ENGINEERING UPDATE

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OPTIMAL SELECTION OF PRICE TERMINAL CONTROLS

By Mike Nicholson C.E.T.
– Price Electronics General Manager

Selecting the optimal HVAC Zone Controls can be a daunting task, even for those familiar with HVAC systems. Price offers a variety of controls solutions for virtually any application. However, in order to maximize cost savings and obtain ideal performance from the system, several factors must be considered:

- Airflow requirements
- Reheat types
- Thermostat selection
- Networking

AIRFLOW REQUIREMENTS

Airflow requirements for a zone can vary depending on application. Demand control ventilation pushes for an even broader range of minimum airflows. Typically, keeping minimum airflow settings low can save energy on the main air handlers and local reheat. However, standard VAV terminals can have trouble reaching these desired low airflows.

Price has developed a controller called the **Price Intelligent Controller (PIC)** designed to handle these low airflows with a new transducer. The airflow sensor (i.e.: Price SP300) works together with the transducer to convert velocity pressure signals into digital (or analog) information. However, at very low airflows the signal is small and a high-performance transducer is needed.

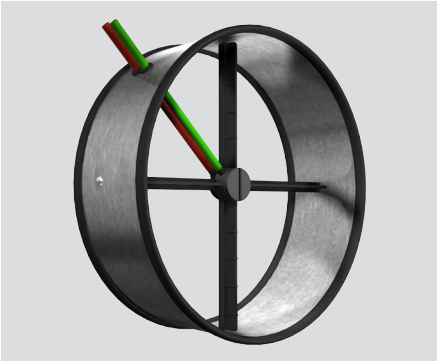
Price has solved this issue with custom firmware and a highly sensitive, temperature compensated digital transducer which can repeatedly measure down to 0.005" W.C. This allows designers to go down to ½ of the standard minimum airflow, which on an 8" terminal is **66 CFM instead of the usual 132 CFM**. This offers a **significant reduction** in minimum airflows, saving energy on reheat and overall fan energy. Since the PIC is designed for handling low airflows, there is no risk of hunting, which is an unstable condition when the damper continuously adjusts, attempting to lock onto its airflow target. Hunting will result in premature actuator failure due to the excessive and constant movements.

REHEAT TYPES

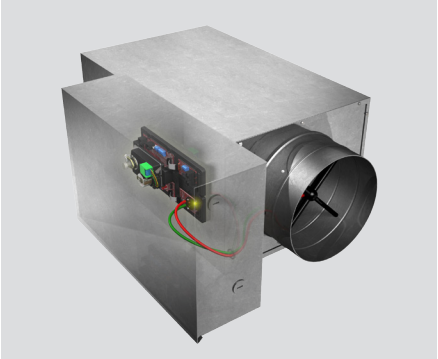
Local reheat may be required to satisfy load demands. Many options for both electric and hot water reheat are available. The **Price Intelligent Controller (PIC)** can handle all types of reheat.

For electric reheat, **Price recommends using an SCR (Silicon Controlled Rectifier) with the optional discharge air temperature (D.A.T) probe.** The SCR modulates the electric heater by pulsing the heat on and off. With this modulation, you can target any percentage of reheat. For example, a 10kW heater with an SCR becomes a 0-10kW since the SCR can take 1% steps to target any amount of reheat within that range.

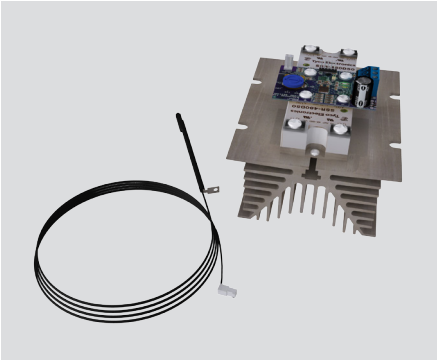
This allows for improved control over staged binary heat (the classic stage



