# HVAC Chilled Beam Systems

An Online Continuing Education Course for Engineers

**Course Number: HV-4021**

**Credit: 4 Hours / 4 PDH / 4 CPD**

# HVAC Chilled Beam Systems

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## Introduction

With many HVAC systems in the global market, water-based systems are increasingly being specified to provide energy-efficient cooling. Chilled beam systems use water as well as air to transport thermal energy and can provide valuable additions to the traditional variable air volume (VAV) systems. As most North American HVAC designers have almost exclusively used VAV systems, they are often not aware of the energy benefits that can be derived by these alternate technologies, which are very commonly applied in rest of the world.

The course is divided into five chapters.

Chapter - 1: Overview Of Chilled Beam Systems

Chapter - 2: Principles Of Operation

Chapter - 3: Air Side Design Considerations

Chapter - 4: Water Side Design Considerations

Chapter - 5: Chilled Beams – Applications, Strengths, and Weaknesses

Annexure: Conclusion And Selection Parameters

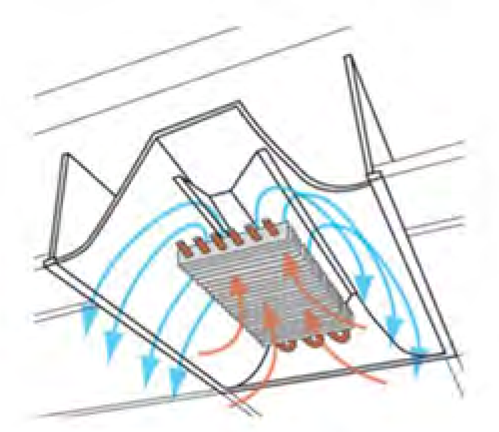
# Chapter – 1

## Overview Of Chilled Beam Systems

A Chilled Beam is a building conditioning system that uses convection and water to move energy throughout a building efficiently. The major advantage of a chilled beam over more conventional forced air systems is that it circulates building air without the noise and the need for heavy air ducts and air handlers.  Chilled beams reduce and save energy due to natural circulation. The use of a chilled beam system allows obtaining excellent results concerning comfort, energy savings, very low noise levels, high hygiene standards; no unpleasant room draughts, uniformity of room temperatures and low maintenance requirements.

There are two types of chilled beams – 'Active' or 'Passive' type. Both types have coils that carry cool (or chilled) water that exchanges sensible heat with warm room air, as the air passes across and between the cooler coils (and their extended surfaces). The difference is on the way airflow, and fresh air is brought into space. Passive chilled beams require ventilation air to be delivered by a separate air-handling system. With active chilled beam systems - sometimes referred to as "induction diffusers" - a building's ventilation air is continuously supplied to chilled beam terminal units by a central air-handling system.

- **Passive Chilled Beam**
  - A passive chilled beam is essentially a water coil mounted in a frame in the ceiling. As cold water passes through the coil, the air in contact with the coil becomes colder and denser and drops into the room. This air movement induces warm air from the room upwards, where it then meets the coil, and the cycle continues.
  - Passive Chilled Beams are primarily used to counteract perimeter solar gains but can also be used for internal space cooling with cooling outputs up to 20 BTU/hr/ft$^2$ of floor area.



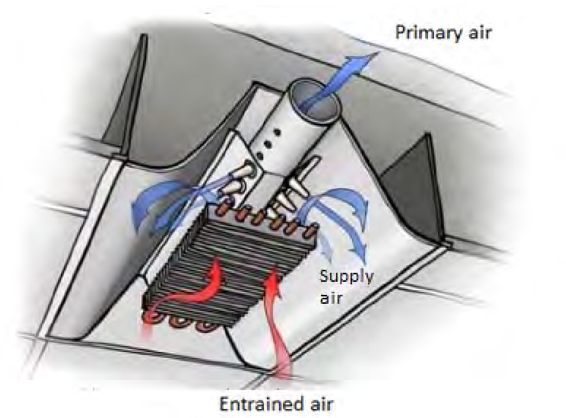
PASSIVE CHILLED BEAM

**Important:** Using passive chilled beam systems, the ventilation air required must be delivered to the building by a separate air handling system.

- **Active Chilled Beam**

  - In contrast to passive chilled beams, in which the convective heat transfer is natural, active chilled beams are characterized by forced convection. Active chilled beam units are supplied with ventilation air from the dedicated outdoor air handling system (DOAS), and chilled water is circulated in a hydronic cooling coil inside the active chilled beam. The primary air enters the room via a pressure plenum and several nozzles along the beam. The high air velocity generated by the nozzles induces room air that passes the coil before it mixes with the primary air. The mixed air is discharged into the room through slots along both long sides of the beam.

