DOAS Supply Air Conditions: Dew Point & Dry Bulb

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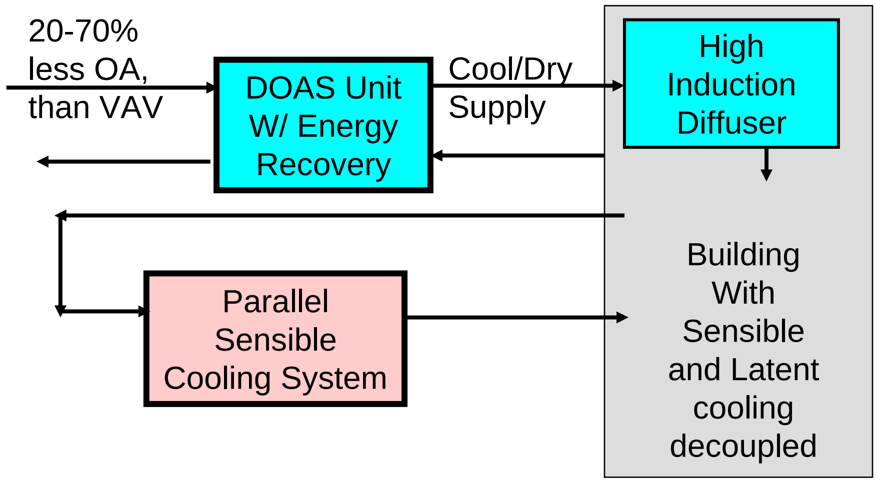
DOAS Objective

- Meet the ventilation requirements of ASHRAE Std. 62.1.
- Decouple the sensible and latent loads:
  - By reducing the OA DPT to that of the design space DPT, i.e. 55F, thus eliminating the entire OA latent load.
  - By reducing the OA DPT even lower so that the DOAS air can also handle all of the space latent load. This would result in all terminal cooling equipment operating with dry surfaces.

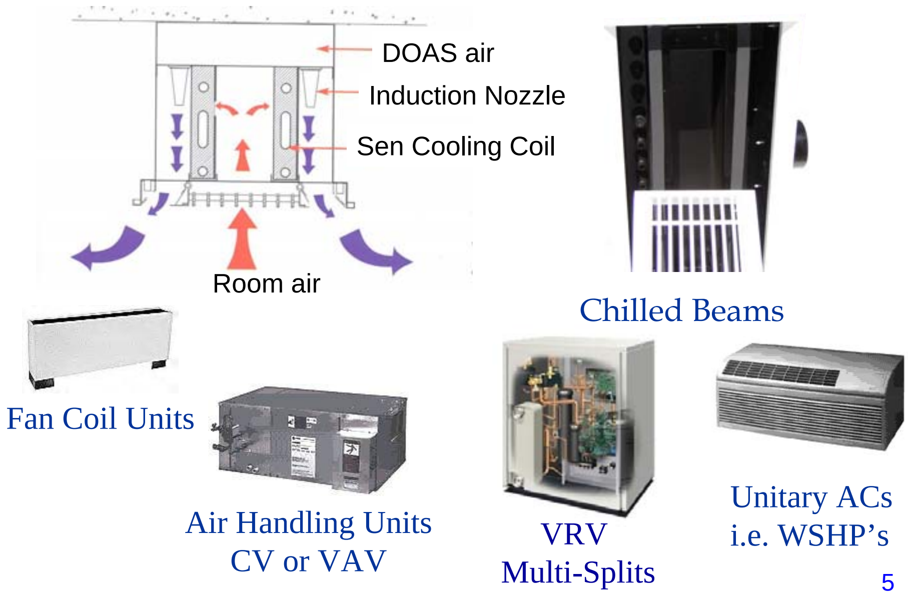
DOAS Defined for this presentation



Key DOAS points:

1. 100% OA delivered to each zone via its own ductwork.
2. Flow rate generally as spec. by Std. 62.1-2007 or greater (LEED, Lat. Ctl)
3. Employ TER, per Std. 90.1-2004.
4. Generally CV.
5. Use to decouple space S/L loads—Dry.
6. Rarely supply at a neutral temperature.
7. Use HID, particularly where parallel sys does not use air.

Parallel Terminal Systems



DPT requirements for parallel equipment: a condensation and septic issue

- For equipment with condensate pans, such as fan coil units, the SA DPT is not critical for condensation control, and can be around 55F, thus eliminating most humidity problems. However there is still the likelyhood that septic amplifier problems will occur.
- For equipment without condensate pans, such as chilled ceilings, the DPT conditions are very important to avoid condensation formation and related issues.

