Introduction to Hydronic Heating and Cooling

Price Training PROGRAMS

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Introduction to Hydronic Systems
Overview

1. History and Introduction
2. Theory and System Design
3. Applications
4. System Design

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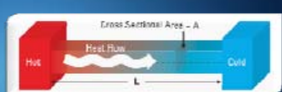
Review

Heat Transfer
- Conduction
- Convection
- Radiation
- Evaporation



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Introduction to Hydronic Systems
History

- **Started in Europe approx. 60 years ago**
  - Metal ceilings
  - Radiant systems
- **Seeking more capacity**
  - Passive chilled beams
- **Integration of ventilation system**
  - Active chilled beams

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- **Water moves energy through the building**
- **Water is much more effective than air**
  - ~600x heat transfer capacity (6°F vs. 20 °F ΔT)
- **Still need ventilation air**

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Benefits

Energy Efficiency:
- Reduced system horsepower
- Free cooling

Reduced Maintenance:
- No moving parts or filters
- No electrical connection required
- No drain pan or condensate pump

Smaller Mechanical System:
- Lower floor-to-floor heights
- Smaller risers - increased tenant floor space

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Heat Transfer

Air Side – Less efficient
- Meet all ventilation requirements
- Remove all latent loads

Water Side – More efficient
- Balance of sensible cooling load
- Higher CHW temp (57-62 F)
- Lower HHW temp (100-140 F)

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Humidity Control

- **Airside to meet 100% of worst case latent load**
  - Infiltration
  - Maximum occupancy
  - Other sources of moisture
- **CHWS Temperature higher than dewpoint (2F recommended min)**
- **Control Strategies**

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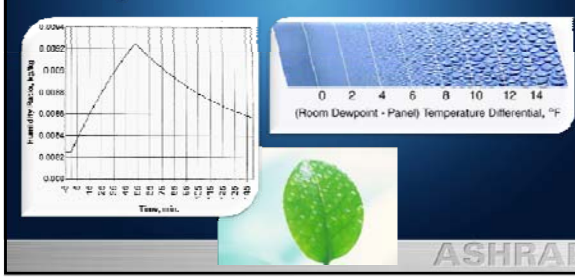
Condensation
- Condensation formation generally takes a while, not like a glass
- Large surface area on which to condense



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Condensation Sensor

- Use condensation sensors as part of control
  - Typically locate one on supply water tubing in area most likely to have the highest dewpoint
  - Use sensor to shut off valve or reset EWT
  - Use supply water temperature +2F above Tdp

Sensor Location	Advantages	Disadvantages
On the face of the beam / panel	Humidity is measured where the risk of roomside condensation is the highest	Integration into the beam or panel may require increased coordination. Sensor may be difficult to access for calibration
In the zone	Humidity is measured at the zone ource of the moisture Sensor is easily accessible	Local spikes in the humidity may cause the system to be overly responsive, reducing capacity
In the return duct	A more average reading of the zone humidity is taken, maximizing the operation of the beam	Cannot respond to local humidity issues

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Standards

Performance Data

No NA test standards available
- ASHRAE TC5.3 CB subcommittee
- AHRI rating program

Currently tested to:
- 14037 – heated ceilings
- 14240 – chilled ceilings
- 15116 – active beams
- 14518 – passive beams

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Standards

Active Beam Performance
- Standardized test methods
  - EN 15116
  - ASHRAE – in development
- Catalogued based on MWT – T_{air}
  - Based on nozzle configuration
- Capacity considerations
  - Nozzles
    - Pressure drop
    - Trade-off:
      - » Small nozzles = high Btuh/cfm, low Btuh/ft
      - » Large nozzles = low Btuh/cfm, high Btuh/ft
  - Primary air temperature
    - High primary air temperature

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Applications

Legend:
- Application of radiant products is natural
- Additional care to control building moisture
- Humidity must be carefully considered

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Applications

- Laboratories
- Commercial Construction
- Owner occupied buildings
- Hospitals
- Educational facilities

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Applications

- Air-side Load Fraction (ALF)
- The smaller the Air-side load fraction, the more energy can be saved by using a Hydronic system

