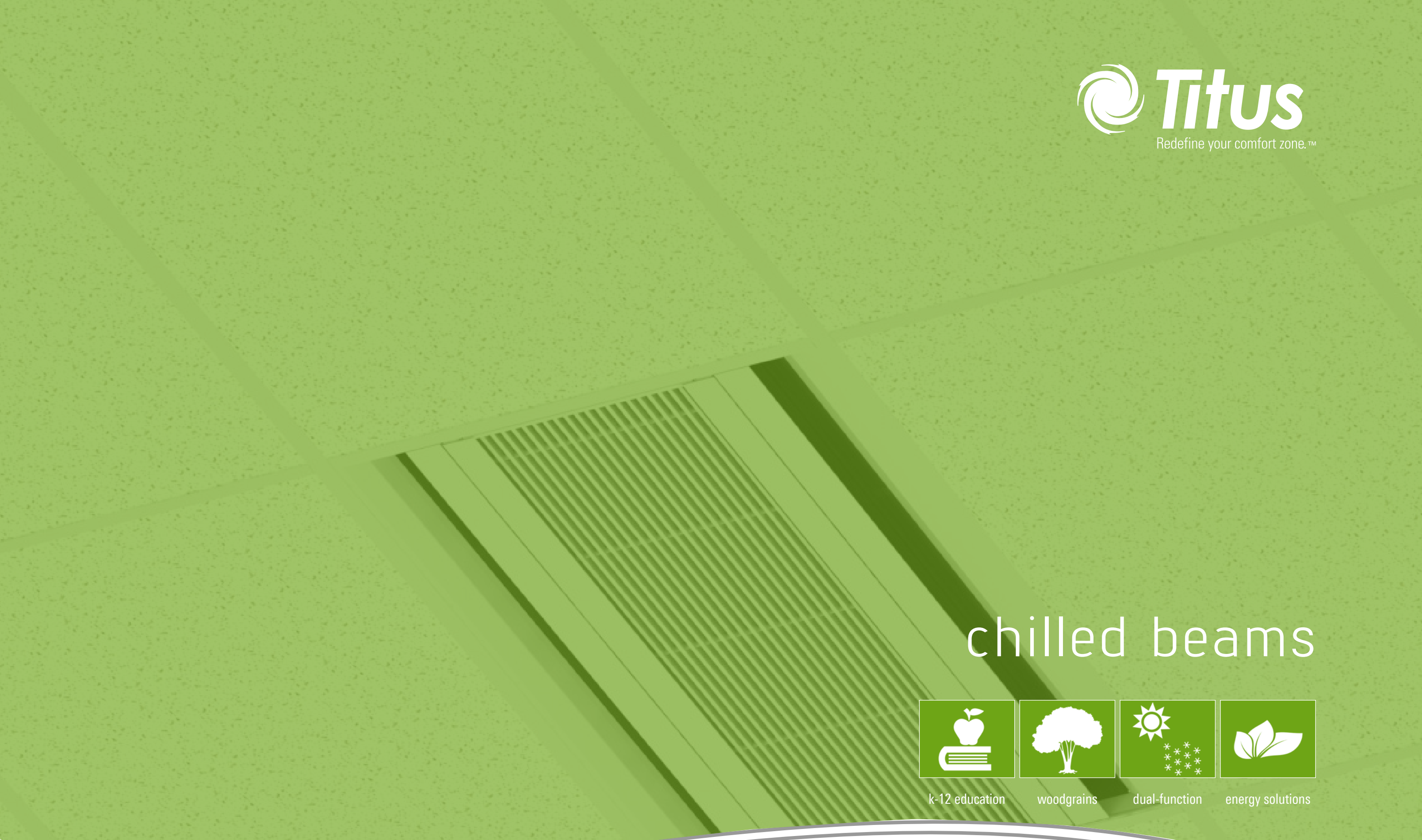
Titus

Redefine your comfort zone.™



chilled beams

k-12 education

woodgrains

dual-function

energy solutions

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Chilled Beam Products

linear active chilled beams

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LINEAR ACTIVE CHILLED BEAM

- 1 or 2 way throw pattern
- Variable lengths ranging from 2 to 10 feet
- For heating and/or cooling applications and perfect for open office environments
- Ceiling mounted
- Hinged access face

CBAL-12

LINEAR ACTIVE CHILLED BEAM

- 1 or 2 way throw pattern
- Variable lengths ranging from 2 to 10 feet
- For heating and/or cooling applications and perfect for open office environments
- Available with safety condensation pan

DISA-V

SIDEWALL CHILLED BEAM

- Horizontal throw pattern
- Available in variable lengths
- For heating and/or cooling applications
- 2-pipe or 4-pipe system

floor mounted – under the sill

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TAO

FLOOR MOUNTED UNDER THE SILL ACTIVE CHILLED BEAM

- Heavy gauge casing construction
- Separate heating and cooling
- Removable condensate pan
- Low sound levels
- Perfect for school applications

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linear passive chilled beams

SPB

PASSIVE CHILLED BEAM

- Available in a variety of lengths
- Produces low noise levels
- Product can be mounted flush with the ceiling or suspended below the ceiling for exposed applications

Overview

The Titus chilled ceiling product line is comprised of chilled beams, both active and passive, radiant ceiling panels, and radiant sails. These products offer optimized performance and provide high levels of thermal comfort for the occupant. In addition to increased occupancy comfort, use of the chilled ceiling products reduce the amount of energy required to heat and cool a building.

The chilled ceiling products provide sensible cooling and heating to the space by utilizing the more efficient heat transfer capacity of water, as opposed to air. This decouples the latent and sensible loads, reducing the energy cost of sensible cooling. With passive beams and radiant products, an additional system is necessary to meet the ventilation and latent cooling needs of the space. The Titus active chilled beams integrate the supply of ventilation air creating an active diffuser. Using the ventilation air to pressurize a plenum with aerodynamically designed nozzles, high velocity jets of air are created forcing induction of room air over the water coils integral to the units. Forced induction dramatically improves the heating and cooling capacity over passive beams and radiant products. Titus active chilled beams harness the energy of the supply air to further reduce total energy consumption.

Titus offers a chilled ceiling product to meet the requirements of any design or installation. Just a single model of passive beam accommodates both exposed and recessed mounting applications. Active chilled beams are available in 1, 2, and 4-way throw patterns. There is even a model for high sidewall applications. In addition to the variety of product solutions available, the appearance of the units can be customized through standard options, which enables seamless integration into any architectural style, traditional or contemporary.

APPLICATION ICONS KEY

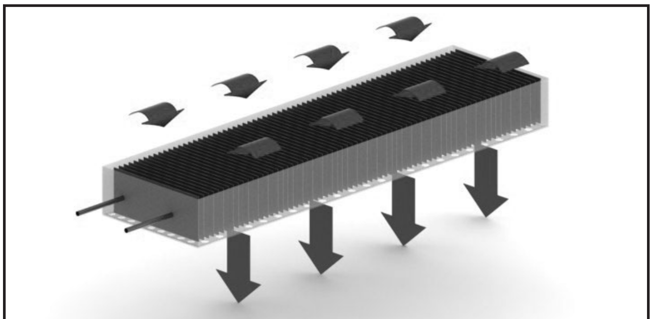
k-12 education	excellent air distribution device for schools and other educational facilities
energy solutions	contributes toward energy savings by reducing operating costs of air distribution devices
woodgrains	additional finish options available for HVAC products that resemble realistic woodgrains, and adds high-end detail quality to any application
dual-function	supplies both heating & cooling from one HVAC device

Introduction

Chilled ceiling systems consist of three main product types: active chilled beams, passive chilled beams, and radiant ceiling panels/sails. Even though these units are commonly referred to as "chilled" products they are also effectively used for both cooling and heating.

Both active and passive beams utilize water coils to provide sensible cooling, reducing the total load that must be addressed through the building's air handlers. Since chilled beams provide sensible only cooling they are best suited for spaces with low to moderate latent loads. This offers considerable potential for energy savings due to the volumetric heat transfer capacity of water and trade-off between fan energy and pumping power.

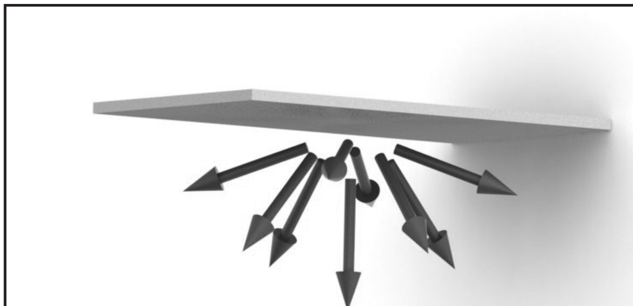
Passive beams consist of a water coil and an enclosure. The enclosure is primarily cosmetic, but helps to maintain even heat transfer across the coil. Passive beams provide cooling primarily through convective heat transfer. A convection current is created where higher density cool air sinks into the space, inducing warm low density air at the ceiling level through the coil. When using passive beams ventilation air must be introduced to the space either through natural or mechanical means.



Convective heat transfer with a passive beam

Incorporating supply air into a beam creates an active diffuser. Ventilation air pressurizes a plenum and the aerodynamically designed jets induce room air over water coils. Forced induction dramatically increases the heating and cooling capacity per square foot, compared to passive beams and radiant products. Active chilled beams harness the energy of the supply air to further reduce total energy consumption.

Radiant ceilings systems emit heating and cooling by both convection and radiation. During cooling, ambient air near the ceiling cools and falls to the occupied area, due to its higher density. The ceiling panels emit cooling and heating to the surrounding surfaces in the area by radiation. Radiant heat transfer typically results in high thermal comfort since the ambient temperature will feel 2.5°F to 5°F cooler/warmer than actual room temperature. This effect has the advantage that the room requires less conditioning than a traditional system, introducing an additional opportunity for energy savings.

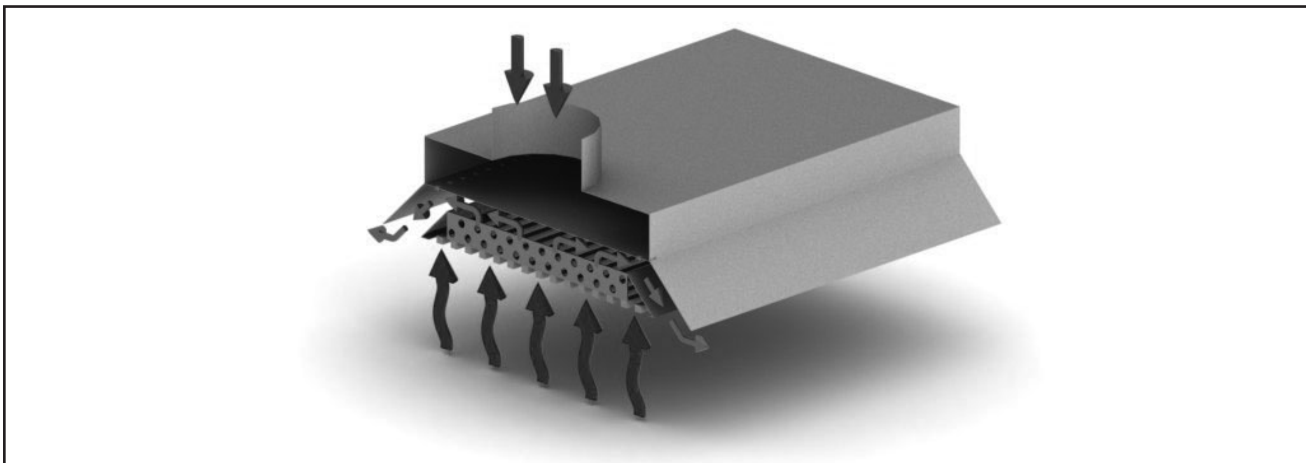


Radiant heat transfer from chilled ceiling panel

History

Modern chilled ceiling systems, more specifically active chilled beams, got their start in the 1920s when Willis Carrier began to develop the concepts for under-sill induction units. Patents were applied for and first installations of these units were completed in 1940. The use of an air-water terminal located in the space was an important advance in and of itself; however, these systems solidified the advantages of an air-water system over an all-air system.

- Water is much more efficient heat transfer medium than air.
- Reduced duct size required to only supply ventilation air increased usable space, and reduced the material cost and installation time.



Active Chilled Beam Operation

Scandinavian engineers, during the mid-1970's, adapted this technology along with radiant heating/cooling panels for overhead applications to work with new buildings designed to utilize natural ventilation. The result of their efforts was the passive chilled beam.

In regions where using natural ventilation was not effective, engineers integrated the mechanical ventilation into chilled beam. Utilizing the same principles used in the under-sill induction boxes, the active chilled beam was developed.

Theoretical Background

HEAT TRANSFER

ASHRAE defines heat transfer as "the flow of heat energy induced by a temperature difference."
Thermal energy can be transferred or be affected by:

- Conduction
- Convection
- Radiation
- Humidity

Thermal conduction is the mechanism of heat transfer by the transfer of kinetic energy between particles or groups of particles at the atomic level.

With solid bodies, such as with an air jet near a window, thermal conduction dominates only very close to the solid surface.

Thermal convection is the transfer by eddy mixing and diffusion in addition to conduction.

The transfer of fluid currents produced by external sources, such as by a blower, is called forced convection.

When the fluid air movement is caused by the difference in density and the action of gravity, it is called natural convection. Natural convection is very active near windows and near heat sources in the occupied spaces. The colder air falls and the warmer air rises.

Radiant heat transfer takes place through matter. It is a change in energy form, from internal energy at the source to electromagnetic energy for transmission, then back to internal energy at the receiver. Examples of radiation are sunshine through the air and window to the inside floor or ceiling light to occupants and to the floor.

All of these methods of heat transfer effect a person's comfort reaction. In addition, humidity has some effect caused by a change in evaporation rate from the body.

Heat transfer is also affected by the following factors:

- A greater temperature difference will result in a greater amount of heat transfer.
- The amount of surface area is directly proportional to the amount of heat transfer.
- The amount of time is also directly proportional to the amount of heat transfer.
- The thermal resistance of the material use affects the rate of heat transfer.

Heat loss is measured in "BTU" which is the amount of heat required to raise 1 lb. of water 1°F. Coefficients used to estimate the value of the heat loss include:

- 'K' Factor: amount of heat transferred in 1 hour through 1 sq. ft. of material, 1" thick at 1°F of temperature difference.
- 'C' Factor: amount of heat transferred in 1 hour through 1 sq. ft. of material through the specified thickness of the material used.
- 'R' Value: resistance to heat transfer, measured as the reciprocal of conductance (1/K or 1/C).
- 'U' Value: designates the overall transmission of heat in 1 hour per sq. ft. of area for the difference of 1°F across specified material.
- Conductance of individual materials is not directly applicable to the heat loss calculation. First, it must be converted to the 'R' value, which is (1/K or 1/C).

Equation 1: For a structure with multiple skin materials, the total heat transmission can be calculated as:

$$U = 1/(R1 + R2 + \ldots .Rn)$$

For hydronic heating and cooling systems heat is removed from the occupied space (cooling) or added to the occupied space (heating) via a closed loop water system. Return air from the space passes across a fin tube coil.

PSYCHROMETRICS

One of the four major elements of thermal energy and comfort is humidity. Psychrometrics uses thermodynamics properties to analyze conditions and processes involving moist air. A detailed study of psychrometrics can be found in Chapter 1 of ASHRAE 2009 Fundamentals Handbook. This section is a summary of how knowledge of psychrometrics can be used to maximize space comfort and system performance.

Atmospheric Air (the air that you breathe), contains many gaseous components including water vapor and containments. Dry Air is atmospheric air with all moisture removed and is used only as a point of reference. Moist Air is a combination of dry air and water vapor and can be considered equal to atmospheric air for this discussion.

A psychrometric chart (FIGURE 4) is a graphical representation of the thermodynamic properties of moist air. There are several charts available to cover all common conditions. The one shown here is taken from ASHRAE Fundamentals Handbook, Chapter 1 and illustrates conditions of 32 to 100°F at sea level.

The Dry-bulb Temperature (DBT), is the temperature measured using a standard thermometer. Dry-bulb is also known as the sensible temperature.

The Wet-bulb Temperature (WBT), is the temperature measured using a 'wetted' thermometer. Wet-bulb is used to determine the moisture content of air.

The Absolute Humidity (AH), is the vapor content of air. It is described in terms of moisture per lb of dry air or grains of moisture per lb. of dry air. AH is also referred to as 'moisture content' or 'humidity ratio.' There are 7000 grains in a lb. of water.

The Relative Humidity (RH), is the vapor content of air. It is described as the percentage of saturation humidity at the same temperature (%). The goal for optimum space comfort is 30-35% for heating conditions, and 45-60% for cooling conditions. Saturation humidity is the maximum vapor content (lb./lb.) per lb. dry air that air can hold at a fixed temperature.

The Dew Point Temperature (DPT), is the temperature at which vapor begins to fall out of air to form condensation. DPT is the temperature at which a state of saturation humidity occurs, or 100% RH. It is also known as the saturation temperature.

The Specific Volume (Spv), is the reciprocal of air density which is described in terms of cubic feet per lb of dry air (cu ft/lb.). An increase in air temperature will result in a decrease in density and an increase in volume. A decrease in atmospheric pressure also decreased air density while increasing volume. At 5000 feet above sea level, density is decreased by 17%. Higher altitudes require larger motors and blowers to move the same effective mass, due to the increase in specific volume.

The Enthalpy (H) is the heat content of air. Enthalpy is also known as the total heat of air. Enthalpy is defendant on the wet-bulb temperature of air. It is described in terms of Btu's per lb. dry air (Btu/lb.).

A Status Point is a location on the psychrometric chart defined by any two psychrometric properties. A hydrometer or psychrometer is commonly used to define a status point.

At 100% RH the wet-bulb will equal the dry-bulb temperature. As the temperature difference between temperatures increases, the RH will decrease.

To locate a status-point, find the dry-bulb temperature on the bottom of the psychrometric chart. Follow this line upward until it intersects with the wet-bulb temperature from the left side of the chart.

From the 'status point' you can locate:

- Absolute Humidity (AH)
- Relative Humidity (RH)
- Dew Point Temperature (DPT)
- Specific Volume (Spv)

When will condensation occur? To determine if a supply air duct or air outlet device will form condensation on the surface:

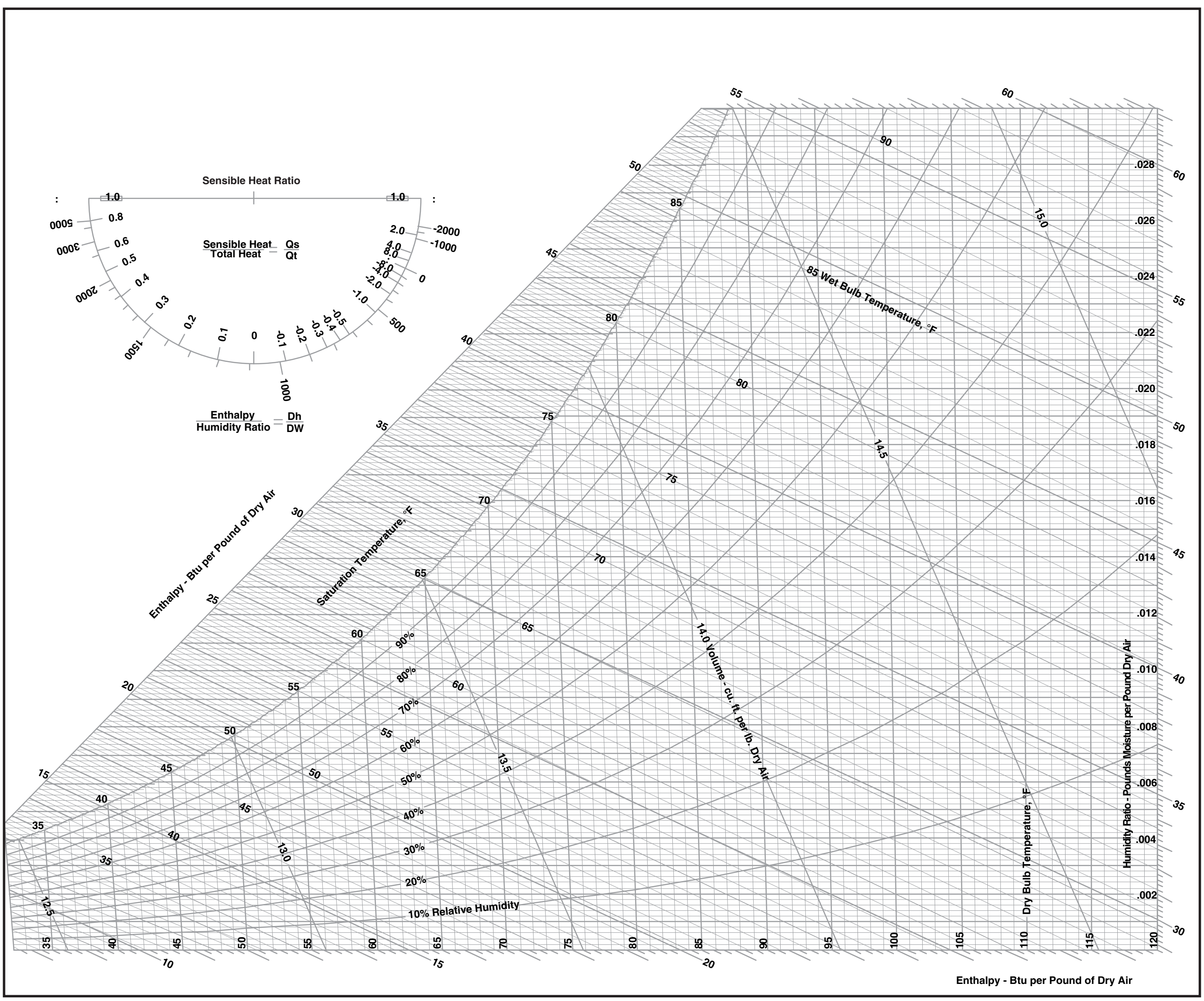


Figure 4. Psychrometric Chart

First, using the R-value of any thermal barrier, determine the minimum surface temperature.

Next, determine the DPT of the atmospheric air in contact with the surface.

If the surface temperature is equal or lower than the DPT, the surface will form condensation. If yes, an additional thermal barrier or other condensation prevention strategies may be required to solve the problem.

Sensible heating (Qsen), is the heat that raises the dry-bulb temperature of air without increasing the moisture content. Because we can easily sense this change in temperature, it is called 'sensible.' Sensible cooling is the removal of heat without removing moisture content of the air.

Latent Heat (Qlat), is the heat content of air due to the presence of water vapor. Latent heat is the heat required to evaporate this same amount of water (970 Btu/lb), also known as the latent heat of vaporization. As latent heat increases, moisture content increases.

Water can be heated to 212°F. If more heat is added, the water will vaporize but the temperature will not change.

Latent Cooling (Qlat), is the removal of latent eat from air without lowering the dry-bulb temperature. To retrieve 1 lb. of condensate, 970 Btu's would need to be removed. As latent heat decreased, moisture content decreases.

Latent Heat of Fusion is the heat required to change a liquid into a solid (144 Btu/lb. Water can be cooled to 32°F. If more heat is removed, it will cause ice to form. To retrieve 1 lb of water from ice, 144 Btu's must be added.

Sensible processes can be shown as horizontal paths on a psychrometric chart. Latent processes can be shown as vertical paths on a psychrometric chart. Most processes include both, resulting in an angled or diagonal path.

Sensible heat factor (SHF) is the measure of sensible heat to latent heat. Sensible heating only is 1.0. Equal proportions result in 0.5. SHF is generally higher than 0.5 because of the cooling processes that remove more sensible heat than latent heat.

INDUCTION

Induction is a flow that occurs as a result of the change in velocity pressure as a jet of air expands. The principals of induced air flow are based on the Venturi effect. The Venturi effect is a derivation of Bernoulli's principle and the continuity laws. In order to satisfy the fluid dynamic principles of continuity, a fluid's velocity must decrease as the flow expands; at the same time the static pressure of the flow must increase. The increase in static pressure balances the decreased velocity, thus maintaining the principles of conservation.

Benefits of Chilled Ceiling Systems

Chilled Ceiling Systems are designed to provide superior occupancy comfort. These systems require less energy to operate, operate more efficiently, and use less materials than conventional all air systems. Tempered and dehumidified air is supplied to the space to meet ventilation requirements and to handle the latent load. The majority of the sensible load is addressed with the chilled ceiling products. Decoupling the latent and sensible loads takes advantage of the superior volumetric heat capacity of water. The reduced volume of air that must be delivered to the space results in reduced air handler capacity and size, smaller duct sizes, and overall energy savings. A higher supply temperature contributes to increased occupancy comfort.

FIRST COST BENEFITS:

- Shallow unit profiles allow for reduced ceiling space requirements; typically require 60% less vertical space than conventional all air systems.
  - Reduced slab to slab spacing; reducing material costs per floor
  - Easily integrated into retrofit applications where space is limited
- Low volume of supply air required for active beams enables reduction of the total amount of air processed at the air-handler by an all air system up to 50%.
  - Reduced air-handler size/capacity, and duct work size

COMFORT AND IAQ BENEFITS:

- Active beams typically supply a constant volume of primary air, decreasing occurrences of dumping and changes to the air motion in the space; issues common to typical VAV systems
- When supplied with primary air from a dedicated outside air system (DOAS) 100% fresh air is supplied to the space
- Dry-coil sensible cooling, eliminates bacterial, fungal, or mold growth associated with fan coils and other unitary products with condensing coils
- Constant primary air volume ensures ventilation requirements are met and helps to maintain relative humidity levels in the space

ENERGY EFFICIENCY AND OPERATIONAL BENEFITS:

- Utilizing the heat transfer capacity of water also takes advantage of the superior operational efficiency of pumps as compared to fans.
  - A 1" diameter pipe can deliver the same cooling/heating capacity as an 18" x 18" duct
  - Reduction of fan energy by a factor of 7 to deliver the same cooling to the space
- Higher supply water temperatures compared to conventional systems allow for use of water side economizers.
  - Increased opportunities for free-cooling
- Significant reduction in maintenance costs and labor as compared to conventional all air systems
  - No moving parts - no blowers, motors, damper actuators to replace
  - Dry-coil operation - does not require regular cleaning and disinfecting of condensate pans
  - Recommend cleaning of coils once every 4 to 5 years, more frequently in hospitality rooms where linens are frequently changed (i.e. hospital patient rooms and hotel rooms)

Chilled Ceiling System Design

CHILLED CEILING APPLICATIONS

Chilled beam and radiant ceiling products are designed to handle high thermal loads in the space. They are also an effective solution in spaces where individual temperature control is desired. Ideal applications are spaces where the sensible heat ratio is greater than 0.75, meaning that 75% or more of the total heat gains in the space are sensible gains. These locations include computer/server rooms, condos/apartments/hotel guest rooms, libraries, and museums.