The Simple Latent Load Equation for selecting the required SA DPT

- Q_L=0.68*scfm*(W_{Room}-W_{supply}).
- Q_L. Btu/hr. The latent load is a function of the envelope transfer, occupant generation, and internal generation—plants, coffee pots etc.
- Scfm, the DOAS SA flow rate in stand. ft^3/min. per ASHRAE Std. 62.1.
  - Can be increased by 30% for a LEED point
  - No need to apply the 62.1 multiple spaces complications, and always less than for all-air systems—often up to 70% less.

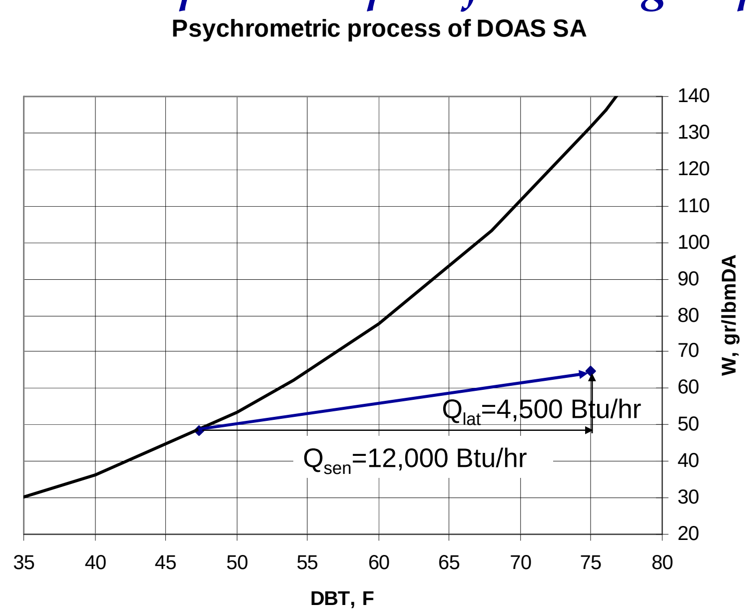
The Simple Latent Load Equation for selecting the required SA DPT

- Q_L=0.68*scfm*(W_{Room}-W_{supply}).
- W_{Room}, the room humidity ratio in gr/lbm_{DA}. If the room is at 75F and 50% RH, the room humidity ratio is 64.9 gr/lbm_{DA}.
- W_{supply}, the required supply air DPT, gr/lbm_{DA}, or the unknown in this effort to determine the required SA DPT.

A simple example: for a single space

- Assumptions:
  - Room occupancy, 20 people
  - Occupant latent generation, 205 Btu/hr
  - Additional latent transfer and generation, 400 Btu/hr. Need to keep the building pressurized to minimize the transfer component.
  - Std. 62.1 ventilation required, i.e. the DOAS SA flow rate, 400 scfm.
  - Design room humidity ratio, 64.9 gr/lbm_{DA}

A simple example: for a single space



A simple example: for a single space

- Solving for W_{Supply}

  $20*205+400=0.68*400*(64.9- W_{Supply})$.

  $W_{Supply}=48.4$ gr/lbm$_{DA}$, or a DPT of 47.3F

If over ventilated by 30% for a LEED point, i.e. SA = 520 scfm

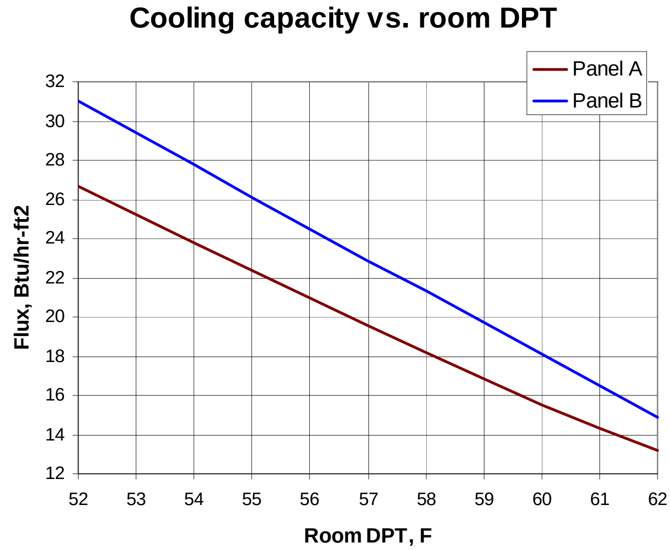
- Solving for W_{Supply}

  $20*205+400=0.68*520*(64.9- W_{Supply})$.

