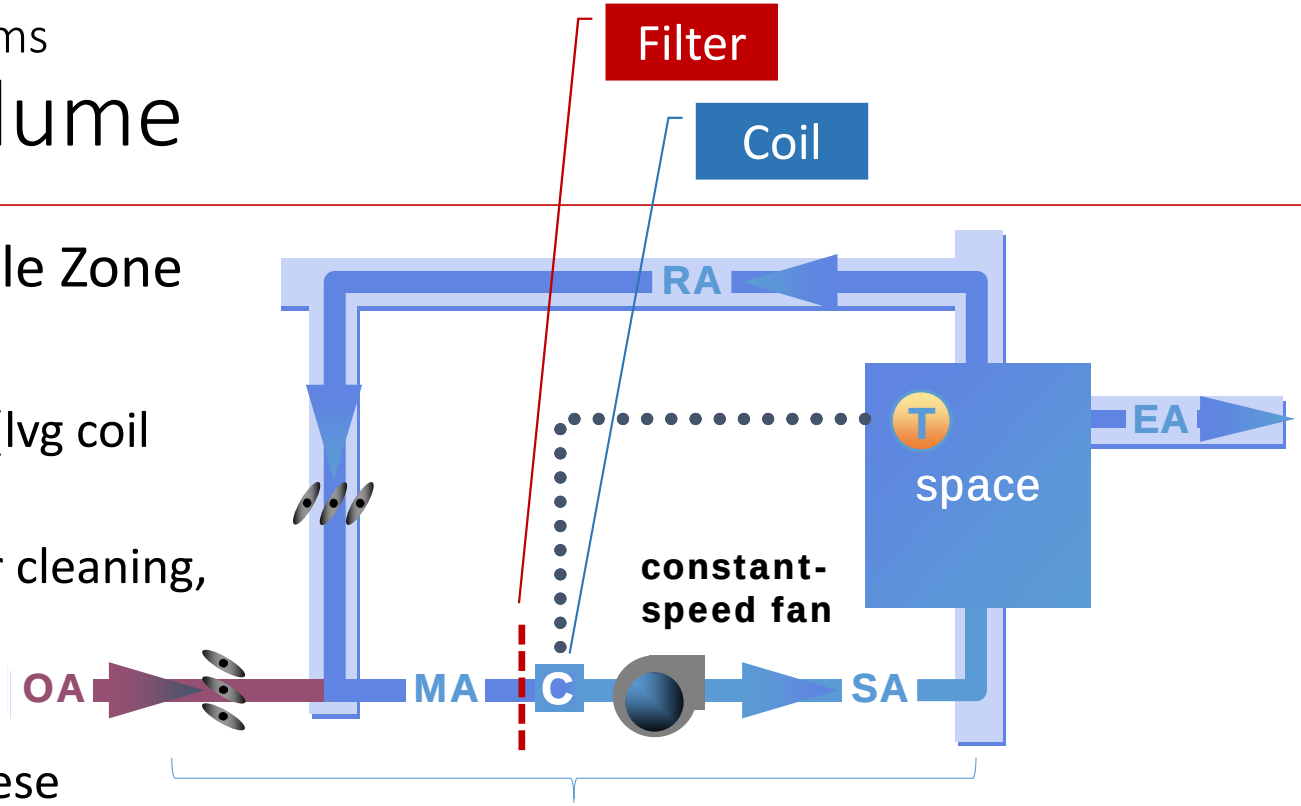
- Ventilation Systems
- Moisture sources
- Low energy technologies
- Installation/Operation/Maintenance
- Summary

three ventilation systems

Constant Volume

Basic System – Single Zone

- One zone, one unit
- Direct temp control (lvg coil temp 55F to 75F)
- Indirect humidity, air cleaning, ventilation control
- Local ventilation
- Probably more of these than any other system



Rooftop, unit ventilation, ptac

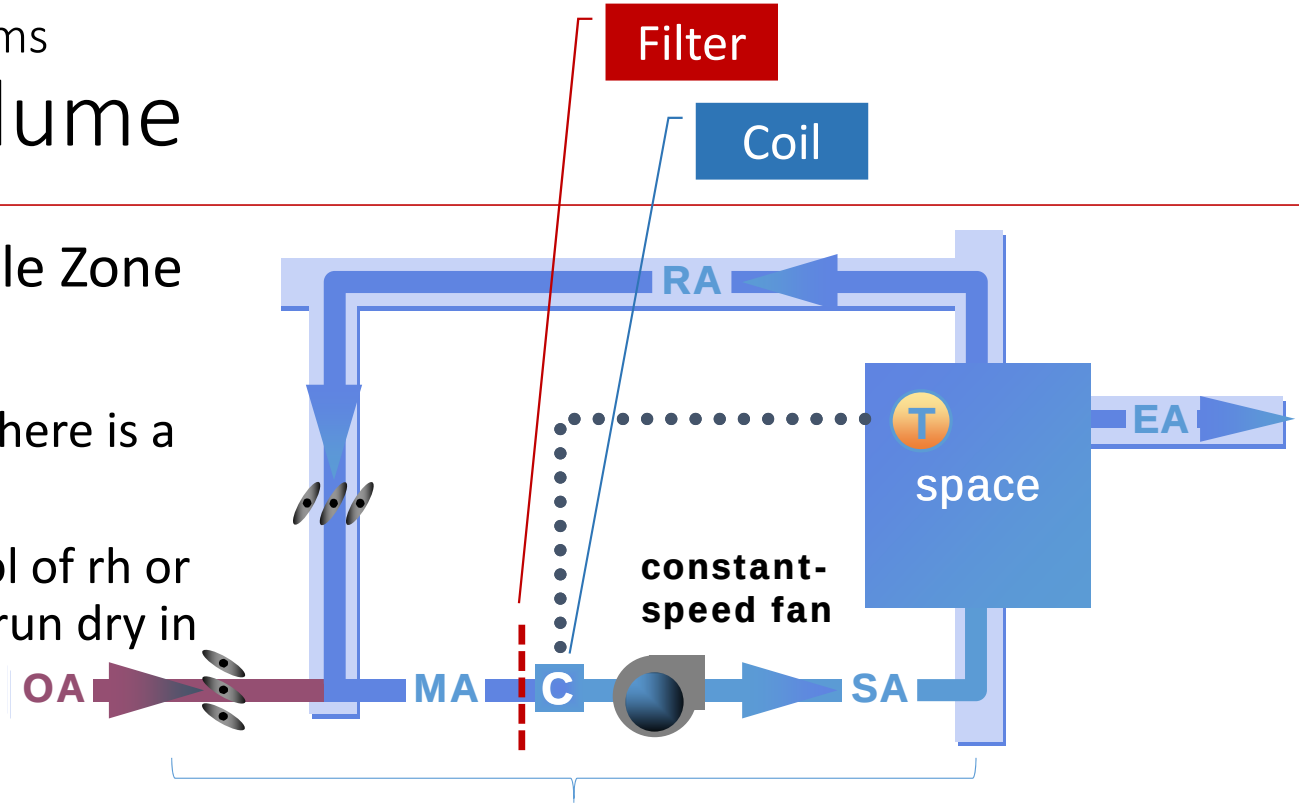
zone temperature determines AHU cooling capacity