Use of chilled ceiling systems should be limited to applications where cooling loads are less than 40 BTUH/ft^2, and heating loads are lower than 15 BTUH/ft^2. More specifically, passive beam and radiant panel usage should be limited to applications where cooling loads are no more than 25 BTUH/ft^2, and active chilled beams are not recommended for use when cooling loads are more than 40 BTUH/ft^2. Chilled ceiling systems are not recommended in these applications since addressing the loads will likely create thermal comfort issues. In transitional spaces where thermal comfort is not critical, chilled ceiling products can be used to address higher loads.

Chilled beams and radiant ceiling systems should not be applied in buildings where relative humidity of the space is not easily maintained. This would include retrofit applications, lobbies, and entrances where there is excessive infiltration.

Chilled beams are best applied when installed no higher than 14 feet above the floor, but can remain effective with installation heights up to 20 feet. When installed above these heights it is difficult to effectively get heating and cooling into the occupied space.

PRACTICAL DESIGN GUIDELINES

There are guidelines that should be followed when considering a chilled ceiling system to ensure the design will create a comfortable environment for occupants and result in optimum energy efficiency.

The system should be designed to meet only the heating and cooling requirements of the actual space. Overdesigning the system will increase the cost of the project, and potentially result in decreased comfort.

Primary air must be adequately dehumidified, and supplied at a flow rate large enough to offset the latent loads of the space. This flow rate must also be high enough to meet the ventilation requirements outlined in ASHRAE standard 62.1.

When heating with chilled beams and radiant panels, care must be taken that the system is not oversized for heating. Entering water temperatures should be as low as possible to meet the heating requirements, and should never be over 140°F.

Condensation control strategies must be implemented to maintain optimum operating conditions, prevent bacterial, mold, and fungus growth, ensure damage to building does not occur.

When designing a chilled beam system it is best to limit the types and configurations of products used. This will help to make logistics during installation and building maintenance easier.

Room air temperature is maintained through regulation of 2-way control valves. Use of 2-way valves is preferred as they will minimize pumping costs.

Systems should be designed to take full advantage of free cooling and heating opportunities through economizers and heat recovery devices. Chilled beams and radiant panels are highly efficient products and offer energy savings over traditional systems. However, one of the biggest advantages these products offer is the additional energy savings that can be achieved in the rest of the system due to the unit operating conditions.

DESIGN METHODOLOGY

The design of chilled ceiling systems is an iterative process between selection of the equipment to be used and the inlet conditions for the system. This also includes placement/orientation. The iterative process enables the inlet conditions to be optimized so that the design results in a comfortable space for the occupant, and that the equipment is operating with the highest efficiency possible. This is true for all chilled ceiling systems, but is especially true for active chilled beams.

Equipment selection is based on the following items and must be balanced for creating an effective, efficient, and comfortable system:

- Total unit capacity
  - Size of units
  - Quantity of units
  - Unit Configuration
- Supply Air
  - Flow rate
  - Temperature
  - Relative humidity
  - Operating pressure
- Entering Water Conditions (cooling & heating)
  - Entering water temperature
  - Flow rate
  - Coil pressure drop
- Unit Placement
  - Throw patterns
  - Throw length
- Noise

Once the inlet conditions and equipment has been selected, the controls for the system are selected. The room control system must be designed to deliver the selected inlet parameters and maintain the energy efficiency of the design. The critical points to be maintained are the entering water conditions as well as the supply air conditions. After control of the critical points has been established, additional controls to compensate for changes in space dew point temperature and occupancy should be considered through a building management system.

This methodology is depicted in Figure 5, Chilled Ceiling Design Methodology.

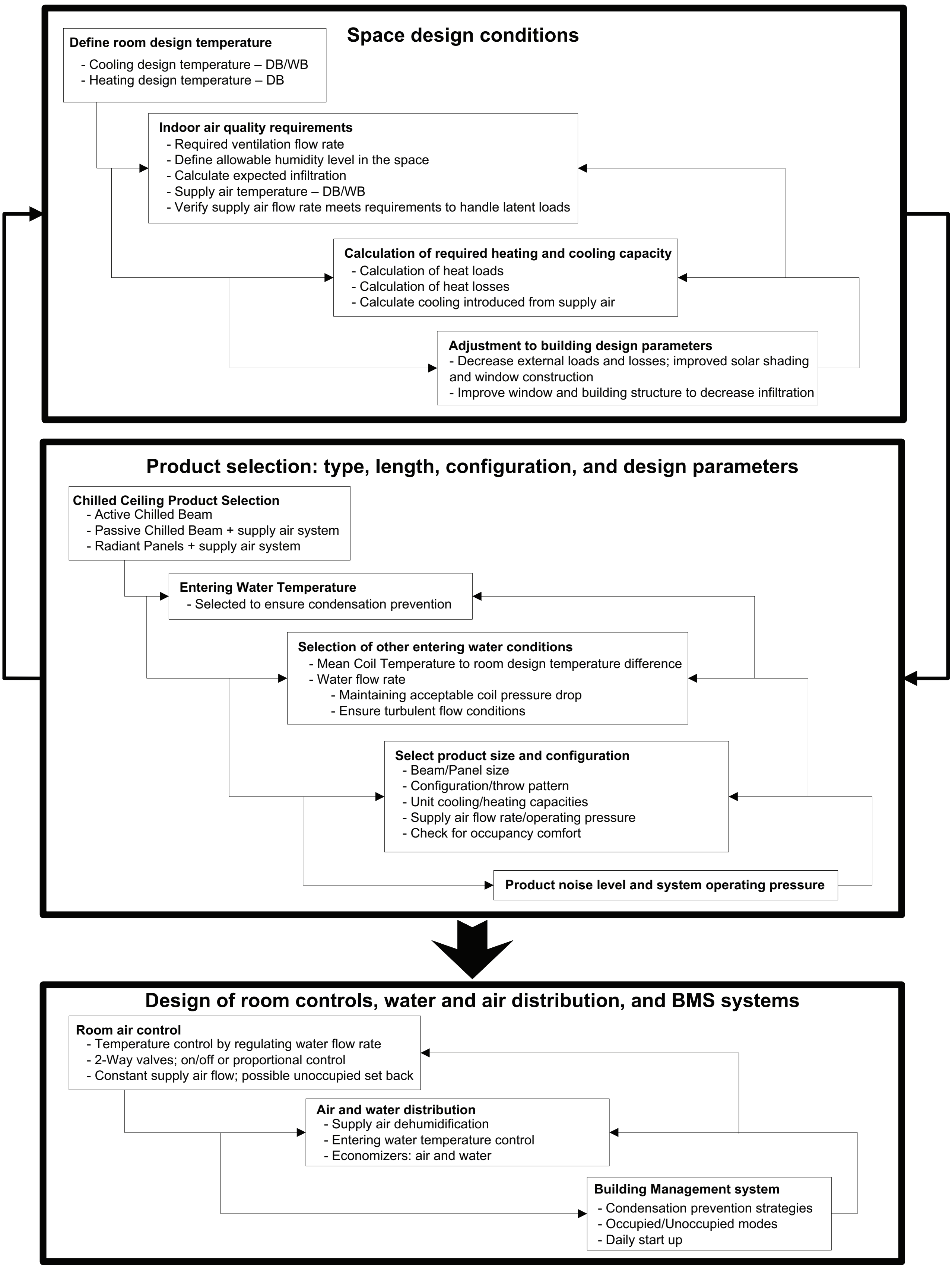
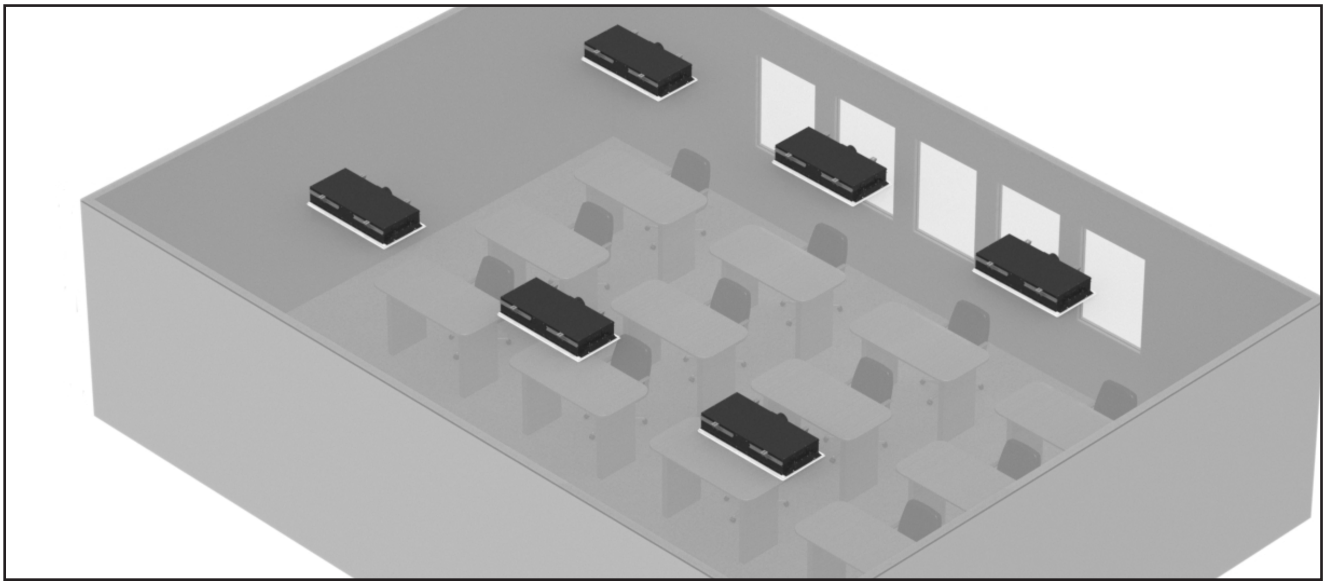


Figure 5. Chilled Ceiling Design Methdology



System Design Process

SPACE DESIGN CONDITIONS

The first step in determining the space design conditions is to define the design temperatures for both heating and cooling. This should be done by following the guidelines set in ASHRAE Standard 55 and the chapters on heating and cooling loads in the ASHRAE Fundamentals Handbook.

Once the design temperatures have been defined, an iterative process should be used to determine the indoor air quality requirements, calculating the required capacities to address the heating/cooling loads, and adjusting the building design/construction (if applicable).

The indoor air quality (IAQ) requirements include supply air flow rate, to meet both ventilation requirements and address the latent loads in the space, determining infiltration, and defining the maximum allowable humidity level.

Based on the building design and construction, anticipated infiltration should be calculated. Information on how to calculate infiltration and how to use infiltration when calculating heat loads and losses can be found in the ASHRAE Fundamentals Handbook. The heat loads and losses calculated associated with infiltration are used in determining the latent cooling requirements. This will affect the volume of supply air necessary to maintain the design humidity levels in the room.

Guidelines for determining the minimum ventilation requirements are given in ASHRAE Standard 62.1. Criteria for maximum relative humidity in the space, based on a humidity ratio of 0.012, is set in ASHRAE Standard 55; for a room design temperature of 75°F, the maximum relative humidity is 63.5%. Once the design conditions for room relative humidity have been determined the supply air flow rate necessary to maintain this level can be calculated. The required flow rate to meet the latent load can be determined by the following equation:

$$\dot{V} = \dot{q} \,/\, [4840 \text{ x } (H_{Rr} - H_{Rp})]$$

$\dot{V}$ = the volumetric flow rate, CFM
$\dot{q}$ = latent heat gain in the space, BTU/H
H_{Rr} = room air humidity ratio, $lbs_{water}/lbs_{dry\ air}$
H_{Rp} = primary air humidity ratio, $lbs_{water}/lbs_{dry\ air}$

It follows that the required flow rate to maintain control of the humidity will rapidly increase as the difference between the room air and primary air humidity ratios decrease. As a result, designs seeking to maintain relatively low humidity ratios will need a high primary flow rate if the dew point temperature of the supply air is close to the design dew point in the room.

Comparing the required supply airflow rates for ventilation and to maintain the relative humidity of the space, the higher of the two flow rates will determine the minimum flow rate allowable for the space. If necessary the supply air flow rate can be increased to supplement the sensible cooling of the products selected.

After the IAQ requirements have been tentatively set, the required equipment capacities to meet the heat loads and losses can are determined. Care should be taken to design around actual loads/losses that will be experienced in the space. Overdesigning the system will increase installation and equipment costs, and could potentially cause thermal comfort issues. Once the capacity requirements have been calculated, either supply air conditions or building design/construction (if possible) can be adjusted to be more suited to chilled ceiling application.

PRODUCT SELECTION

The type of product to be used to is at the designer's discretion. However the recommended limitations of maximum capacity per square foot should not be exceeded where high levels of thermal comfort are required.

Once product type has been decided the entering water temperature should be selected such that condensation is prevented. The majority of chilled ceiling products do not include a means to collect or manage condensation. This means the temperature of the heat transfer surface, either water coil or panel/sail surface, must be higher than the dew-point temperature of the space to prevent the formation of condensation. However, to achieve the maximum cooling capacity the entering water temperature should be as low as possible. This can be difficult when trying to get the most capacity out of chilled ceiling products.

There are several ways to operate these products to prevent condensation. The primary step to preventing condensation is for the chilled water design supply temperature to be at least 1°F above the dew-point temperature of the space. Also, the supply air to the space must also be sufficiently dehumidified to maintain the design relative humidity conditions. The secondary measures are noted below:

- Properly insulated valves and piping
- Measures used to shut off chilled water flow
  - Condensation sensors installed on the supply water piping
  - Relative humidity/dew-point temperature sensor installed in the return air path
- Raising the chilled water supply temperature
  - Using a relative humidity sensor in conjunction with a room temperature system to determine moisture content and dew-point temperature of the space. Using this information the chilled water temperature can be adjusted upward to prevent condensation. This measure should only be used in the event that an entire building is at risk for condensation.

At this time the supply air temperature should be tentatively selected. Supply air temperature can be varied between cooling and heating, but most designs keep a fixed temperature as long as heating requirements can be met.

The size and configuration of products selected should be completed while adjusting the following parameters:

- Water flow rate: this should be selected to minimize pressure drop, should be no higher 10 ft w.g., while maintaining turbulent flow through the product
- Supply airflow rate: flow rate must be maintained above the minimum determined for IAQ requirements, but can be increased to offset the sensible cooling requirements of the product selected
  - Increasing the flow rate in active beams while maintaining the same nozzle geometry will result in an increase of operating pressure. The recommended operating range is typically between 0.2 in w.g. and 0.8 in w.g. Operating pressure in active beams will also directly impact the noise generated by the product during operation.
- Unit placement/Configurations:
  - Radiant panels and sails: These products should be installed so that no more than 75% of the available ceiling space is made up of active panels/sails. Panels models with perforated faces and backed with acoustic fleece insulation can be used to improve noise attenuation within the space.

  - Passive Beams: Passive beams should not be installed directly above occupants since the highest velocities occurring from the convection process will occur directly underneath the beam

  - It is critical to the operation of passive beams that adequate space is provided for air flow through the beam. When installed in a flush mount application, shadow gaps, perforated ceiling tiles, dummy beams, or return air grilles must be installed so that warm room air enter the air path for the passive beams. It is recommended that the total free area for the return air path be at least 50% of the passive beam surface area. In exposed applications, the beams should be installed with a minimum distance between the top surface of the beam and the ceiling that is equivalent to half of the beam width, see Figure 7.

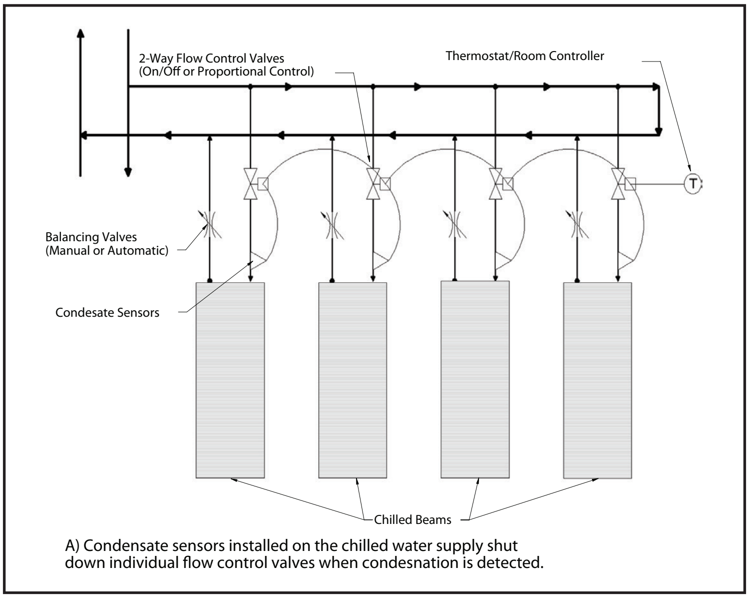


Figure 6a. Condensation Prevention Strategies

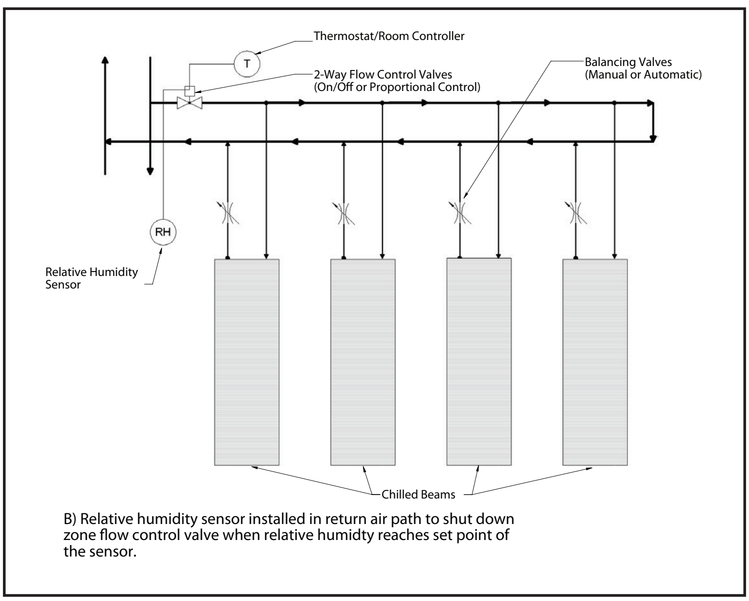


Figure 6b. Condensation Prevention Strategies

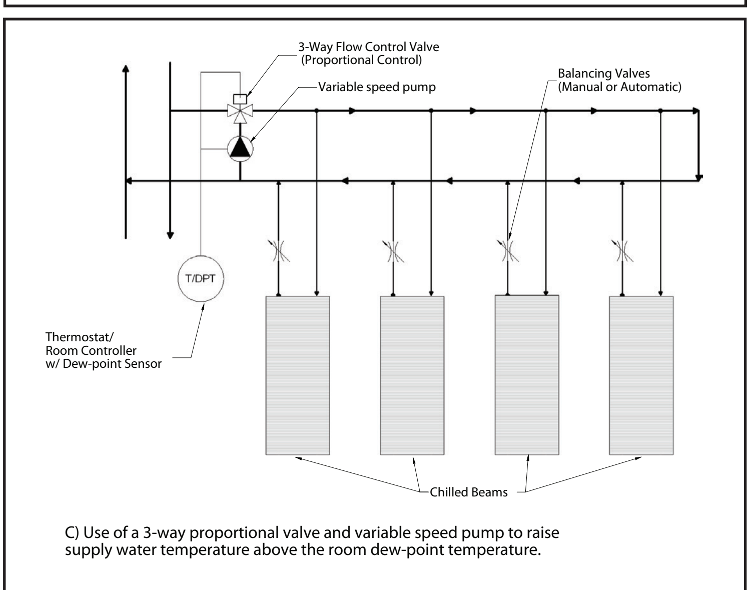
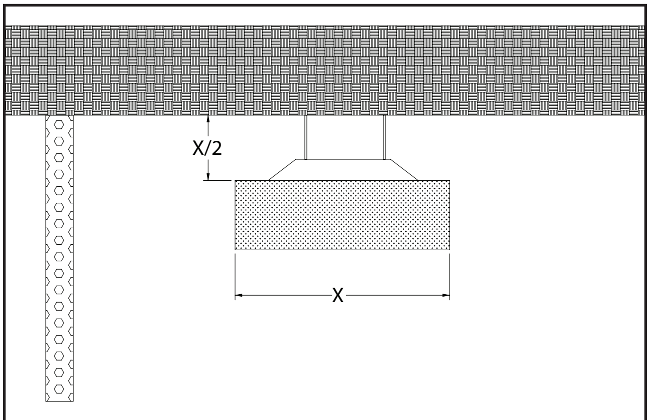


Figure 6c. Condensation Prevention Strategies



Passive beams should be mounted such that the return air path is not restricted.

Figure 7. Passive beam mounting height

- Active Beams: With the different configurations available in active beams, 1, 2, and 4-way beams a design can be implemented to effectively create a comfortable space. In open office spaces as well as internal offices 2-way or 4-way beams are typically used. The flexibility provided by 2-way and 4-way beams, due to multiple sizes and nozzle configurations, allow them to be appropriately applied in most applications. 1-way beams are typically used in perimeter zones and small spaces such as individual offices and hotel rooms.

- After the throw pattern has been decided, placement of the beam within the space can be determined. Active chilled beams, because of their design, share throw characteristics with conventional slot diffusers. Placement and orientation of active beams is critical for thermal comfort due long throw values associated with active beams. In open office plans it is typically more cost effective to use several longer beams that are installed parallel to the long direction of conventional ceiling systems, instead of numerous smaller beams the length of the module division. (Figure 8, Open-office Active Beam Layout) However in an open office the number and size of beams used will be determined by balancing the cost per beam, cost of air side operating pressure, and water side pumping power to achieve optimum energy efficiency.

- When applying 2-way and 4-way beams in small offices and individual offices the recommended location is directly above the occupants. This will result in the lowest velocities within the occupied space. It is also recommended that 2-way beams are installed lengthwise in the space. This will allow for the use of longer beams, reducing the cooling requirements per linear foot which will in-turn lower total air flow per foot and the resulting velocities in the space ensuring occupancy comfort. If placement is required near a wall use of 1-way throw beams are recommended. 1-way beams can also be effectively used in perimeter zones for cooling applications; however they should be supplemented with baseboard heating to address window loads during the heating season. 2-way beams can be effectively applied in perimeter zones for both heating and cooling. Care must be taken if 2-way beams are installed parallel to windows. In intermediate seasons when internal cooling is required and window surfaces are cool an acceleration of the air can occur in the space creating drafts and potential discomfort.

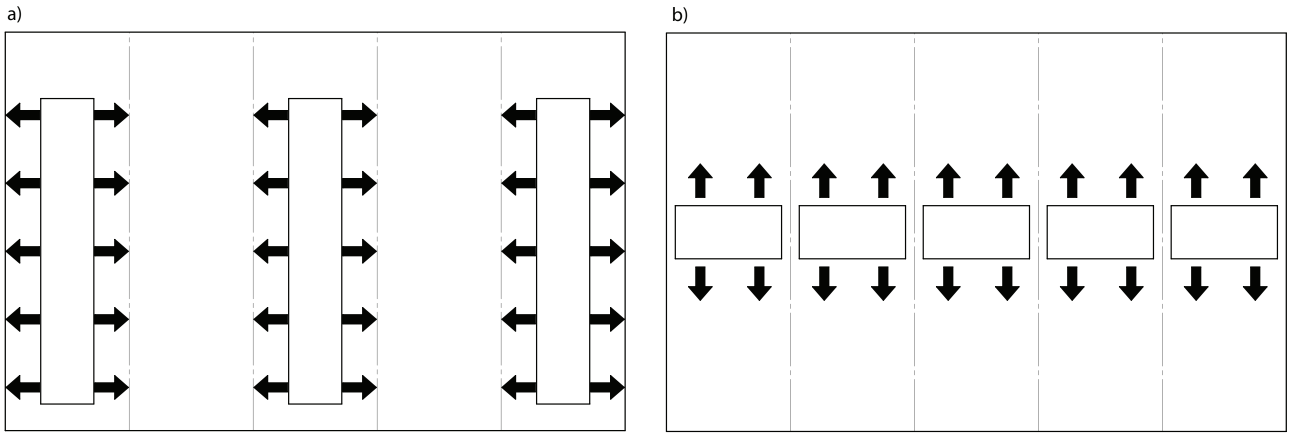
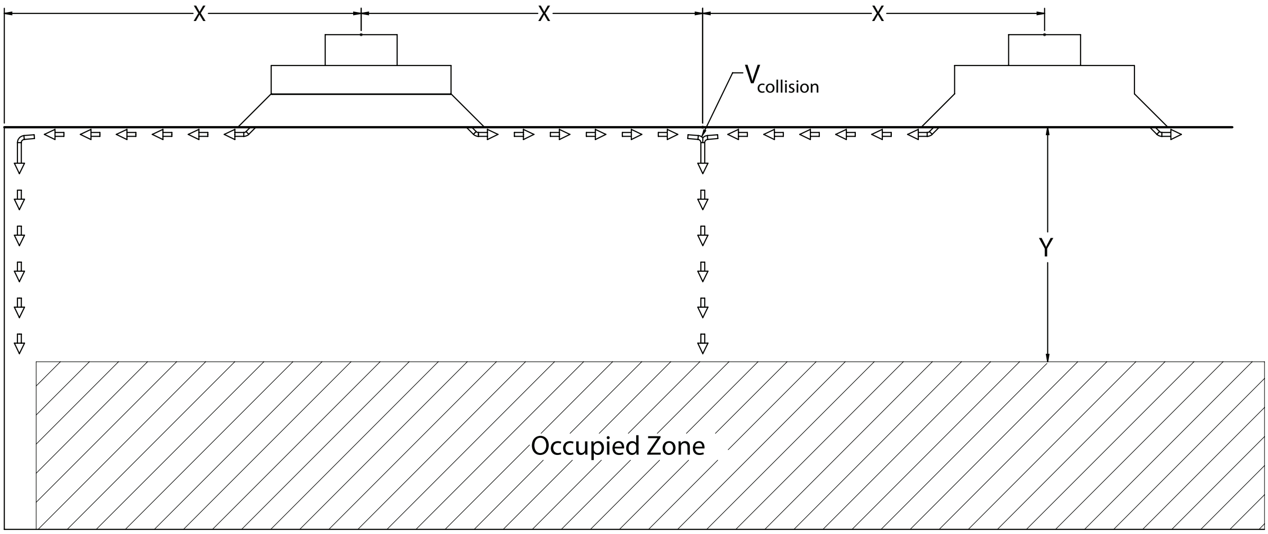


Figure 8 - Open-office Active Beam Layout: In lengthwise installations(a) there are less piping and duct connections than in crosswise installations(b). In crosswise installations, there is typically one beam per module. Even if the total cost for the beams in both layouts are the same, installation costs, additional valves, piping, and ductwork will prove to be more costly.



The minimum distance between units (2X) or minimum distance from a sidewall (X), can be determined by taking the difference between the diffuser's characteristic throw to 50 fpm (T_{50}) and the distance between the ceiling and the occupied zone (Y).