  $W_{Supply}=52.2$ gr/lbmDA, or a DPT of 49.3F

- In each case the SA DBT is lower than the conventional 50-55F.

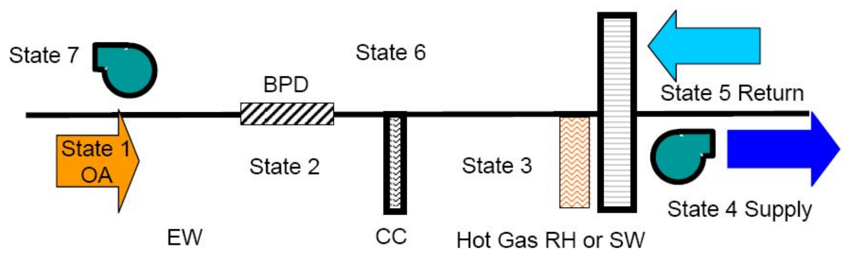
Impact of DPT selection on a chilled ceiling's capacity.



DOAS equipment on the market today

- I: Cooling equipment. that adds sensible energy recovery or hot gas for central reheat.
- II: Cooling equipment that uses total energy recovery, with or without reheat.
- III: Cooling equipment that uses total energy recovery and passive dehumidification wheels
- IV: Cooling equipment that uses active dehumidification wheels, generally without energy recovery.

DOAS equipment on the market



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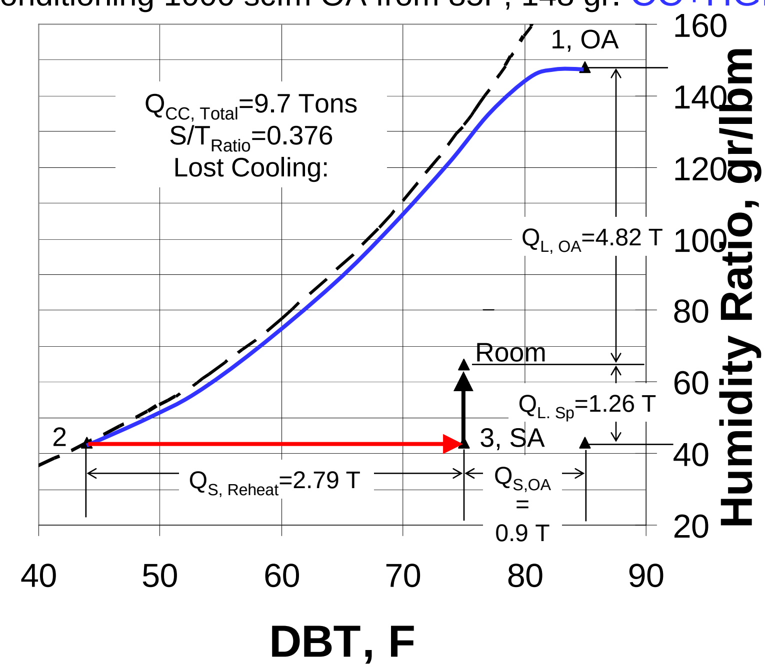
Conditioning 1000 scfm OA from 85F, 148 gr. CC+HGRH