three ventilation systems

Constant Volume

Basic System – Single Zone

- Oh, yeah.
- Winter operation – there is a heating coil, too.
- Seldom direct control of rh or dp, so cold climates run dry in winter …



Rooftop, unit ventilation, ptac

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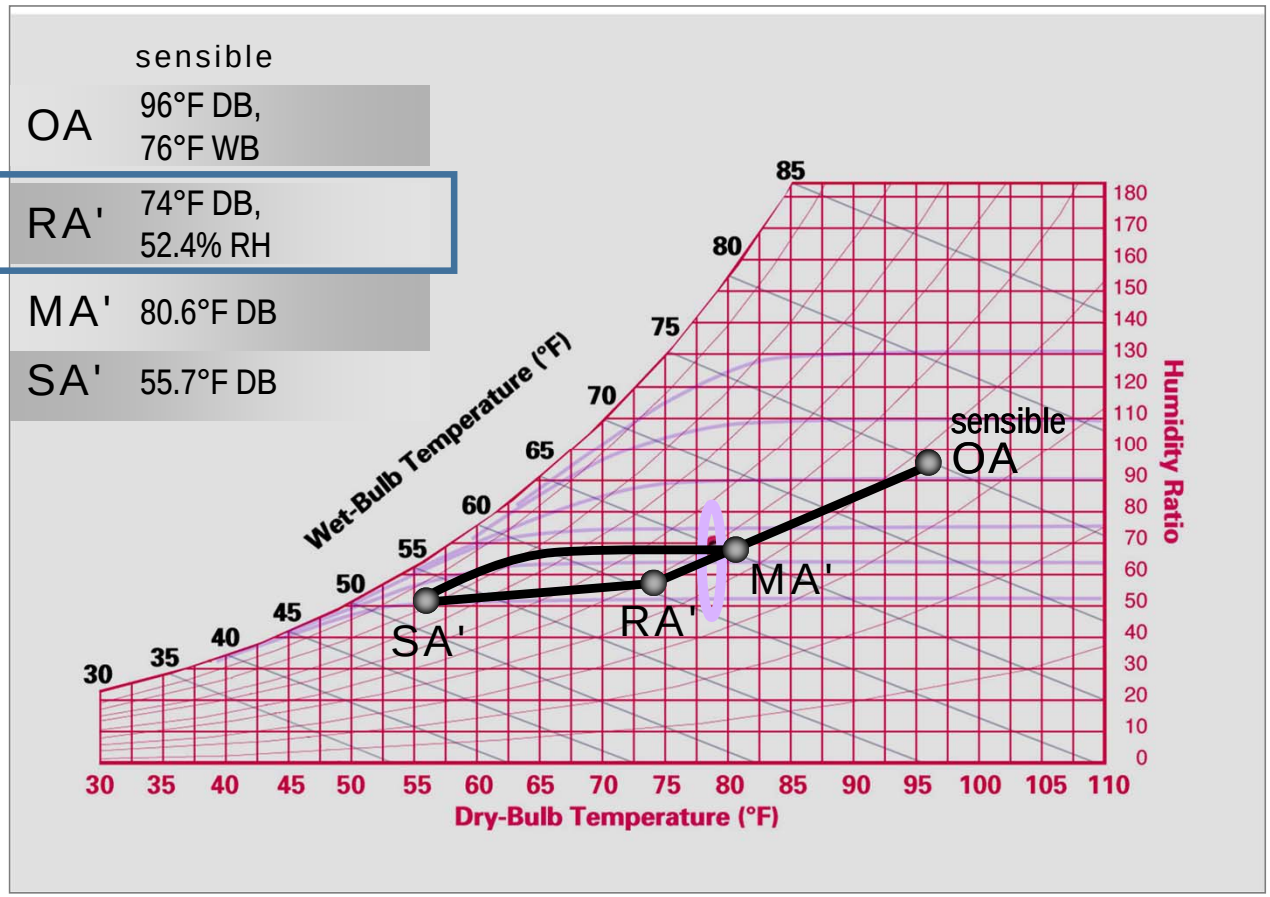
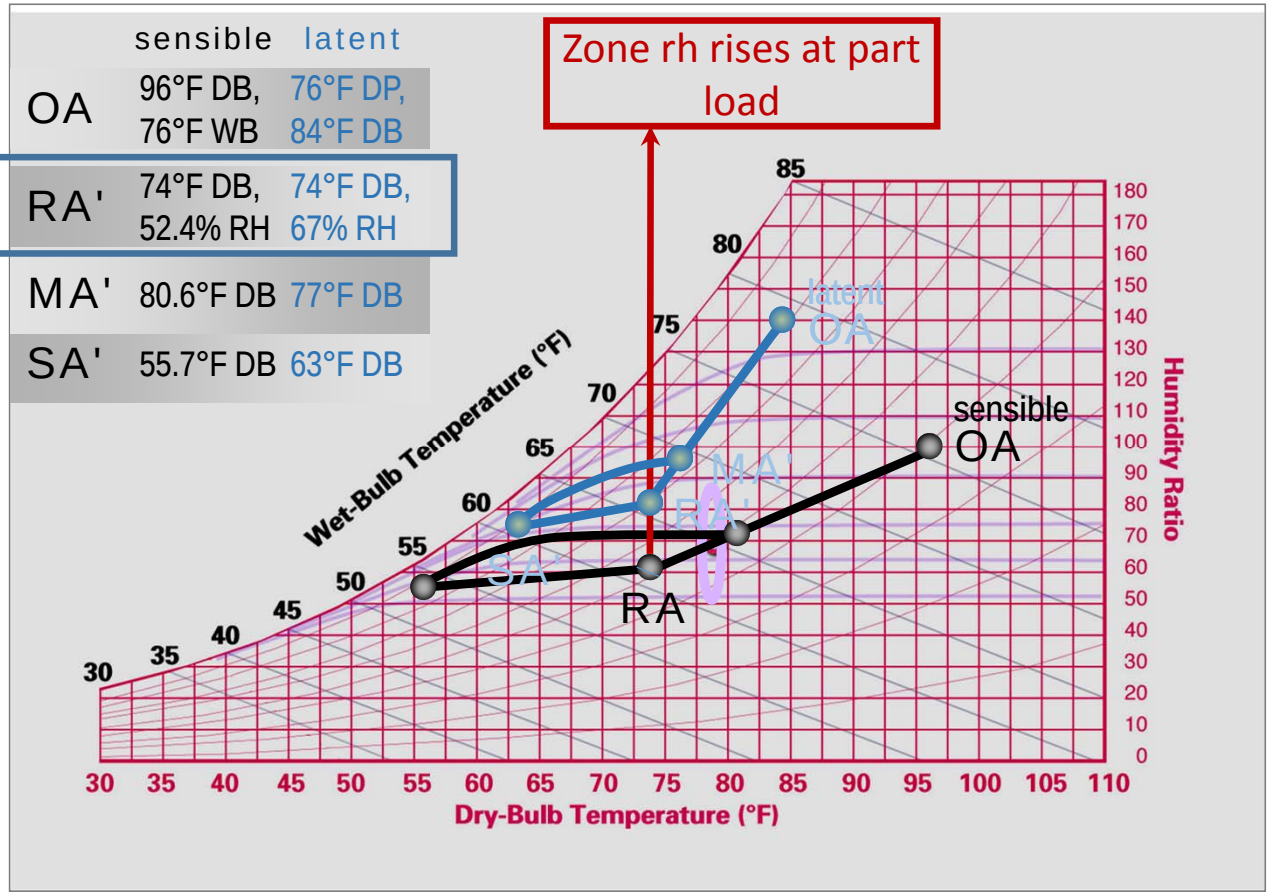
three ventilation systems