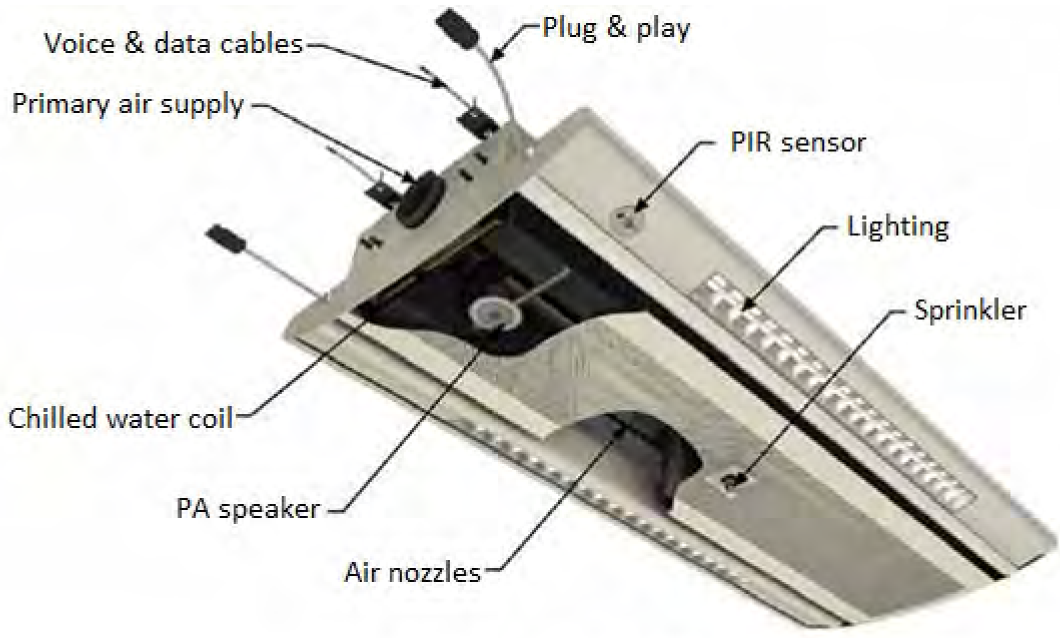
  - Active chilled beams with primary supply air have much higher sensible cooling capacities than passive chilled beams and are capable of cooling outputs up to 40 BTU/hr/ft$^2$ of floor area.




ACTIVE CHILLED BEAM

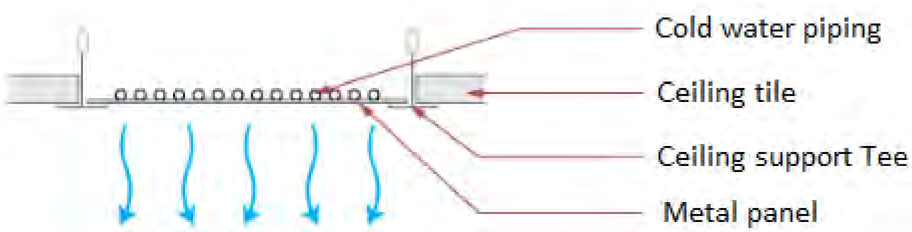
**Caution:** Chilled beams are not designed to handle condensation, and the design must avoid it. The temperature of the surfaces of the beam must not fall below the dew-point temperature of the surrounding air. Otherwise, condensation is likely – any dehumidification (or latent cooling) must be undertaken with an associated air supply system.

- **Multi-service Chilled Beams**
  - Multi-service chilled beams (MSCBs) combine chilled beams with additional building services such as lighting, audio equipment, speakers, occupancy sensors, smoke detectors, cables, etc. This type of Active Chilled Beam is usually customized to meet specific project requirements.
  - The outer frame is often customized to provide a visual appeal that is consistent with the architecture of the space in which it is mounted.




**Multi-service Chilled Beam**

- **Chilled Ceilings**
  - Chilled ceilings differ from chilled beams in that they rely more on radiant cooling (not convective).
  - A chilled ceiling is a metal sheet with water pipes running above it. The pipes heat or cool the metal panel, which then radiates that energy toward the building occupants.




**Chilled Ceiling**

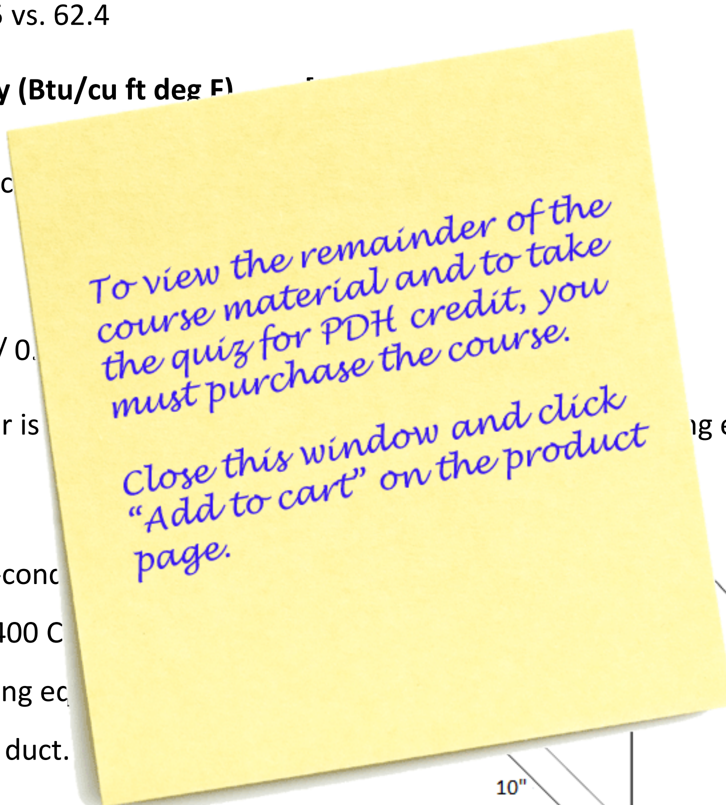
**Why Chilled Beam**

Chilled beams combine the major advantages of water and air. Air ensures the ventilation and water serves as an efficient transport medium for heat and cooling. The design intent is to maximize the water use so that the beams deliver most of the cooling via the water circuit. This is because the water carries significantly more energy than air.

**Air vs. Water**

- **Specific heat (Btu/lb deg F)**
  - 0.244 vs. 1.0
- **Density (lb/cu ft)**
  - 0.075 vs. 62.4
- **Heat capacity (Btu/cu ft deg F)**
  - Heat c
- **Ratio**
  - 62.4 / 0.

    Water is ng energy.




**Example:**

1 Ton of standard air-conc

equipment provides 400 C

can be distributed using ec

10" x 10" rectangular duct.

10"