Figure 9. Local Velocity Diagram

- The ideal location for most active beams is directly above the occupant. This is because the lowest velocities in the space will occur in the induced air path. If it is desired to position an active beam close to a wall, a unit with an asymmetrical or 1-way throw pattern is recommended. As active chilled beams have throw characteristics similar to linear slot diffusers the same principles for determining thermal comfort conditions should be used. Location for final placement should take into consideration the allowable average air speed in the occupied space in accordance with ASHRAE Standard 55. Accounting for the air side sensible capacity will allow for reduced capacity requirements of the water coils in the beams. Designing with this in mind will reduce airflow requirements per linear foot, which will help to meet the requirements for thermal comfort. When placing two beams in the same space as shown in Figure 9, Local velocity diagram, care must be taken to ensure that the colliding air streams do not result in velocities over 50 fpm causing discomfort. A general guideline to achieve air velocities of 50 fpm or less in the occupied space is to ensure the velocities of colliding airstreams are below 100 fpm. If velocities at the point of collision are greater than 100 fpm, the distance from the ceiling for the air flow to slow to 50 fpm is noted in the equation below:

$$Y=T_{50}-X$$

Where:
Y = distance from the ceiling
X = half the distance to the adjacent diffuser
T_{50} = diffuser characteristic throw to 50 fpm

CONTROL OF CHILLED CEILING SYSTEMS

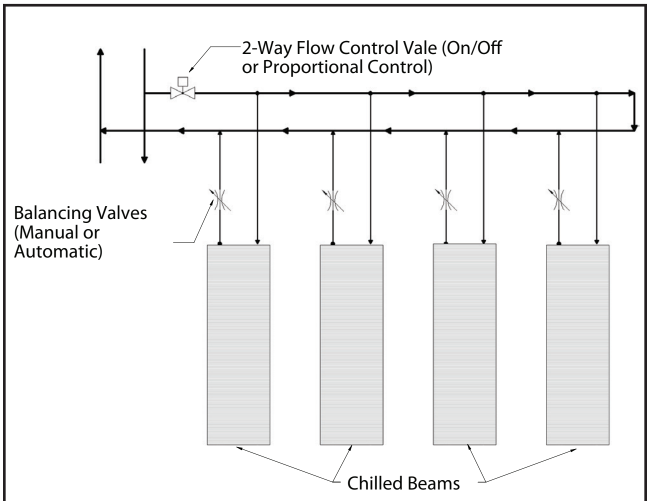
Very basic room controls can be used with chilled ceiling systems. This is due to the fact that most systems are designed to operate with a constant volume of supply air. Also, the large coil size, combined with relatively low velocities across the coils result in a fairly long response time.

With chilled beams or radiant systems, the most common method for controlling room temperature is regulating the water flow rate through the selected equipment. The alternative is to vary the supply water temperature.

The control of water flow rate is achieved through on-off, time proportional on-off, or modulating control valve actuators. The maximum flow rate should be limited by a balancing valve installed on each beam circuit. It is generally recommended for 2-way valves to be used to reduce pumping costs, but 3-way valves can be used when pump speeds are not variable. While on-off and modulating actuator control is straight forward, time proportional on-off systems are a bit more complex. These systems use a feedback control loop to open and close an on-off actuator such that the total time open is proportional to the percentage of flow that is requested by a modulated room controller. While control of this system is more complex, actuator first costs are greatly reduced.

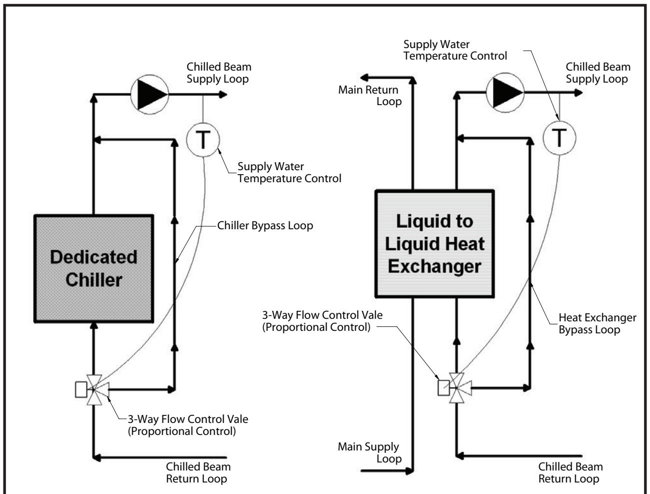
Chilled beams should be connected in parallel so that each beam sees the same entering water temperature. For the greatest flexibility of control each beam should be fitted with an actuated control valve. With this setup, the flow rate can be modulated in each beam. And, in the event the entering water temperature reaches a point where condensation is a concern the flow rate to individual units affected can be shut down, so that the entire zone do not suffer a loss in sensible capacity. The alternative is one actuated control valve per zone. In either situation, each beam should be fitted with isolation valves on the both the supply and return.

Alternatively to varying water flow rate through the beam, the entering water temperature can be varied according to the load in the space. This requires more sophisticated control sequences. Varying the water temperature also requires a bypass loop, that can inject higher temperature water from the return loop of the chilled beams or main air handler into the supply water loop for the beams.



A) Beams installed with a single 2-way valve serving a entire zone.

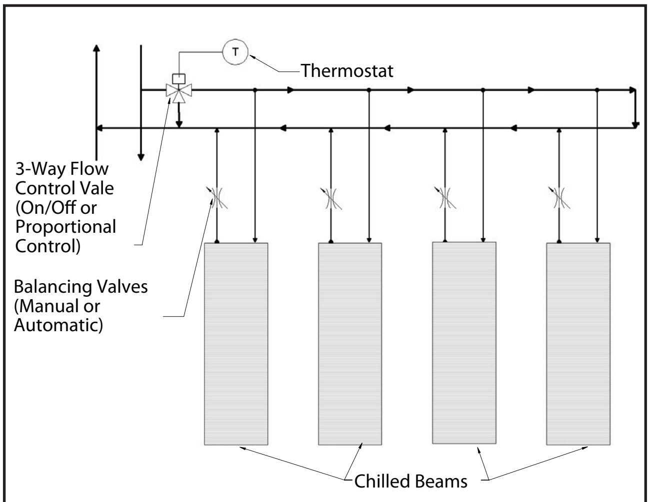
Figure 10a. Chilled beam zone control - Single flow control



A) Supply temperature control with dedicated chiller

B) Supply temperature control secondary chilled beam loop

Figure 11a. Supply water temperature control with dedicated chiller;
Figure 11b. Supply water temperature control chilled beam loop



B) Beams installed with a single 3-way valve serving a entire zone.

Figure 10b. Chilled beam zone control

In order to control the supply water temperature a dedicated chiller and supply/return circuits can be used (see Figure 11a), or heat exchanger between the main air handler loop and chilled beam loop are acceptable (see Figure 11b).

When designing systems with occupied/unoccupied modes or with night set back set ups. It is critical to ensure the design relative humidity conditions are met prior any water based sensible cooling. In most cases, 30 minutes of dry-air ventilation will be enough to prevent any condensation during morning start-up and when returning to occupied modes. This can easily be achieved for night set back/morning start up by offsetting the time schedules for the air handlers and chilled beam system pumps.

Linear Active Chilled Beams

CBAL-24

- CBAL-24 is a linear active chilled beam diffuser with 1-way and 2-way air distribution
- Unique linear design provides high induction and low noise levels
- Available in cooling & supply air or cooling, heating & supply air configurations
- Insulated plenum for improving performance and to prevent condensation
- Available as diffuser shell (no coil/piping)
- Accessories include rubber lip seal, stainless steel hoses with or without isolation ball valves
- Standard finish is #26 white paint on diffuser face
- Diffuser is designed to fit into standard module ceiling grids 24” in width

CBAL-24

energy solutions

See website for Specifications

AVAILABLE MODEL:

CBAL-24

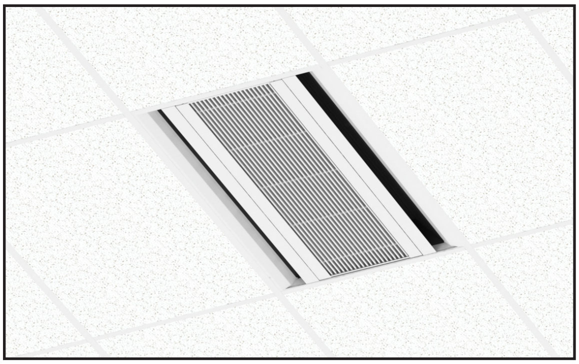
OVERVIEW

Titus active chilled beams features the aerodynamic properties of Titus ceiling diffusers with the extra benefits of using hydronic coils and induced air to reduce the high sensible thermal loads. The primary air from the DOAS is supplied to the ceiling mounted or sidewall chilled beams subsequent to it being discharged through a series of nozzles located along the length of the beam and this causes room air to be induced through one or two coils and mixes with the primary supply air. This mixture of air is then discharged into the space through the ceiling slot diffusers. This provides high cooling outputs with low amounts of primary air. The reduced volume of air results in the reduction of the air handler capacity and size, smaller duct sizes, and the overall energy consumption.

The supplied air from the DOAS unit is tempered and dehumidified to handle the latent load. The remaining loads in the space are addressed with the heat exchanger which is incorporated into the chilled beam.

ADVANTAGES

- Removal of high thermal loads is possible in this air/water system
- The height of the air duct system is reduced to a minimum, due to the low supply of primary air
- Substantial reduction in the operating costs, due to low primary air volume
- Improvement of the thermal comfort inside the room
- Individual adjustment of the primary air volume by means of the nozzle configuration
- Suitable for several standard ceiling grids
- Contributing sound levels below NC-30



Rendering of CBAL-24 installed in a ceiling

CEILING MOUNTED, LINEAR ACTIVE CHILLED BEAM

The CBAL’s are offered for both, cooling and heating, in 12” and 24” widths and lengths from 2 to 10 ft. They can be easily integrated into different grids styles within a suspended ceiling, drywall ceiling or exposed.

The low overall height of the CBAL product line is ideal for reducing the space required for false ceiling in any application.

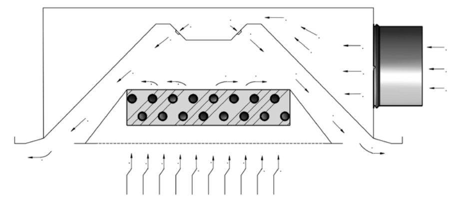
CBAL-24 STANDARD FEATURES

- 1 way and 2 way air pattern
- 2 to 10 foot chilled beam length in 1 foot increment
- 2 and 4 pipe coil configurations
- Cooling and/or heating coils
- Left or right hand pipe configurations
- ½" SWT or MNPT water connections
- Air vent
- Multiple nozzle sizes are available to vary the primary air supply and chilled beam performance
- Perforated round or linear bar return grille facing
- Hinged access return grille panel for easy room side access to the coil
- Heavy gauge, galvanized steel casing
- Top or side air inlet; several diameters available
- Contributing sound levels below NC30
- Adjustable mounting brackets
- Internally painted surface
- Pressure port for air-side balancing and flow verification
- Polyester painted white (RAL 9010)

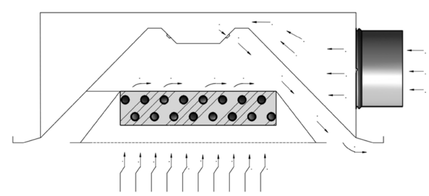
OPTIONS

- EcoShield, anti-microbial insulation
- Separate or additional primary air supply
- Diffuser shell only (no coil/piping)
- 12", 18" and 24" return/exhaust box extension
- Lay-in, NT and DF Tegular mounting frame
- Custom color matching
- Stainless steel hoses and valves
- Slim-less coupling for continuous look
- Drain connection
- Thermostat and humidity sensors

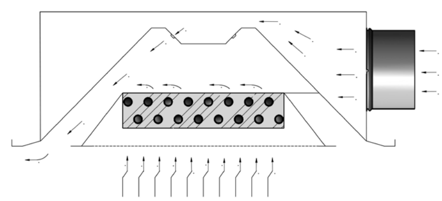
CBAL-24 2 Way



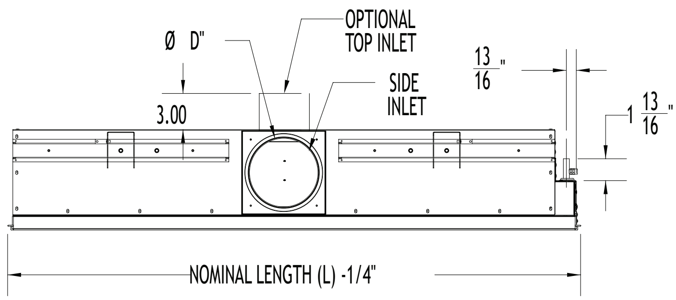
CBAL-24 1 Way (front)

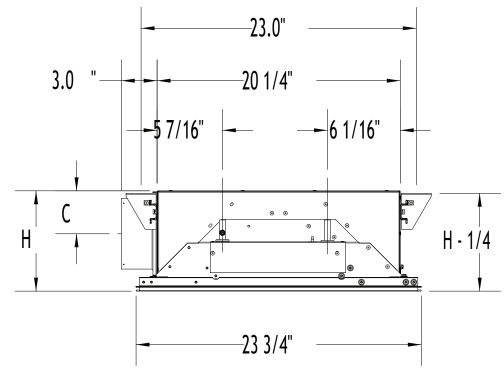


CBAL-24 1 Way (back)

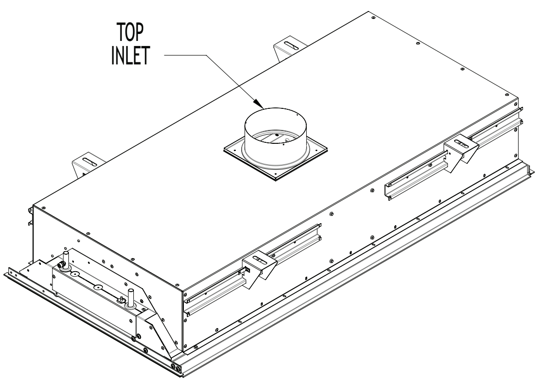


CBAL-24" WIDTH



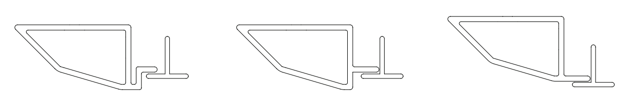


2 PIPE RIGHT HAND 1 WAY IS SHOWN



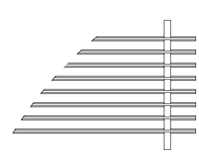
2 PIPE LEFT HAND 1 WAY,
TOP INLET IS SHOWN

BORDER TYPE

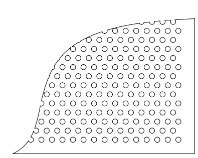


TEGULAR 9/16" | TEGULAR 15/16" | LAY IN

NOTES:
HAND OF UNIT DETERMINED BY COOLING WATER SUPPLY CONNECTION WHEN FACING HORIZONTAL AIR INLET CONNECTION.



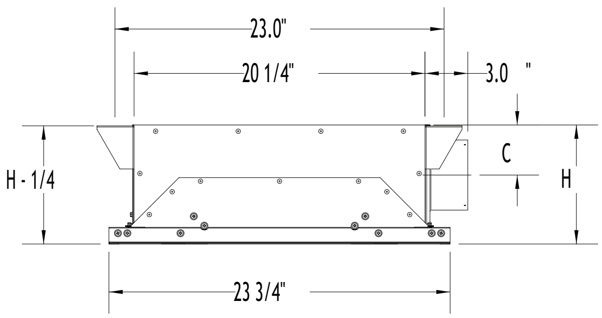
LB - Linear Bar Grille

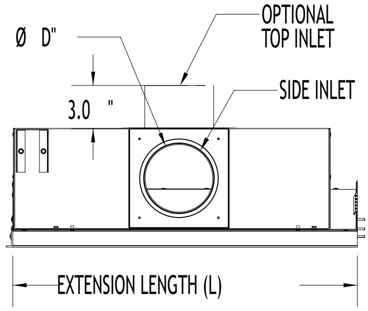


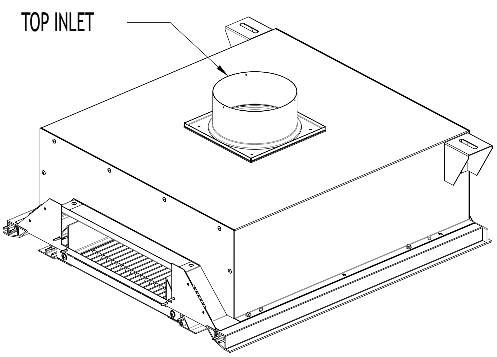
CP - Circular Perforation

All dimensions are in inches

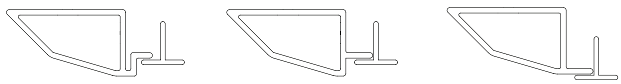
CBAL-24" WIDTH EXTENSION



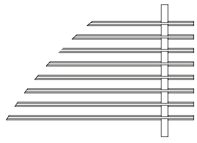




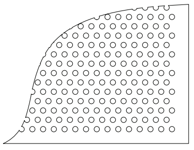
BORDER TYPE



TEGULAR 9/16" | TEGULAR 15/16" | LAY IN



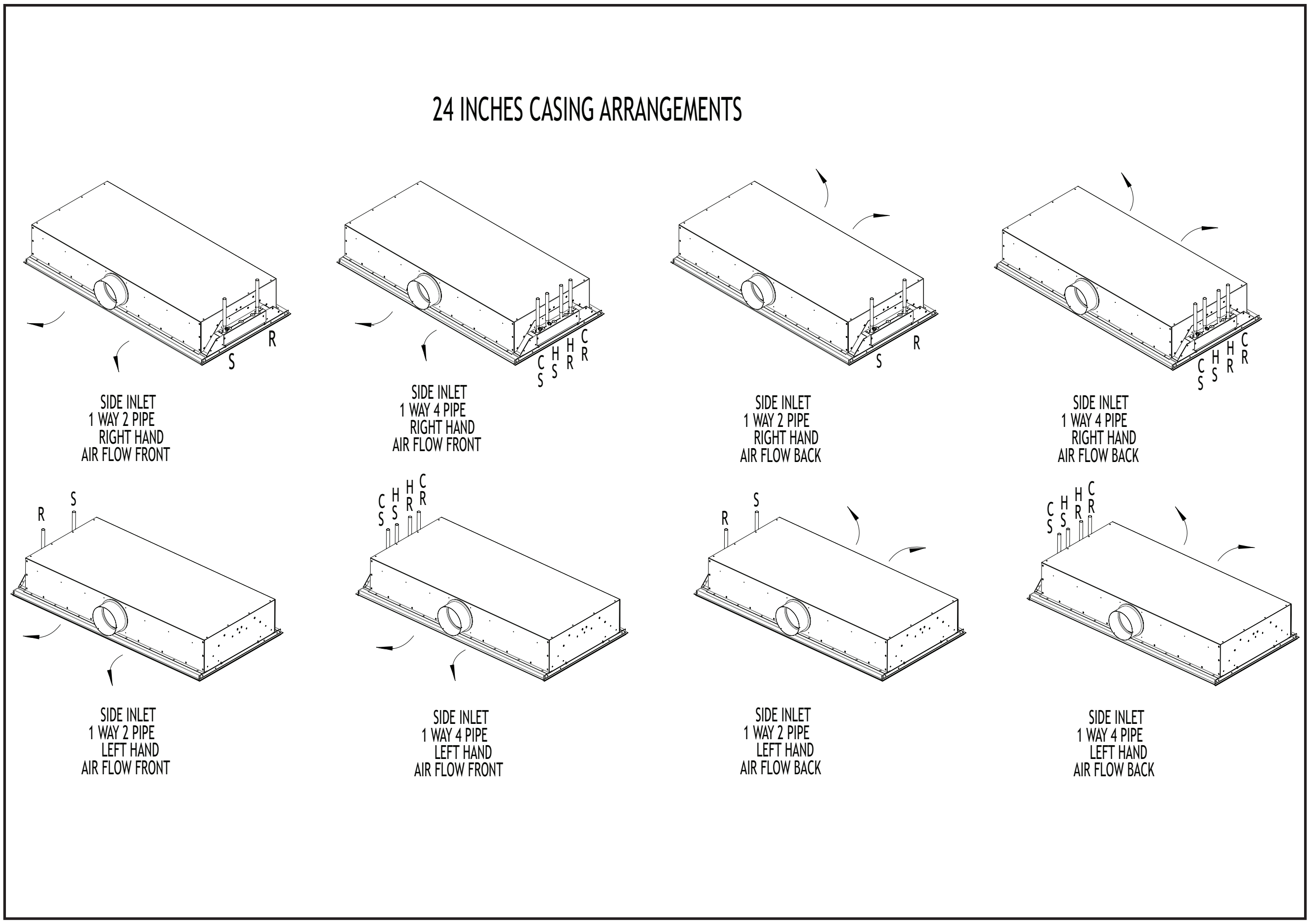
LB - Linear Bar Grille



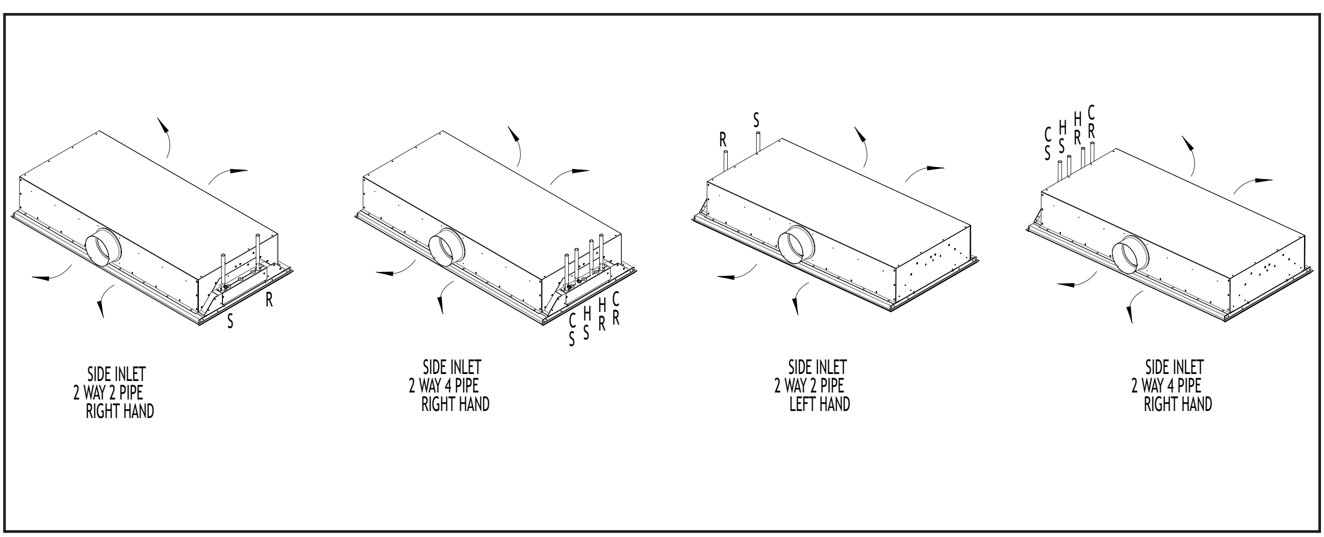
CP - Circular Perforation

All dimensions are in inches

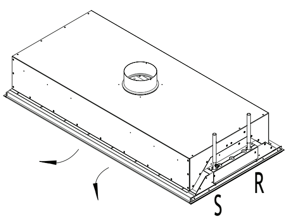
CBAL-24" CASING ARRANGEMENTS



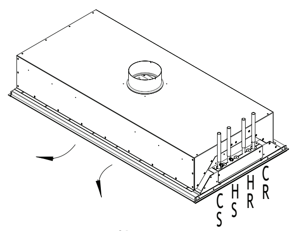
CBAL-24" CASING ARRANGEMENTS



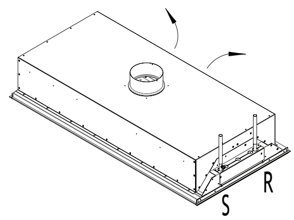
CBAL-24" CASING ARRANGEMENTS



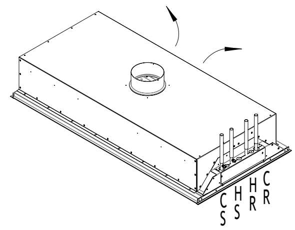
TOP INLET
1 WAY 2 PIPE
RIGHT HAND
AIR FLOW FRONT



TOP INLET
1 WAY 4 PIPE
RIGHT HAND
AIR FLOW FRONT

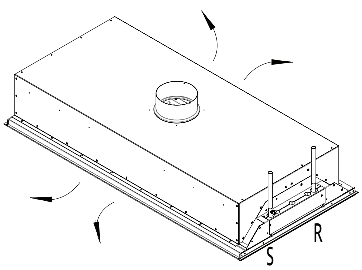


TOP INLET
1 WAY 2 PIPE
RIGHT HAND
AIR FLOW BACK

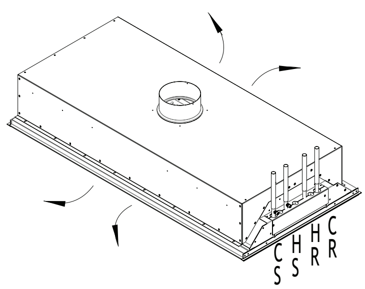


TOP INLET
1 WAY 4 PIPE
RIGHT HAND
AIR FLOW BACK

CBAL-24" CASING ARRANGEMENTS



TOP INLET
2 WAY 2 PIPE
RIGHT HAND



TOP INLET
2 WAY 4 PIPE
RIGHT HAND

R - Return S - Supply;

HR - Heating Return HS - Heating Supply;