Constant Volume – Design Load



three ventilation systems

Constant Volume – Part Load

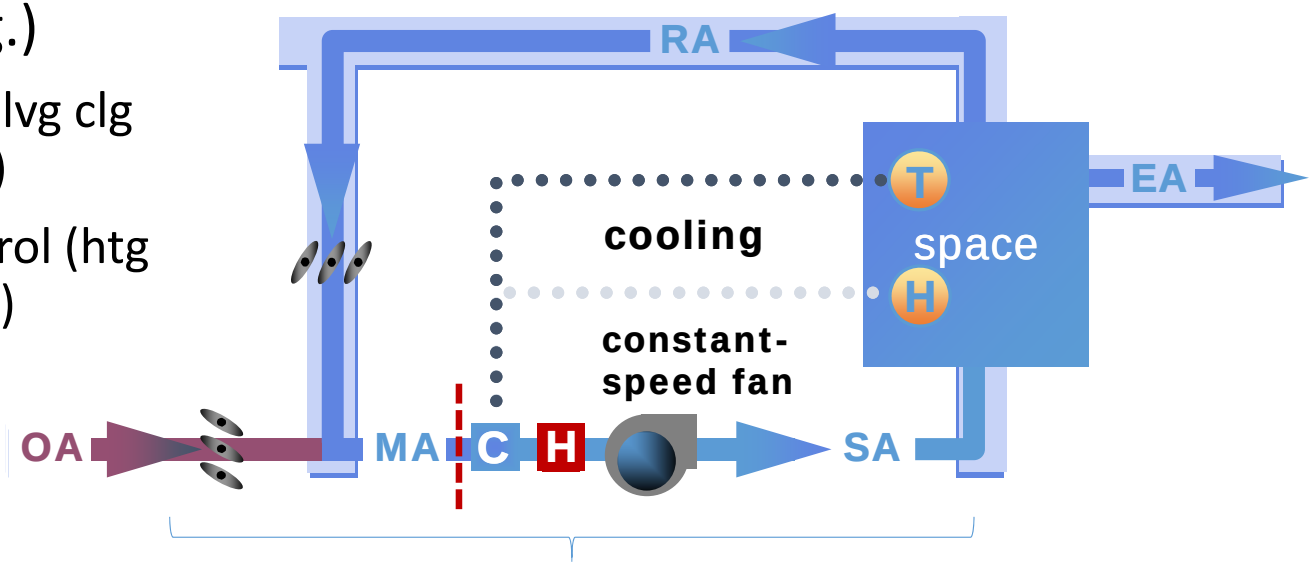


three ventilation systems

Constant Volume Plus - Cooling

CV Plus **Reheat** (e.g.)

