

In-floor Active Chilled Beams

Perimeter Heating and Cooling for Underfloor Air Systems



Tate[®]



Chilled Beams

Energy Efficient Perimeter Heating and Cooling Solutions

Chilled Beams

The latest innovations in commercial construction are targeted to improve environmental performance of a building throughout its lifecycle. Chilled beams have become a more common design strategy for controlling the perimeter zone and sometimes the interior zones of many buildings. In a chilled beam, water pipes pass chilled and hot water through a heat exchanger or a “beam”, which is then capable of cooling or heating air delivered to a space. The energy efficiency and improved capacity of water cooling and heating coupled with the ability to condition perimeter loads before they affect the occupant have been a strong catalyst to the growth in popularity.

Tate has introduced a new take on the tradition ceiling mounted chilled beam that offers the same benefits while removing some of the negatives associated with overhead chilled beams.

In-floor Active Chilled Beams

In-floor Active Chilled Beams provide the energy savings of an overhead chilled beam while avoiding many of the concerns. By bringing chilled water to the perimeter of a space under a raised floor there is little concern of damage from leaking water lines and latent loads producing condensate. In-floor Active Chilled Beams use only preconditioned air. In the event of an air handler malfunction condensate can be easily piped to a drain.

Overhead active chilled beams require extensive ductwork to meet the ventilation requirements of the space. The In-floor Active Chilled Beam requires little to no ductwork as it utilizes the benefits of increasingly popular under floor air distribution design.

Another advantage of In-floor Active Chilled Beams is improved heating capacity. Located directly under the perimeter glass, the beam catches cold air as it falls, heats it, and supplies it back to the space, saving energy and providing maximum heating performance.



Segmented In-floor Active Chilled Beam application



Continuous In-floor Active Chilled Beam with exposed concrete ceiling

Benefits of In-floor Active Chilled Beams

- Handle perimeter heating and cooling loads
- Chilled water is delivered safely below the floor
- Gain the full energy efficiency advantage of water for cooling and heating by conditioning at the source of the load
- Preconditioned plenum air delivered to the chilled beam will not produce condensate
- Ability to use water below dew point and control condensation
- Easily manage shoulder season conditioning
- Gain advantages of stratified airflow vs. overhead chilled beams

Improve Design & Performance

Underfloor Air Distribution and In-floor Active Chilled Beams

Underfloor Air Distribution (UFAD)

Underfloor Air Distribution (UFAD) uses a raised floor to create an air distribution plenum to improve energy efficiency and modularity of design. UFAD uses stratified airflow to improve the ventilation effectiveness and indoor air quality of the interior space. Stratified airflow refers to the delivery of air at a low velocity near the floor, allowing the air to naturally rise to a ceiling return, pulling contaminants and CO₂ away from occupants.

UFAD systems also improve flexibility and control. UFAD allows for easy diffuser reconfiguration in reaction to office occupancy and layout changes. Each diffuser can be equipped with personal comfort controls so that occupants can adjust the amount and direction of airflow in their space.

Aesthetically, UFAD eliminates the need for drop ceilings and reduces the amount of service distribution space allowing for larger windows with greater daylighting and access to views.

In-floor Active Chilled Beams Improve UFAD

Overall, placing a chilled beam at the perimeter can simplify the design of a UFAD system by eliminating the concern for thermal decay. Typical UFAD designs use spider ducting to deliver air within 50 feet of the perimeter so it can be delivered to the space before it warms under the floor. The In-Floor Active Chilled Beam solves this by bringing chilled water to cool air directly at the perimeter of the building. Using chilled beams in place of perimeter fan powered boxes under the raised floor allows furniture and partitions to be placed freely in the building without the concern for maintenance access to equipment.

Aesthetically, the In-floor Active Chilled Beam reduces the quantity of visible diffusers within the perimeter zone and creates a cleaner appearance. By using segmented or continuous linear grilles along the perimeter of the building the in-floor chilled beam seamlessly integrates into the design of the space.



Great River Energy, LEED Platinum, 166,000 ft² of UFAD



Census Bureau, 1 million ft² of UFAD

Benefits of In-floor Active Chilled Beams & UFAD

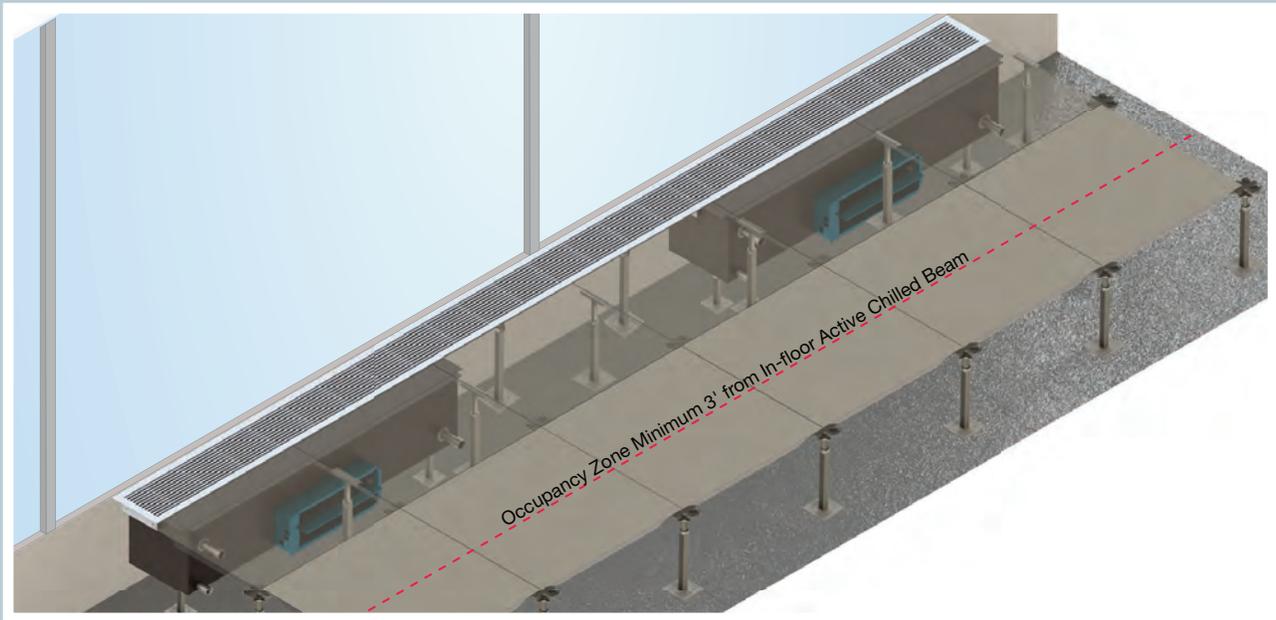
- Eliminates the need for spider ducting under the raised floor
- Eliminates the concerns associated with thermal decay
- No trapped equipment to maintain under the floor
- Linear grille improves aesthetics by reducing the number of diffusers in the perimeter zone
- Improved ventilation effectiveness
- UFAD provides personal comfort control
- Flexibility and modularity of UFAD