CR - Cooling Return CS - Cooling Supply

CBAL-24 / 1-WAY / 2 PIPE

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
4	B1	0.134	10	0.35	-	1461	1678	3713	3713	2-4-5
	B2	0.165	20	0.61	-	1914	2347	4870	4870	4-5-6
	B3	0.228	30	0.26	-	1873	2523	4766	4766	4-5-7
			40	0.47	-	2258	3124	5750	5750	5-6-8
			50	0.73	-	2546	3629	6488	6488	5-6-9
	B4	0.307	60	0.47	-	2235	3535	5690	5690	5-6-9
			70	0.64	15	2395	3911	6100	6100	6-7-10
			80	0.83	19	2531	4264	6451	6451	6-7-11
6	B1	0.134	10	0.15	-	1348	1565	3427	3427	2-3-5
			20	0.6	-	2631	3064	6707	6707	4-5-7
	B2	0.165	30	0.58	-	2749	3399	7008	7008	5-6-8
	B3	0.228	40	0.2	-	2469	3335	6290	6290	5-6-8
			50	0.32	-	2889	3972	7367	7367	5-6-9
			60	0.45	-	3218	4518	8214	8214	6-7-10
			70	0.62	15	3488	5004	8908	8908	6-7-11
			80	0.81	19	3715	5448	9494	9494	7-8-11
	B4	0.307	90	0.46	19	3187	5136	8134	8134	6-8-11
			100	0.57	22	3335	5501	8516	8516	7-8-12
			110	0.69	25	3468	5851	8856	8856	7-9-12
			120	0.82	27	3587	6186	9163	9163	7-9-13
8	B1	0.134	10	0.08	-	1006	1223	2555	2555	1-2-5
			20	0.33	-	2736	3169	6976	6976	3-5-7
			30	0.75	-	3620	4270	9247	9247	5-6-9
	B2	0.165	40	0.57	-	3516	4382	8980	8980	5-6-9
	B3	0.228	50	0.18	-	3016	4099	7695	7695	5-6-9
			60	0.25	-	3447	4747	8803	8803	6-7-10
			70	0.35	-	3796	5312	9703	9703	6-7-11
			80	0.45	-	4088	5821	10455	10455	7-8-11
			90	0.57	20	4338	6287	11100	11100	7-8-12
			100	0.7	23	4555	6721	11662	11662	7-9-13
	B4	0.307	110	0.41	23	3899	6282	9968	9968	7-9-12
			120	0.49	26	4050	6649	10357	10357	7-9-13
			130	0.57	28	4187	7003	10710	10710	8-9-13
			140	0.67	30	4311	7343	11032	11032	8-10-14
			150	0.76	32	4426	7675	11328	11328	8-10-14
10	B1	0.134	10	0.05	-	472	689	1198	1198	1-2-5
			20	0.21	-	2696	3129	6872	6872	3-5-7
			30	0.47	-	3792	4442	9691	9691	5-6-9
	B2	0.165	40	0.36	-	3622	4488	9253	9253	5-6-9
			50	0.57	-	4223	5306	10804	10804	6-7-10
			60	0.82	-	4685	5985	11999	11999	6-8-11
	B3	0.228	70	0.22	-	3958	5474	10118	10118	6-7-11
			80	0.29	-	4314	6047	11040	11040	7-8-11
			90	0.37	18	4617	6566	11823	11823	7-8-12
			100	0.45	21	4879	7045	12502	12502	7-9-13
			110	0.55	24	5109	7492	13099	13099	8-9-13
			120	0.65	26	5314	7913	13630	13630	8-10-14
			130	0.77	28	5498	8314	14108	14108	8-10-14
	B4	0.307	140	0.46	30	4699	7731	12036	12036	8-10-14
			150	0.53	32	4836	8085	12390	12390	8-10-14
			160	0.6	34	4962	8428	12716	12716	9-11-15
			170	0.68	36	5078	8760	13017	13017	9-11-15
			180	0.76	37	5186	9085	13298	13298	9-11-16

CBAL-24 / 2-WAY / 2 PIPE

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
4	B1	0.134	10	0.09	-	858	1075	2177	2177	1-2-4
			20	0.35	-	2434	2867	6188	6188	2-4-5
			30	0.8	-	3292	3942	8379	8379	4-5-7
	B2	0.165	40	0.61	-	3189	4055	8166	8166	4-5-6
	B3	0.228	50	0.19	-	2702	3785	6871	6871	4-5-6
			60	0.27	-	3122	4422	7943	7943	4-5-7
			70	0.37	-	3468	4984	8829	8829	4-5-8
			80	0.48	17	3763	5496	9583	9583	5-6-8
			90	0.61	20	4018	5967	10236	10236	5-6-9
			100	0.75	23	4243	6409	10813	10813	5-6-9
	B4	0.307	110	0.42	22	3572	5955	9093	9093	5-6-9
			120	0.5	25	3724	6323	9484	9484	5-7-9
			130	0.58	27	3863	6679	9840	9840	6-7-10
			140	0.67	29	3991	7023	10167	10167	6-7-10
			150	0.77	31	4109	7358	10470	10470	6-7-10
6	B1	0.134	20	0.15	-	2247	2680	5711	5711	2-3-5
			30	0.34	-	3532	4182	8992	8992	3-5-7
			40	0.61	-	4386	5252	11179	11179	4-5-8
	B2	0.165	50	0.41	-	4013	5096	10222	10222	4-5-7
			60	0.59	-	4581	5881	11680	11680	5-6-8
			70	0.8	17	5047	6563	12875	12875	5-6-9
	B3	0.228	80	0.21	-	4115	5848	10484	10484	5-6-8
			90	0.27	17	4488	6437	11441	11441	5-6-9
			100	0.33	20	4815	6981	12279	12279	5-6-9
			110	0.4	22	5104	7487	13023	13023	5-7-10
			120	0.48	25	5364	7963	13691	13691	6-7-10
			130	0.56	27	5599	8415	14295	14295	6-7-10
			140	0.65	29	5814	8846	14847	14847	6-8-11
			150	0.75	31	6010	9259	15355	15355	6-8-11
	B4	0.307	160	0.41	31	5030	8496	12833	12833	6-8-11
			170	0.46	33	5176	8858	13207	13207	6-8-11
			180	0.52	34	5312	9211	13556	13556	7-8-11
			190	0.58	36	5439	9554	13884	13884	7-8-12
			200	0.64	37	5559	9891	14193	14193	7-8-12
			210	0.71	39	5672	10221	14484	14484	7-9-12
			220	0.78	40	5780	10545	14760	14760	7-9-12
			220	0.78	40	6422	11187	14760	14760	7-9-12

CBAL-24 / 2-WAY / 2 PIPE CONTINUED

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
8			20	0.08	-	1677	2110	4258	4258	1-3-5
			30	0.19	-	3424	4074	8717	8717	3-4-7
			40	0.34	-	4560	5426	11626	11626	3-5-8
			50	0.52	-	5388	6471	13753	13753	4-6-8
			60	0.75	-	6033	7333	15412	15412	5-7-9
	B2	0.165	70	0.45	-	5349	6865	13653	13653	5-6-9
			80	0.58	18	5860	7593	14967	14967	5-6-9
			90	0.74	21	6296	8245	16091	16091	6-7-10
	B3	0.228	100	0.2	18	5027	7193	12824	12824	5-6-9
			110	0.24	21	5407	7790	13801	13801	5-7-10
			120	0.28	23	5745	8344	14672	14672	6-7-10
			130	0.33	25	6050	8866	15457	15457	6-7-10
			140	0.38	28	6327	9359	16171	16171	6-8-11
			150	0.44	29	6580	9829	16824	16824	6-8-11
			160	0.5	31	6813	10279	17426	17426	7-8-11
			170	0.56	33	7029	10711	17982	17982	7-8-12
			180	0.63	35	7229	11128	18500	18500	7-9-12
			190	0.7	36	7416	11531	18984	18984	7-9-12
			200	0.78	38	7591	11923	19437	19437	7-9-13
	B4	0.307	210	0.46	40	6362	10911	16261	16261	7-9-12
			220	0.51	41	6498	11263	16613	16613	7-9-12
			230	0.55	42	6628	11610	16946	16946	7-9-13
			240	0.6	43	6750	11948	17262	17262	8-9-13
			250	0.65	45	6867	12282	17563	17563	8-9-13
			260	0.71	46	6978	12610	17851	17851	8-10-14
			270	0.76	47	7084	12932	18125	18125	8-10-14
10			20	0.05	-	787	1220	1996	1996	1-2-5
			30	0.12	-	3054	3704	7769	7769	2-4-7
			40	0.21	-	4493	5359	11453	11453	3-5-8
			50	0.33	-	5525	6608	14106	14106	4-6-8
			60	0.48	-	6320	7620	16152	16152	5-7-9
			70	0.65	16	6960	8476	17805	17805	5-7-10
	B2	0.165	80	0.38	16	6037	7770	15422	15422	5-6-9
			90	0.47	19	6574	8523	16807	16807	6-7-10
			100	0.59	22	7038	9204	18006	18006	6-7-10
			110	0.71	25	7446	9829	19060	19060	6-8-11
	B3	0.228	120	0.19	22	5878	8477	15014	15014	6-7-10
			130	0.22	25	6255	9071	15985	15985	6-7-10
			140	0.26	27	6596	9628	16864	16864	6-8-11
			150	0.3	29	6906	10155	17665	17665	6-8-11
			160	0.34	31	7190	10656	18400	18400	7-8-11
			170	0.38	32	7453	11135	19077	19077	7-8-12
			180	0.43	34	7695	11594	19705	19705	7-9-12
			190	0.48	36	7921	12036	20290	20290	7-9-12
			200	0.53	37	8132	12464	20837	20837	7-9-13
			210	0.58	38	8330	12879	21349	21349	6-9-13
			220	0.64	40	8516	13281	21832	21832	8-10-13
			230	0.7	41	8691	13673	22287	22287	8-10-14
			240	0.76	42	8857	14055	22717	22717	8-10-14
	B4	0.307	250	0.5	47	7450	12865	19072	19072	8-9-13
			260	0.54	48	7584	13216	19417	19417	8-10-14
			270	0.58	49	7711	13559	19746	19746	8-10-14
			280	0.62	50	7832	13897	20060	20060	8-10-14
			290	0.67	51	7949	14230	20361	20361	8-10-14
			300	0.72	52	8060	14558	20650	20650	8-10-15
			310	0.76	53	8167	14882	20926	20926	9-10-15

CBAL-24 / 1-WAY / 4 PIPE

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
4	B1	0.134	10	0.35	-	1336	1553	2714	2714	2-4-5
	B2	0.165	20	0.61	-	1754	2187	3580	3580	4-5-6
	B3	0.228	30	0.26	-	1716	2366	3502	3502	4-5-7
			40	0.47	-	2072	2938	4246	4246	5-6-8
			50	0.73	-	2340	3423	4809	4809	5-6-9
	B4	0.307	60	0.47	-	2051	3351	4201	4201	5-6-9
			70	0.64	15	2199	3715	4513	4513	6-7-10
			80	0.83	19	2326	4059	4781	4781	6-7-11
6	B1	0.134	10	0.15	-	1233	1450	2501	2501	2-3-5
			20	0.6	-	2419	2852	4977	4977	4-5-7
	B2	0.165	30	0.58	-	2528	3178	5209	5209	5-6-8
	B3	0.228	40	0.2	-	2268	3134	4658	4658	5-6-8
			50	0.32	-	2658	3741	5486	5486	5-6-9
			60	0.45	-	2966	4266	6143	6143	6-7-10
			70	0.62	15	3218	4734	6686	6686	6-7-11
			80	0.81	19	3431	5164	7147	7147	7-8-11
	B4	0.307	90	0.46	19	2937	4886	6080	6080	6-8-11
			100	0.57	22	3075	5241	6378	6378	7-8-12
			110	0.69	25	3199	5582	6644	6644	7-9-12
			120	0.82	27	3311	5910	6885	6885	7-9-13
8			20	0.33	-	2516	2949	5184	5184	3-5-7
			30	0.75	-	3342	3992	6952	6952	5-6-9
	B2	0.165	40	0.57	-	3244	4110	6742	6742	5-6-9
	B3	0.228	50	0.18	-	2777	3860	5739	5739	5-6-9
			60	0.25	-	3180	4480	6603	6603	6-7-10
			70	0.35	-	3507	5023	7311	7311	6-7-11
			80	0.45	16	3782	5515	7909	7909	7-8-11
			90	0.57	20	4017	5966	8425	8425	7-8-12
			100	0.7	23	4222	6388	8877	8877	7-9-13
	B4	0.307	110	0.41	23	3604	5987	7521	7521	7-9-12
			120	0.49	26	3746	6345	7831	7831	7-9-13
			130	0.57	28	3874	6690	8113	8113	8-9-13
			140	0.67	30	3992	7024	8371	8371	8-10-14
			150	0.76	32	4100	7349	8608	8608	8-10-14
10			20	0.21	-	2479	2912	5104	5104	3-5-7
			30	0.47	-	3503	4153	7302	7302	5-6-9
	B2	0.165	40	0.36	-	3344	4210	6957	6957	5-6-9
			50	0.57	-	3909	4992	8187	8187	6-7-10
	B3	0.228	60	0.16	-	3255	4555	6764	6764	6-7-10
			70	0.22	-	3659	5175	7641	7641	6-7-11
			80	0.29	-	3995	5728	8376	8376	7-8-11
			90	0.37	18	4281	6230	9007	9007	7-8-12
			100	0.45	21	4529	6695	9558	9558	7-9-13
			110	0.55	24	4747	7130	10046	10046	8-9-13
			120	0.65	26	4942	7541	10483	10483	8-10-14
			130	0.77	28	5117	7933	10877	10877	8-10-14
	B4	0.307	140	0.46	30	4358	7390	9180	9180	8-10-14
			150	0.53	32	4488	7737	9467	9467	8-10-14
			160	0.6	34	4607	8073	9733	9733	9-11-15
			170	0.68	36	4717	8399	9979	9979	9-11-15
			180	0.76	37	4820	8719	10210	10210	9-11-16

CBAL-24 / 2-WAY / 4 PIPE

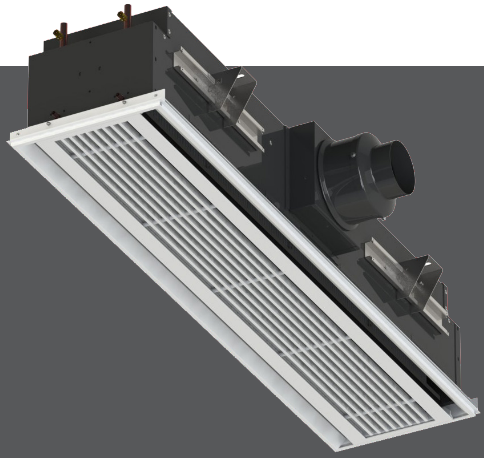
Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
4	B1	0.134	20	0.35	-	2227	2660	4523	4523	2-4-5
			30	0.8	-	3018	3668	6165	6165	4-5-7
	B2	0.165	40	0.61	-	2923	3789	5967	5967	4-5-6
	B3	0.228	50	0.19	-	2473	3556	5033	5033	4-5-6
			60	0.27	-	2861	4161	5837	5837	4-5-7
			70	0.37	-	3181	4697	6506	6506	4-5-8
			80	0.48	17	3454	5187	7077	7077	5-6-8
			90	0.61	20	3690	5639	7575	7575	5-6-9
			100	0.75	23	3899	6065	8015	8015	5-6-9
	B4	0.307	110	0.42	22	3276	5659	6705	6705	5-6-9
			120	0.5	25	3418	6017	7002	7002	5-7-9
			130	0.58	27	3547	6363	7273	7273	6-7-10
			140	0.67	29	3665	6697	7522	7522	6-7-10
			150	0.77	31	3775	7024	7753	7753	6-7-10
6	B1	0.134	20	0.15	-	2055	2488	4169	4169	2-3-5
			30	0.34	-	3240	3890	6629	6629	3-5-7
			40	0.6	-	4032	4898	8296	8296	4-5-8
	B2	0.165	50	0.41	-	3685	4768	7564	7564	4-5-7
			60	0.58	-	4214	5514	8681	8681	5-6-8
			70	0.79	-	4647	6163	9604	9604	5-6-9
	B3	0.228	80	0.2	-	3780	5513	7764	7764	5-6-8
			90	0.26	-	4127	6076	8497	8497	5-6-9
			100	0.32	-	4431	6597	9143	9143	5-6-9
			110	0.38	-	4701	7084	9719	9719	5-7-10
			120	0.46	-	4943	7542	10238	10238	6-7-10
			130	0.54	17	5163	7979	10710	10710	6-7-10
			140	0.62	19	5364	8396	11143	11143	6-8-11
			150	0.71	21	5548	8797	11541	11541	6-8-11
	B4	0.307	160	0.37	19	4632	8098	9571	9571	6-8-11
			170	0.42	21	4767	8449	9861	9861	6-8-11
			180	0.47	22	4894	8793	10133	10133	7-8-11
			190	0.52	24	5014	9129	10389	10389	7-8-12
			200	0.57	25	5126	9458	10630	10630	7-8-12
			210	0.63	27	5232	9781	10858	10858	7-9-12
			220	0.69	28	5332	10097	11074	11074	7-9-12
			230	0.76	29	5427	10409	11280	11280	7-9-13

CBAL-24 / 2-WAY / 4 PIPE CONTINUED

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe: Cooling Only		Heating Only		Throw 150-100-50 fpm/ft
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
8	B1	0.134	30	0.19	-	3140	3790	6420	6420	3-4-7
			40	0.33	-	4194	5060	8639	8639	3-5-8
			50	0.52	-	4966	6049	10286	10286	4-6-8
			60	0.75	-	5569	6869	11587	11587	5-7-9
	B2	0.165	70	0.44	-	4930	6446	10209	10209	5-6-9
			80	0.57	-	5407	7140	11236	11236	5-6-9
			90	0.73	-	5816	7765	12122	12122	6-7-10
	B3	0.228	100	0.18	-	4629	6795	9565	9565	5-6-9
			110	0.22	-	4983	7366	10324	10324	5-7-10
			120	0.26	-	5300	7899	11005	11005	6-7-10
			130	0.3	-	5586	8402	11622	11622	6-7-10
			140	0.35	16	5845	8877	12185	12185	6-8-11
			150	0.4	18	6083	9332	12703	12703	6-8-11
			160	0.46	20	6303	9769	13182	13182	7-8-11
			170	0.51	22	6506	10188	13627	13627	7-8-12
			180	0.58	23	6694	10593	14042	14042	7-9-12
			190	0.64	25	6871	10986	14430	14430	7-9-12
			200	0.71	26	7036	11368	14795	14795	7-9-13
			210	0.78	28	7192	11741	15140	15140	8-9-13
	B4	0.307	220	0.42	27	6006	10771	12535	12535	7-9-12
			230	0.46	29	6128	11110	12800	12800	7-9-13
			240	0.5	30	6243	11441	13052	13052	8-9-13
			250	0.54	31	6353	11768	13292	13292	8-9-13
			260	0.59	32	6457	12089	13521	13521	8-10-14
			270	0.63	33	6557	12405	13741	13741	8-10-14
			280	0.68	34	6653	12718	13951	13951	8-10-14
			290	0.73	35	6745	13026	14153	14153	8-10-14
			300	0.78	36	6833	13331	14347	14347	8-10-15
10	B1	0.134	30	0.12	-	2798	3448	5706	5706	2-4-7
			40	0.21	-	4131	4997	8507	8507	3-5-8
			50	0.33	-	5094	6177	10562	10562	4-6-8
			60	0.47	-	5839	7139	12171	12171	5-7-9
			70	0.64	-	6441	7957	13484	13484	5-7-10
	B2	0.165	80	0.36	-	5573	7306	11594	11594	5-6-9
			90	0.46	-	6077	8026	12690	12690	6-7-10
			100	0.57	-	6514	8680	13646	13646	6-7-10
			110	0.69	15	6899	9282	14492	14492	6-8-11
	B3	0.228	120	0.17	-	5124	8023	11273	11273	6-7-10
			130	0.2	-	5778	8594	12039	12039	6-7-10
			140	0.23	-	6098	9130	12735	12735	6-8-11
			150	0.26	-	6390	9639	13373	13373	6-8-11
			160	0.3	18	6658	10124	13961	13961	7-8-11
			170	0.33	20	6905	10587	14505	14505	7-8-12
			180	0.37	22	7134	11033	15012	15012	7-9-12
			190	0.42	23	7348	11463	15486	15486	7-9-12
			200	0.46	25	7548	11880	15931	15931	7-9-13
			210	0.51	26	7735	12284	16349	16349	8-9-13
			220	0.56	27	7912	12677	16743	16743	8-10-13
			230	0.61	29	8078	13060	17117	17117	8-10-14
			240	0.66	30	8236	13434	17471	17471	8-10-14
			250	0.72	31	8386	13801	17808	17808	8-10-14
			260	0.78	32	8528	14160	18129	18129	8-10-15
	B4	0.307	270	0.44	33	7149	12997	15045	15045	8-10-14
			280	0.48	34	7264	13329	15300	15300	8-10-14
			290	0.51	35	7374	13655	15544	15544	8-10-14
			300	0.55	36	7479	13977	15778	15778	8-10-15
			310	0.58	37	7581	14296	16004	16004	9-10-15
			320	0.62	38	7678	14609	16221	16221	9-11-15
			330	0.66	39	7772	14920	16430	16430	9-11-15
			340	0.7	40	7862	15226	16632	16632	9-11-16
			350	0.74	41	7949	15530	16827	16827	9-11-16
			360	0.79	41	8033	15831	17016	17016	9-11-16

CBAL-12

- CBAL-12 is a linear active chilled beam diffuser with 1-way and 2-way air distribution
- Unique linear design provides high induction and low noise levels
- Available in cooling & supply air or cooling, heating & supply air configurations
- Insulated plenum for improving performance and to prevent condensation
- Available as diffuser shell (no coil/piping)
- Accessories include rubber lip seal, stainless steel hoses with or without isolation ball valves
- Standard finish is #26 white paint on diffuser face
- Diffuser is designed to fit into standard module ceiling grids 12" in width



CBAL-12

energy solutions

See website for Specifications

AVAILABLE MODEL:

CBAL-12

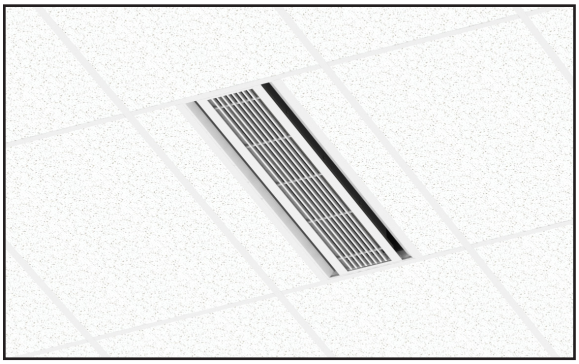
OVERVIEW

Titus active chilled beams features the aerodynamic properties of Titus ceiling diffusers with the extra benefits of using hydronic coils and induced air to reduce the high sensible thermal loads. The primary air from the DOAS is supplied to the ceiling mounted or sidewall chilled beams subsequent to it being discharged through a series of nozzles located along the length of the beam and this causes room air to be induced through one or two coils and mixes with the primary supply air. This mixture of air is then discharged into the space through the ceiling slot diffusers. This provides high cooling outputs with low amounts of primary air. The reduced volume of air results in the reduction of the air handler capacity and size, smaller duct sizes, and the overall energy consumption.

The supplied air from the DOAS unit is tempered and dehumidified to handle the latent load. The remaining loads in the space are addressed with the heat exchanger which is incorporated into the chilled beam.

ADVANTAGES

- Removal of high thermal loads is possible in this air/water system
- The height of the air duct system is reduced to a minimum, due to the low supply of primary air
- Substantial reduction in the operating costs, due to low primary air volume
- Improvement of the thermal comfort inside the room
- Individual adjustment of the primary air volume by means of the nozzle configuration
- Suitable for several standard ceiling grids
- Contributing sound levels below NC-30



Rendering of CBAL-12 installed in a ceiling

CEILING MOUNTED, LINEAR ACTIVE CHILLED BEAM

The CBAL's are offered for both, cooling and heating, in 12" and 24" widths and lengths from 2 to 10 ft. They can be easily integrated into different grids styles within a suspended ceiling, drywall ceiling or exposed.

The low overall height of the CBAL product line is ideal for reducing the space required for false ceiling in any application.

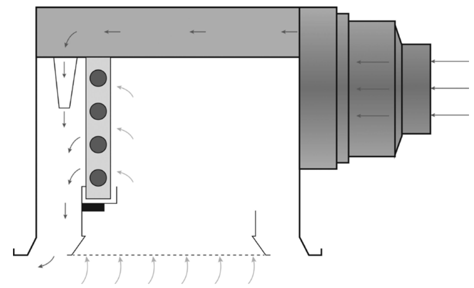
CBAL-12 STANDARD FEATURES

- 1 way and 2 way air pattern
- 2 to 10 foot chilled beam length in 1 foot increment
- 2 and 4 pipe coil configurations
- Cooling and/or heating coils
- Left or right hand pipe configurations
- ½" SWT or MNPT water connections
- Air vent
- Multiple nozzle sizes are available to vary the primary air supply and chilled beam performance
- Perforated round or linear bar return grille facing
- Hinged access return grille panel for easy room side access to the coil
- Heavy gauge, galvanized steel casing
- Top or side air inlet; several diameters available
- Contributing sound levels below NC30
- Adjustable mounting brackets
- Internally painted surface
- Pressure port for air-side balancing and flow verification
- Polyester painted white (RAL 9010)

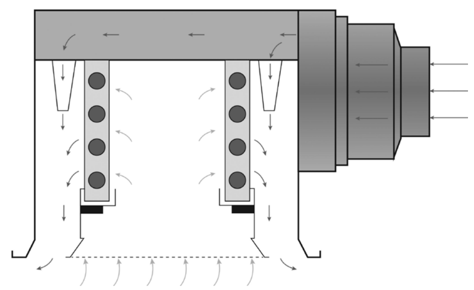
OPTIONS

- EcoShield, anti-microbial insulation
- Separate or additional primary air supply
- Diffuser shell only (no coil/piping)
- 12", 18" and 24" return/exhaust box extension
- Lay-in, NT and DF Tegular mounting frame
- Custom color matching
- Stainless steel hoses and valves
- Slim-less coupling for continuous look
- Drain connection
- Thermostat and humidity sensors

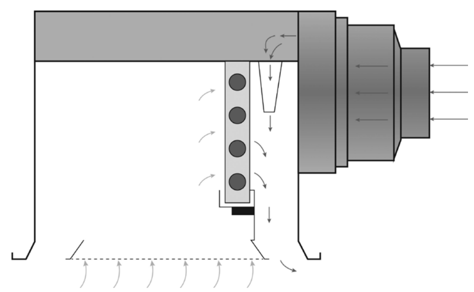
CBAL-12 1 Way (back)



CBAL-12 2 Way



CBAL-12 1 Way (front)



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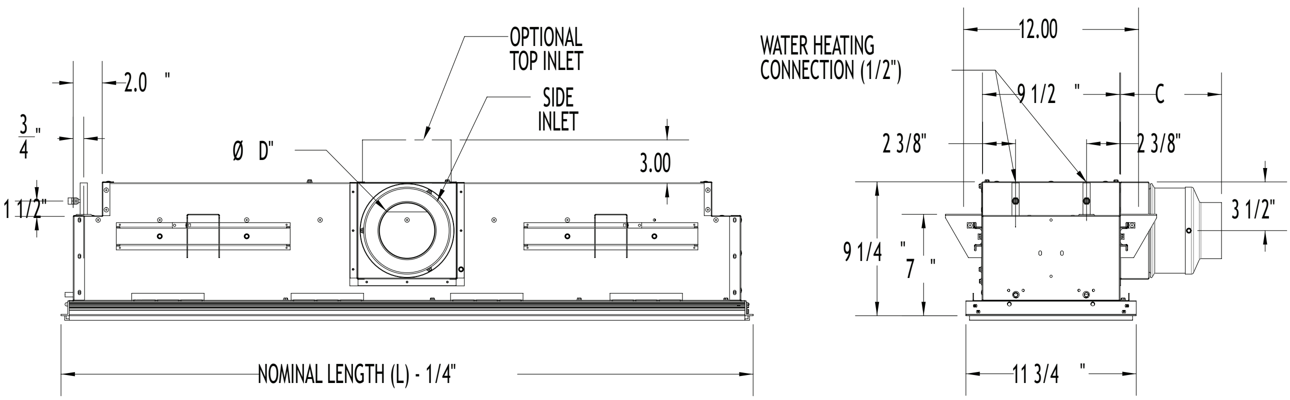
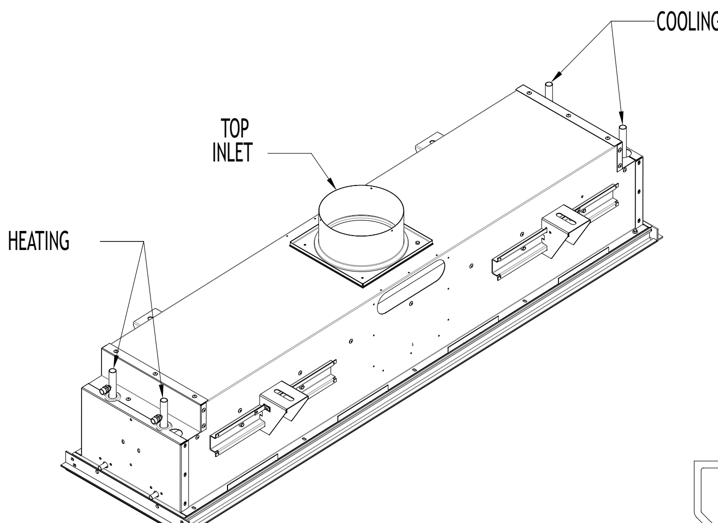
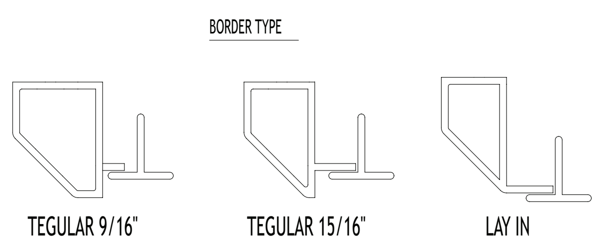
CBAL-12" WIDTH



4 PIPE RIGHT HAND 2 WAY, SIDE INLET IS SHOWN

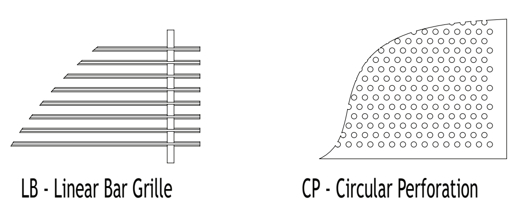


4 PIPE RIGHT HAND 2 WAY,
TOP INLET IS SHOWN



NOTES:

HAND OF UNIT DETERMINED BY COOLING WATER SUPPLY CONNECTION WHEN FACING HORIZONTAL AIR INLET CONNECTION.