- Direct temp control (lvg clg coil temp 55F to 75F)
- Direct humidity control (htg coil off when cooling)
- Indirect air cleaning, ventilation control
- Local ventilation



Rooftop, unit ventilation, ptac

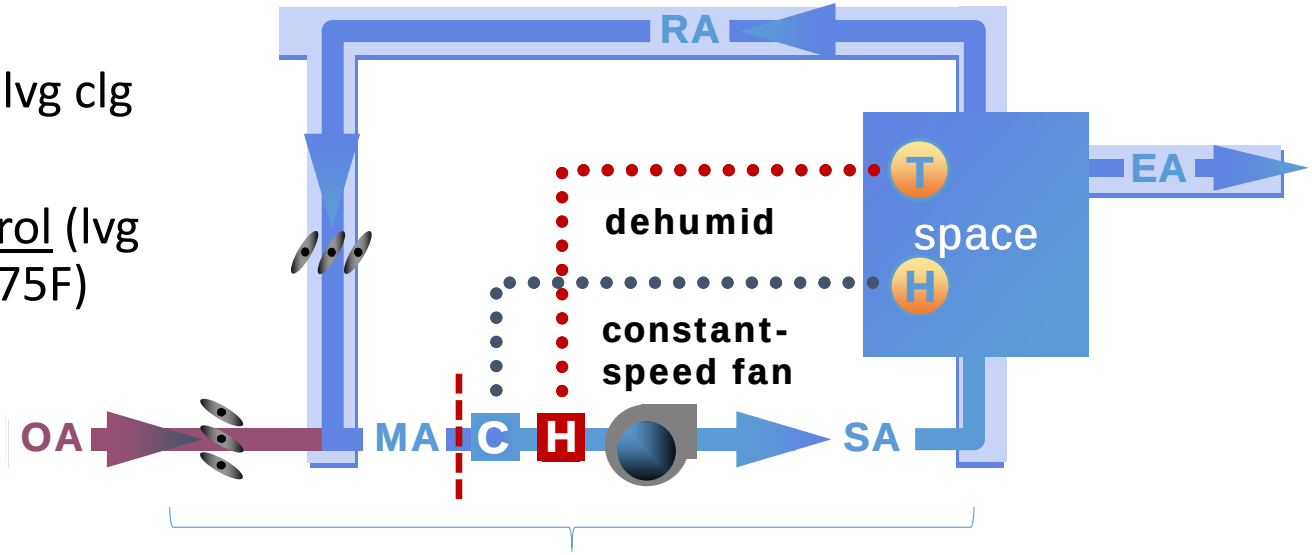
zone temperature determines AHU cooling capacity

three ventilation systems

Constant Volume Plus - Dehumidifying

CV Plus **Reheat** (e.g.)

- Direct temp control (lvg clg coil temp 55F)
- Direct humidity control (lvg htg coil temp 55F to 75F)
- Indirect air cleaning, ventilation control
- Local ventilation