In-floor Active Chilled Beam Applications

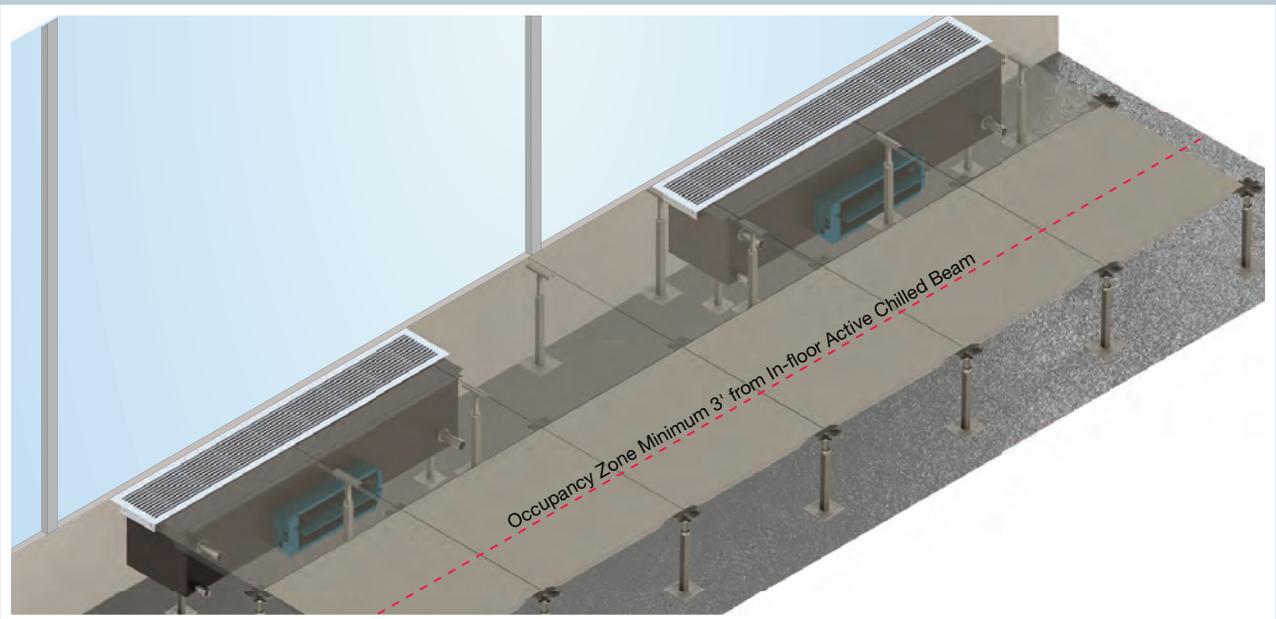
Typical In-floor Active Chilled Beam Design

In-floor Active Chilled Beams allow for complete seamless integration. The beam can be installed as a continuous linear grille along the perimeter or segmented only where needed. Using chilled beams reduces the number of diffusers in the perimeter zone and eliminates the need for equipment to be installed under floor panels. With In-floor Active Chilled Beams you gain all the aesthetic benefits of a raised floor including the elimination of the drop ceiling and the reduction in service distribution space for expanded daylighting and access to views.

Continuous Design: In-floor Active Chilled Beams installed with a blanking grille between units.