	Office	Classroom	Lobby
Ventilation Requirement (typ, cfm)	0.15	0.5	1
Air Volume (All Air System) (typ, cfm)	1	1.5	2
Air-side Load Fraction	**15%**	**33%**	**50%**

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Radiant Ceiling System Basics

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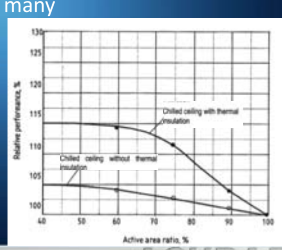
System Design – Radiant Ceiling Components

- Typically active area is <70%
  - Fire, PA, Ventilation services
- Capacity will depend on many factors
  - proximity to warm / cool surfaces
  - Forced convection over panel
  - Convective component



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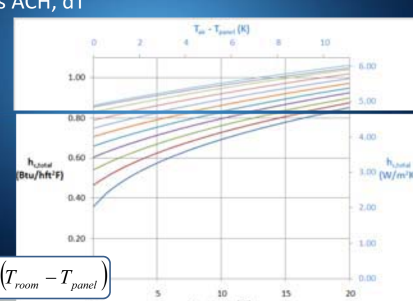
System Design

Capacity vs ACH, dT



$$q''_{convection} = h\left(T_{room} - T_{panel}\right)$$

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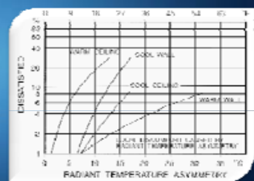
System Design – Radiant Ceiling Components

Radiant asymmetry

- Difference between the temperature of opposing surfaces
- < 5% PD
- Based on average ceiling temperature



Operative Temperature

- $T_{op} = (T_{MRT} + T_{air})/2$

TABLE 5.2.4.1
Allowable Radiant Temperature Asymmetry

Radiant Temperature Asymmetry °C (°F)			
Warm Ceiling	Cool Wall	Cool Ceiling	Warm Wall
< 5 (9.0)	< 10 (18.0)	< 14 (25.2)	< 23 (41.4)

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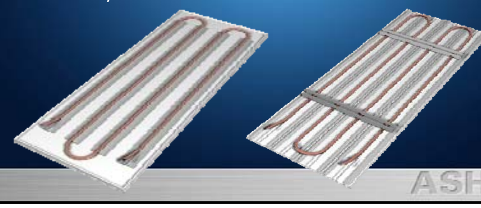
Applications – Radiant Panels

- Primarily radiant heating/cooling – no airflow
- Quick response to load demand
- Used along perimeters or spot cooling interior
- **2 types:** Linear & Modular
- ~35 Btu/ft^2



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Applications – Radiant Panels

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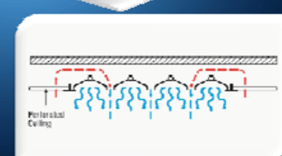
Applications - Sails

- Radiant and convective cooling
- Increased performance over panels
- Profiles and free area encourage convection
- Architectural integration



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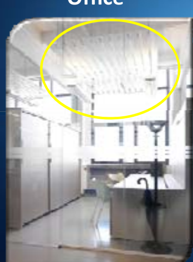
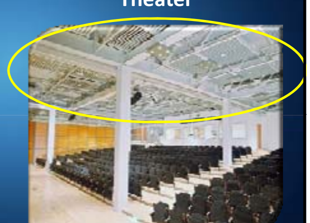
Applications - Sails