Price SP300 Flow Sensor



Price Single Duct with PIC



SCR with DAT probe

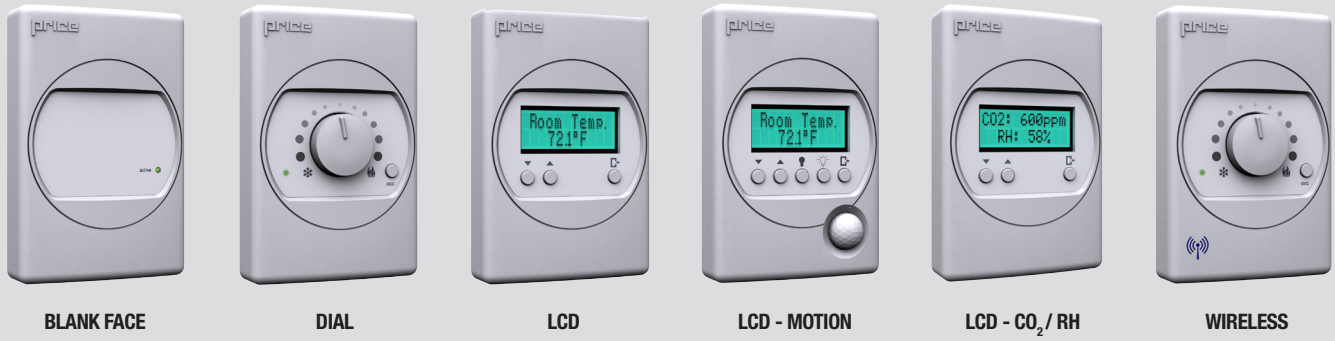


Figure 1 - Price Thermostat Options

1, 2, 3), also there's no noise or wear out of mechanical contactors. With the DAT probe, the SCR will automatically modulate the heat to maintain a maximum discharge air temperature. With the DAT set to 95˚F, regardless of the airflow, the SCR will never exceed that temperature. This helps save energy, prevent stratification, and greatly reduces the risk of tripping the electric heater safeties.

The **Price Intelligent Controller (PIC)** can also control all types of hot water reheat valves including: binary (24 VAC on/off – standard and fail-safe), floating point (24 VAC – clockwise, counter-clockwise), and modulating (0-10 VDC).

The PIC can also (optionally) disable reheat when the supply air temperature (S.A.T.) is warm. This is done to save local electric reheat when the main air handler (typically natural gas) is in heating mode. In most territories natural gas is a more cost effective energy source than electric heat, therefore the above strategy can save facilities a significant amount of money.

THERMOSTAT SELECTION

There are several options for thermostats, and while their task is simple, a proper selection is essential. The four main aspects to consider when selecting a thermostat are:

- Set point adjustment – allow users to change or set from network
- Providing information to users – LCD screen
- Occupancy sensing – motion sensor for real-time occupancy modes
- CO_2 sensing – for purging excessive CO_2

Price offers a full range of thermostats that work with the **Price Intelligent Controller (PIC)** and other models (See **Figure 1**).

The simplest model is a blank face thermostat. Equipped with only a thermistor and PIC service port, user set point is unavailable. These types of thermostats are typically used in larger buildings where the Building Management System (BMS) has control of the set point (i.e.: Airports and large commercial buildings).

The next model is a dial thermostat, which allows set point adjustment but has local set point display. This is very cost effective and allows the user some control. Set point minimum and maximums are set in the PIC and can be a wide range (i.e.: 65-80˚F) or narrow (i.e.: 70-74˚F). Beneficially, the installer can tweak the temperature ranges to fit their application.

The LCD thermostat allows set point adjustment via a push button and can display the local room temperature.

The LCD can also display custom settings such as the room name and number, set point only, humidity, and/or CO_2. Because the thermostat now has a display, many options can be setup utilizing both the push buttons and screen. All Price Intelligent Controllers can be fully balanced and setup via the LCD thermostat. The LCD thermostat can also double as a service tool, setting up controls that are using the dial or blank face thermostats.

Thermostats with occupancy sensing capabilities allow for dynamic control and are more flexible than hard set schedules. The LCD thermostat with motion sensing allows an automatic setback to night heating and cooling set points. This can save energy in spaces that are occupied on random occasions. The adjustable timeouts allow for setback after any number of minutes.

While monitoring temperature is an excellent way to help with occupancy comfort, measuring CO_2 adds another variable of control. The LCD thermostat with CO_2 sensing allows purge modes to flush excessive CO_2 from a room. Also, when using BACnet, the CO_2 reading in parts per million (ppm) can be read by the BMS system allowing for on-demand control of fresh air intake.

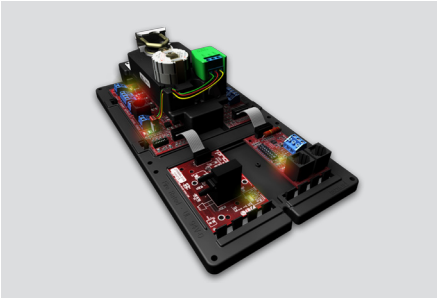
In some applications, running wires to a thermostat is not possible or is very difficult (i.e.: glass/cement walls). In this case, a wireless thermostat is the best solution. Price offers a wireless thermostat with dial adjust and extremely long battery life. Price's wireless thermostat batteries will last over five years, while the battery life & signal strength can be read in real-time at the controller and via the BMS system. This allows easy and pro-active maintenance of the system.

