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. 55°F, 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.
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 likelihood 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

- $Q_L = 0.68 \times \text{scfm} \times (W_{Room} - W_{supply})$.
- $Q_L$, 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. ft³/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

- $Q_L = 0.68 \times \text{scfm} \times (W_{Room} - W_{supply})$.
- $W_{Room}$, the room humidity ratio in gr/lbm$_{DA}$. If the room is at 75°F 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\(_\text{DA}\)

\[
\text{Solving for } W_{\text{Supply}} = 20 \times 205 + 400 = 0.68 \times 400 \times (64.9 - W_{\text{Supply}}).
\]

\[
W_{\text{Supply}} = 48.4 \text{ gr/lbm}_{\text{DA}}, \text{ or a DPT of 47.3°F.}
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**Psychrometric process of DOAS SA**

- \( Q_{\text{sen}} = 12,000 \text{ Btu/hr} \)
- \( Q_{\text{lat}} = 4,500 \text{ Btu/hr} \)
A simple example: for a single space

- Solving for $W_{\text{Supply}}$
  
  $20 \times 205 + 400 = 0.68 \times 400 \times (64.9 - W_{\text{Supply}})$.
  
  $W_{\text{Supply}} = 48.4 \text{ gr/lbm}_{\text{DA}},$ or a DPT of $47.3^\circ \text{F}$

If over ventilated by 30% for a LEED point, i.e. $SA = 520 \text{ scfm}$

- Solving for $W_{\text{Supply}}$
  
  $20 \times 205 + 400 = 0.68 \times 520 \times (64.9 - W_{\text{Supply}})$.
  
  $W_{\text{Supply}} = 52.2 \text{ gr/lbm}_{\text{DA}},$ or a DPT of $49.3^\circ \text{F}$

- In each case the SA DBT is lower than the conventional 50-55F.
Impact of DPT selection on a chilled ceiling’s capacity.

Cooling capacity vs. room DPT

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

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

1, OA

Q_{CC, Total} = 9.7 Tons
S/T Ratio = 0.376
Lost Cooling:

QL, OA = 4.82 T
QL, sp = 1.26 T

Q_{S, Reheat} = 2.79 T
Q_{S, OA} = 0.9 T
DOAS equipment on the market

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

- $Q_{CC,\, Total} = 5.6 \text{ Tons}$
- $S/T_{\text{Ratio}} = 0.57$
- 43% reduction in OA load, and a real improvement in the $S/T_{\text{Ratio}}$

Leaving EW:
- $Q_{L,\, OA} = 0.96 \text{ T}$
- $Q_{L,\, sp} = 1.26 \text{ T}$

Entering Room:
- $Q_{S,\, Reheat} = 2.79 \text{ T}$
- $Q_{S} = 0.2 \text{ T}$
DOAS equipment on the market today

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

Q_{CC, Total} = 4 Tons

SW further reduces the CC load, but also causes the SA to have 2 ton less sen. Cooling capacity
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

Q_{CC, \text{Total}}=4 \text{ Tons}
but the SA has lost
1.8 tons of sen cooling
DOAS equipment on the market today

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

$Q_{CC,\text{Total}}=5.2$ Tons and a 0.8 ton loss in sensible cooling
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