Office



Theater



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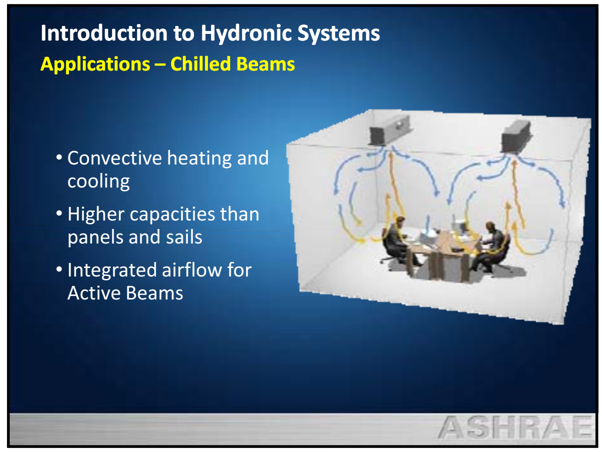
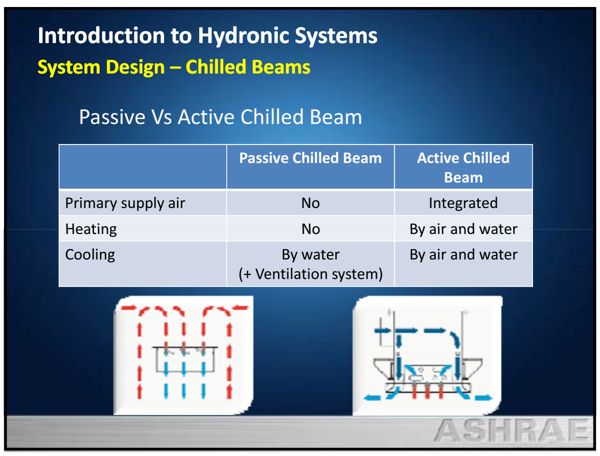
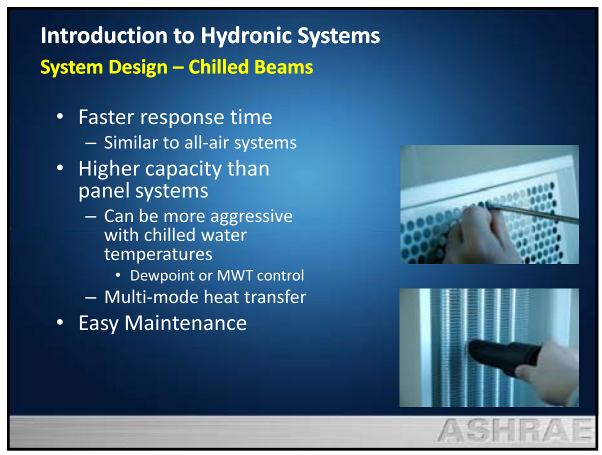
Applications - Sails

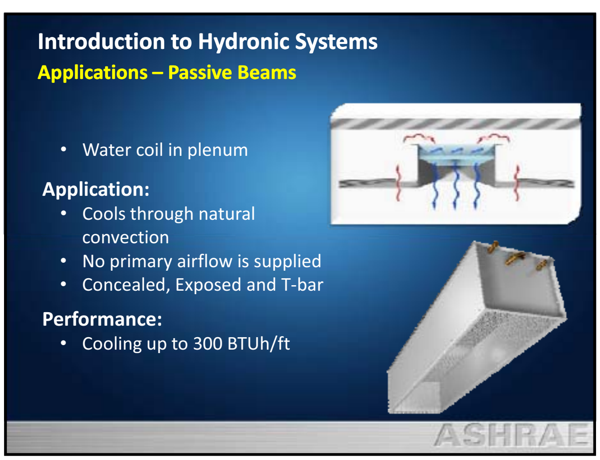
Boardroom

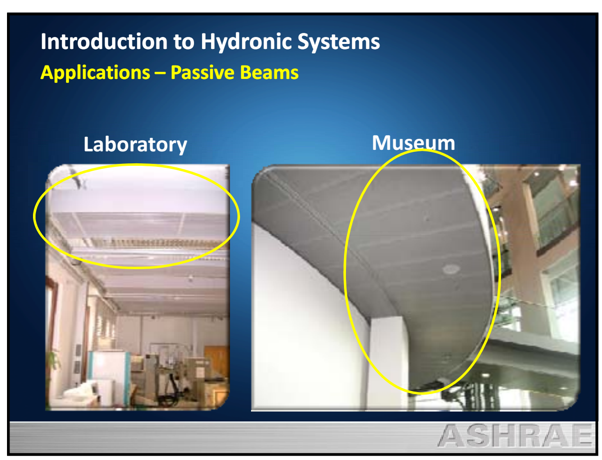




	Passive Chilled Beam	Active Chilled Beam
Primary supply air	No	Integrated
Heating	No	By air and water
Cooling	By water (+ Ventilation system)	By air and water