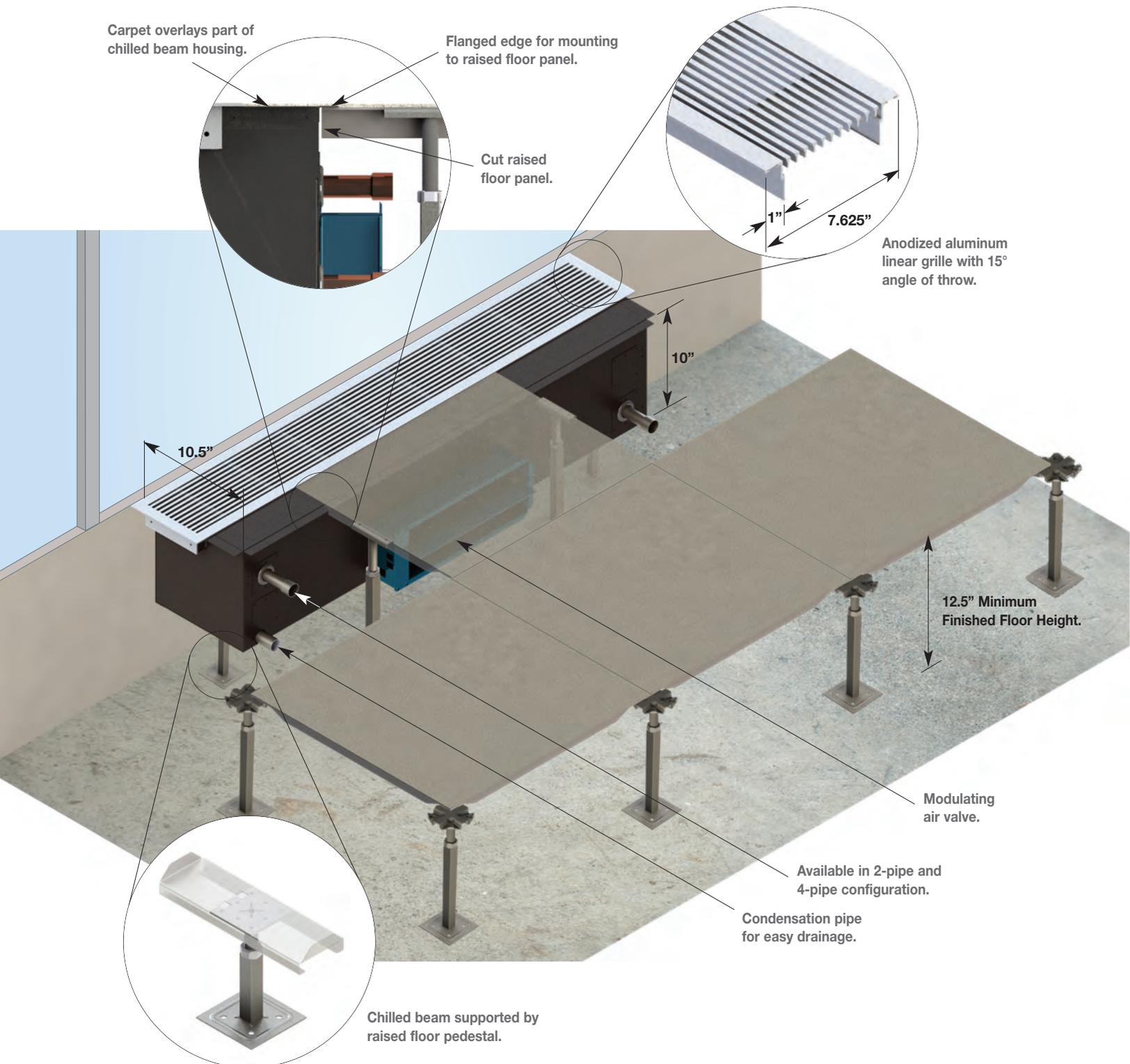


Segmented Design: In-floor Active Chilled Beams installed with raised floor panels and carpet between units.



Tate In-floor Active Chilled Beams

With a wide product range the In-floor Active Chilled Beam offers many benefits over other perimeter solutions commonly used in raised floor office environments. The image below shows the above and below floor visual of this easy to install solution that offers buildings in almost any climate a highly efficient perimeter heating and cooling solution.



Product Options



2-Pipe

The 2-Pipe model is designed to create an efficient and simple solution to meet perimeter heating and cooling needs. A supply and return water connections are located on opposite ends of the chilled beam. Hot and Chilled water can be alternately passed through these based on the building demands and the facility operators control. By time modulating the air valves and water valves controlled by a thermostat located in the space, one can meet the perimeter demands of any season.



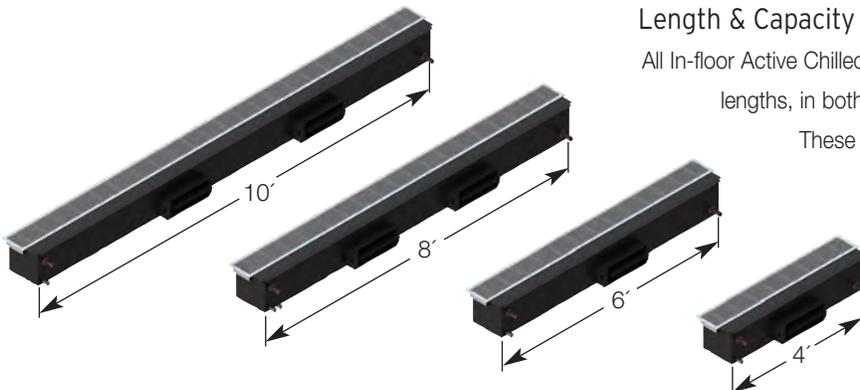
4-Pipe

The 4-Pipe model is designed to maximize control and always meet any heating and cooling needs. Two supply and two return water connections are located on opposite ends of the chilled beam. Hot and Chilled water can be simultaneously passed through these based on the building demands. Time modulated air valves and water valves allow the unit to meet demand based on a thermostat located in the space.



2-Pipe with Electric Heat

Much like the 4-Pipe model, the 2-Pipe with electric heat is designed to maximize control, by utilizing electric heat at the perimeter where hot water is unavailable or uneconomical. A supply and return water connections are located on opposite ends of the chilled beam and an electrical connection is located on the device. Chilled water can be passed through the coils for cooling, while the electric heating coil can be activated for heating. By time modulating the air valves, water valves, and electric heat, one can meet the perimeter demands of any season.

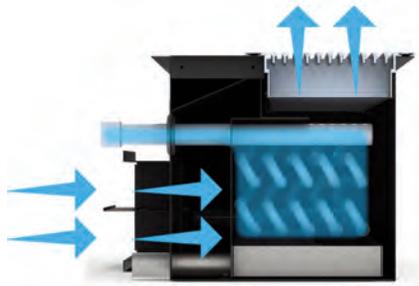


Length & Capacity Options

All In-floor Active Chilled Beams are available in 4, 6, 8 and 10 feet lengths, in both typical (TD) and high (HD) density designs.

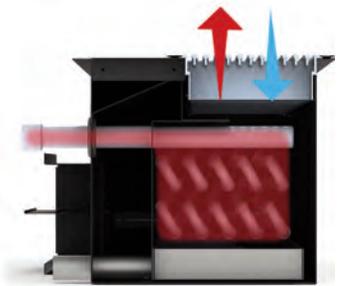
These options reflect the ability to achieve a greater capacity by adding an additional air valve to create an HD unit

2-Pipe: Modes of Operation



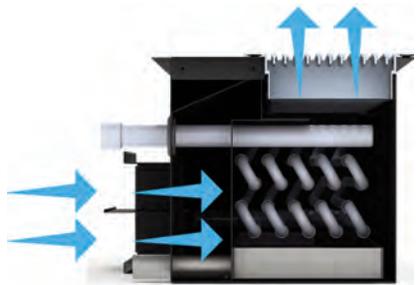
Cooling Mode

The Thermostat detects a cooling condition and the Aquastat detects chilled water: The control box will begin to time modulate the air valves and open the water valve. Chilled water flows through the coil, and air passes through the unit in a time modulation of six second full open bursts. Once the thermostat detects that the occupied space has reached set point, the system will return to suspend mode, closing the air and water valves awaiting further system demands.