NETWORKING

Networking allows for communication with all zone controllers. The network or Building Management System (BMS) can then remotely monitor, control, and alarm based on real-time conditions. This is useful for energy savings, custom sequences, local and remote maintenance. However, devices on a network typically must speak the same language. In the past, nearly every vendor had their own proprietary network. This made total system integration difficult and expensive. The networking solution is a standard protocol that all vendors can use.

BACnet was developed for exactly this situation. Sometimes known as the ASHRAE Standard 135, BACnet allows multiple vendors/devices to share information. Price fully supports BACnet on all of its controls allowing full integration with new and existing systems. Over the years, BACnet has gone from a small contender to the De facto standard for BMS systems, offering a large variety of solutions ranging from not only HVAC, but to lighting, security, and energy management.

Price recommends specifying BACnet and ordering the BACnet option with the **Price Intelligent Controller (PIC)** on jobs where a network is required.



Price Intelligent Controller (PIC) with BACnet

Other things to consider are:

- BACnet Testing Laboratories (BTL) Listing
- BACnet points list
- Physical Network type – RS-485, Ethernet, UDP/IP

A BACnet Testing Laboratories (BTL) listing assures users that the product has been tested to meet the requirements of BACnet. This testing helps with system integration, and guarantees products will communicate and share information over the network. Price has several BTL listed products, including the **Price Intelligent Controller (PIC)**.

A BACnet points list comes with each BACnet product, showing the data points that are available to the BMS. The points list helps the BMS system programmer setup, monitor and control the devices. It is good practice to ensure that any essential data points are on the BACnet points list.

When the PIC is ordered with BACnet (recommended), it will come with a BACnet expansion card which allows Native BACnet MS/TP communication. Native communication means the product directly supports the protocol and does not require a protocol convertor. BACnet MS/TP runs on an RS-485 network using two wires plus a recommended ground reference.

Price offers several products that have been tested and approved in the BACnet testing laboratories.

Terminology

BACnet®: A data communication protocol for building automation and control networks.

BACnet Point: A variable that is accessible on the network. It may be 'read only' or also 'writable'.

BTL Listed: Products that have been tested to ASHRAE 135 and certified to meet the standard. All currently listed products are available to view at *www.bacnetinternational.net/btl/index.php?m=113*

The benefits of MS/TP are:

- Lower cost than Ethernet
- Long cable runs of 1000+ ft.
- Daisy chain – no need to run each wire back to a central location

Once the daisy chain RS-485 network is run, a BACnet router can convert the MS/TP network up to BACnet UDP/IP and then all BMS systems can share/control the data.