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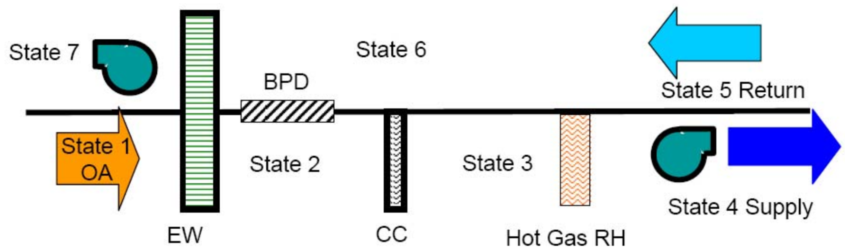
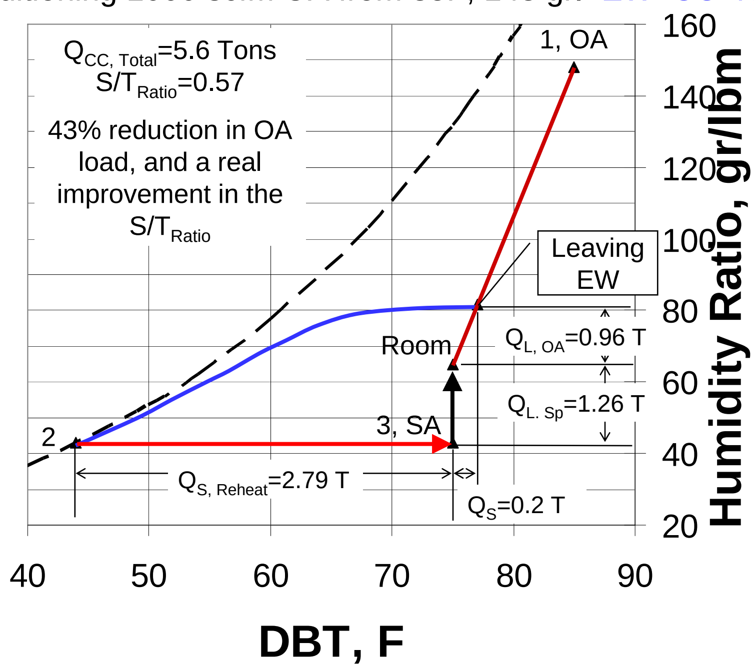
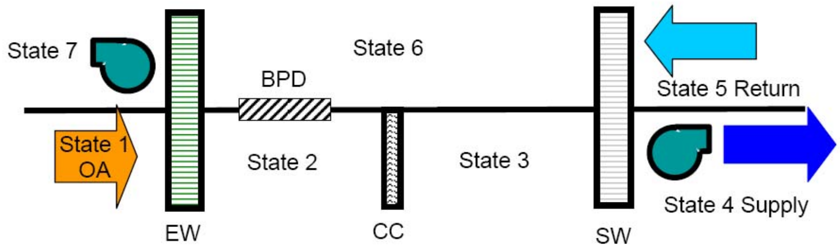
DOAS equipment on the market



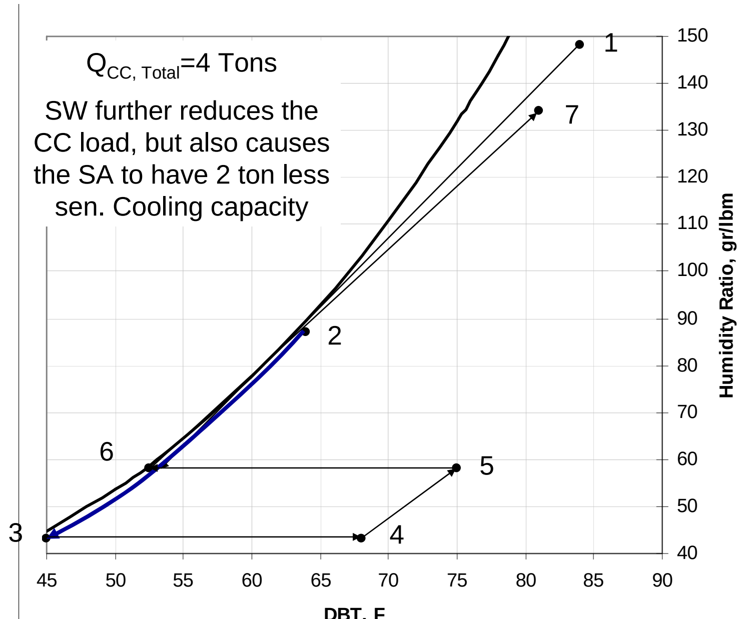
Conditioning 1000 scfm OA from 85F, 148 gr. EW+CC+HGRH



DOAS equipment on the market today



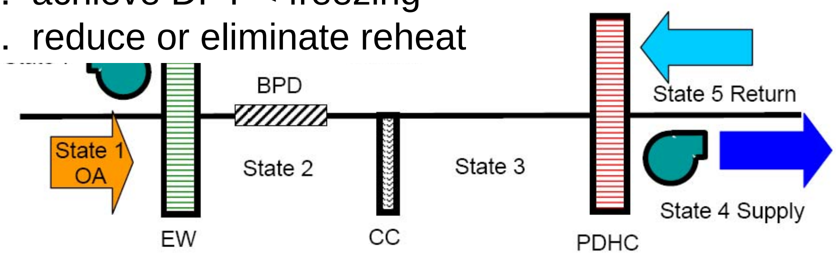
Conditioning 1000 scfm OA from 85F, 148 gr w/ EW+CC+SW



