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Design Bulletin 3

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Considerations for Active Chilled Beam Designs

What About Secondary Water?

This design bulletin deals with questions and considerations in the design of **Secondary Chilled Water** concepts

What secondary chilled water temperature should be used?

There is no hard & fast rule, but as a safe design consideration a temperature +1ºC above the room design dew point temperature is a good value to avoid unwanted condensation under normal situations.

Reason: The lower the secondary chilled water temperature, the greater the secondary cooling capacity for a given amount of air and secondary water flow per unit. However, condensation is not desirable for ACB's so a temperature high enough to avoid a dew point conflict is a wise choice. Generally, secondary water +1ºC above room dew point temperature is a good design consideration.

If a higher than necessary secondary chilled water temperature is chosen just for conservatism against dew point conflicts, the resulting secondary water flow requirement (and corresponding pump energy requirements) will be increased for a given secondary coil cooling performance.

Assume the total secondary air cooling requirement for a project is 15,000 Watts and an average secondary cooling water temperature differential of 3-4ºC is taken as a design consideration. Further assume that secondary cooling of 850W per ACB is required to meet the design loads.

The following compares two different entering secondary water temperatures and their corresponding required water flow rates for similar sensible cooling capacities in an identical cooling coil for both scenarios.

	Entering Secondary Water Temperature	
	13ºC	15ºC
Coil Cooling Delivered	851W	853W
Secondary Water Flow Rate	0.05 L/s	0.15 L/s
Leaving Water Temperature	17.1ºC	16.4ºC

It can be observed from the table above that using a higher 15ºC entering secondary water temperature for the same target sensible cooling capacity results in a 200% increase in water flow rate and results in an average leaving water temperature of 16.4ºC (1.4ºC Δt) versus a target water temperature differential of 3-4ºC and lower water flow requirement where colder 13ºC secondary water is chosen, not to mention the obvious increase in secondary coil water pressure drop associated to the higher flow for the same typical coil size.

As no heat exchanger can be 100% efficient, the secondary heat exchanger in an ACB is highly unlikely to produce condensation where the secondary water temperature is 1ºC above the room dew point temperature. Needless to say, it is important that room design loads accurately identify the latent cooling requirements to ensure adequate latent cooling is being delivered.

How is secondary chilled water flow rate best determined?

Most base building designs will assume a water delta of 3 or 4 degrees for the purpose of sizing risers and distribution networks. This is fine for initial sizing but in reality, the same secondary water delta for all units in an installation is highly unlikely where sensible loads vary for different parts of the building.

Trying to design the ACB system for identical secondary water temperature differential for all units seriously limits the selection process and can lead to too many ACB units selected for a given space and load.

It is often more advantageous to allow lower water delta's where higher sensible capacities are needed and can only be satisfied by using higher water flow rates. Limiting the ACB selection to a fixed water delta often restricts the ACB selection and forces more units than are really

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How many Active Chilled Beams can be controlled by one water flow control device?

Control logic can be designed down to each individual ACB unit controlled by a single flow valve or typical zone related ACB units controlled together by a single valve.

NOTE: See the following question regarding the importance of using water balancing valves where multiple ACB units are controlled by one flow valve.

The more ACB units controlled by one valve, the greater is the risk of having inconsistent pipework flow resistance across the group of units.

Obviously, where more than one ACB unit is controlled by a single valve, it is important to ensure each ACB unit on the flow control valve is seeing the same cooling load profile or degree of load diversity. Where any two or more units in a group will see a different load profile, diversity or zone control requirement; those units should be controlled by a separate flow valve responding only to the relevant zone conditions and water flow rates.

Are water balancing valves recommended for Active Chilled Beams?

Yes, a very good recommendation.

Reason: It is often difficult to ensure the resistance in the pipework can be equal for a number of ACB units installed and controlled together from a single flow control valve, thereby risking the possibility of inconsistent water flow through each ACB unit. An individual balancing valve or 'commissioning set' for each ACB unit will ensure water flow per unit is delivered where resistance varies.

Note: Typically an ACB unit will have 60-70% of the sensible cooling capacity delivered by the secondary water cooling coil. If the water flow rate is inaccurate by 10%, this virtually ensures the coil sensible cooling capacity is incorrect by 7% (10% of 70%).

Where different ACB units in a control zone operate from the same water flow control valve and have different secondary coil sensible capacities and water flow rates, it is even more important to use balancing valves to ensure the correct water flow is delivered to each unit as the different resistances imposed by differing water flow rates makes it impossible to balance water flow through pipework resistance alone.

Can the secondary water circuit be used to deliver heating water for Active Chilled Beams?

Yes, significant heating capacity can be delivered to the space using heating water but there are inherent control limitations.

See comments in Design Bulletin 5 - Heating, for more detail.

Where higher ACB heating capacity than can be realistically delivered by primary air is needed, the secondary water circuit can be converted to a hot water circuit through the use of changeover valves enabling hot water to flow to all units on the floor.

The down side to this strategy is limiting all units to heating operation regardless of what load diversity might dictate in terms of coincidental heating/cooling calls from the spaces served. If the secondary water circuit is converted to a hot water heating circuit, should any part of the floor enter the cooling mode, secondary cooling through chilled water is not possible until the secondary water circuit is switched back to chilled water cooling mode, in which case heating is no longer available to the rest of the floor.

Alternatively, a 4-pipe strategy can be used to enable both hot and chilled water on the floor and to the ACB units at the same time but this requires the designer to specify the system as a 4-pipe system sized accordingly.

When using hot water heating at the ACB units, the primary air strategy should be changed to a thermally neutral primary air temperature or a temperature that delivers 25-30% of the net heating requirement in order to provide part-load heating performance when heating water flow is terminated thereby avoiding over-heating the space. This strategy can provide a greater degree of control over part load heating operation.

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

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

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