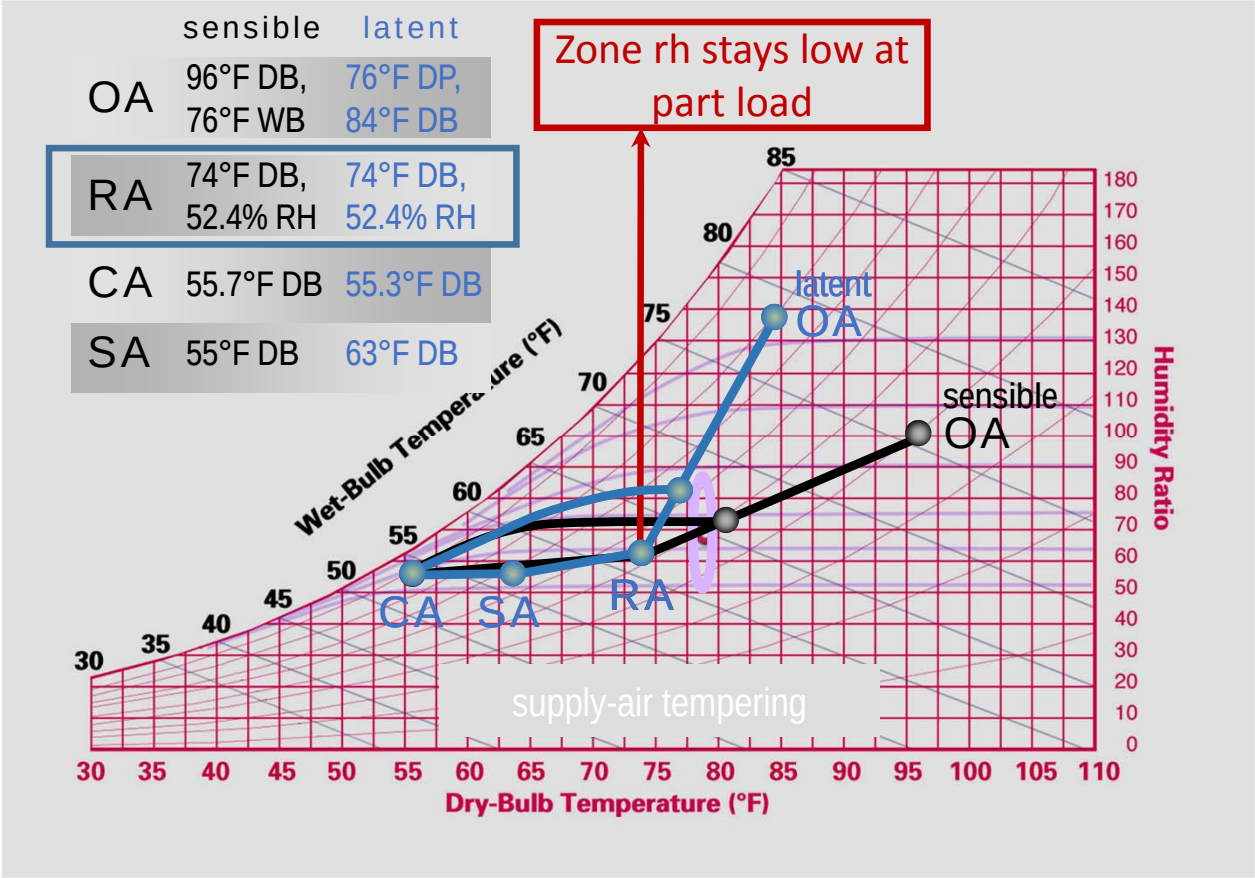


Rooftop, unit ventilation, ptac

zone temperature determines AHU reheat capacity

three ventilation systems

Constant Volume Plus

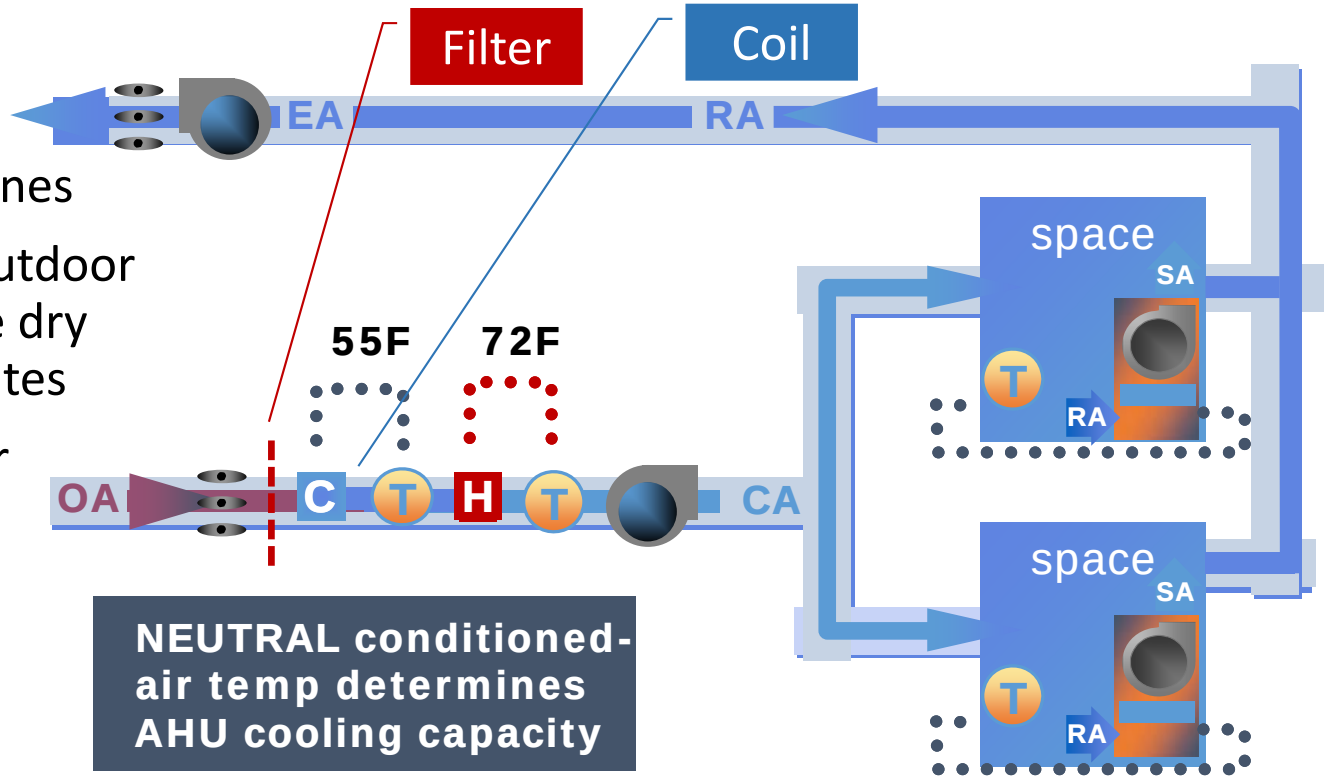


three ventilation systems

100% Outdoor Air System (DOAS)

Basic CV DOAS

- One OA unit, many zones
- Central neutral, dry outdoor air … zones tend to be dry in winter in cold climates
- Central ventilation, air cleaning
- Local units for zone temp control
- Rising popularity