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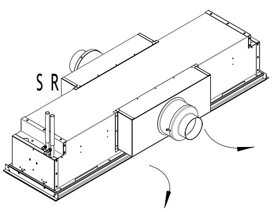
DIMENSIONS

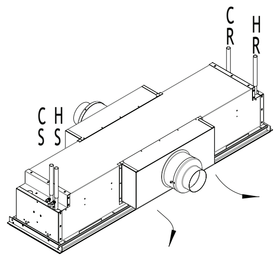
All dimensions are in inches

CBAL-12" CASING ARRANGEMENTS

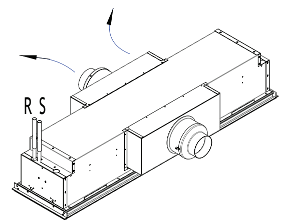
12 INCHES CASING ARRANGEMENTS



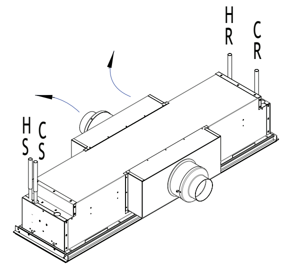
SIDE INLET
1 WAY 2 PIPE
LEFT HAND
AIR FLOW FRONT
(RIGHT HAND
AIR FLOW BACK)



SIDE INLET
1 WAY 4 PIPE
LEFT HAND
AIR FLOW FRONT
(RIGHT HAND
AIR FLOW BACK)

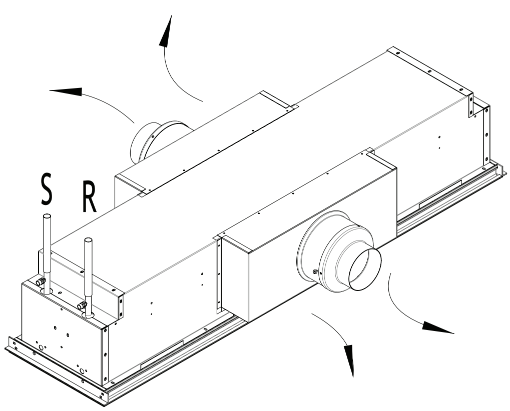


SIDE INLET
1 WAY 2 PIPE
LEFT HAND
AIR FLOW BACK
(RIGHT HAND
AIR FLOW FRONT)

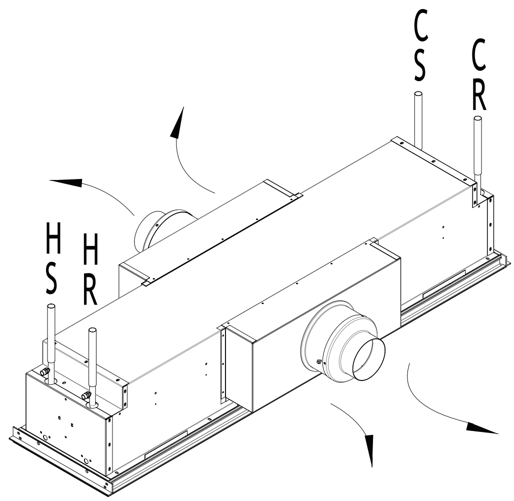


SIDE INLET
1 WAY 4 PIPE
LEFT HAND
AIR FLOW BACK
(RIGHT HAND
AIR FLOW FRONT)

CBAL-12" CASING ARRANGEMENTS

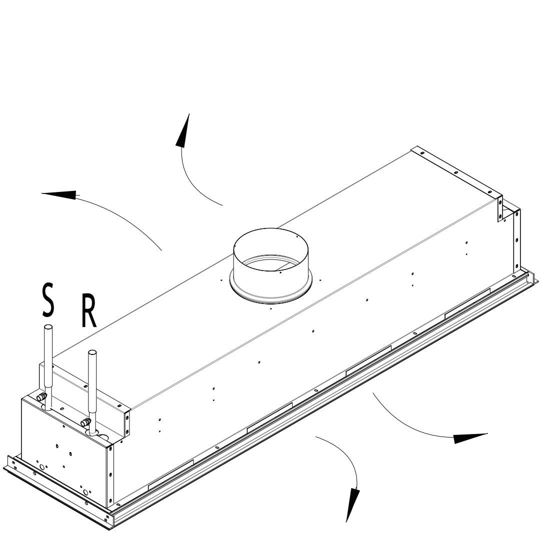


SIDE INLET
2 WAY 2 PIPE
LEFT HAND
(RIGHT HAND)

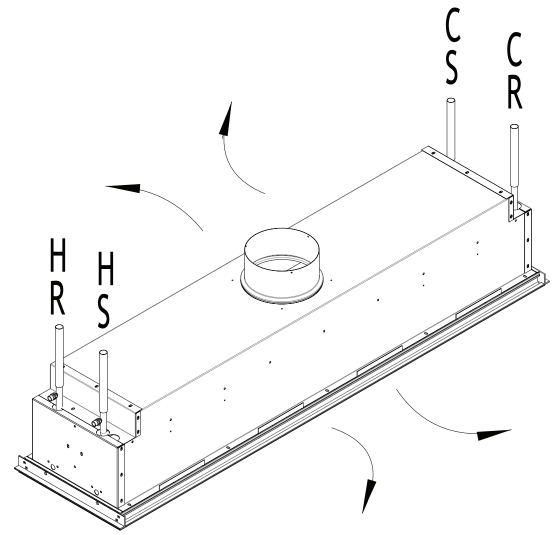


SIDE INLET
2 WAY 4 PIPE
RIGHT HAND
(LEFT HAND)

CBAL-12" CASING ARRANGEMENTS

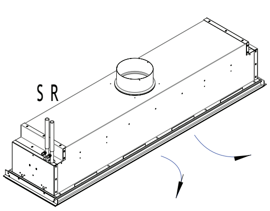


TOP INLET
2 WAY 2 PIPE

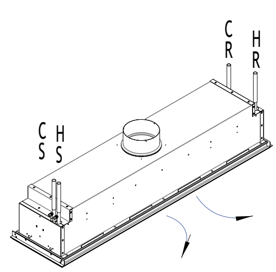


TOP INLET
2 WAY 4 PIPE

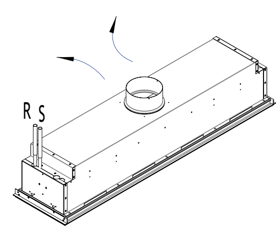
CBAL-12" CASING ARRANGEMENTS



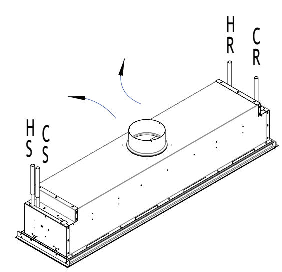
TOP INLET
1 WAY 2 PIPE
LEFT HAND
AIR FLOW FRONT



TOP INLET
1 WAY 4 PIPE
LEFT HAND
AIR FLOW FRONT



TOP INLET
1 WAY 2 PIPE
RIGHT HAND
AIR FLOW BACK



TOP INLET
1 WAY 4 PIPE
RIGHT HAND
AIR FLOW BACK

CBAL-12 / 1-WAY / 2 PIPE

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe: Cooling Only: Coil Btu-h	Capacity - 2 Pipe: Cooling Only: Total Btu-h	Capacity - 2 Pipe: Heating Only: Coil Btu-h	Capacity - 2 Pipe: Heating Only: Total Btu-h	Throw 150-100-50 fpm/ft
4	A1	0.24	10	0.13	-	557	774	1485	1485	2-3-6
			20	0.51	-	940	1373	2507	2507	4-6-8
	A2	0.32	30	0.37	-	1064	1714	2838	2838	5-7-10
			40	0.65	-	1276	2142	3402	3402	7-8-11
	A3	0.39	50	0.42	-	1177	2260	3139	3139	7-8-12
			60	0.61	-	1321	2621	3523	3523	8-9-13
			70	0.83	17	1455	2971	3879	3879	8-10-14
6	A1	0.24	10	0.07	-	1072	1289	2858	2858	1-3-5
			20	0.29	-	1057	1490	2818	2818	4-5-8
			30	0.65	-	1392	2042	3713	3713	5-7-10
	A2	0.32	40	0.37	-	1461	2327	3896	3896	6-8-11
			50	0.58	-	1680	2763	4480	4480	7-9-13
			60	0.83	-	1881	3181	5015	5015	8-10-14
	A3	0.39	70	0.47	-	1664	3180	4438	4438	8-10-14
			80	0.61	18	1809	3542	4824	4824	9-11-15
			90	0.78	21	1946	3895	5189	5189	9-11-16
8	A1	0.24	10	0.04	-	903	1120	2408	2408	1-2-5
			20	0.15	-	1097	1530	2925	2925	3-5-8
			30	0.35	-	1516	2166	4042	4042	5-7-10
			40	0.61	-	1833	2699	4887	4887	6-8-12
			50	0.96	-	2110	3193	5626	5626	7-9-13
	A2	0.32	60	0.44	-	2068	3368	5514	5514	8-10-14
			70	0.6	15	2273	3789	6060	6060	9-11-15
			80	0.79	19	2464	4197	6572	6572	9-11-16
	A3	0.39	90	0.42	18	2137	4086	5697	5697	9-11-16
			100	0.52	21	2280	4446	6080	6080	10-12-17
			110	0.63	24	2417	4800	6446	6446	10-12-18
			120	0.75	27	2548	5147	6796	6796	11-13-18
10	A1	0.24	10	0.02	-	943	1160	2514	2514	1-1-4
			20	0.1	-	793	1226	2114	2114	2-4-8
			30	0.21	-	1598	2248	4260	4260	4-6-10
			40	0.38	-	1958	2824	5221	5221	6-8-12
			50	0.59	-	2262	3345	6032	6032	7-9-13
			60	0.86	-	2535	3835	6760	6760	8-10-14
	A2	0.32	70	0.38	-	2443	3959	6514	6514	8-11-15
			80	0.49	17	2650	4383	7066	7066	9-11-16
			90	0.62	20	2844	4793	7585	7585	10-12-17
			100	0.77	23	3029	5195	8077	8077	10-13-18
	A3	0.39	110	0.4	22	2596	4979	6922	6922	10-12-18
			120	0.48	25	2737	5336	7299	7299	11-13-18
			130	0.56	27	2873	5689	7661	7661	11-14-19
			140	0.65	29	3004	6036	8010	8010	11-14-20
			150	0.74	31	3130	6379	8347	8347	12-15-21
			160	0.84	33	3252	6718	8673	8673	12-15-21

CBAL-12 / 2-WAY / 2 PIPE

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe: Cooling Only: Coil Btu-h	Capacity - 2 Pipe: Cooling Only: Total Btu-h	Capacity - 2 Pipe: Heating Only: Coil Btu-h	Capacity - 2 Pipe: Heating Only: Total Btu-h	Throw 150-100-50 fpm/ft
4	A1	0.24	10	0.03	-	823	1040	2194	2194	0-1-3
			20	0.13	-	1000	1433	2667	2667	2-3-6
			30	0.29	-	1383	2033	3689	3689	3-5-7
			40	0.52	-	1674	2540	4464	4464	4-6-8
			50	0.81	-	1928	3011	5142	5142	5-6-9
	A2	0.32	60	0.37	-	1890	3190	5039	5039	5-7-9
			70	0.51	-	2078	3594	5541	5541	6-7-10
			80	0.66	18	2254	3987	6012	6012	6-8-11
			90	0.84	22	2421	4370	6456	6456	7-8-11
	A3	0.39	100	0.44	21	2085	4251	5559	5559	6-8-11
			110	0.53	23	2211	4594	5896	5896	7-8-12
			120	0.63	26	2332	4931	6218	6218	7-9-12
			130	0.74	28	2448	5264	6528	6528	7-9-13
			140	0.86	30	2560	5592	6828	6828	8-9-13
6	A1	0.24	10	0.02	-	904	1121	2410	2410	0-1-2
			20	0.07	-	1902	2335	3178	3178	1-2-5
			30	0.16	-	1479	2129	3945	3945	2-4-7
			40	0.29	-	1876	2742	5004	5004	3-5-8
			50	0.46	-	2183	3266	5822	5822	4-6-9
			60	0.66	-	2454	3754	6543	6543	5-7-10
	A2	0.32	70	0.29	-	2368	3884	6314	6314	5-7-10
			80	0.38	16	2571	4304	6856	6856	5-8-11
			90	0.48	19	2762	4711	7365	7365	6-8-11
			100	0.59	22	2943	5109	7847	7847	7-9-12
			110	0.72	25	3115	5498	8305	8305	7-9-13
	A3	0.39	120	0.37	24	2654	5253	7078	7078	7-9-12
			130	0.44	26	2787	5603	7433	7433	7-9-13
			140	0.51	28	2915	5947	7774	7774	7-9-13
			150	0.58	30	3039	6288	8104	8104	8-10-13
			160	0.66	32	3159	6625	8424	8424	8-10-14
			170	0.75	34	3275	6957	8734	8734	8-10-14

CBAL-12 / 2-WAY / 2 PIPE CONTINUED

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe: Cooling Only Coil Btu-h	Capacity - 2 Pipe: Cooling Only Total Btu-h	Capacity - 2 Pipe: Heating Only Coil Btu-h	Capacity - 2 Pipe: Heating Only Total Btu-h	Throw 150-100-50 fpm/ft
8	A1	0.24	10	0.01	-	988	1205	2635	2635	0-0-1
			20	0.04	-	1609	2042	4289	4289	1-1-4
			30	0.1	-	1778	2427	4739	4739	2-3-6
			40	0.16	-	1946	2812	5189	5189	3-4-8
			50	0.24	-	2348	3431	6262	6262	4-5-9
			60	0.35	-	2664	3964	7105	7105	4-6-10
			70	0.48	-	2943	4459	7849	7849	5-7-10
			80	0.63	18	3199	4932	8531	8531	6-8-11
			90	0.79	21	3437	5386	9165	9165	6-8-12
	A2	0.32	100	0.33	20	3221	5387	8590	8590	6-9-12
			110	0.4	22	3410	5793	9094	9094	6-9-13
			120	0.47	25	3591	6190	9575	9575	7-9-13
			130	0.55	27	3763	6579	10035	10035	7-10-14
			140	0.64	29	3929	6961	10478	10478	8-10-14
			150	0.73	31	4089	7338	10904	10904	9-10-15
	A3	0.39	160	0.38	31	3454	6920	9211	9211	7-10-14
			170	0.43	33	3581	7263	9550	9550	7-10-14
			180	0.48	34	3705	7604	9879	9879	8-10-15
			190	0.54	36	3825	7940	10199	10199	8-11-15
			200	0.59	37	3941	8273	10510	10510	9-11-16
			210	0.65	39	4055	8604	10813	10813	9-11-16
			220	0.72	40	4166	8931	11109	11109	9-12-16
10	A1	0.24	10	0.01	-	1063	1280	2835	2835	0-0-1
			20	0.03	-	1678	2111	4475	4475	0-1-4
			30	0.06	-	2409	3059	5225	5225	1-2-6
			40	0.1	-	1416	2282	5975	5975	2-4-8
			50	0.15	-	2400	3483	6400	6400	3-5-9
			60	0.22	-	2803	4103	7474	7474	4-6-10
			70	0.3	-	3124	4640	8331	8331	4-7-10
			80	0.39	16	3408	5141	9089	9089	5-8-11
			90	0.5	19	3669	5618	9784	9784	6-8-12
			100	0.61	22	3912	6078	10432	10432	6-9-12
			110	0.74	25	4141	6524	11042	11042	7-9-13
	A2	0.32	120	0.3	23	3844	6443	10252	10252	6-9-13
			130	0.36	26	4030	6846	10747	10747	7-10-14
			140	0.41	28	4208	7240	11221	11221	7-10-14
			150	0.48	30	4379	7628	11677	11677	8-10-15
			160	0.54	32	4544	8010	12117	12117	8-11-15
			170	0.61	33	4703	8385	12542	12542	9-11-16
			180	0.68	35	4857	8756	12953	12953	9-11-16
			190	0.76	36	5007	9122	13352	13352	10-12-17
	A3	0.39	200	0.41	37	4216	8548	11243	11243	8-11-16
			210	0.45	38	4338	8887	11568	11568	8-11-16
			220	0.49	40	4457	9222	11884	11884	9-12-16
			230	0.54	41	4572	9554	12192	12192	9-12-17
			240	0.58	42	4685	9883	12493	12493	9-12-17
			250	0.63	43	4795	10210	12788	12788	10-12-17
			260	0.68	45	4903	10535	13075	13075	10-13-18
			270	0.74	46	5009	10857	13357	13357	10-13-18
			280	0.79	47	5112	11177	13633	13633	11-13-18

CBAL-12 / 4-WAY / 1 PIPE

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
4	A1	0.24	10	0.13	-	502	719	897	897	2-3-6
			20	0.51	-	848	1281	1520	1520	4-6-8
	A2	0.32	30	0.37	-	961	1611	1723	1723	5-7-10
			40	0.65	-	1152	2018	2071	2071	7-8-11
	A3	0.39	50	0.42	-	1063	2146	1909	1909	7-8-12
			60	0.61	-	1193	2493	2145	2145	8-9-13
			70	0.83	17	1315	2831	2366	2366	8-10-14
6	A1	0.24	10	0.07	-	967	1184	1735	1735	1-3-5
			20	0.29	-	954	1387	1999	1999	4-5-8
			30	0.65	-	1258	1908	2263	2263	5-7-10
	A2	0.32	40	0.37	-	1320	2186	2376	2376	6-8-11
			50	0.58	-	1519	2602	2739	2739	7-9-13
			60	0.83	-	1701	3001	3073	3073	8-10-14
	A3	0.39	70	0.47	-	1505	3021	2713	2713	8-10-14
			80	0.61	18	1636	3369	2954	2954	9-11-15
			90	0.78	21	1761	3710	3182	3182	9-11-16
8	A1	0.24	10	0.04	-	815	1032	1459	1459	1-2-5
			20	0.15	-	990	1423	1777	1777	3-5-8
			30	0.35	-	1370	2020	2467	2467	5-7-10
			40	0.61	-	1658	2524	2993	2993	6-8-12
	A2	0.32	50	0.31	-	1670	2753	3015	3015	6-9-13
			60	0.44	-	1872	3172	3386	3386	8-10-14
			70	0.6	-	2058	3574	3730	3730	9-11-15
			80	0.79	19	2233	3966	4054	4054	9-11-16
	A3	0.39	90	0.42	18	1934	3883	3502	3502	9-11-16
			100	0.52	21	2065	4231	3743	3743	10-12-17
			110	0.63	24	2190	4573	3974	3974	10-12-18
			120	0.75	27	2310	4909	4196	4196	11-13-18
10	A1	0.24	10	0.02	-	851	1068	1524	1524	1-1-4
			20	0.1	-	715	1148	1280	1280	2-4-8
			30	0.21	-	1444	2094	2602	2602	4-6-10
			40	0.38	-	1772	2638	3203	3203	6-8-12
			50	0.59	-	2049	3132	3713	3713	7-9-13
	A2	0.32	60	0.28	-	2011	3311	3644	3644	7-10-14
			70	0.38	-	2214	3730	4018	4018	8-11-15
			80	0.49	17	2402	4135	4368	4368	9-11-16
			90	0.62	20	2580	4529	4699	4699	10-12-17
			100	0.77	23	2749	4915	5015	5015	10-13-18
	A3	0.39	110	0.4	22	2353	4736	4276	4276	10-12-18
			120	0.48	25	2482	5081	4517	4517	11-13-18
			130	0.56	27	2606	5422	4748	4748	11-14-19
			140	0.65	29	2726	5758	4972	4972	11-14-20
			150	0.74	31	2842	6091	5189	5189	12-15-21

CBAL-12 / 2-WAY / 4 PIPE

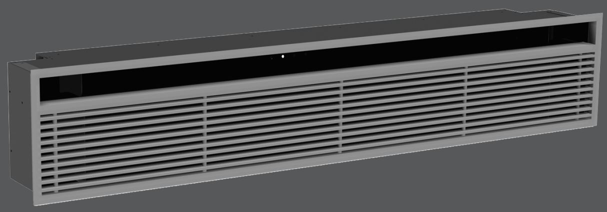
Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
4	A1	0.24	10	0.03	-	742	959	1328	1328	0-1-3
			20	0.13	-	902	1335	1618	1618	2-3-6
			30	0.29	-	1250	1900	2248	2248	3-5-7
			40	0.52	-	1514	2380	2729	2729	4-6-8
	A2	0.32	50	0.26	-	1525	2608	2749	2749	4-6-9
			60	0.37	-	1710	3010	3088	3088	5-7-9
			70	0.51	-	1881	3397	3403	3403	6-7-10
			80	0.66	18	2042	3775	3700	3700	6-8-11
	A3	0.39	90	0.36	18	1767	3716	3194	3194	6-7-10
			100	0.44	21	1887	4053	3415	3415	6-8-11
			110	0.53	23	2002	4385	3626	3626	7-8-12
			120	0.63	26	2112	4711	3830	3830	7-9-12
			130	0.74	28	2218	5034	4027	4027	7-9-13
6	A1	0.24	10	0.02	-	815	1032	1460	1460	0-1-2
			20	0.07	-	1721	2154	1934	1934	1-2-5
			30	0.16	-	1337	1987	2407	2407	2-4-7
			40	0.29	-	1698	2564	3066	3066	3-5-8
			50	0.46	-	1977	3060	3580	3580	4-6-9
			60	0.66	-	2224	3524	4036	4036	5-7-10
	A2	0.32	70	0.29	-	2145	3661	3891	3891	5-7-10
			80	0.38	16	2330	4063	4234	4234	5-8-11
			90	0.48	19	2505	4454	4559	4559	6-8-11
			100	0.59	22	2670	4836	4867	4867	7-9-12
			110	0.72	25	2828	5211	5162	5162	7-9-13
	A3	0.39	120	0.37	24	2406	5005	4376	4376	6-9-12
			130	0.44	26	2528	5344	4602	4602	7-9-13
			140	0.51	28	2645	5677	4821	4821	7-9-13
			150	0.58	30	2759	6008	5033	5033	8-10-13
			160	0.66	32	2868	6334	5238	5238	8-10-14
			170	0.75	34	2975	6657	5438	5438	8-10-14

CBAL-12 / 4-WAY / 1 PIPE

Unit Length ft	Nozzle Size	Nozzle Dia	Airflow CFM Total (Primary)	Static Pressure in.	Sound NC	Capacity - 2 Pipe				Throw 150-100-50 fpm/ft
						Cooling Only		Heating Only		
						Coil Btu-h	Total Btu-h	Coil Btu-h	Total Btu-h	
8	A1	0.24	10	0.01	-	892	1109	1599	1599	0-0-1
			20	0.04	-	1454	1887	2620	2620	1-1-4
			30	0.09	-	1608	2257	2901	2901	1-3-6
			40	0.16	-	1761	2627	3182	3182	3-4-8
			50	0.24	-	2127	3210	3858	3858	4-5-9
			60	0.35	-	2416	3716	4393	4393	4-6-10
			70	0.48	-	2671	4187	4869	4869	5-7-10
			80	0.63	18	2905	4638	5307	5307	6-8-11
			90	0.79	21	3123	5072	5717	5717	6-8-12
	A2	0.32	100	0.33	20	2925	5091	5345	5345	6-9-12
			110	0.4	22	3099	5482	5671	5671	6-9-13
			120	0.47	25	3264	5863	5984	5984	7-9-13
			130	0.55	27	3423	6239	6284	6284	7-10-14
			140	0.64	29	3575	6607	6574	6574	8-10-14
			150	0.73	31	3722	6971	6854	6854	9-10-15
	A3	0.39	160	0.38	31	3139	6605	5747	5747	7-10-14
			170	0.43	33	3255	6937	5967	5967	7-10-14
			180	0.48	34	3369	7268	6182	6182	8-10-15
			190	0.54	36	3479	7594	6391	6391	8-11-15
			200	0.59	37	3586	7918	6595	6595	9-11-16
			210	0.65	39	3691	8240	6794	6794	9-11-16
			220	0.72	40	3793	8558	6989	6989	9-12-16
			230	0.79	41	3893	8875	7179	7179	10-12-17
10	A1	0.24	10	0.01	-	960	1177	1722	1722	0-0-1
			20	0.03	-	1517	1950	2736	2736	0-1-4
			30	0.06	-	2183	2833	3961	3961	1-2-6
			40	0.1	-	1279	2145	2301	2301	2-4-8
			50	0.15	-	2174	3257	3945	3945	3-5-9
			60	0.22	-	2542	3842	4629	4629	4-6-10
			70	0.3	-	2836	4352	5178	5178	4-7-10
			80	0.39	16	3097	4830	5668	5668	5-8-11
			90	0.5	19	3336	5285	6120	6120	6-8-12
			100	0.61	22	3559	5725	6543	6543	6-9-12
			110	0.74	25	3770	6153	6945	6945	7-9-13
	A2	0.32	120	0.3	23	3497	6096	6426	6426	6-9-13
			130	0.36	26	3668	6484	6750	6750	7-10-14
			140	0.41	28	3832	6864	7063	7063	7-10-14
			150	0.48	30	3990	7239	7365	7365	8-10-15
			160	0.54	32	4142	7608	7657	7657	8-11-15
			170	0.61	33	4289	7971	7940	7940	9-11-16
			180	0.68	35	4432	8331	8215	8215	9-11-16
			190	0.76	36	4570	8685	8483	8483	10-12-17
	A3	0.39	200	0.41	37	3840	8172	7078	7078	8-11-16
			210	0.45	38	3952	8501	7292	7292	8-11-16
			220	0.49	40	4061	8826	7502	7502	9-12-16
			230	0.54	41	4168	9150	7707	7707	9-12-17
			240	0.58	42	4272	9470	7908	7908	9-12-17
			250	0.63	43	4374	9789	8104	8104	10-12-17
			260	0.68	45	4474	10106	8297	8297	10-13-18
			270	0.74	46	4572	10420	8487	8487	10-13-18
			280	0.79	47	4667	10732	8672	8672	11-13-18

DISA-V

- DISA-V is a linear sidewall active chilled beam diffuser with horizontal air distribution
- Unique linear design provides high induction and low noise levels
- Configurable as cooling & supply air (CO) or cooling, heating & supply air (CH) configurations
- Available as diffuser shell (no coil/piping)
- Accessories include rubber lip seal
- Standard finish is RAL 9010 white paint on diffuser face
- Diffuser is designed to be recessed into a sidewall, soffit or bulkhead



DISA-V

energy solutions

See website for Specifications

AVAILABLE MODEL:

DISA-V

OVERVIEW

The DISA-V sidewall active chilled beam diffuser was developed for removing high thermal loads from the space. Supplied with tempered and dehumidified primary air, to handle the latent load, the beam addresses the remaining loads in the space with a heat exchanger installed in the unit. Decoupling the latent and sensible loads takes advantage of the superior volumetric heat capacity of water. The reduced the volume of air that must be delivered to the space results in reducing air handler capacity and size, smaller duct sizes, and overall energy savings.