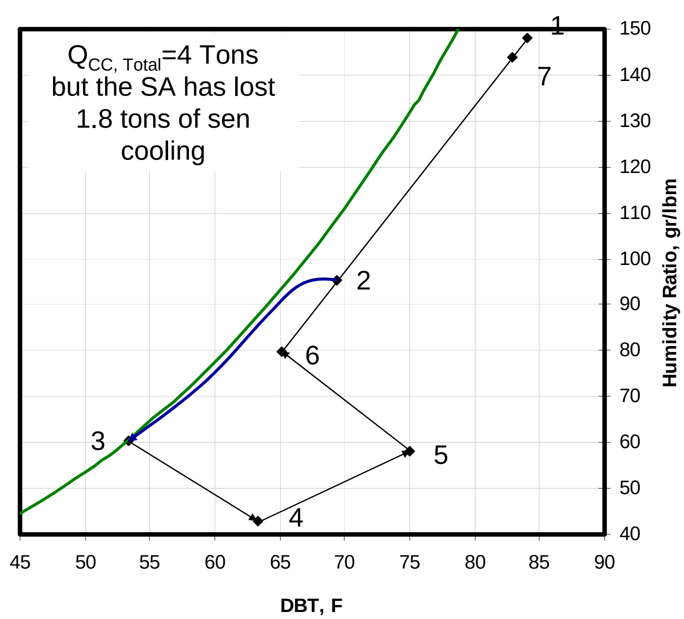
DOAS equipment on the market today

Desiccant added for 3 reasons:

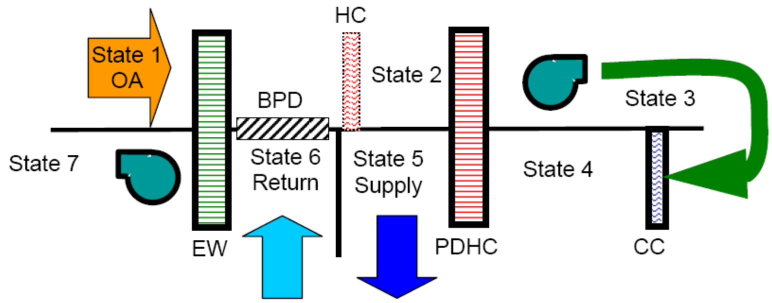
1. 45F CHWS still works
2. achieve DPT < freezing
3. reduce or eliminate reheat



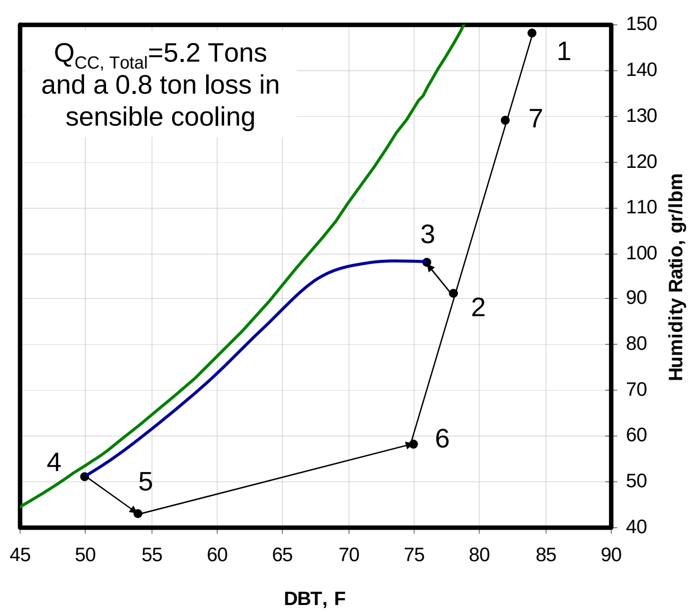
Conditioning 1000 scfm OA from 85F, 148 gr w/ EW+CC+PDHC