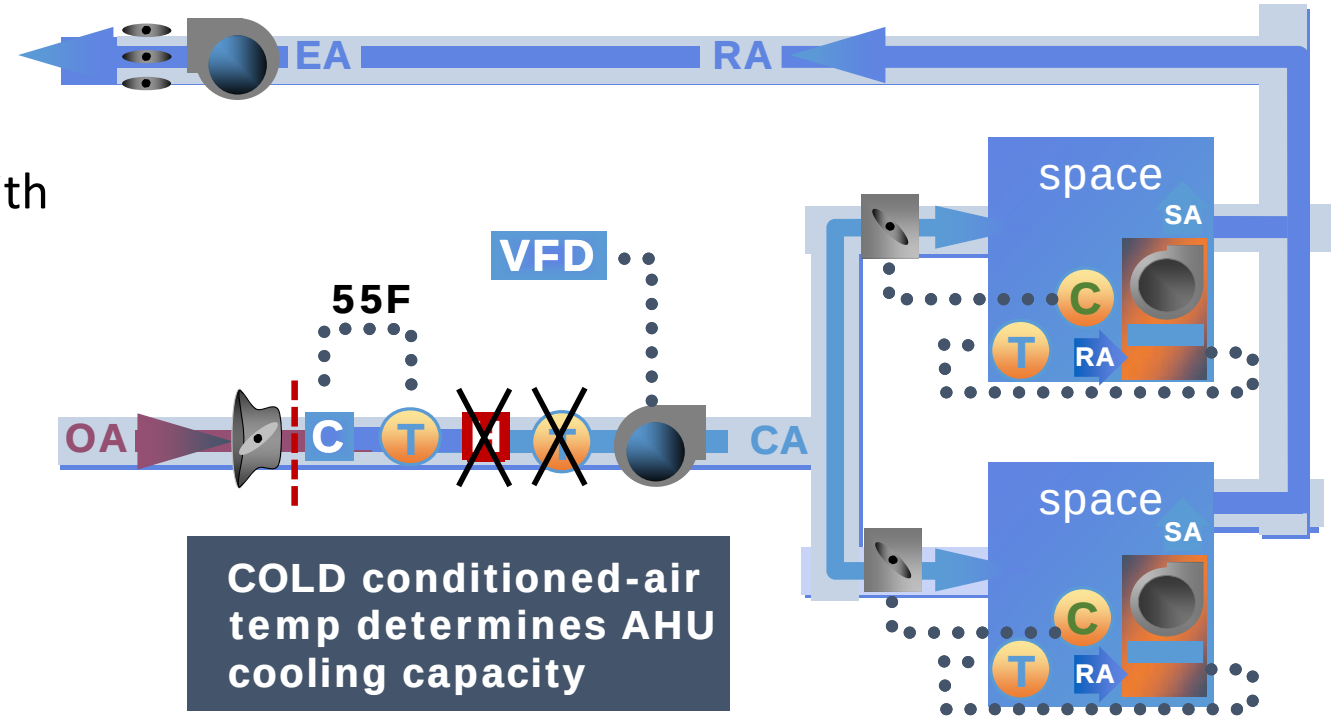
WSHP, fan-coil

three ventilation systems

100% Outdoor Air System Plus

Enhanced DOAS w/cold air and VAV

- Cold central temp (with cooling and reheat)
- Central air cleaning
- Central ventilation w/VAV for DCV
- Local units for zone temperature control



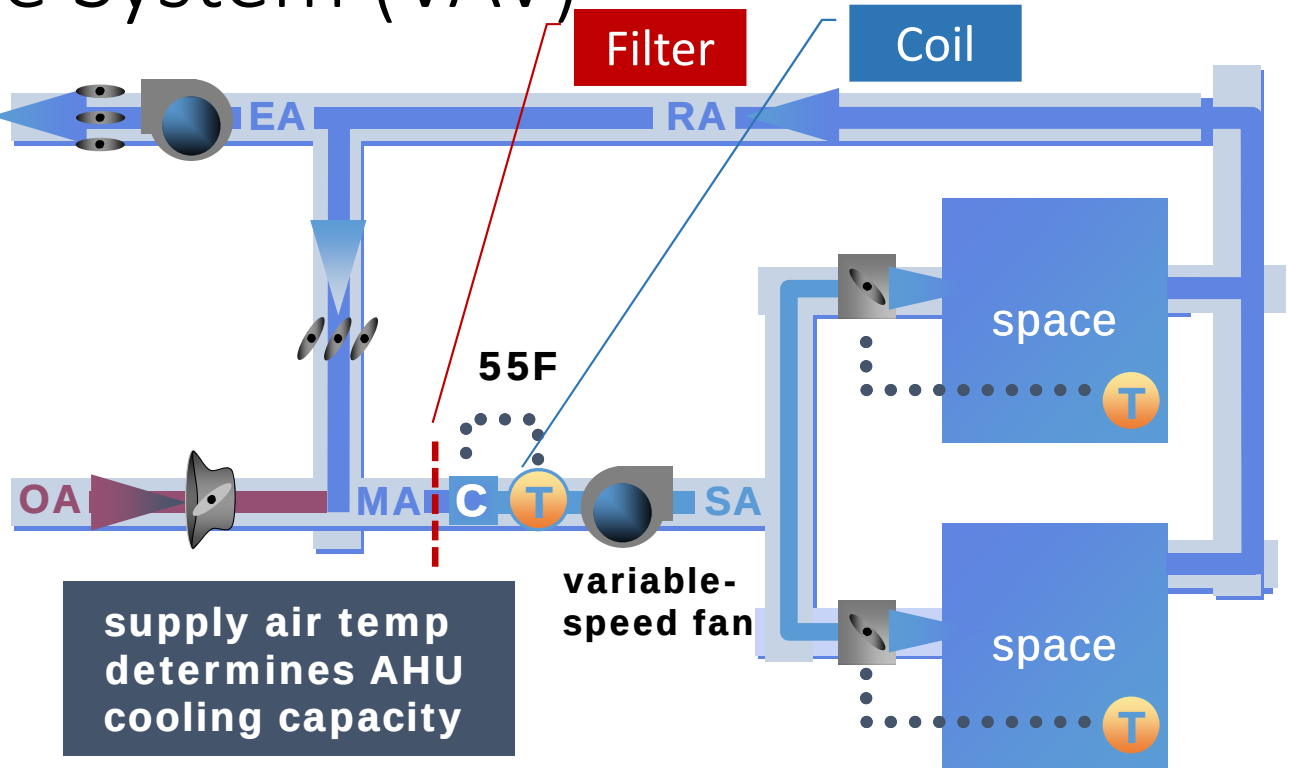
WSHP, fan-coil

three ventilation systems

Multiple-Zone System (VAV)