In the primary distribution channel, CNC formed nozzles are precisely arranged. The number and size of nozzles (A, B, C, D) can be varied, thus allowing optimum adjustment of the primary supply air volume. By reducing the primary air to meet the minimum requirements for either room ventilation or latent load in the space, total system energy costs are reduced.

The primary air, supplied by the air distribution system is supplied to the mixing chamber via induction nozzles. In the mixing chamber, room air is induced through a vertically mounted heat exchanger, to address sensible loads in the space. The primary air is mixed with the cooled secondary air and supplied to the room in a horizontal throw pattern through 1-slot diffuser integrated into the unit design.

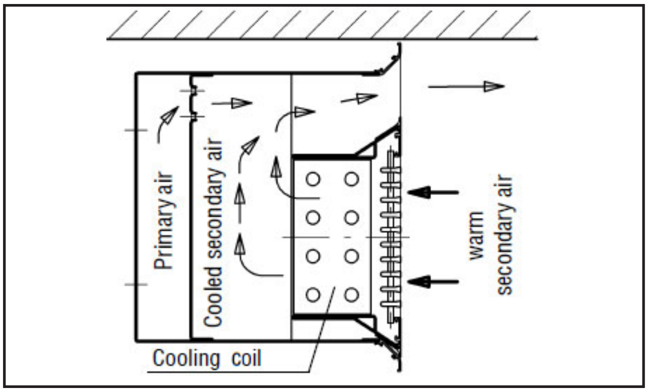
DISA-V chilled beams are available in a multitude of configurations, resulting in products that easily integrate into any building or design. These products have been designed to address heating and cooling loads in the space, with either a 2-pipe or 4-pipe system. The construction of the DISA-V product line is ideal for installation in soffits and sidewalls where ceiling space is limited. The horizontal throw pattern is enables comfortable cooling to be delivered to small spaces by effectively rolling without creating drafts.

INSTALLATION

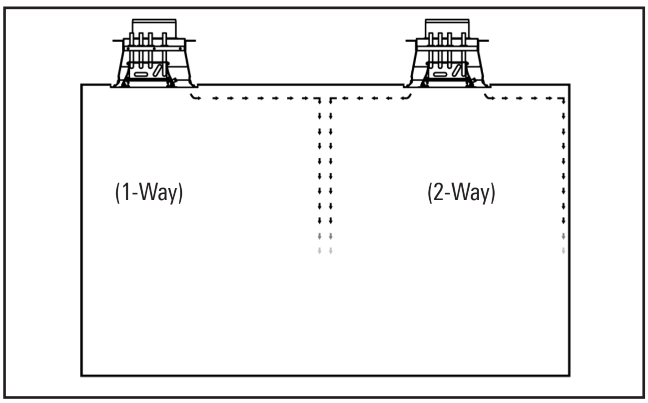
In order to achieve a uniform cooling capacity, the beams should be connected to the cold water distribution system in parallel. It is recommended that DISA-V chilled beams are connected to the supply air duct system which controls the supplied primary air volume. When integrated with room controllers, the units can be used both for single room and zone control.

ADVANTAGES

- Removal of high thermal loads is possible in this air/water system
- The size of the supply duct system is minimized due to reduced primary air requirements
- Substantial reduction in the operating costs due to low primary air volume
- Improved thermal comfort inside the space
- Individual adjustment of the primary air volume by means of the nozzle configuration A, B, C, & D
- Suitable for all standard ceiling grids



Schematic diagram of the mode of operation



Schematic diagram of the jet path

CONSTRUCTION

HOUSING

- Galvanized sheet steel, with 1 or 2 connection pipes E4", E5" and E6", position of primary air inlet:
- with 1 central connection piece (AS1, -AS4*)
- with 2 central connection pieces at the same distance (-AS2/AS3)

SLOT

- Extruded aluminum profile painted to RAL 9010 (white, standard)

PERFORATED SHEET GRILLE (-SR,-SQ,-RE,-OB)

- Galvanized sheet steel painted to RAL 9010 (white, standard)

LOUVRE GRID (-PA)

- Extruded aluminum profile painted to RAL 9010 (white, standard)

HEAT EXCHANGER (4-PIPE COOLING AND HEATING)

- Galvanized sheet steel frame
- Aluminum fins
- A E12mm, copper tubing (14 tubes for cooling mode / 4 for heating mode)
- Connection Cu, 12mm x 1.0mm (wall) smooth wall

ACCESSORIES

EXTENSION

- Possible up to 12 inches. The total length and the extension of the DISA-V must not exceed 10 feet

RUBBER LIP SEAL (-GD)

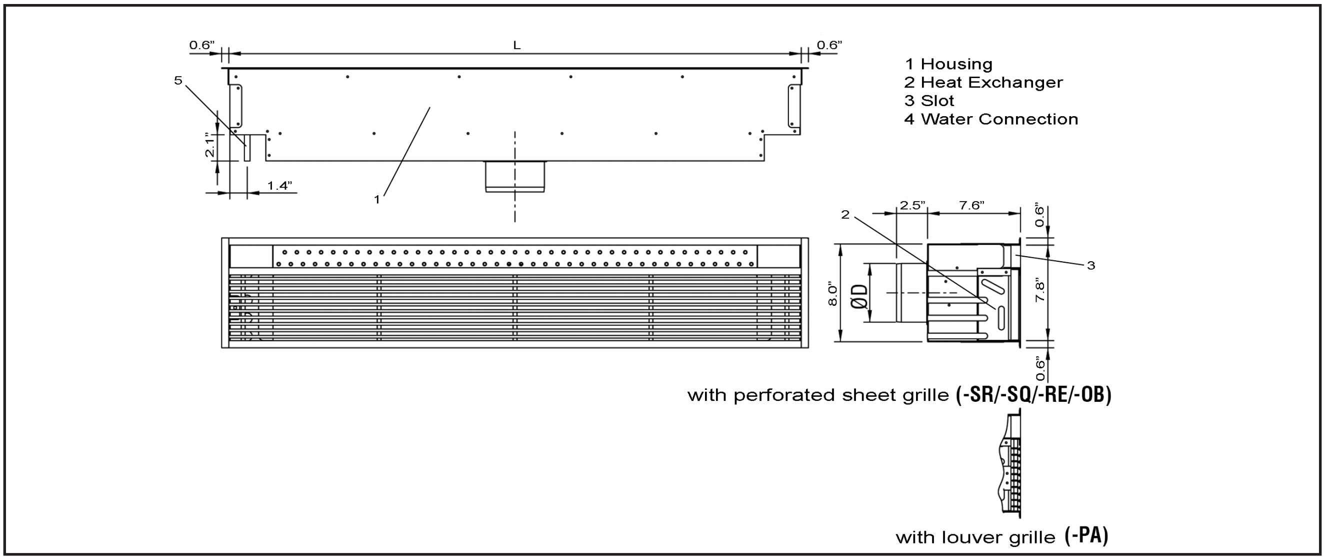
- At the connection pipe for better tightness

CONTROL OPTIONS

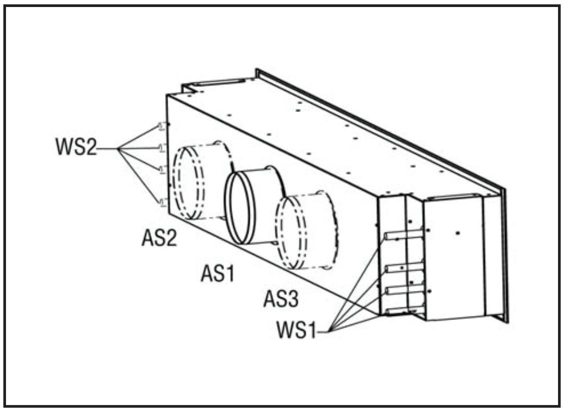
- Valves
- Actuators
- Temperature controls
- Condensation sensor

DIMENSIONS

DISA-V UNIT DIMENSIONS



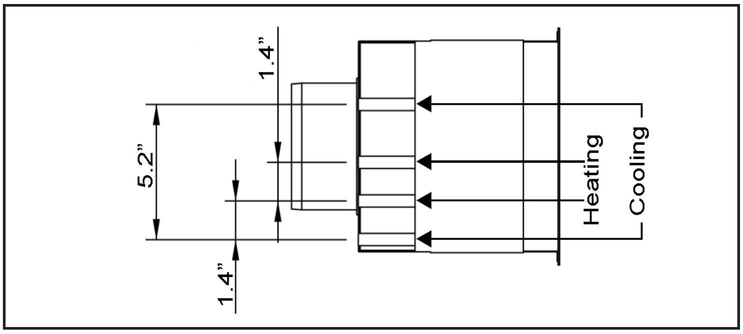
ARRANGEMENT OF THE CONNECTION PIPES (-AS) AND WATER CONNECTION (-WS)



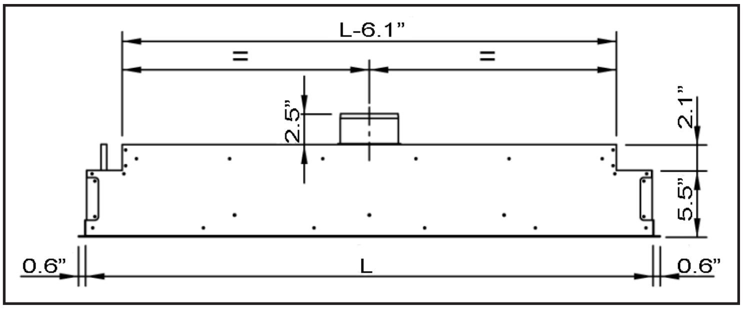
Number/position of the connection pipes
- with 1 central connection piece (AS1)
- with 2 central connection pieces (-AS2/AS3)

Number/position of the water connections
- with 4 water connections (2 for cooling mode / 2 for heating mode)
- sideways top left (-WS1)
- sideways top right (-WS2)

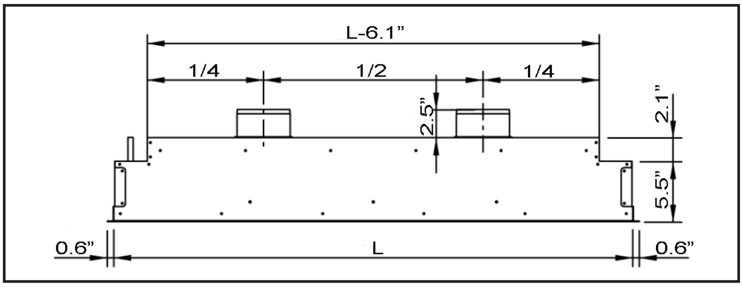
WATER CONNECTIONS



DUCT CONNECTIONS WITH 1 CONNECTION PIECE (-AS1)

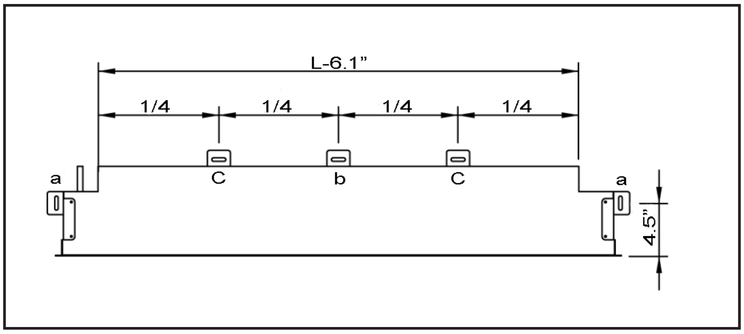


WITH 2 CONNECTION PIECES (-AS2/-AS3)



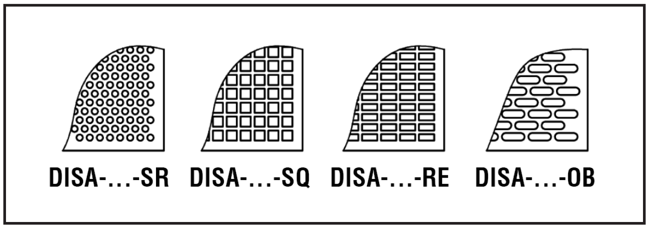
DIMENSIONS

WATER CONNECTIONS



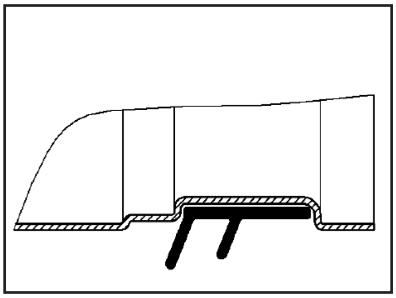
L	Single Connection	Dual Connection
900	a,c	a,b
1200		
1500		
1800		
2100		
2400		
2700		
3000		

PERFORATED SHEET GRILLE



ACCESSORIES

Rubber lip seal (-GD)



DISA-V

L	Nozzle	Primary Air			Cooling			Heating	
	Type	P_s	V_{air}	Q_{air}	Δp_w	Q_{coil}	Q_{Total}	Δp_w	Q_{Total}
[ft]		[in wg]	[CFM]	[BTUH]	[ft wg]	[BTUH]	[BTUH]	[ft wg]	[BTUH]
3	A	0.2	6.15	133	2.14	341	474	0.13	321
		0.5	9.75	212		549	761		495
		0.8	12.50	266		693	959		573
	B	0.2	10.60	229		566	795		525
		0.5	16.95	362		788	1150		659
		0.8	21.40	457		921	1378		706
	C	0.2	19.71	423		788	1211		693
		0.5	31.15	665		1109	1774		740
		0.8	39.20	843		1293	2136		730
	D	0.2	29.45	635		768	1402		737
		0.5	46.62	1003		1211	2214		699
		0.8	58.91	1262		1467	2730		618
4	A	0.2	9.32	198	2.68	498	696	0.17	478
		0.5	14.62	314		778	1092		727
		0.8	18.44	396		959	1355		839
	B	0.2	15.89	338		798	1136		771
		0.5	25.00	536		1075	1610		959
		0.8	31.57	676		1228	1904		1027
	C	0.2	29.03	624		1075	1699		1007
		0.5	45.98	989		1440	2429		1075
		0.8	58.06	1245		1648	2893		1051
	D	0.2	43.65	938		1058	1996		1071
		0.5	69.08	1484		1563	3047		1003
		0.8	87.30	1873		1842	3716		884
5	A	0.2	11.87	252	3.15	635	887	0.20	604
		0.5	18.65	399		993	1392		938
		0.8	23.52	505		1218	1723		1085
	B	0.2	20.13	433		1020	1454		989
		0.5	32.00	686		1372	2057		1245
		0.8	40.26	863		1563	2426		1338
	C	0.2	37.08	795		1368	2163		1307
		0.5	58.70	1259		1829	3088		1406
		0.8	74.17	1590		2105	3695		1385
	D	0.2	55.73	1198		1334	2532		1406
		0.5	88.15	1890		1979	3869		1327
		0.8	111.25	2388		2324	4712		1184
6	A	0.2	14.83	317	3.65	792	1109	0.23	761
		0.5	23.31	502		1242	1744		1170
		0.8	29.45	631		1522	2153		1355
	B	0.2	25.22	543		1273	1815		1239
		0.5	40.05	860		1696	2556		1549
		0.8	50.43	1082		1924	3006		1662
	C	0.2	46.62	1000		1699	2699		1628
		0.5	73.74	1580		2249	3828		1740
		0.8	93.02	1993		2590	4582		1709
	D	0.2	69.93	1501		1665	3166		1737
		0.5	110.61	2375		2440	4814		1634
		0.8	139.64	2996		2815	5811		1450

PERFORMANCE BASED ON:

COOLING:
Room Air Temperature = 75°F
Primary Air Temperature = 55°F
Water Supply Temperature = 57°F
Water Flow Rate = 1.25 gpm

HEATING:
Room Air Temperature = 70°F
Primary Air Temperature = 55°F
Water Supply Temperature = 120°F
Water Flow Rate = 0.5 gpm

LEGEND:
P_s - Unit Inlet Pressure [in wg]
V_{air} - Primary Air Flow Rate [CFM]
Q_{air} - Capacity, Primary Air [BTUH]
Q_{coil} - Capacity, Water Coil [BTUH]
Q_{Total} - Capacity, Unit Total [BTUH]
Δp_w - Water Coil Pressure Drop [ft wg]

DISA-V (continued)

L	Nozzle Type	Primary Air			Cooling			Heating	
		P_s	V_{air}	Q_{air}	Δp_w	Q_{coil}	Q_{Total}	Δp_w	Q_{Total}
[ft]		[in wg]	[CFM]	[BTUH]	[ft wg]	[BTUH]	[BTUH]	[ft wg]	[BTUH]
7	A	0.2	17.38	372	4.15	928	1300	0.27	887
		0.5	27.34	587		1454	2040		1378
		0.8	34.54	740		1774	2515		1597
	B	0.2	29.67	635		1494	2129		1460
		0.5	46.83	1007		1979	2986		1836
		0.8	59.12	1269		2238	3508		1972
	C	0.2	54.67	1170		1979	3149		1928
		0.5	86.46	1853		2614	4466		2074
		0.8	108.92	2337		3057	5394		2044
	D	0.2	82.01	1761		1931	3692		2068
		0.5	129.68	2781		2846	5626		1958
		0.8	163.59	3511		3265	6776		1747
8	A	0.2	19.92	427	4.69	1058	1484	0.30	1013
		0.5	31.36	672		1662	2334		1590
		0.8	39.63	850		2027	2876		1842
	B	0.2	34.12	730		1716	2446		1679
		0.5	53.82	1153		2262	3415		2119
		0.8	67.81	1457		2542	3999		2279
	C	0.2	62.72	1344		2259	3603		2231
		0.5	98.96	2122		2941	5063		2409
		0.8	125.02	2678		3446	6125		2378
	D	0.2	94.08	2016		2197	4214		2402
		0.5	148.75	3190		3190	6380		2283
		0.8	187.74	4026		3692	7718		2044
9	A	0.2	22.67	485	5.19	1204	1689	0.34	1157
		0.5	35.81	768		1897	2665		1808
		0.8	45.13	969		2303	3272		2098
	B	0.2	38.78	833		1952	2784		1914
		0.5	61.24	1314		2552	3866		2416
		0.8	77.34	1658		2846	4504		2597
	C	0.2	71.41	1532		2552	4084		2542
		0.5	112.73	2419		3289	5708		2740
		0.8	142.40	3361		3917	7278		2706
	D	0.2	107.22	2300		2487	4787		2733
		0.5	169.52	3634		3596	7230		2597
		0.8							
10	A	0.2	25.43	546	5.66	1344	1890	0.37	1297
		0.5	40.05	860		2095	2955		2030
		0.8	50.64	1085		2484	3569		2354
	B	0.2	43.44	935		2153	3088		2146
		0.5	68.87	1474		2706	4180		2713
		0.8	86.88	1863		2982	4845		2914
	C	0.2	80.10	1720		2706	4425		2849
		0.5	126.72	2716		3613	6329		3074
		0.8	159.77	3429		4371	7800		3033
	D	0.2	120.36	2579		2648	5227		3064
		0.5	190.29	4081		4094	8175		2914
		0.8							

PERFORMANCE BASED ON:

COOLING:
Room Air Temperature = 75°F
Primary Air Temperature = 55°F
Water Supply Temperature = 57°F
Water Flow Rate = 1.25 gpm

HEATING:
Room Air Temperature = 70°F
Primary Air Temperature = 55°F
Water Supply Temperature = 120°F
Water Flow Rate = 0.5 gpm

LEGEND:
P_s - Unit Inlet Pressure [in wg]
V_{air} - Primary Air Flow Rate [CFM]
Q_{air} - Capacity, Primary Air [BTUH]
Q_{coil} - Capacity, Water Coil [BTUH]
Q_{Total} - Capacity, Unit Total [BTUH]
Δp_w - Water Coil Pressure Drop [ft wg]

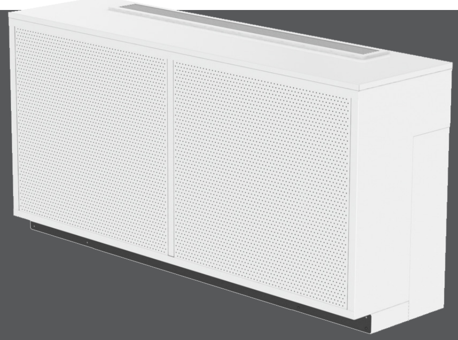
DISA-V SOUND DATA (dBA)

L	P_S	Nozzle Type											
		A			B			C			D		
		Connection Piece Diameter			Connection Piece Diameter			Connection Piece Diameter			Connection Piece Diameter		
[ft]	[in wg]	ø4"	ø5"	ø6"	ø4"	ø5"	ø6"	ø4"	ø5"	ø6"	ø4"	ø5"	ø6"
3	0.2	20	20	20	20	20	20	20	20	20	25	24	24
	0.2	20	20	20	20	20	20	20	20	20	28	28	28
	0.3	20	20	20	20	20	20	21	21	21	34	34	34
	0.4	21	21	21	21	21	21	25	24	24	39	39	39
	0.5	23	23	23	23	23	23	28	28	27	44	44	44
	0.6	26	26	26	27	27	27	32	32	32	51	50	50
4	0.2	20	20	20	20	20	20	20	20	20	29	25	25
	0.2	20	20	20	20	20	20	21	20	20	32	29	28
	0.3	20	20	20	20	20	20	25	22	21	37	35	34
	0.4	21	21	21	21	21	21	28	25	25	41	40	40
	0.5	23	23	23	24	24	24	31	28	28	45	45	44
	0.6	27	27	27	28	28	28	35	33	33	51	51	51
5	0.2	20	20	20	20	20	20	23	20	20	34	28	26
	0.2	20	20	20	20	20	20	26	20	20	37	31	29
	0.3	20	20	20	20	20	20	30	24	22	41	37	35
	0.4	22	22	22	23	22	22	33	27	25	45	42	40
	0.5	24	24	24	25	25	24	35	30	29	48	46	45
	0.6	27	27	27	29	28	28	39	35	33	53	52	52
6	0.2	20	20	20	20	20	20	29	21	20	40	33	27
	0.2	20	20	20	20	20	20	31	23	20	42	36	30
	0.3	20	20	20	22	20	20	35	28	23	46	41	36
	0.4	22	22	22	25	23	22	38	31	27	50	45	41
	0.5	25	25	24	28	25	25	41	34	30	52	49	46
	0.6	28	28	28	31	29	29	44	38	34	56	54	52
7	0.2	20	20	20	20	20	20	33	25	20	44	37	29
	0.2	20	20	20	21	20	20	35	28	20	46	40	32
	0.3	20	20	20	25	21	20	39	32	25	50	45	38
	0.4	23	23	23	28	24	23	42	36	28	53	49	42
	0.5	25	25	25	30	26	26	45	39	31	56	52	47
	0.6	28	28	28	33	30	29	48	42	36	60	57	53
8	0.2	20	20	20	21	20	20	37	29	20	48	42	32
	0.2	20	20	20	24	20	20	39	32	22	50	44	35
	0.3	21	21	21	27	22	21	43	36	27	54	49	40
	0.4	24	23	23	30	25	24	46	40	30	57	53	44
	0.5	26	26	26	33	28	26	48	43	33	60	56	48
	0.6	29	29	29	36	31	30	51	46	37	63	60	54
9	0.2	20	20	20	24	20	20	40	33	23	51	46	35
	0.2	20	20	20	27	20	20	43	36	25	54	48	38
	0.3	22	21	21	31	24	21	46	40	30	57	53	43
	0.4	25	24	24	34	27	24	49	44	33	60	57	47
	0.5	27	26	26	36	30	27	52	47	36	63	60	50
	0.6	30	29	29	39	34	31	55	50	40	66	63	56
10	0.2	20	20	20	27	20	20	43	36	25	54	49	38
	0.2	20	20	20	30	22	20	46	39	28	57	52	41
	0.3	24	22	22	33	26	22	50	44	33	61	57	46
	0.4	26	25	24	36	30	25	53	47	36	64	60	50
	0.5	29	27	27	39	32	28	55	50	39	66	63	53
	0.6	32	30	30	42	36	31	58	54	43	69	67	58

Floor Mounted – Under the Sill

TAO

- Floor mounted, under the sill or fully exposed active chilled beam perfectly suited for educational and healthcare facilities
- Suited for climate zones with heat loads greater than 250 Btuh per foot
- Designed to meet the highest ventilation effectiveness required in schools and healthcare facilities while maximizing the hydronic system to handle the sensible load
- Circular perforated front face for return air
- Pencil proof grille
- Ultra quiet operation
- Available in 5 and 6 ft length to match different classrooms spaces and loads
- Heavy gauge painted cabinet
- Pressure port for air-side balancing and flow verification



TAO

energy solutions | dual-function | woodgrains | k-12 education

AVAILABLE MODEL:

TAO

FINISHES

Standard Finish - #26 White
Optional Finish - Woodgrains (See Woodgrains Brochure for Finishes)

OVERVIEW

Installed along building perimeters to best handle extreme temperatures where they start – from the outside in - the TAO (Temperature Ambient Optimizer) provides superior thermal comfort in areas where high ventilation loads are needed, such as educational facilities and theaters. It combines the benefits of both chilled beam and displacement units, rolled into one system perfect for extreme climates.