Heating Mode

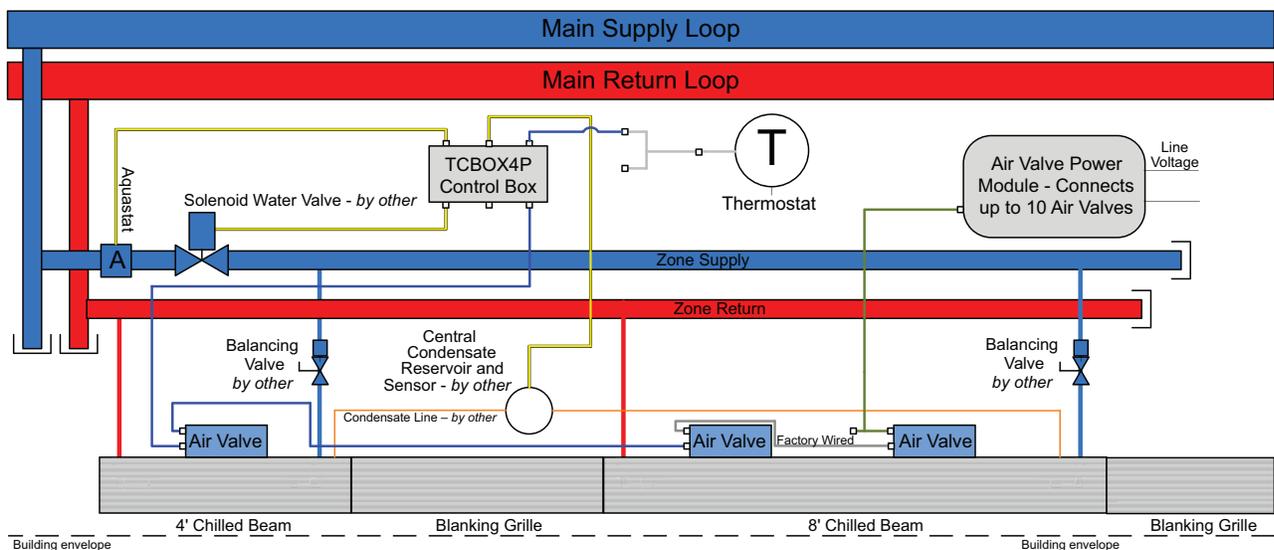
The Thermostat detects a heating condition and the Aquastat detects hot water: The control box will begin to time modulate the water valve while the air valve remains closed. As hot water flows through the coil, air falls into the chilled beam where it is heated and convects out into the space. If additional heating is required to reach setpoint, the air valve will also time modulate. Once the thermostat detects that the occupied space has reached set point, the system will return to suspend mode, closing the air and water valves, awaiting further system demands.



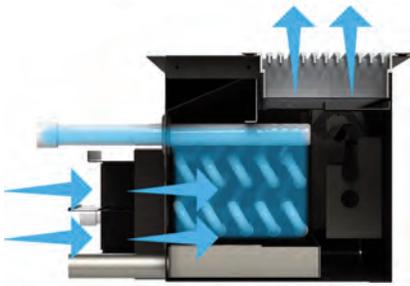
Shoulder Season

The Thermostat detects a cooling condition and the Aquastat detects hot water: The control box will time modulate the air valves while the water valve remains closed. Once the thermostat reaches set point, the air valves will close and the system will return to suspend mode.

The Thermostat detects a heating condition and the Aquastat detects chilled water: The control box will instruct the system to remain in suspend mode, awaiting further system demands.

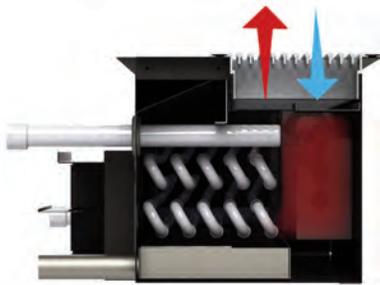


2-Pipe with Electric Heat: Modes of Operation



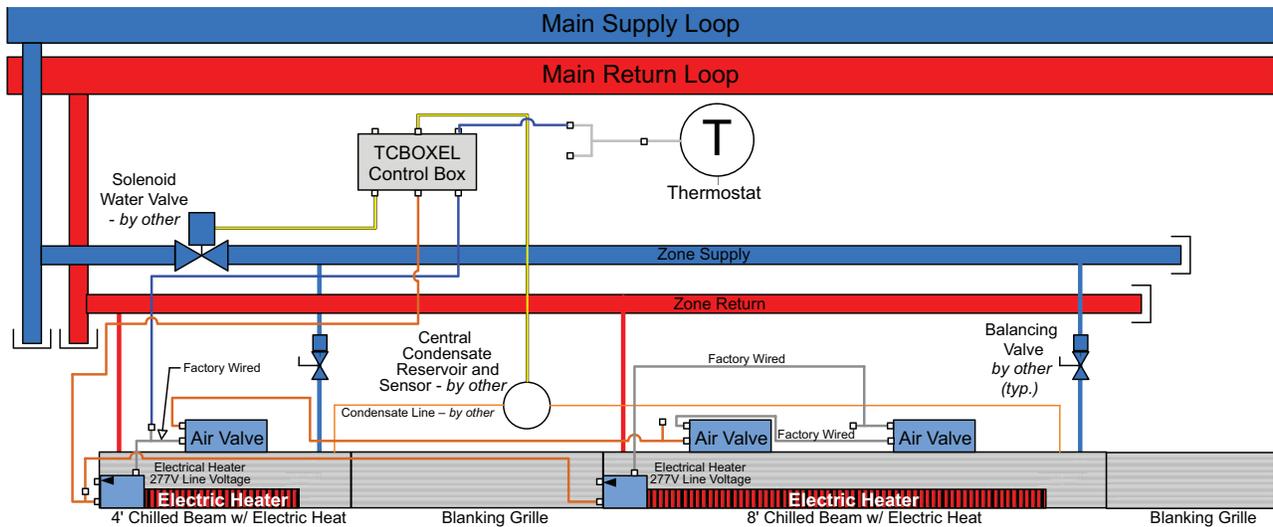
Cooling Mode

The Thermostat detects a cooling condition and the Aquastat detects chilled water: The control box will begin to time modulate the air valves and open the water valve. Chilled water flows through the coil, and air passes through the unit in a time modulation of six second full open bursts. Once the thermostat detects that the occupied space has reached set point, the system will return to suspend mode, closing the air and water valves awaiting further system demands.