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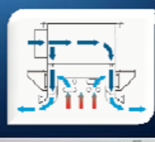
Applications – Active Beams

Nozzles drive induction

Application:
- Primary airflow is supplied
- Exposed and T-bar
- 2 way discharge

Performance:
- Cooling up to 1300 BTUh/ft



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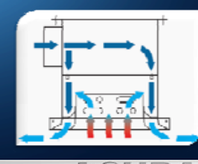
System Design – Active Chilled Beam

Components
- Air Plenum
- Water coil

Technology:
- Primary air supplied for ventilation
- High velocity induces room air into coil
- Various nozzle sizes



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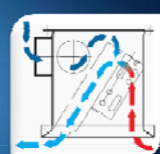
System Design – Active Chilled Beam

One Way Throw



Performance
- Cooling up to 825 BTUh/ft

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Applications – Active Beams

Lab, TN

School, MA

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Hydronic Heating & Cooling Capacity Comparison

	Panels	Sails	Passive Beams	Active Beams
Heating Performance (BTUh/Unit Surface ft²)	80	~50	-	525
Cooling Performance (BTUh/Unit Surface ft²)	35	55	150	650
Cooling Cost ($) / BTU	1.33	1.42	0.37	0.38
Ventilation function	None	None	None	Integrated

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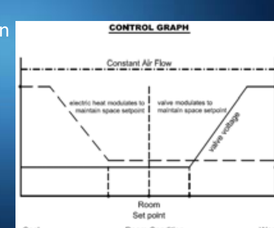
Design Considerations - Controls

- CHWS Temperature Control
- Demand Control Ventilation
- VAV
- Packaged system



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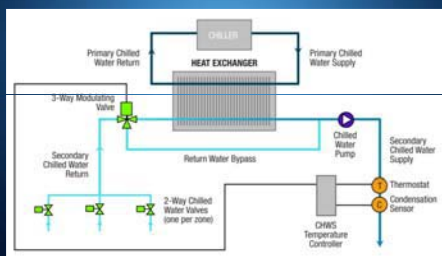
Design Considerations - Piping

Piping schematic for shared chiller



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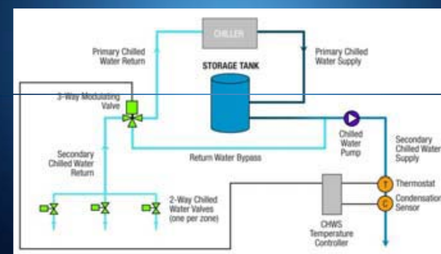
Design Considerations - Piping

Piping schematic for dedicated chiller



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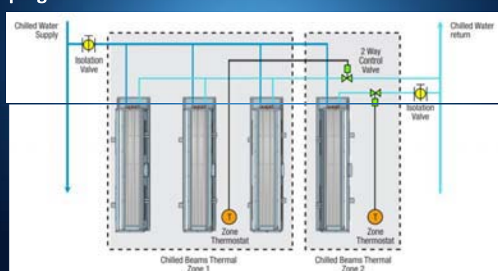
Design Considerations - Piping

Piping schematic for zone control



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Design Considerations - Piping

Hose and Valve Packages

- Single and double braided stainless steel hose kits
- NPT connections on all components
- Automatic temperature control valve
- Shut off valves
- Manual balance valve
- Automatic flow control valve

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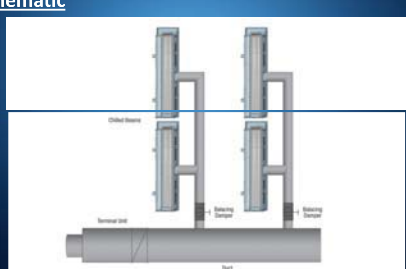
Design Considerations - Airside

Duct schematic



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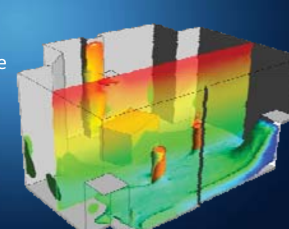
Design Considerations

- CFD Analysis
- Controls integration
- Mock up testing
- Commissioning assistance
- Operations training
- Post installation support



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Open Discussion
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