SELECTION USING THE ALL-IN-ONE SOFTWARE: ENGINEERING EDITION

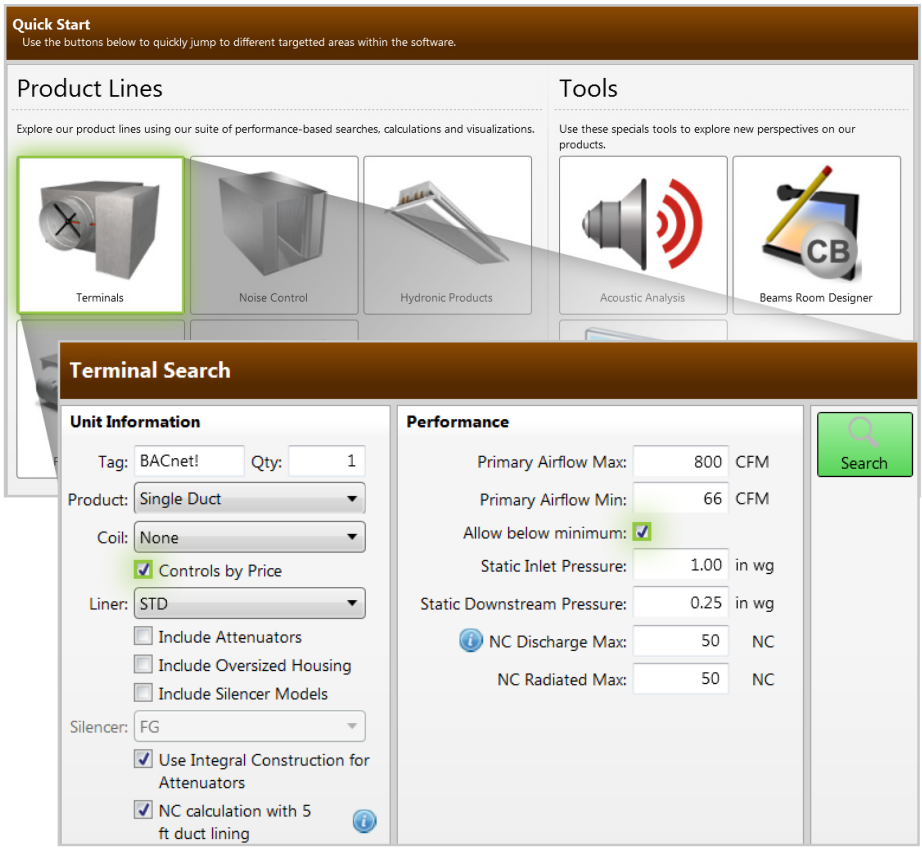
Using Price's All-In-One Software: Engineering Edition allows for fast and easy selection of terminal units with controls. Download this software from *www.priceindustries.com/software/all-in-one*. Once installed select: "**Terminals**" then "**Controls by Price**" and "**Allow below minimum**" to begin.

PRICE CONTROLS

Price Controls are manufactured in-house to work seamlessly with Price Terminal Units. To ensure fast delivery, all Price Controls are stocked at our factories. Before an order ships, the controller is calibrated with all airflow factors/flows and then is factory mounted. Once on-site, the controller is **ready to use, with no programming or setup required.** Balancing can be done using either the LCD thermostat or Linkersoft2 setup software. This software is available for download at *www.priceindustries.com/resources/download/1604*.

When combined with a cutting edge airflow transducer allowing for ultra-low minimum flows, a BACnet protocol with BTL listing, and a huge variety of thermostat and reheat options, Price Controls is the best choice for VAV zone control.

To see the full Price Controls product offering, visit *www.priceindustries.com/controlsolution* today. For more information and assistance with your next project, contact the Price Controls Application Engineering Team at *controls@priceindustries.com*.



All-In-One Software Engineering Edition - Terminals with Controls

Summary of Benefits

- **Designed in-house** – seamless integration with Price Terminal Units
- **Stocked at factories** – for quick lead times
- **Factory mounted** – reducing cost and on-site labor required
- **Calibrated at factory** – no on-site setup/programming
- **BTL listed** – easy integration with all Building Management Systems

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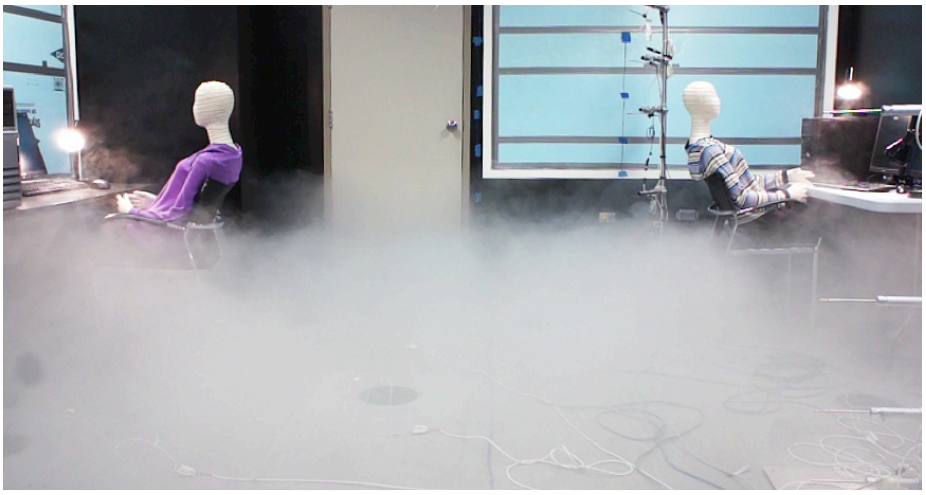
PRODUCT FEATURE: PRICE ROUND FLOOR DISPLACEMENT DIFFUSER

By Alf Dyck, P. Eng.
– Vice President of Product Engineering

Recent research conducted by the Center for the Built Environment (CBE) has confirmed that the Price Round Floor Displacement Diffuser (RFDD) provides a stratified environment with increased ventilation effectiveness, energy efficiency, and comfort compared to traditional underfloor air distribution (UFAD) outlets. The Price RFDD is unique in the UFAD market as it projects the supply air horizontally at low velocity as compared to conventional vertical-discharge, high-mixing outlets. Although Price has marketed the RFDD as a displacement outlet since its introduction in 2002, the CBE study desired to evaluate its performance in a full-scale UFAD mock-up of an interior zone at various conditions.