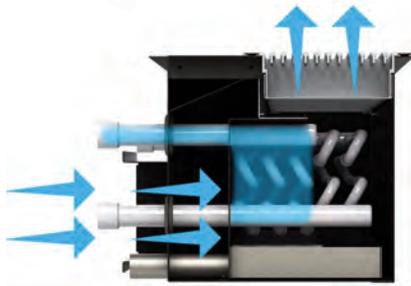


Heating Mode

The Thermostat detects a heating condition: The control box will begin to time modulate the electric heater while the air valve remains closed. As the electric coil heats up, air falls into the chilled beam where it is heated and convects out into the space. If additional heating is required to reach setpoint, the air valve will also time modulate. Once the thermostat detects that the occupied space has reached set point, the system will return to suspend mode, closing the air and de-energizing the heater, awaiting further system demands.

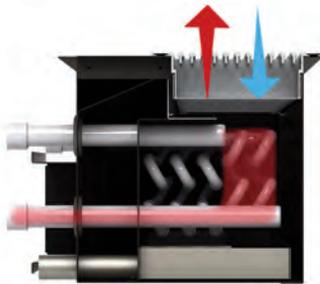


4-Pipe: Modes of Operation



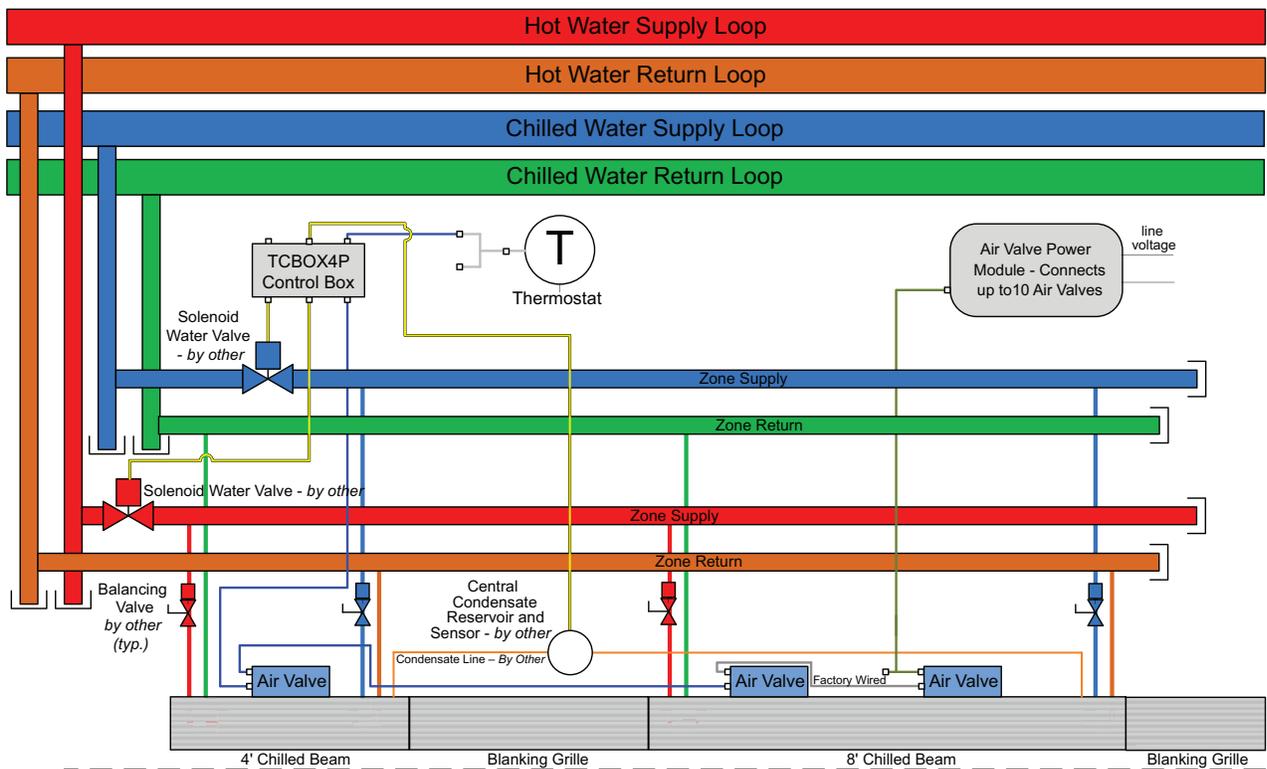
Cooling Mode

The Thermostat detects a cooling condition: The control box will begin to time modulate the air valves and open the chilled water valve. Chilled water flows through the coil, and air passes through the unit in a time modulation of six second full open bursts. Once the thermostat detects that the occupied space has reached set point, the system will return to suspend mode, closing the air and chilled water valves awaiting further system demands.