Ideal for use in classrooms and theaters where air quality and sound are critical, the TAO supplies 100% outside air while meeting ANSI Standard S12.60 for acoustics in educational facilities.

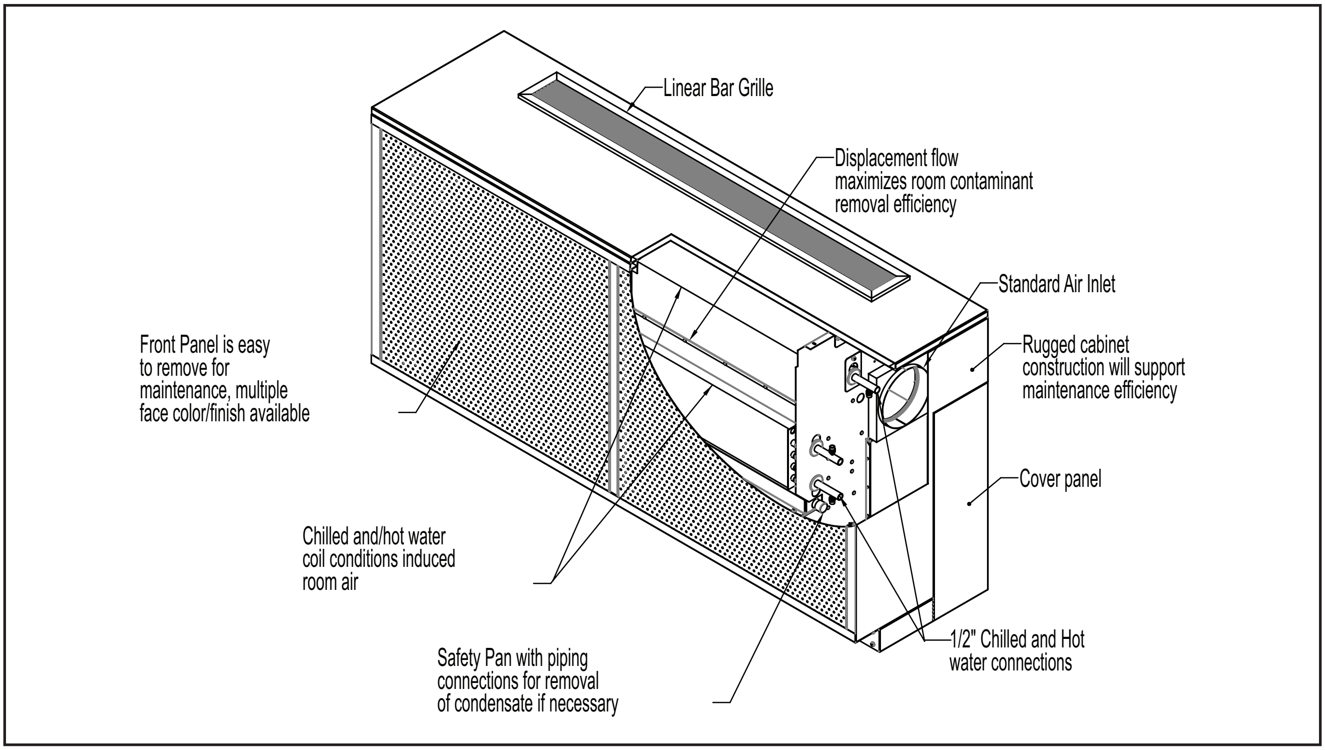
ADVANTAGES

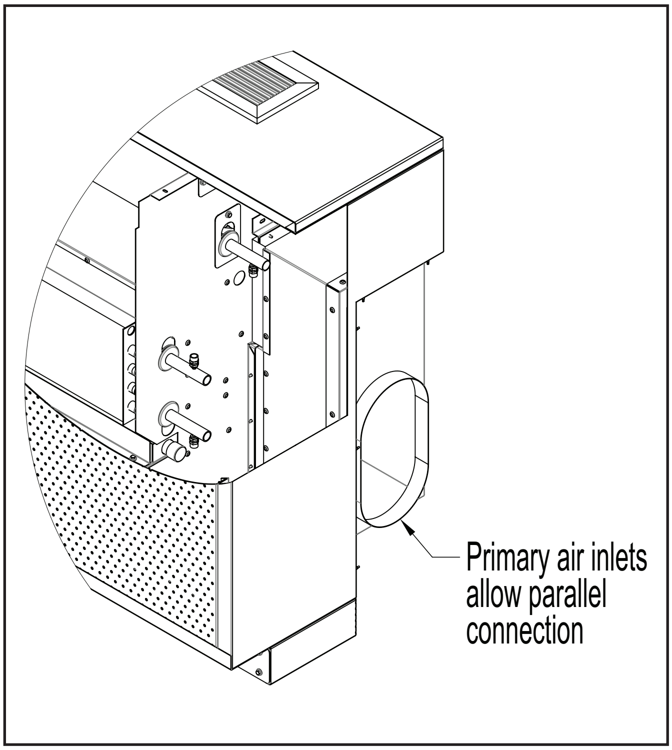
- Maximizes the displacement ventilation benefits and enhances the removal of space respiratory contaminants
- Dedicated heating coil to neutralize the thermal load of the window or perimeter wall
- 2 x 2 pipe vertical mounted coil with removable condensate tray for cooling during the Summer and to provide supplemental heating for the Winter
- Optional integral primary air parallel duct connection to minimize air pressure drop, noise and ease of installation

See website for Specifications

Multiple TAO units installed in an elementary school

TAO UNIT DIMENSIONS

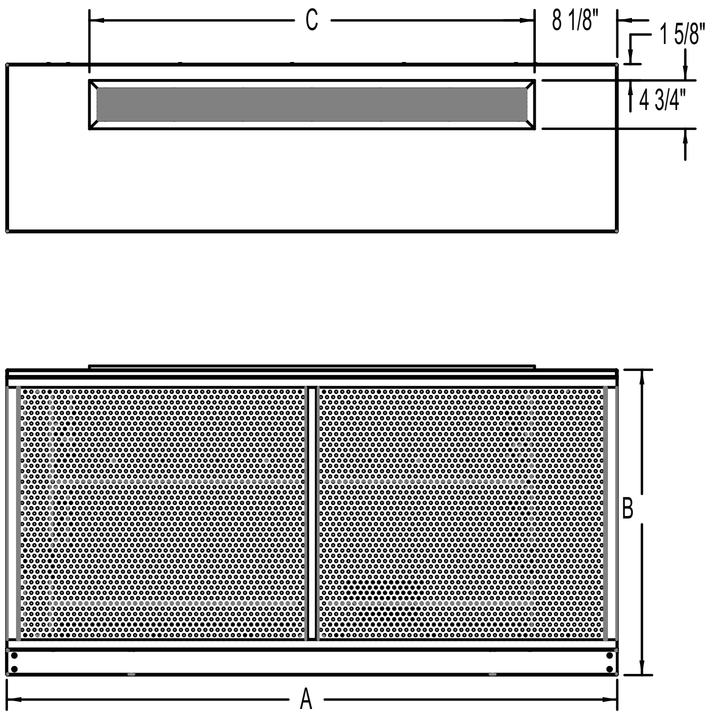




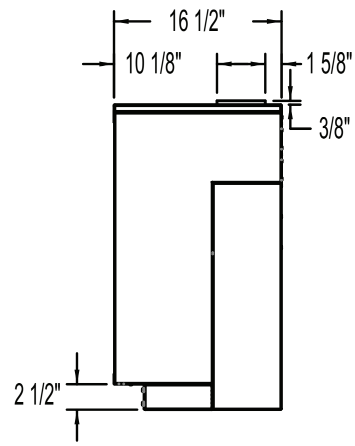
All units are shipped as right air inlet connecting. To modify the unit to allow a left side air connection, simply remove the cover panel and cap from the left side and replace them on the right. For center units in series, remove the cover panel and cap from the left side and discard.

All dimensions are in inches

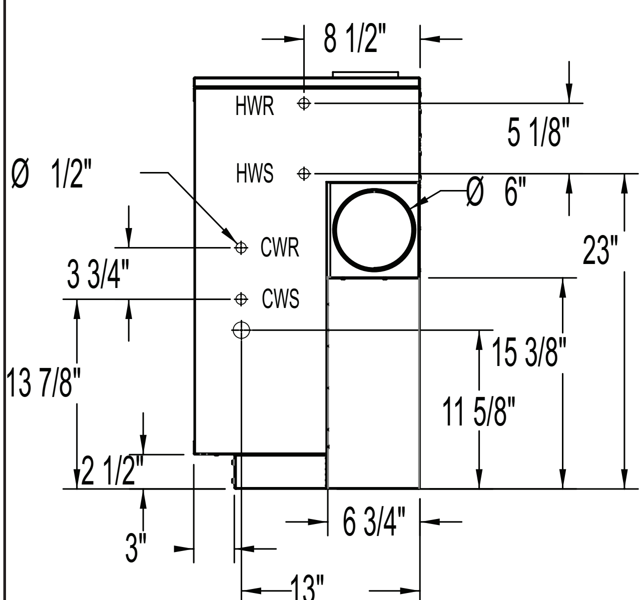
TAO UNIT DIMENSIONS



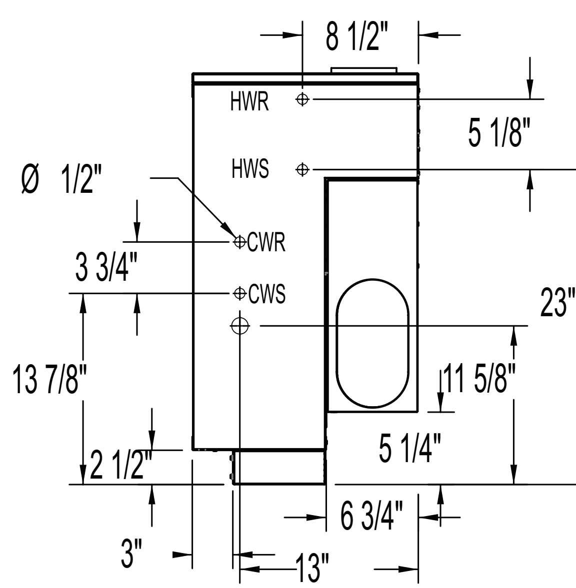
Inlet Size	Unit	Dimensions		
		A	B	C
6″ Round	5 ft	60	30	43 3/4
8″ Oval	6 ft	72	30	55 3/4



6″ ROUND INLET FOR STAND-ALONE APPLICATIONS



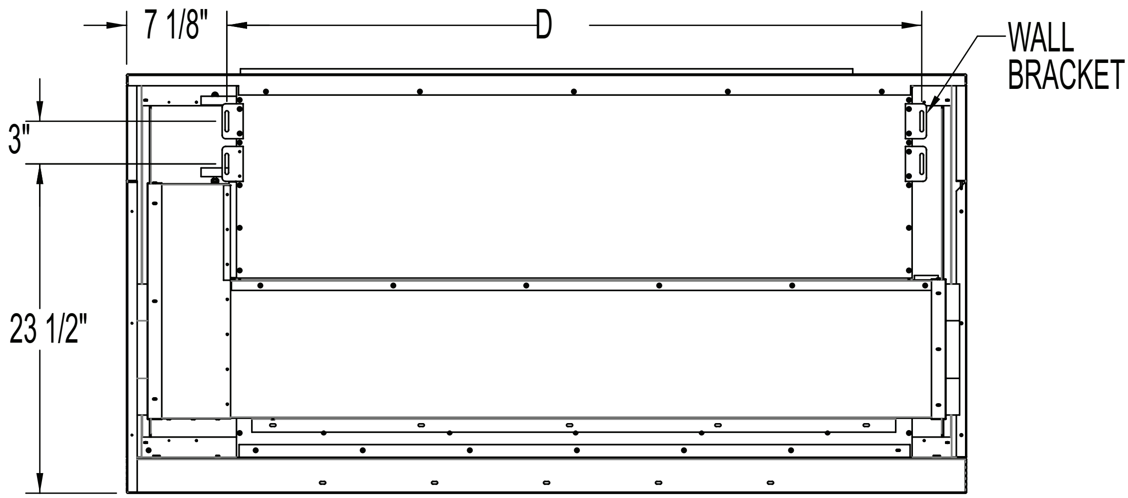
8″ OVAL INLET FOR MULTI-UNIT APPLICATIONS



All dimensions are in inches

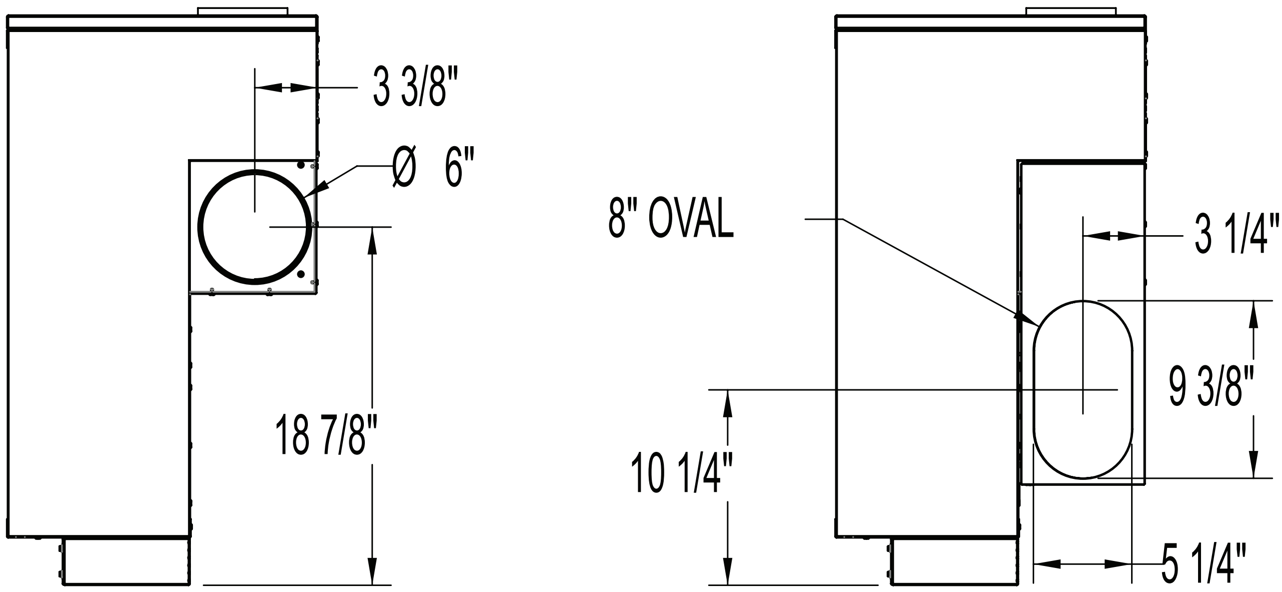
TAO UNIT DIMENSIONS

Wall Mounting



Inlet Size	Unit	D
6" Round	5 ft	49 1/8
8" Oval	6 ft	61 1/8

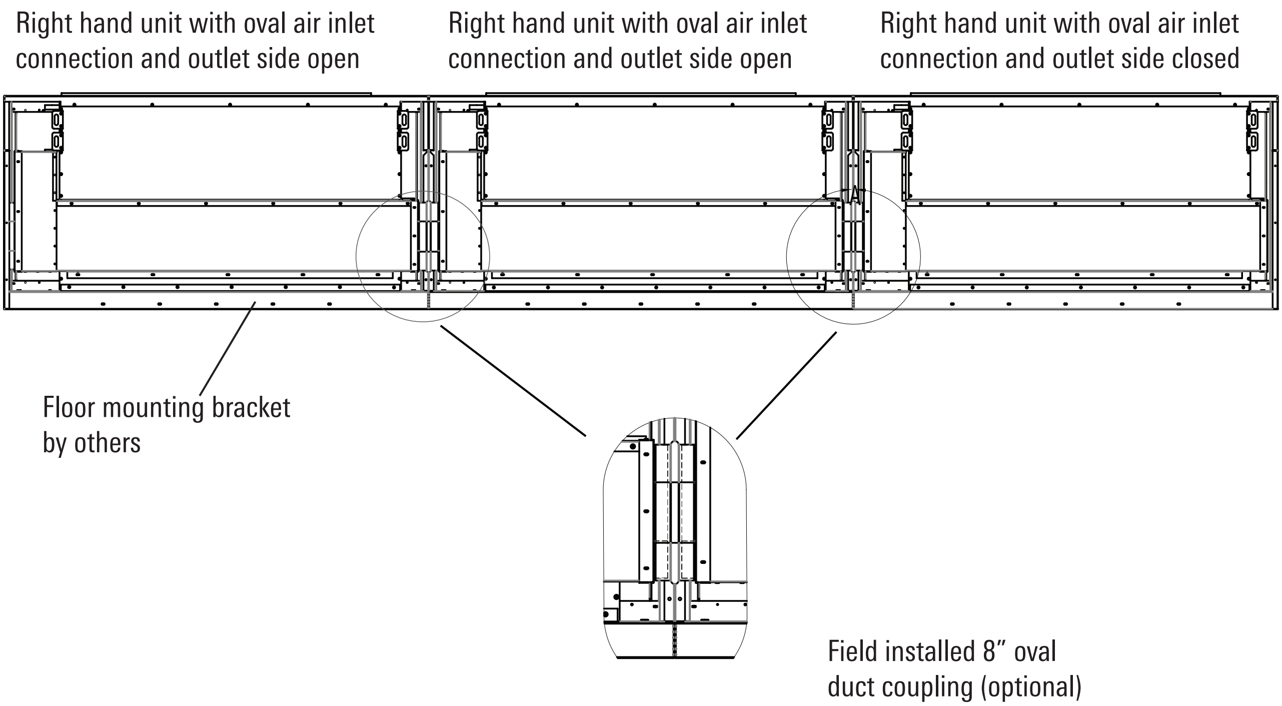
Duct Connections (Stand-alone configuration shown)



All dimensions are in inches

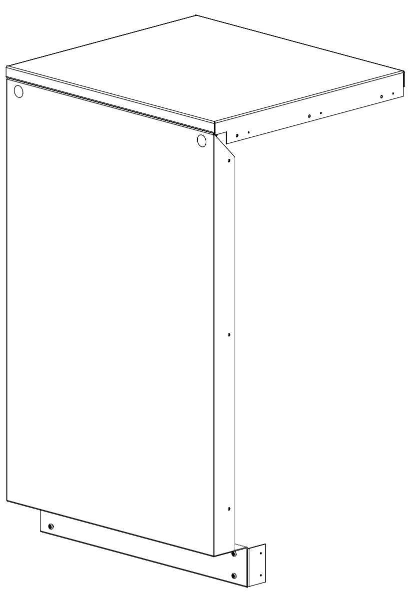
TAO

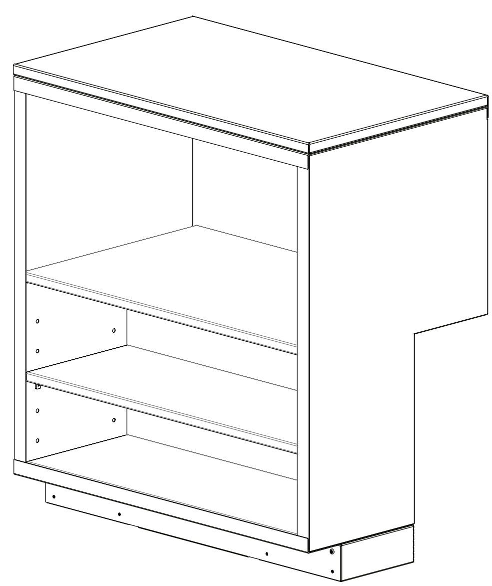
Multiple Units Connected in Parallel



Units viewed from the back showing interconnection between units

Filler Panel & Bookshelf Details


Filler panel (optional)


Bookshelf (optional)

TAO WATER

Coil Rows	**Water** flow (gpm)	ΔPw (ft wg)	CBAF TAO - 5 ft										
			Secondary Cooling [Btu/h] at Prime Air Flows [CFM]										
			80	90	100	110	120	130	140	150	160	170	180
Air inlet P [w.g."]			0.25"	0.33"	0.40"	0.48"	0.56"	0.64"	0.75"	0.82"	0.92"	1.00"	1.12"
Supply airflow			210	247	278	309	339	370	403	432	459	480	518
2	0.5	0.08	1278	1414	1535	1644	1738	1823	1907	1966	2025	2056	2129
	0.75	0.18	1380	1542	1689	1825	1943	2053	2163	2240	2319	2360	2461
	1	0.32	1437	1615	1779	1932	2066	2192	2318	2408	2501	2549	2668
	1.25	0.49	1474	1662	1838	2002	2147	2284	2422	2521	2624	2677	2810
	1.5	0.7	1500	1695	1879	2052	2205	2350	2498	2603	2714	2771	2914
Room Air Temperature: 75°F, **Water** Entering Temperature: 57°F													
			Secondary Heating [Btu/h] at Prime Air Flows [CFM]										
2	0.5	0.08	2639	3018	3277	3525	3763	4038	4343	4552	4793	4948	5318
	0.75	0.17	2725	3133	3413	3685	3949	4255	4599	4836	5112	5291	5722
	1	0.3	2769	3193	3486	3771	4048	4372	4737	4991	5286	5479	5945
	1.25	0.47	2796	3230	3531	3824	4110	4445	4824	5087	5396	5597	6086
	1.5	0.66	2815	3255	3561	3860	4152	4495	4883	5154	5472	5679	6184
Room Air Temperature: 70°F, **Water** Entering Temperature: 140°F													

Correction factors for other entering conditions:							
ΔT (°F)		8	13	18	23	28	33
Cooling Factor		0.71	0.82	1.00	1.23	1.51	1.85
ΔT (°F)	60	65	70	75	80	85	90
Heating Factor	0.85	0.93	1.00	1.07	1.14	1.22	1.30

Coil Rows	**Water** flow (gpm)	ΔPw (ft wg)	CBAF TAO - 6 ft										
			Secondary Cooling [Btu/h] at Prime Air Flows [CFM]										
			120	130	140	150	160	170	180	190	200	210	220
Air inlet P [w.g."]			0.23"	0.33"	0.43"	0.50"	0.61"	0.70"	0.75"	0.88"	0.96"	1.00"	1.12"
Supply airflow			291	331	369	405	442	477	513	547	579	612	644
2	0.5	0.1	1564	1682	1809	1918	2018	2109	2192	2265	2329	2392	2448
	0.75	0.22	1711	1854	2014	2153	2282	2402	2514	2614	2701	2790	2869
	1	0.39	1794	1954	2133	2292	2440	2580	2711	2828	2933	3039	3134
	1.25	0.6	1848	2019	2212	2383	2545	2699	2844	2974	3091	3210	3317
	1.5	0.85	1885	2064	2268	2449	2621	2785	2940	3080	3206	3335	3452
Room Air Temperature: 75°F, **Water** Entering Temperature: 57°F													
			Secondary Heating [Btu/h] at Prime Air Flows [CFM]										
2	0.5	0.1	3503	4050	4513	4903	5311	5619	5947	6224	6455	6678	6891
	0.75	0.21	3653	4257	4775	5219	5689	6048	6435	6766	7045	7316	7578
	1	0.37	3731	4366	4916	5390	5895	6283	6705	7068	7375	7675	7966
	1.25	0.57	3780	4434	5004	5497	6024	6432	6877	7260	7586	7904	8215
	1.5	0.81	3813	4481	5064	5570	6114	6535	6996	7393	7733	8065	8389
Room Air Temperature: 70°F, **Water** Entering Temperature: 140°F													

Correction factors for other entering conditions:							
ΔT (°F)		8	13	18	23	28	33
Cooling Factor		0.71	0.82	1.00	1.23	1.51	1.85
ΔT (°F)	60	65	70	75	80	85	90
Heating Factor	0.85	0.93	1.00	1.07	1.14	1.22	1.30

TAO (ETHYLENE/GLYCOL)

Coil Rows	**Ethylene Glycol/** Water flow (gpm)	ΔPw (ft wg)	CBAF TAO - 5 ft										
			Secondary Cooling [Btu/h] at Prime Air Flows [CFM]										
			80	90	100	110	120	130	140	150	160	170	180
Air inlet P [w.g."]			0.25″	0.33″	0.40″	0.48″	0.56″	0.64″	0.75″	0.82″	0.92″	1.00″	1.12″
Supply airflow			210	247	278	309	339	370	403	432	459	480	518
2	0.5	0.33	1173	1239	1329	1408	1473	1533	1590	1635	1669	1689	1737
	0.75	0.54	1250	1377	1491	1592	1679	1757	1835	1897	1943	1971	2039
	1	0.76	1319	1462	1592	1709	1810	1904	1996	2070	2126	2160	2242
	1.25	0.99	1365	1520	1662	1791	1903	2007	2111	2195	2258	2297	2391
	1.5	1.23	1398	1563	1741	1852	1973	2086	2198	2290	2359	2401	2505
Room Air Temperature: 75°F, **Fluid** Entering Temperature: 57°F, Ethylene Glycol 35%													
			Secondary Heating [Btu/h] at Prime Air Flows [CFM]										
2	0.5	0.1	3273	3714	4010	4291	4559	4863	5197	5423	5681	5845	6233
	0.75	0.23	3391	3870	4195	4507	4805	5148	5527	5786	6083	6275	6729
	1	0.39	3455	3956	4297	4626	4942	5307	5714	5992	6314	6521	7017
	1.25	0.6	3550	4088	4459	4820	5170	5577	6034	6351	6720	6904	7538
	1.5	0.86	3582	4133	4513	4884	5245	5666	6141	6470	6856	7106	7713
Room Air Temperature: 70°F, **Fluid** Entering Temperature: 160°F, Ethylene Glycol 50%													

Correction factors for other entering conditions:							
ΔT (°F)		8	13	18	23	28	33
Cooling Factor		0.64	0.72	1.00	1.28	1.55	1.83
ΔT (°F)			70	75	80	85	90
Heating Factor			0.77	0.83	0.88	0.94	1.00

Coil Rows	**Ethylene Glycol/** Water flow (gpm)	ΔPw (ft wg)	CBAF TAO - 6 ft										
			Secondary Cooling [Btu/h] at Prime Air Flows [CFM]										
			120	130	140	150	160	170	180	190	200	210	220
Air inlet P [w.g."]			0.23″	0.33″	0.43″	0.50″	0.61″	0.70″	0.75″	0.88″	0.96″	1.00″	1.12″
Supply airflow			291	331	369	405	442	477	513	547	579	612	644
2	0.5	0.4	1394	1483	1578	1657	1729	1793	1852	1902	1946	1989	2027
	0.75	0.66	1550	1664	1787	1892	1988	2077	2158	2229	2291	2352	2406
	1	0.93	1646	1776	1918	2042	2155	2260	2358	2444	2519	2595	2663
	1.25	1.21	1710	1852	2009	2146	2273	2391	2501	2599	2685	2772	2805
	1.5	1.51	1757	1908	2076	2223	2361	2489	2610	2717	2812	2908	2994
Room Air Temperature: 75°F, **Fluid** Entering Temperature: 57°F, Ethylene Glycol 35%													
			Secondary Heating [Btu/h] at Prime Air Flows [CFM]										
2	0.5	0.13	4302	4923	5437	5862	6299	6624	6966	7251	7487	7712	7926
	0.75	0.28	4508	5201	5784	6274	6784	7167	7576	7920	8207	8483	8747
	1	0.48	4621	5355	5979	6507	7060	7479	7928	8309	8628	8936	9232
	1.25	0.74	4787	5594	6291	6889	7525	8013	8541	8993	9376	9748	10110
	1.5	1.05	4843	5673	6393	7015	7678	8189	8745	9222	9628	10023	10403
Room Air Temperature: 70°F, **Fluid** Entering Temperature: 160°F, Ethylene Glycol 50%													

Correction factors for other entering conditions:							
ΔT (°F)		8	13	18	23	28	33
Cooling Factor		0.64	0.72	1.00	1.28	1.55	1.83
ΔT (°F)			70	75	80	85	90
Heating Factor			0.77	0.83	0.88	0.94	1.00

Linear Passive Chilled Beams

SPB

- SPB is a linear passive chilled beam diffuser
- Unique design accommodates both recessed and exposed mounting
- Available in 2-pipe configuration
- Available as diffuser shell (no coil/piping)
- Standard finish is RAL 9010 white paint on diffuser face

SPB

energy solutions

See website for Specifications

AVAILABLE MODEL:

SPB

OVERVIEW

Passive chilled beams are primarily used to provide comfortable sensible cooling, and can be used in many heating applications as well. The primary mode of heat transfer is by convection, with a percentage of heat transfer transmitted through radiation. During cooling, warm room air rises to the ceiling area; cool air around the coil sinks down to the occupied area as a result of the higher density. As the cool air descends in to the space, more warm air is drawn over the coil creating a convective current that drives the system.

