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Design Bulletin 5

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Considerations for Active Chilled Beam Designs

What About Heating Strategies?

This design bulletin deals with considerations of **Heating** using Active Chilled Beams

Can ACB's deliver all heating capacity in the primary air?

Yes, heating can be delivered to the space through primary air but the heating process actually occurs at the primary air handler.

Let's assume a perimeter space has a net heating requirement of 5650W, after considering internal loads of people, lighting and equipment. The same space has a primary air ventilation strategy of 335 L/s and a design heating set-point of 21ºC.

Design:

The primary air temperature is calculated as required to satisfy net heating losses with each room occupied.

Required heating primary air temperatures, based on ACB primary air quantities per zone, are calculated as:

$$\left[\frac{(W / cp)}{M}\right] \text{ +21ºC = Required Primary Air Temp}$$

Where: W = Heating Requirement (Watts)
cp = Constant for dry air (1.213)
M = Primary Air Mass Flow (L/s)
21ºC = Room design temperature

Therefore:

$$\left[\frac{(5650W / 1.213)}{335\ L/s}\right] \text{ +21ºC = 35ºC Required Primary Air Temp}$$

If the primary air temperature is too low to deliver the required heating, either the primary air quantity or the primary air temperature will have to be increased to reach the target heating capacity per unit.

As primary air is mixed with induced secondary room air at the entrainment ratio dictated by the ACB, the 35ºC primary air will not be delivered directly to the space. The mixed air delivered to the space will be reduced in temperature by the induced secondary air resulting in a slightly cooler supply air temperature and a reduced buoyancy compared to 35ºC heating air.

The reduced buoyancy of the heating supply air contributes to reducing warm air stratification thereby resulting in improved delivery of the heating capacity to the occupied space.

Similar to cooling operation, as heating losses reduce with increases in ambient temperature, primary air temperature should also be reduced to prevent over-heating of the space at part-load conditions corresponding to the reduction in building fabric losses as ambient to room temperature differential decreases.

For more design considerations, see other issues of the Design Bulletin

THIS ISSUE:

This series of design bulletins is provided by Dadanco in the interest of sharing design experience with those interested in learning more about Active Chilled Beam design fundamentals

Considerations for Active Chilled Beam Designs

Can hot water be used to deliver higher heating capacities in Active Chilled Beams?

Yes. There are two methods of employing hot water heating.

Hot water heating can deliver significant heating capacity due to the higher localised secondary air quantity passing over the heat exchanger but can prove to be more expensive to install due to the need to have a hot water circuit and duplicate control points installed on the floor.

Heating capacities must be selected using coil prediction software or test data as capacities cannot be easily calculated without knowledge of the coil efficiency, coil secondary air quantity, entering air temperature and water flow rate.

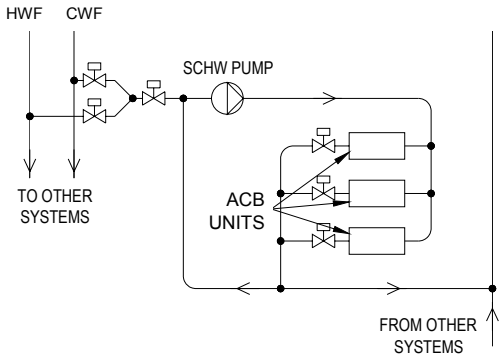
1: 2-Pipe ACB heating (Changeover System)

2-pipe heating assumes the secondary water circuit used for sensible cooling will be converted to hot water flow for heating use.

The diagram at right depicts a typical 2-pipe changeover system ACB connection where a single water circuit is connected to single ACB unit coils.

Heating or cooling water can be introduced to the water circuit with an 'either-or' valve logic never allowing both heating and cooling temperatures to operate on the floor simultaneously.

Hot water heating designs can use thermally neutral primary air to ensure the primary air stream does not influence heating capacity delivered to the space.



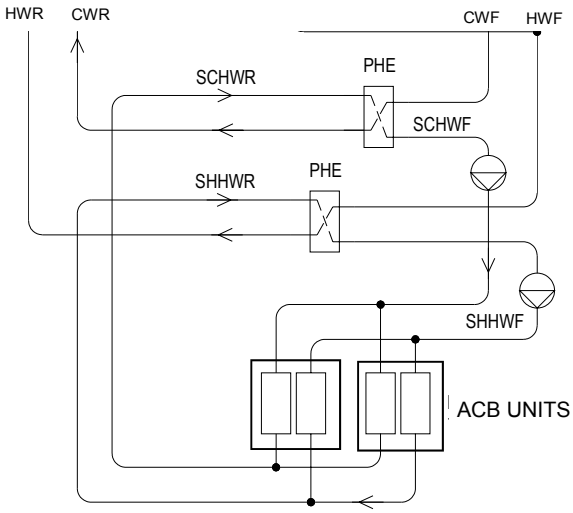
2: 4-Pipe ACB heating with 4 pipe water system

4-pipe heating assumes there is a separate heating water circuit on the floor for heating use other than the secondary chilled water circuit used for sensible cooling.

The diagram at right depicts a typical 4-pipe ACB system connection where both heating and cooling water are connected to single ACB units. The coil arrangement can be either separate coils in the ACB unit or independent water circuits in the one secondary coil.

Heating and cooling water are controlled separately with an 'either—or' valve logic never allowing both valves to open simultaneously unless the control strategy is complex enough to allow both valves to operate for a hot water 'reheat' strategy.

Since the secondary coil can deliver significant heating capacity, 4-pipe hot water heating designs can also use thermally neutral primary air to ensure the primary air stream does not influence heating capacity delivered to the space.



Alternatively, designing the primary air system to provide something in the order of 25-30% of net heating requirement would allow the primary air heating component to handle part-load heating scenarios where the heating water flow is terminated to prevent over-heating the space.

Like cooling designs, heating hot water can be modulated or ON/Off control can be used to control heating capacity and prevent-over heating of the space.

Where heating loads vary significantly during part-load conditions as fabric losses reduce, heating water temperatures can be re-scheduled for lower temperatures to reflect the changes in fabric losses (heating loads).

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ACTIVE CHILLED BEAM

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