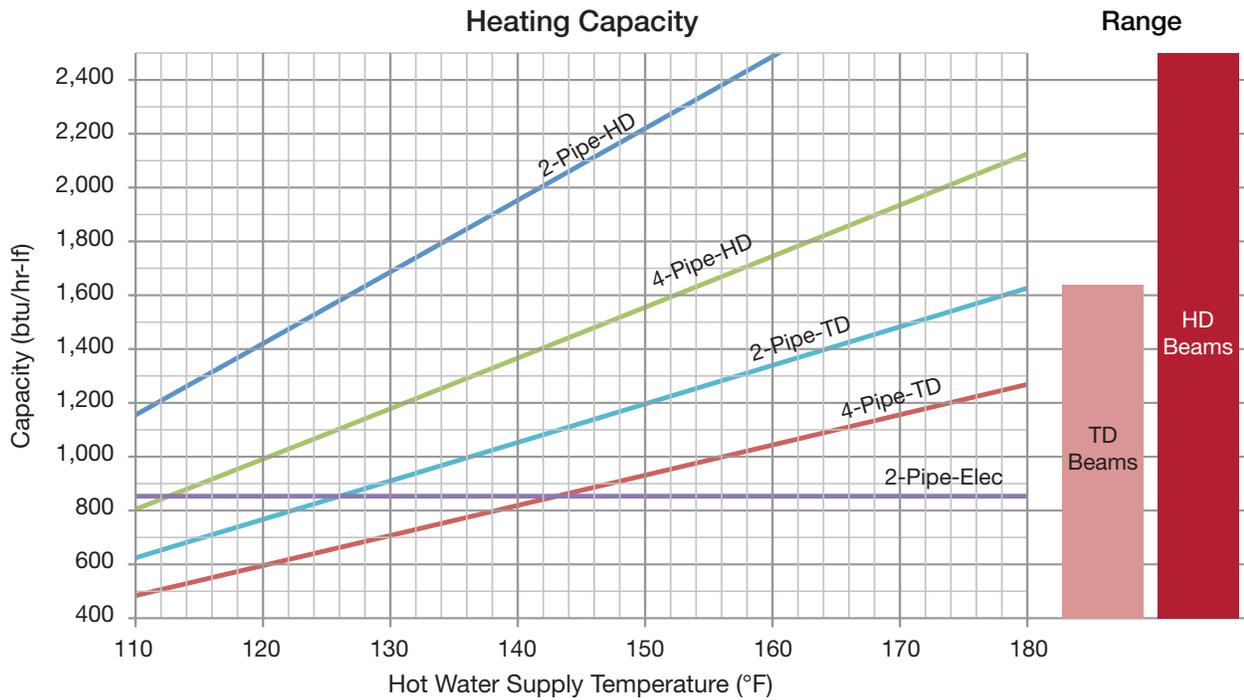
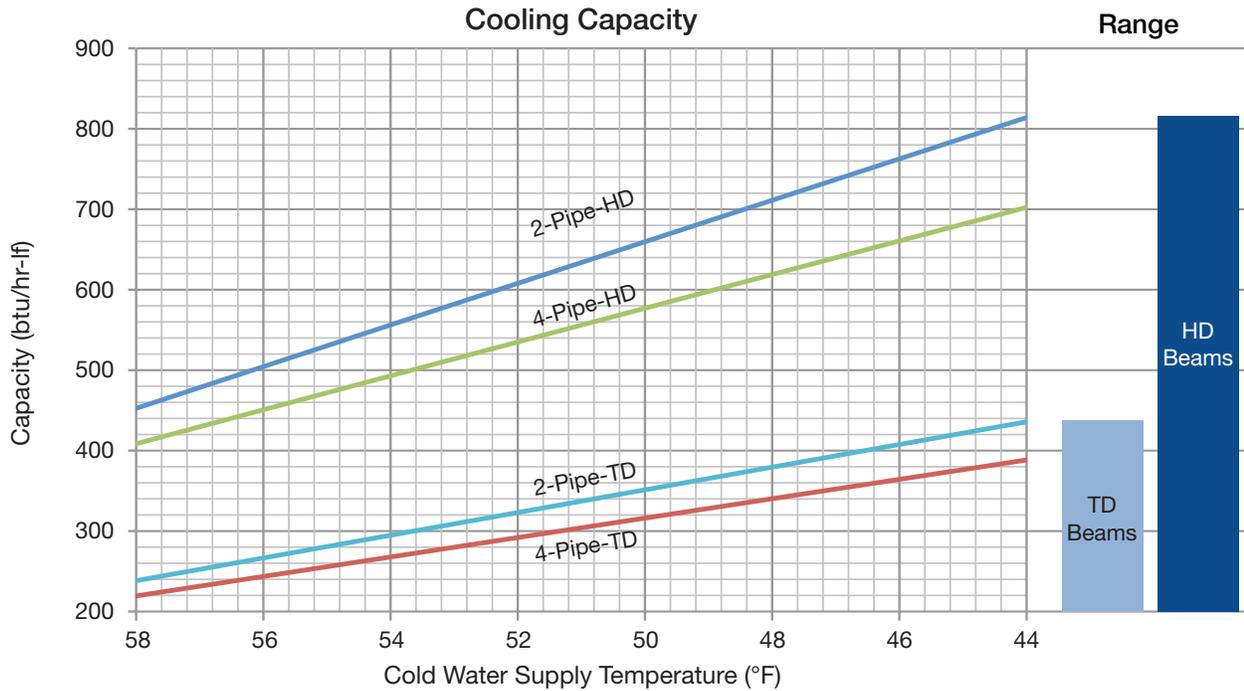
Heating Mode

The Thermostat detects a heating condition and the Aquastat detects hot water: The control box will begin to time modulate the hot water valve while the air valve remains closed. As hot water flows through the coil, air falls into the chilled beam where it is heated and convects out into the space. If additional heating is required to reach setpoint, the air valve will also time modulate. Once the thermostat detects that the occupied space has reached set point, the system will return to suspend mode, closing the air and hot water valves, awaiting further system demands.



In-floor Active Chilled Beam Performance

The chart below provides heating and cooling capacities per linear foot for Tate's In-floor Active Chilled Beams based on several fixed parameters. Every chilled beam is available in both typical density (TD) and high density (HD) designs. These options reflect the ability to achieve a greater capacity by increasing the air flow of the device. For more information about applying these products to a specific project please contact us at **800-231-7788** or email **TCBHelp@tateaccessfloors.com**.



1. TD Ratings based on 19 CFM/LF @ .05" H₂O Static Pressure, 2.0 GPM, 66°F db Inlet Air @ 50% RH, and 72°F db room
2. HD Ratings based on 38 CFM/LF @ .05" H₂O Static Pressure, 2.0 GPM, 66°F db Inlet Air @ 50% RH, and 72°F db room
3. Electric heat ratings based on 1/4kW per linear foot

Applying In-Floor Active Chilled Beams

It is important to select a Chilled Beam that meets both load and architectural needs. Chilled Beam selections have been made to fulfill maximum load within a 10 ft. perimeter zone. Capacities were determined based on the given conditions listed below: chilled water temperature, hot water temperature, inlet air temperature, flow rate, and room conditions. We have broken our space into zones for a proper load calculation: a conference space, an open office area, and a private office. Next, given space conditions (occupancy and skin load), we determined the heat load present in our space. Lastly we have decided whether it is preferred to use a segmented or continuous design.

For example, for our conference space we decided to use a segmented design. We next calculated out our total load within the space we expect to be handled by the chilled beam to be 3680 btu/hr. Next, we chose the HD/lf as the space is a high load density area, so we divide out the load by 520 btu/(hr-lf), resulting in a minimum length of 8 linear feet of chilled beam. Therefore, we have selected the 8' long, segmented High Density chilled beam for this conference space.