Variable Air Volume

- One air handler, many zones, recirculating air
- Central air cleaning
- Central ventilation w/VAV for DCV
- Local boxes for zone temperature control by adjusting airflow
- Again, zones run dry in cold climates in winter



three ventilation systems

Some Other Ventilation Systems

- Other VAV
  - Series and parallel fan-powered VAV
  - Dual-fan dual-duct VAV
- Natural Ventilation – Engineered openings or operable windows
  - Must be a mixed-mode system
  - Can passively cool during economizer conditions
  - NA must be “off” (closed) during heating and cooling modes
  - Does not filter or dehumidify during NA operation
  - Really works best in temperate climates
- And so on …

Outline

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- Operating modes
- Moisture sources
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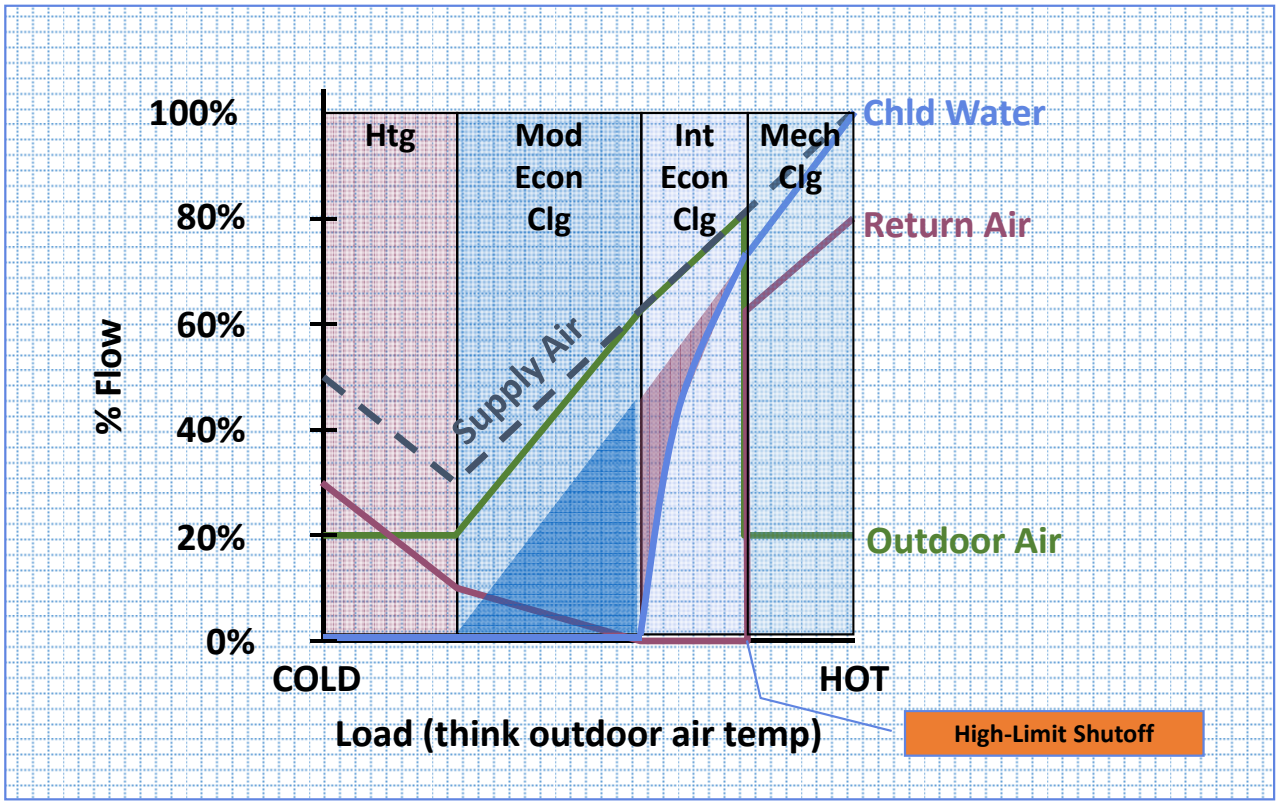
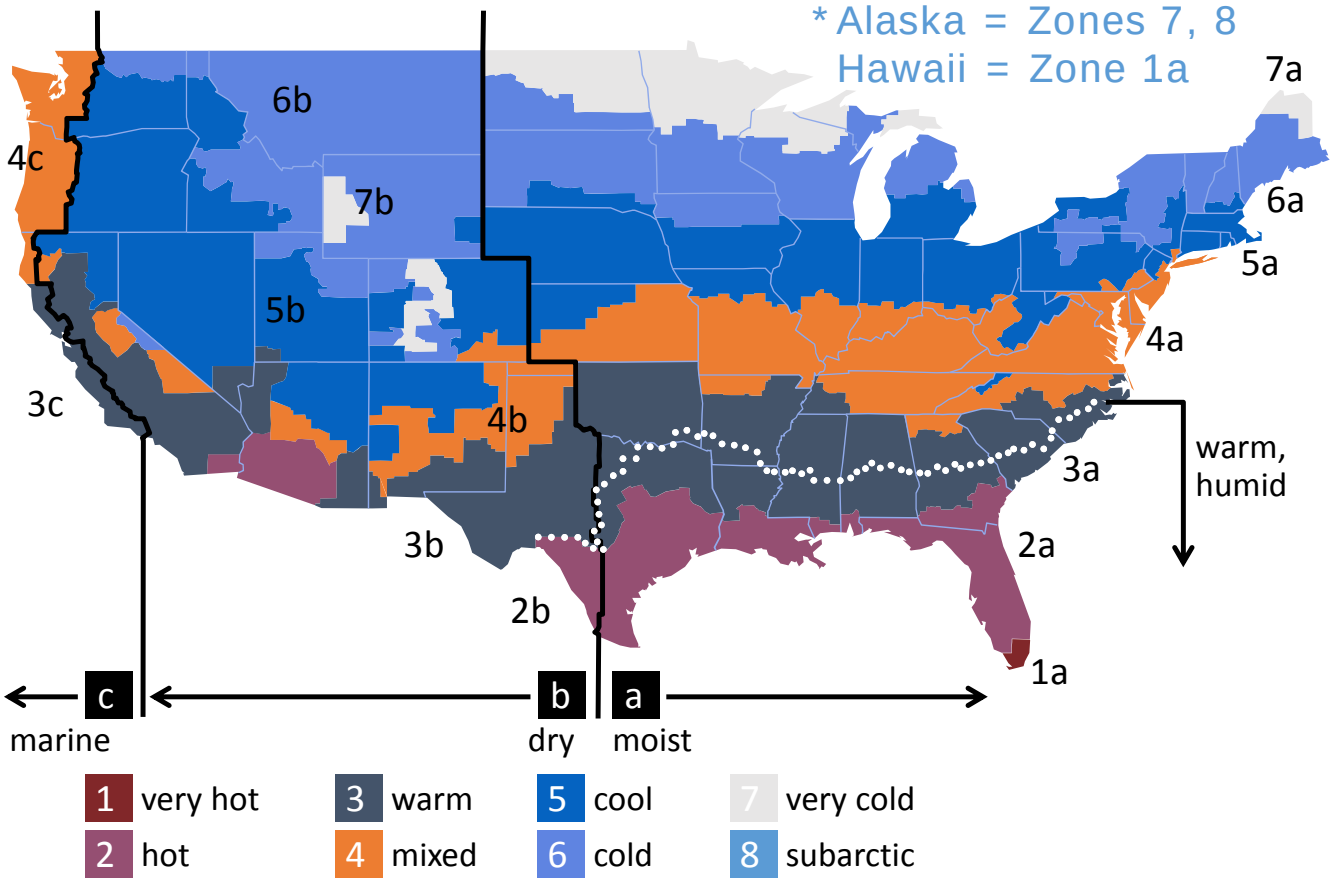
operating modes