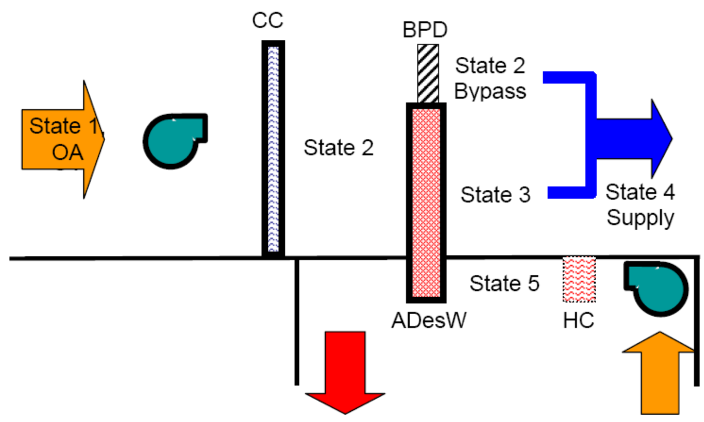
DOAS equipment on the market today



Conditioning 1000 scfm OA from 85F, 148 gr w/ EW+PDHC+CC



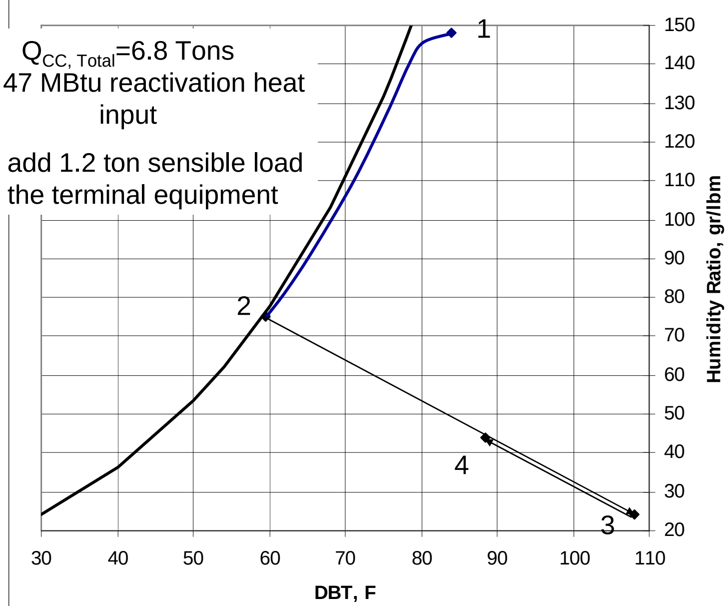
DOAS equipment on the market today



Conditioning 1000 scfm OA from 85F, 148 gr w/ CC+ADesW

$Q_{CC,\ Total}$=6.8 Tons and 47 MBtu reactivation heat input

And add 1.2 ton sensible load to the terminal equipment



Selecting the appropriate SA DBT

- Based upon the DOAS equipment available, each of which is capable of delivering the required DPT, there are many options for SAT.
- Given that the required DPTs for the simple example discussed above were below the ordinary SAT of 50-55F, it is often thought that the SA must be warmed, even to a neutral temperature.
- It was noted that as the SAT was increased, it lost some of its ability to do sensible cooling, throwing more load onto the terminal equipment.

Things to consider when selecting the SA DBT

- The **advantages** of using SA temperature equal to the required DPT, i.e. no reheat
  - It can offset a part of the terminal equipment's sensible cooling duty
  - First and operating costs associated with central reheat equipment is eliminated.
  - Simplifies controls.
  - Reduces the total load on the cooling plant

Things to consider when selecting the SA DBT

- The **disadvantages** of using SA temperature equal to the required DPT, i.e. no reheat.
  - Terminal reheat may be needed at times. It is allowed by Std 90.1 when the flow rate does not exceed that required for ventilation. Not all code jurisdictions allow terminal reheat.
    - » Terminal reheat can be minimized with either DCV or Critical zone SAT reset. Next speaker will address these two options.

Things to consider when selecting the SA DBT

- Diffuser selection is more critical: dumping and condensation formation must be avoided.
- UFAD can not be used, since the SAT can't be below about 68F
- If terminal equipment is placed in series (never recommended) the low temperatures cause the terminal equipment to be derated. Series also requires the fan in the terminal equipment to handle all the air moving in the space. The next speaker will discuss this in detail.

Conclusions

- Computing the required DOAS SA DPT has been shown to be easy.
- The industry has many fine pieces of equipment to meet the required DPT.
  - Some operating at low CC temperatures, which can derate the cooling equipment.
  - Some with passive dehumidification equipment that facilitate low DPT's with ordinary CC temperatures.
  - Some with active desiccant wheels.
  - In most cases an EW is highly advised.

Conclusions

- Selecting the SA DBT is a trade off involving first cost, operating cost, and complexity.
- Reheat avoidance is most common concern when selecting the SA DBT.
  - Reheat can be minimized in many ways as discussed.

Questions