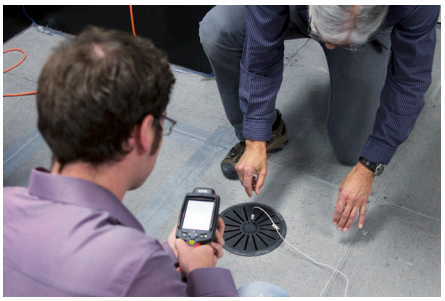
The CBE is a consortium of industry partners dedicated to improving the quality and energy efficiency of buildings. Price has been a member of the CBE for many years, collaborating on several research projects. When the CBE proposed the UFAD displacement research project, we were excited to participate and offered the use of Price Research Center North (PRCN) for the mock-up. The CBE has conducted research projects at PRCN in the past and were very impressed with the facility and staff so they gratefully accepted the offer.

The researchers performed the study in the Mock-up Room, which is equipped with a raised floor, dedicated supply air system, and data acquisition system including sensor trees. With the aid of PRCN staff, the CBE researchers replicated an interior office space which included furniture, equipment, and thermal mannequins. The researchers varied the loads, supply air volume, and the number of diffusers to evaluate thermal comfort and stratification over a range of conditions.



A smoke test being conducted at PRCN to test the performance of Price RFDDs as an underfloor outlet

Results of the research indicated that the RFDD created a stratified environment similar to a well-designed displacement ventilation system. The stratification did not vary significantly with increased load or number of diffusers. Other observations were no personal air movement and low draft risk. The CBE report concluded that compared with conventional UFAD outlets, the increased stratification of the RFDD results in higher ventilation effectiveness (indoor air quality) and higher system energy efficiency.



Paul Raftery and Fred Bauman from CBE conduct research at PRCN

The CBE is planning to publish the results of this research project and have recently added the RFDD to their UFAD design tool. Both of these initiatives will have a positive impact on the selection and specification of the Price RFDD on UFAD projects.

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TECH TIP: TEST STANDARD, ASHRAE 200, AND CERTIFICATION PROGRAM, AHRI 1240, RELEASED FOR ACTIVE CHILLED BEAMS

By Jerry Sipes, Ph.D., P.E.
– Vice President of Engineering

In the HVAC design process, designers must balance product selection and performance against design parameters such as sound, thermal capacity, and power consumption characteristics. It's expected that the manufacturer's performance data is accurate and the product will perform as described. Manufacturers provide performance data for their products, but without a standard to verify performance against or a required minimum set of data in a specific format, it could be argued that the data presented is more marketing than engineering as it's difficult to compare performance of one brand against another, particularly if different test methodologies were used. Without a consistent test method and certification program, product selection and performance expectations might be based on who has the best story and who you trust.

This has been particularly true of chilled beam products, where some manufacturers provide data to different standards or to a self-generated test method. Most commonly, there have been two different standards that manufacturers have been using to develop performance data. The first standard is Nordtest Method NT VVS 078, Ceiling Cooling Systems: Cooling Capacity, 1999-11. The second standard is European Standard EN 15116, Ventilation in Buildings – Chilled beams – Testing and Rating of Active Chilled Beams, 2008. Both standards outline the testing requirements for thermal performance of water coils in active chilled beams.

Nordtest Method NT VVS 078 primarily focuses on passive cooling products (panels and passive beam type products), not induced air movement products like active chilled beams, and as a result, doesn't address primary airflow, primary pressure drop, or primary air temperature as part of the standard. It has no guidance on testing for sound or induced air volume. If the manufacturer of beams lists NT VVS 078 as the test method, they should also reference the standard they used for sound measurement, primary airflow, and pressure drop as well as the throw distance.

European Standard EN 15116 does focus on active chilled beams, but like the NT VVS 078 standard, it doesn't provide guidance on testing for sound or induced air volume. If the manufacturer of beams lists EN 15116 as the test method, they should also reference the standard they used for sound measurement as well as the throw distance.