From Max Heating to Max Cooling …

- Most climates …
  - Heat in winter
  - Can (must) use economizer cooling for some conditions
  - Need mechanical cooling in summer



U.S. climate zones*



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moisture sources

Liquid Water Examples

- Anytime …
  - Leaks in envelope, pipes, valves
  - Cleaning processes – carpet shampooing, mopping
- When cooling …
  - Condensate on cooling coils
  - Coil water droplet carryover (due to increased air velocity – dirty filter)
  - Drain pan overflow or spitting traps (often poor design or installation)
  - Condensate on pipes, ducts (usually due to damage)
- When heating …
  - Condensate on windows
  - Condensate on and in walls … in general, it's too dry in winter in cold climates

moisture sources

Water Vapor Examples

- Anytime, but can be reduced
  - Vapor pressure diffusion (usually low)
  - Infiltration of moist air (can be high in summer – wind and weather and bldg)
  - Exfiltration of “moist” air (can be high in winter – wind, stack effect in winter)
  - Evaporation – pools, fountains, cleaning processes (usually low)
- Anytime, but must be dealt with
  - Viable people (well, depends on population density, activity)
  - Outdoor air for ventilation (can be high in summer – depends on climate)

moisture sources

What to Do?

- You will have moisture sources
- Design building to minimize sources
- Design HVAC to reduce moisture
- Control moisture with high limit (like 62F dp or 65% rh)
  (this, of course, takes equipment and energy)
- Perhaps, design with low limit in future (comfort, health)

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low energy technologies

Examples for the Future

- Reduced cooling load
  - Low energy lights
  - Window shading/treatment
  - High efficiency office equipment
- System trends
  - Perhaps more VAV (even one-zone VAV on the rise)
  - Perhaps more 100% OA systems (separate loads to control rh)
  - More efficient filters (MERV 8 to MERV 13)
  - Increased ventilation (+30%)
  - Increased control complexity (more economizer, less reheat, more DCV)
  - All trends change traditional system operation and maintenance

low energy technologies

Examples for the Future

- Reduced cooling load …
  - May increase heating energy, depending on bldg/climate
  - May increase zone relative humidity, depending on system type
- System trends
  - VAV reduces rh rise, but increases system complexity
  - 100% OA (DOAS) reduces rh rise, but adds significant complexity
  - High efficiency filtration adds to operating cost
  - Increase OA adds operating cost and rh control complexity
  - Increase complexity reduces likelihood of long-term success w/o training

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Summary

- There are many types of system
- System choice depends on (for example)
  - Climate
  - Building type
  - Budget
  - Operating staff
- VAV, DOAS future bodes well for reduced rh and particle control
- As cooling loads drop, rh may rise, but complexity certainly rises

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Questions?

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