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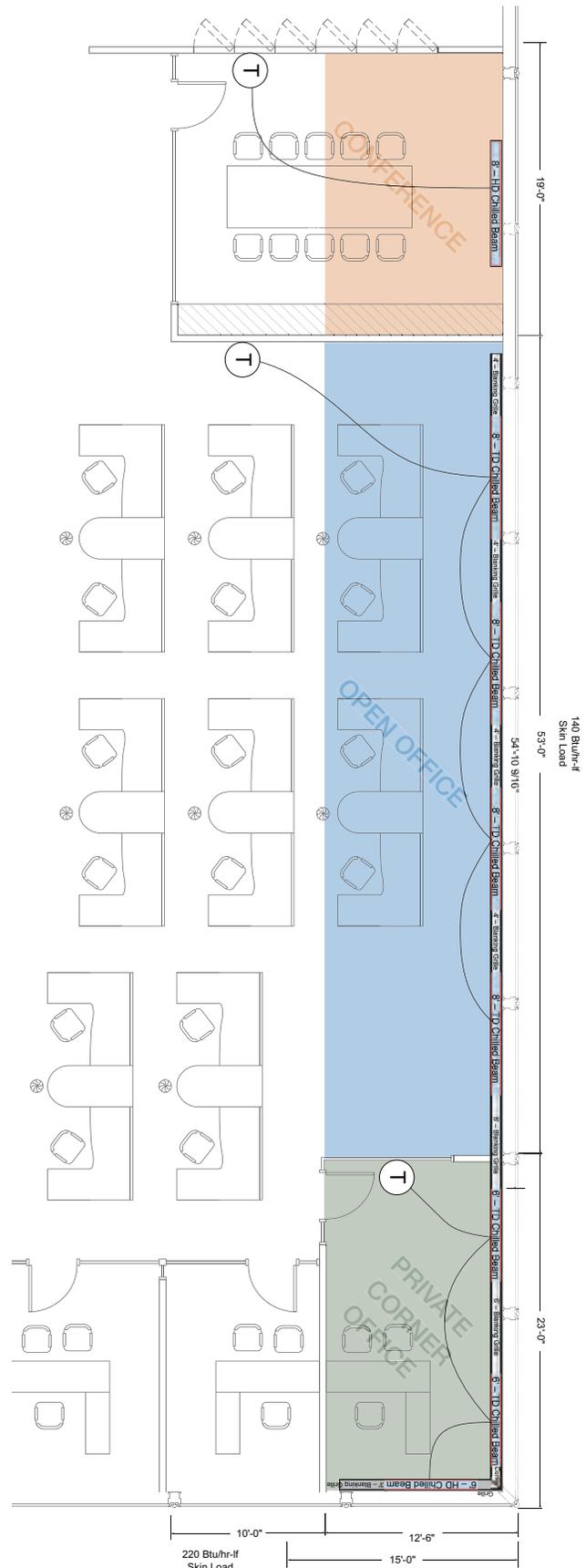
Building Conditions:

	Cooling	Heating
North Average Load ¹	140 btu/(hr-lf)	190 btu/(hr-lf)
East Average Load ¹	220 btu/(hr-lf)	180 btu/(hr-lf)
Water	55°F Chilled	130°F Hot
Supply Air	63°F Supplied Air + 3°F Rise across floor plate = 66°F Chilled Beam Entering Air	
Room Condition	72°F, 50%RH	

Chilled Beam Capacities Based on 2-Pipe model:

	Cooling	Heating
TD Capacity	280 btu/(hr-lf)	910 btu/(hr-lf)
HD Capacity	520 btu/(hr-lf)	1680 btu/(hr-lf)

¹Simplified loads provided for demonstrative purposes only.



Conference: 19'-0" North Facing with 4 Occupants in perimeter zone

Cooling

Skin Load	19'×140btu/(hr-lf)=	2660 btu/hr
Occupancy Sensible Load	4 people×255 btu/(hr-person)=	1020 btu/hr
Total Load		= 3680 btu/hr

1 x 8' HD Chilled Beam - Segmented 1 unit x8' Long x520 btu/(hr-lf)= 4160 btu/hr

Heating

Heating Load- North ²	19'×190btu/(hr-lf)=	3610 btu/hr
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1 x 8' HD Chilled Beam - Segmented 1 unit x8' Long x1680 btu/(hr-lf)= 13440 btu/hr

Open Office: 53'-0" North Facing with 4 Occupants in perimeter zone

Cooling

Skin Load	53'×140btu/(hr-lf)=	7420 btu/hr
Occupancy Sensible Load	4 People×255 btu/(hr-Person)=	1020 btu/hr
Total Load		= 8440 btu/hr

4 x 8' TD Chilled Beam - Continuous 4 units x8' Long x280 btu/(hr-lf)= 8960 btu/hr

Heating

Heating Load- North ²	53'×190btu/(hr-lf)=	10070 btu/hr
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4 x 8' TD Chilled Beam - Continuous 4 unit x8' Long x910 btu/(hr-lf)= 29120 btu/hr

Private Corner Office: 23'-0" North Facing, 12'-6" East Facing with 1 Occupant in perimeter zone

Cooling

Skin Load- North	23'×140btu/(hr-lf)=	3220 btu/hr
Skin Load- East	12.5'×220btu/(hr-lf)=	2750 btu/hr
Occupancy Sensible Load	1 Person×255 btu/(hr-Person)=	255 btu/hr
Total Load		= 6225 btu/hr

2 x 6' TD Chilled Beam - Continuous 2 units x6' Long x280 btu/(hr-lf)= 3360 btu/hr

1 x 6' HD Chilled Beam - Continuous 1 unit x6' Long x520 btu/(hr-lf)= 3120 btu/hr

Heating

Heating Load- North ²	23'×190btu/(hr-lf)=	4370 btu/hr
Heating Load- East ²	12.5'×180btu/(hr-lf)=	2250 btu/hr
Total Load		= 6220 btu/hr

2 x 6' TD Chilled Beam - Continuous 2 units x6' Long x910 btu/(hr-lf)= 10920 btu/hr