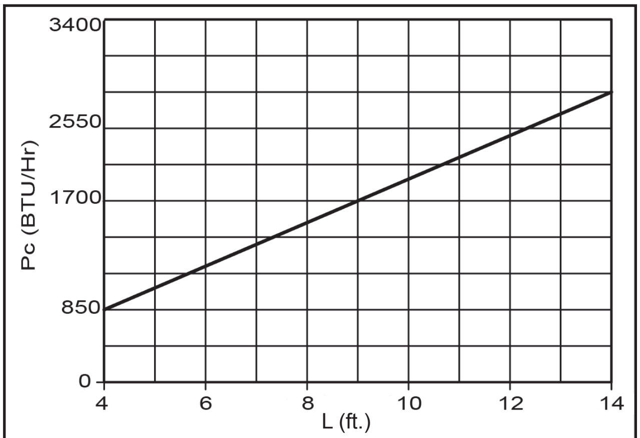
The exposed face of the passive beam is constructed from either painted perforated stainless steel, or a linear bar grille. The cooling strips are available in lengths of 4 feet to 14 feet in intervals of 2 feet. The beams are designed for integration into a suspension ceiling or for exposed mounting, suspended below the ceiling surface.

ADVANTAGES

- SPB models designed to accommodate recessed or exposed installation with a single model
- Easy cleaning of the water coil and housing
- Quick and simple installation
- Provides comfortable, effective heating and cooling to the space

The diagram shows the approximate cooling capacity Pc in BTUH at a water flow rate of 0.8 gpm and a temperature difference between room air and the average water temperature of 14.5° F.

Quick Select Chart



MOUNTING INFORMATION

Mounting brackets that can slide along the longitudinal axis are mounted on the beam, 2 per beam.

Alternatively, mounting shackles can be provided with are fastened to the beam and rest on the T-shaped support profiles of the false ceiling having a center-to-center distance of 600 mm. This reduces the mounting time as well as the mounting costs. The number of shackles required per beam, depending on length, is noted in the table below.

Beam Length	Shackles required
4 to 6	2
8 to 10	3
12 to 14	4

CLEANING OF THE GRILLE / COIL

The top side of the beam is open allowing direct access to cleaning the coil. The beam grilles are sectioned to allow access to the coil by pushing up individual sections and sliding them over an adjacent section. A vacuum with brush attachment is recommended for maximum effectiveness. Do not use any scouring agents for cleaning these components; damage to the unit construction materials (galvanized steel, aluminum and copper) and the surface coatings (paint and anodized surfaces) may occur. After completion of maintenance, grille must be returned to its original operating position.

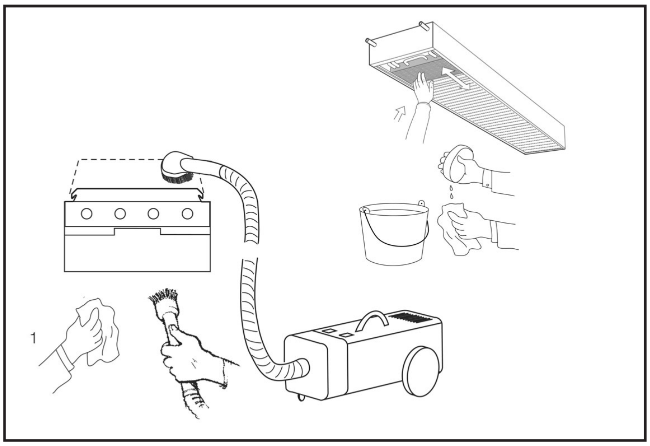
CONSTRUCTION

HOUSING

- Galvanized sheet steel painted to RAL 9010 (white)

PERFORATED SHEET GRILLE (-SR)

- Stainless steel painted to RAL 9010 (white)
- 46% free area, round perforations



LINEAR BAR GRILLE (-PA)

- Extruded aluminum profile painted to RAL 9010 (white)

WATER COIL

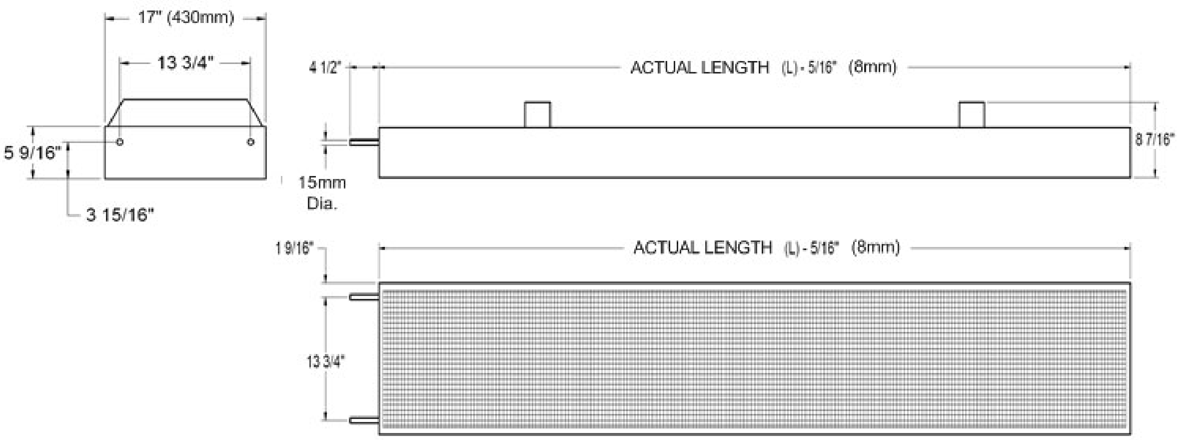
- Galvanized sheet steel frame
- Mechanically bonded aluminum fins
- Smooth copper tubes ø15 x 1.0 mm
- Integrated manual air vent
- Maximum working pressure, 200 psi

ACCESSORIES

UNIT EXTENSION

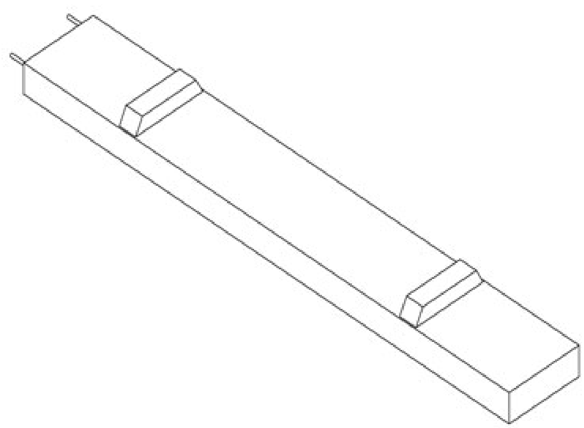
- Available in lengths from ½ inch to 12 inches total unit length must not exceed 14 feet
- Used to adjust the beam length to match ceiling architecture, or when the strips are installed in rows or exposed applications, allowing for concealment of water connections
- Extension has open ends, allowing for piping to be passed through the extension piece
- The grille face can is easily removable for access to water connections

SPB 17-IN NOMINAL WIDTH



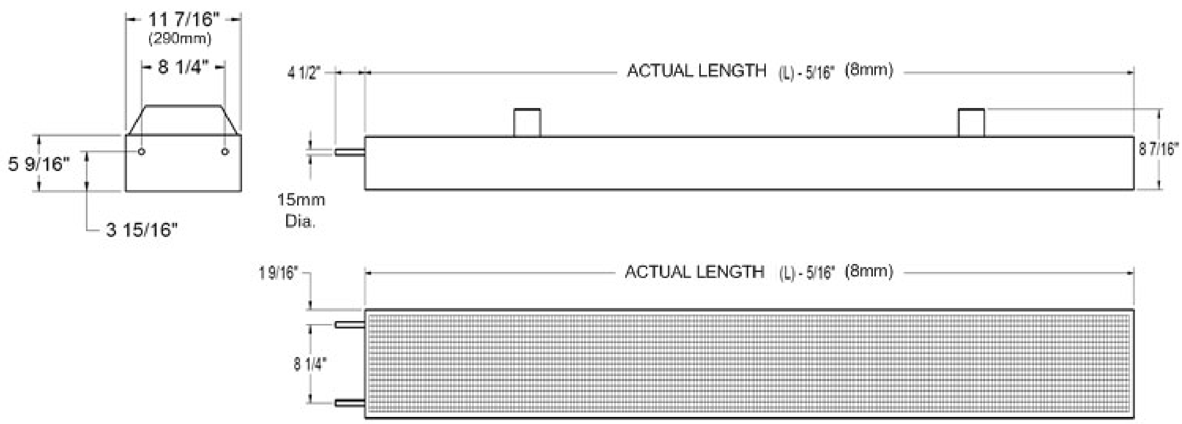
Piping Configuration:
2-pipe connection (15 mm Dia.)
located on end of diffuser

Nominal Length	Actual Lengths (L)
4ft	3.9ft
6ft	5.9ft
8ft	7.9ft
10ft	9.8ft
12ft	11.8ft
14ft	13.8ft



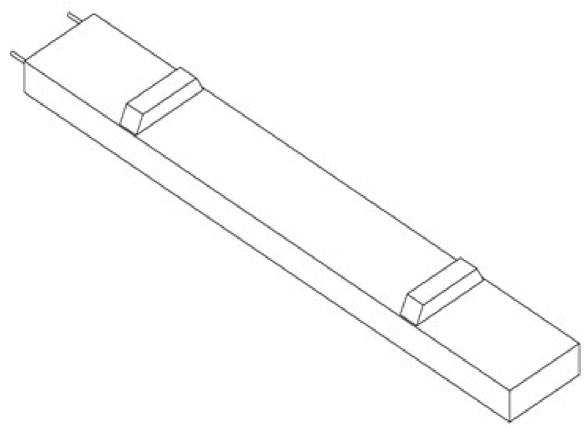
Note: dimensions are in inches or mm.

SPB 12-IN NOMINAL WIDTH



Piping Configuration:
2-pipe connection (15 mm Dia.)
located on end of diffuser

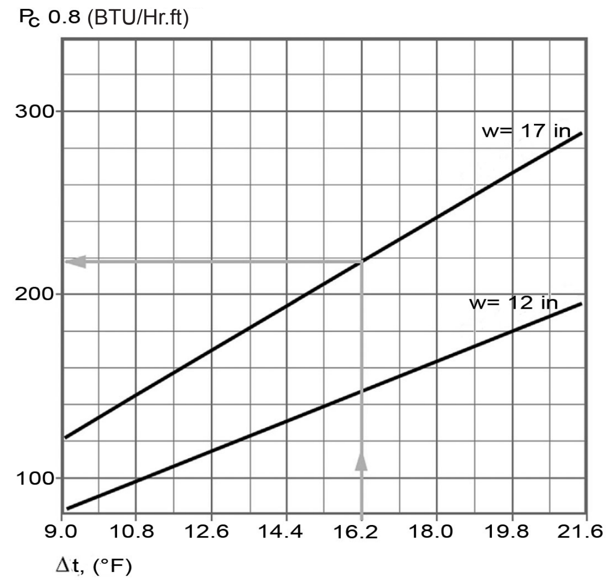
Nominal Length	Actual Lengths (L)
4ft	3.9ft
6ft	5.9ft
8ft	7.9ft
10ft	9.8ft
12ft	11.8ft
14ft	13.8ft



Note: dimensions are in inches or mm.

TECHNICAL DATA - COOLING

Cooling capacity per unit length (BTUH/ft)
$P_{C0.8}$ for passive beams, SPB
AMOUNT OF WATER = 0.8 GPM

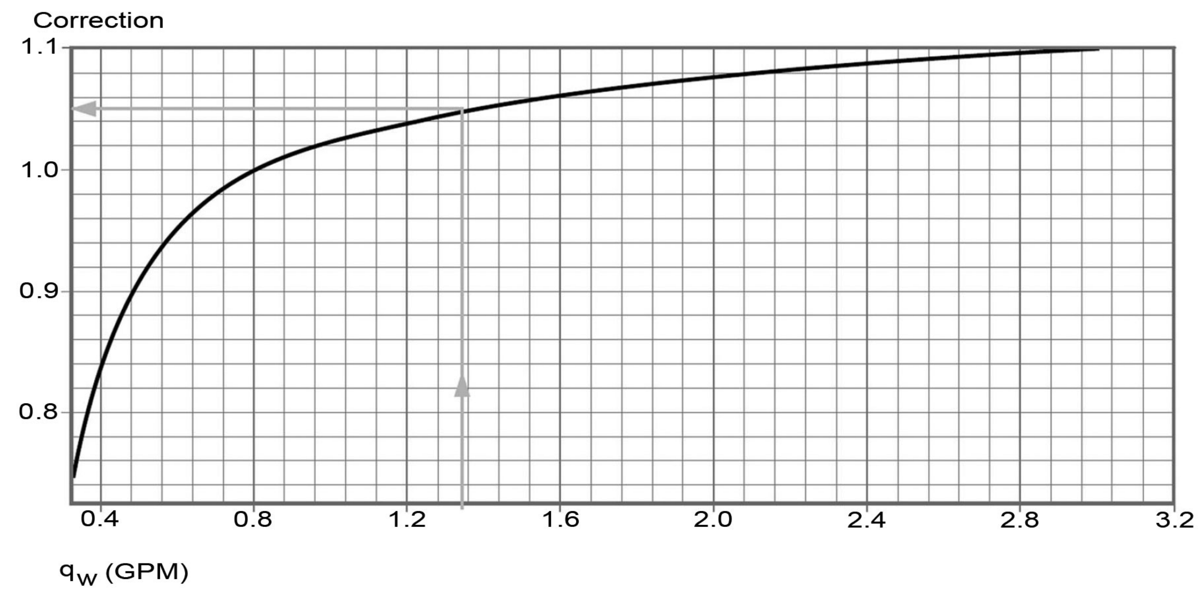


The diagram is based on tests according to the Nordtest method, which are conducted with a very small temperature difference between air entering the beam and the average room temperature 3.5 feet above the floor. For installations with concentrated sources of heat at or near the ceiling, the actual temperature difference 2 to 4°F. In this case, beams should be selected taking this into consideration. In practice, the strip will have a higher capacity based on the increased temperature difference.

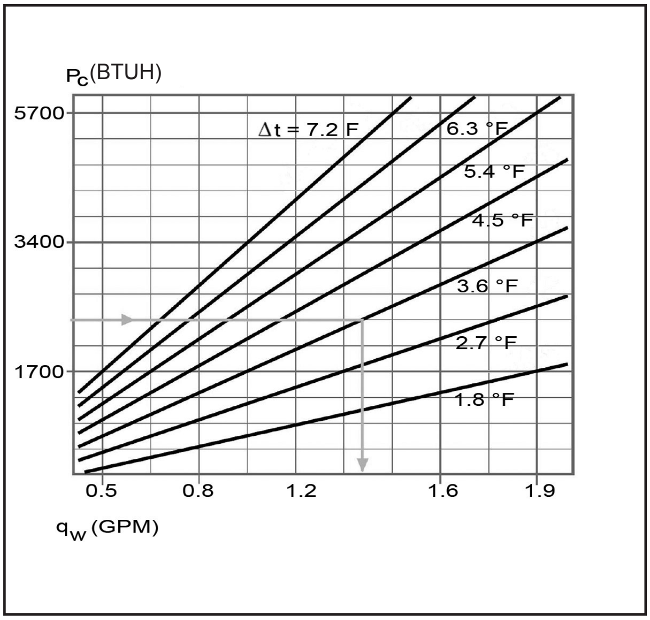
LEGEND:

P_c	- Capacity [BTUH]
L	- Length, Nominal [ft]
P_{co8}	- Capacity @ 0.8 gpm per length [BTUH/ft]
Δt	- Temperature difference, avg. water temperature vs. room air temperature [BF]
Δt_w	- Temperature difference, entering water temperature vs. leaving water temperature [BF]
q_w	- Water flow rate [gpm]
Δp_w	- Water Coil Pressure Drop [ft wg]
W	- unit width [in]

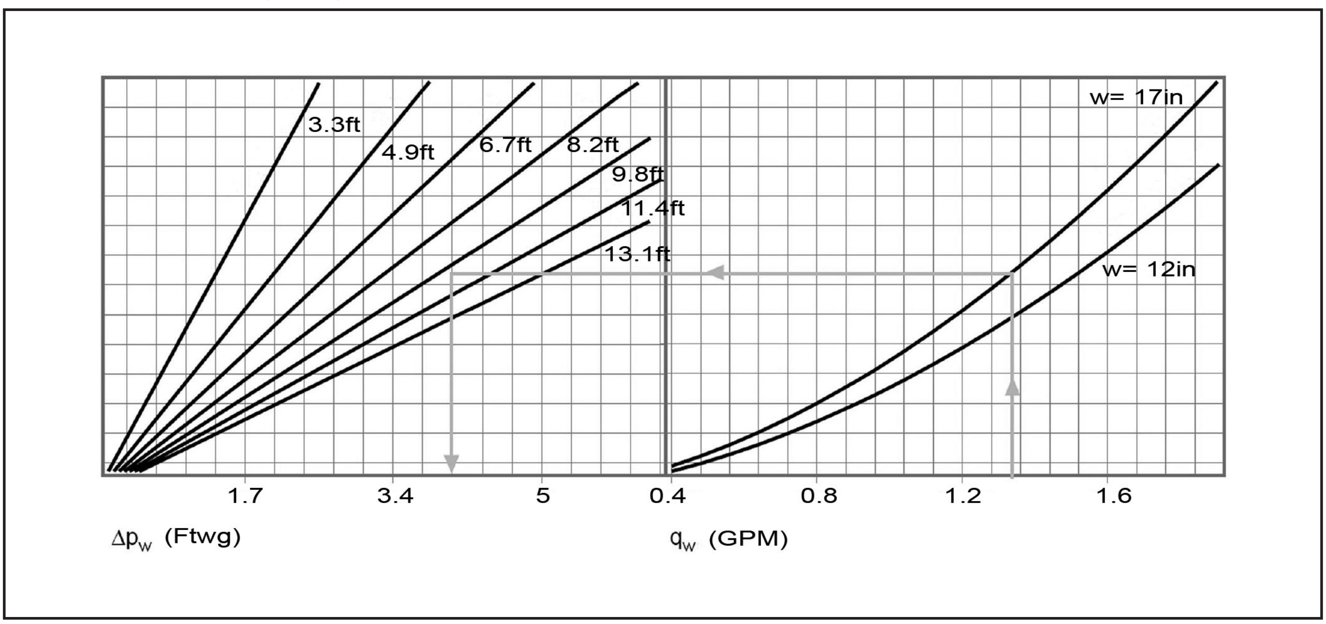
CORRECTION OF THE COOLING EFFECT OF AMOUNTS OF WATER UNEQUAL TO 0.8 GPM



AMOUNT OF WATER (GPM)



PRESSURE DROP, WATER (FT WG)

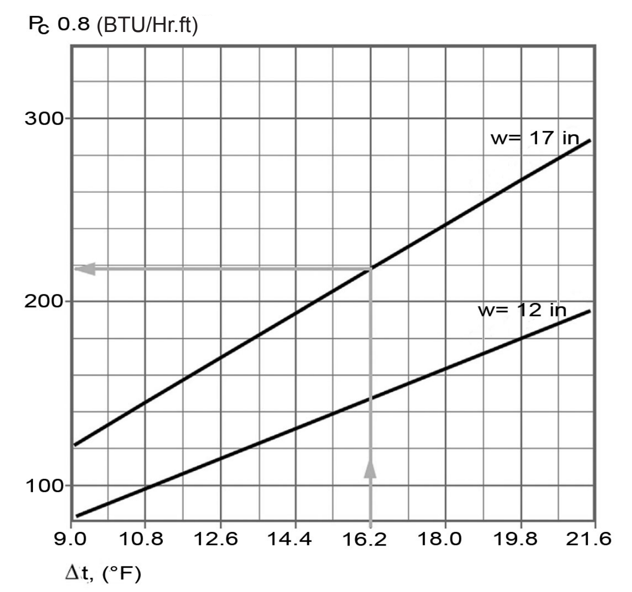


SELECTION EXAMPLE

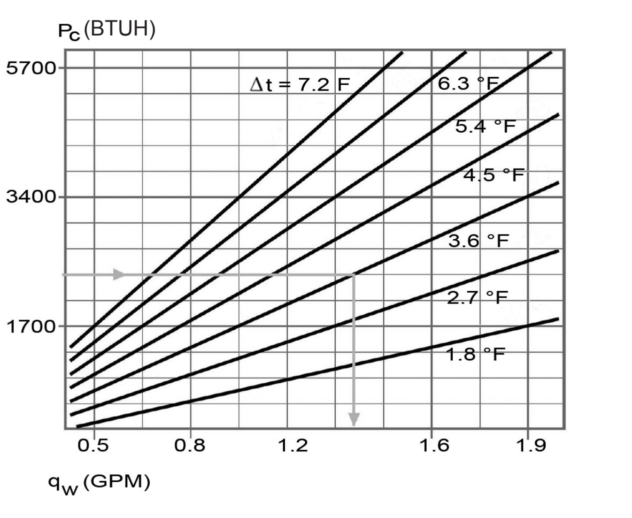
Criteria/design conditions:
Max. length of strip - 14 feet
Required cooling capacity - 2400 BTUH
Room air temperature - 75°F
Entering water temperature - 57°F
Leaving water temperature - 61°F

Solution:
Mean coil temperature = (57+61)/2 = 59°F
Difference between room air temperature and mean coil temperature Δt = 75-59 = 16°F.

According to the diagram below, the cooling capacity, $P_{C0.8}$ for the 17" wide beam at a water flow rate of 0.8 gpm is 215 BTUH/ft.

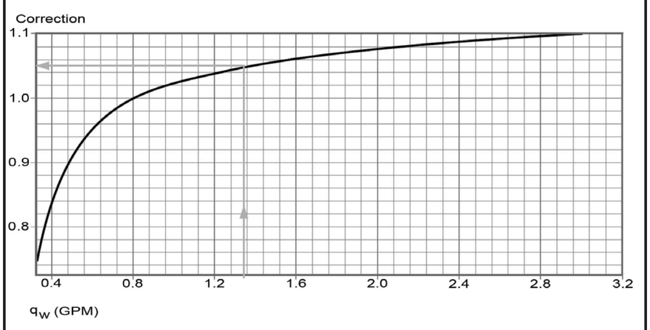


In the capacity versus water flow rate diagram the amount of water q_w is 1.3 gpm at Δt_w = 4°F and the cooling capacity is 2400 BTUH.



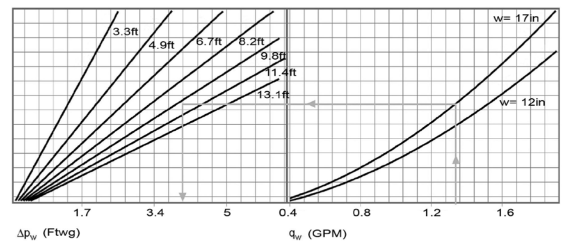
A correction must be made to the beam performance based on the diagram below to adjust for water flow rates other than 0.8 gpm is K = $P_{c1.3}$ vs $P_{c0.8}$ = 1.04. Thus, due the higher amount of water, the actual capacity is 4% higher than the value shown in the diagram. P_c = 1.04 x 215 = 224 BTUH/ft.

Required effective length (coil length) L_{eff} = 2400/223 = 10.8ft.



Minimum unit length = 10.8ft + .3ft = 11.1ft. The next larger beam length, of 12 feet will be required to provide the required cooling in the space.

According to the water coil pressure drop diagrams, the pressure loss, based on unit effective length (L_{eff}) of the above the beam in this selection example Δpw is 4.35 ft wg.



Notes