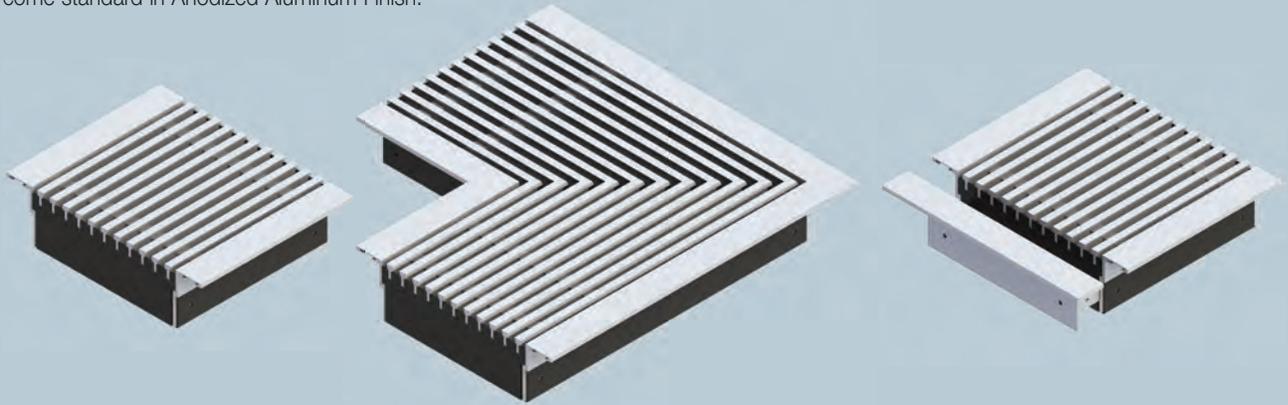
1 x 6' HD Chilled Beam - Continuous 1 unit x6' Long x1680 btu/(hr-lf)= 10080 btu/hr

²Heating Capacity provided is maximum capacity in additional heating mode, device operation will throttle down this capacity to meet demand.

In-floor Active Chilled Beam Accessories

Linear Grille Accessories

Tate also offers a line of Grille Accessories to architecturally design aesthetic solutions utilizing In-Floor Active Chilled Beams. All Grilles come standard in Anodized Aluminum Finish.



Continuous Blanking Grilles:

Faux grilles which can be installed between chilled beams to provide a single run of continuous linear grille where multiple chilled beams are installed with separation. Blanking grilles are sealed to prevent air leakage.

Continuous Corner Grille Kits:

Continuous Corner Grille Kits are to be installed along with chilled beams and blanking grilles to produce the appearance of a continuous grille around a corner of a space. Corner grilles are sealed to prevent any air leakage and are aesthetic in design.

Continuous End Cap Kits:

Continuous End Cap Kits are a solution intended to allow the termination of a run of continuous blanking grilles with a flanged side. The final installation is identical to the edge seen on the segmented chilled beam.

Power and Control Accessories



Thermostats:

Thermostats are designed to serve a single zone of chilled beams and provide a signal to the control box indicating the cooling or heating demands within that zone.



Quick Cables:

Quick Cables are used to connect all of the controls packages together as well as daisy chain chilled beams together for operation. Most connections require little or no manual wiring and simply click into place. Quick Cables are color coded and labeled for each use.



Air Valve Power Modules:

Air Valve Power Modules are designed to power up to 10 Air Valves. It is important to keep in mind that one chilled beam may have more than a single air valve.



Control Boxes:

Control Boxes are designed to serve a single zone. The control box has three inputs, thermostat, condensate alarm and aquastat (2-Pipe) and three outputs, Cooling Valve, Heating, and Air Valves. Based on the signals provided, the control box will output the appropriate controls to the chilled beam system to meet demand.

Improves UFAD Energy Performance

Perimeter Water Cooling with In-floor Active Chilled Beams vs. Fan Power Terminal Device

In-Floor Active Chilled Beams bring many benefits, one of which is energy savings. In this comparison, we evaluate the operational energy savings associated with the use of a under floor fan powered terminal device perimeter solution vs. a chilled beam solution. We have included a list of loads and equations used for this comparison. As you can see, we would expect somewhere in the range of 20%-30% reduction in floor plate HVAC energy use. Also, the air handler could now be sized smaller for additional tenable floor space.

We would be glad to help you analyze your space and determine what energy savings might be associated with the use of an In-Floor Active Chilled Beam. Contact us at **800-231-7788** or email

TCBHelp@tateaccessfloors.com for details.

Typical Open Office Building Parameters		
-	Building length (ft)	240
-	Building width (ft)	120
-	Total Floorplate Area (ft ²)	28,800
A_p	12' Perimeter Area (ft ²)	8,064
L_p	Total Perimeter Length (ft)	720
T_{rm}	Room Condition	72°F
C_e	Chilled Water kWhr/Ton	0.55
F_e	Fan kWhr/cfm	0.0003
h_s	Skin Load (btu/hr-lf)	150

Perimeter Air		Typical FPTD	Chilled Beam
T_{air}	Room Supply Air Temp (°F)	66°	55°
	Skin Load (btu/hr) ($h_s \times L_p$)	108,000	
	People Sensible Load (btu/hr) ($1.275 \text{ btu/hr-ft}^2 \times A$)	10,282	
	Equipment Load (btu/hr) ($3 \text{ btu/hr-ft}^2 \times A$)	24,192	
H_p	Total Load (Btu/hr)	142,474	
Q_p	Primary Air (CFM) ($H_p / [1.08 \times (T_{rm} - T_{air})]$)	21,987	7,760
Perimeter Energy			
	Chilled Water kWhr ($(H_p \times C_e) / 12,000 \text{ Btu/hr}$)	6.5	
	FPTD Fan Energy kWhr ($F_e \times Q_p$)	6.6	
E_p	Total Perimeter kWhr	6.6	6.5
Interior Air			
Q_i	Total Interior Primary Air (CFM) (Given)	11,305	
Air Handler			
Q_t	AHU Volume (CFM) ($Q_p + Q_i$)	33,292	19,065
E_{ahu}	AHU Fan kWhr ($F_e \times Q_t$)	10.0	5.7
Energy Analysis			
	Total kWhr ($E_p + E_{ahu}$)	16.6	12.2
	Primary AHU CFM Reduction	43%	
	Floor Plate HVAC Energy Reduction	26%	

Note: Although perimeter supply air volume has been reduced by the lower supply air temperature, this does not adversely affect the total quantity of ventilation air provided to the perimeter zone. The In-floor Active Chilled Beam's supply air volume exceeds the ventilation requirements to the zone prescribed by IMC 2009.

Tate®



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