It's my opinion that using either NT VVS 078 or EN 15116 can make your specifications/design documents more complicated and submittals less easily compared to verify performance compliance. Many times, I have only seen references to the coil capacity and no mention as to how the other design parameters were obtained. Due to the dynamic interactions of the water coil, induction ratio, static pressure, and discharge characteristics, how is a designer to understand the efficiency of the product selection without proper and complete data?

There are no provisions or requirements for testing sound generation, induced air volume, or throw distance in either standard. In part, due to the minimal reported performance metrics in the two aforementioned standards, ASHRAE developed a new method of test, ASHRAE Standard 200 Methods of Testing Chilled Beams, and AHRI developed a new certification program, AHRI 1240/1241, Standard for Performance Rating of Active Chilled Beams.

Manufacturers using either the EN 15116 or NT VVS 078 standards often downplay sound generation and report it as a dBA or NC with little (if any) explanation of how the value was determined. As you may recall in other Tech Tips, I have discussed the importance of proper sound data to help prevent spaces that do not meet the space sound design goal. Both dBA and NC are approximations and have serious design limitations.

The dBA is a measured and averaged value of the sound generated by the chilled beam and is environment specific. The data is only valid in the room it was measured in and the distance and orientation of the instrument relative to the chilled beam. Since the room and measurement method weren't described in either standard, the reported dBA values are most likely not consistent between

manufacturers and are unlikely to reflect actual sound characteristics of the space you are designing. This leaves you with a design challenge. In my opinion, dBA values aren't a good design parameter as your space will have either less or more sound attenuation (reflective, absorptive or diffusing room surfaces) or different room volumes than the space where you obtained the dBA measurement.

NC values are a commonly used design parameter in the HVAC industry. For diffusers, ASHRAE Standard 70 instructs manufacturers to test their diffusers by octave band and then assume 10 dB absorption in all frequencies before determining the NC value. The 10 dB absorption is based on a typical office and it's possible that most spaces won't have that much absorption. Unless you specify the attenuation characteristics of the occupied space and then use those attenuation values, the NC number may not be a good representation of the space being designed. I believe that most manufacturers of active chilled beams use the 10 dB factor when determining the NC values for their products. Since active beams use nozzles to inject the primary air into the induction chamber, they have a sound generation characteristic that will change based on the driving static pressure. If the static is high enough (above 1 to 1.5 inches W.C. depending on the beam size, type, etc.), there is a possibility that the active chilled beam will start generating pure tones in the 2000 Hz band. That is why both Standard 200 and Standard 1240 require sound power to be reported by octave band rather than by NC as the NC value is an average and doesn't indicate if pure tones are present. As long as the NC calculation is consistent between vendors, NC values allow a comparison between different products. Your specifications should specify Standard 200 as the method of test and then require either a 10 dB attenuation across the octave bands, or a specified amount of attenuation, before determining the NC value.

For more on dBA ratings and NC values, please see Chapter 7, Basics of Acoustics, of the Price Engineer's HVAC Handbook.

In 2009, ASHRAE Technical Committee 5.3 Room Air Distribution called for a new test standard to be developed to address the limited performance data and different test methods currently being used. At the same time, AHRI formed a new product section, chilled beams, to develop a certification program for active chilled beams that would use the ASHRAE method of test. I volunteered to chair both standards and am excited to let you know that after five years of work, both are now publicly available documents.

ASHRAE Standard 200-2015, Methods of Testing Chilled Beams

Purpose: To define laboratory methods of testing chilled beams to determine performance.

Scope: Defines laboratory methods of testing chilled beams to determine performance. It specifies test instrumentation, facilities, installation methods, and procedures for determining the performance of chilled beams.

Table 1 shows a summary of the different test parameters between the three chilled beam test standards.

Standard	NT VVS 078	EN 15116	ASHRAE 200
Water Coil Sensible Capacity	•	•	•
Water Pressure Drop	•	•	•
Water Flow Rate	•	•	•
Water Temperature Differential	•	•	•
Primary Air Pressure Drop		•	•
Primary Airflow Rate		•	•
Induced Airflow Rate			•
Induction Ratio			•
Discharge Air Throw Distance			•
Sound Generation (sound power by octave)			•
Total Sensible Cooling Capacity of Device			•
Sensible Water Coil Energy per Unit Volume of Primary Air			•

Table 1: Comparison of Test Standards

Now that we have a test method for active chilled beams that provides an enhanced data set, how does a designer decide if the data provided is representative of the product performance characteristics? That is where the AHRI certification program comes into play.

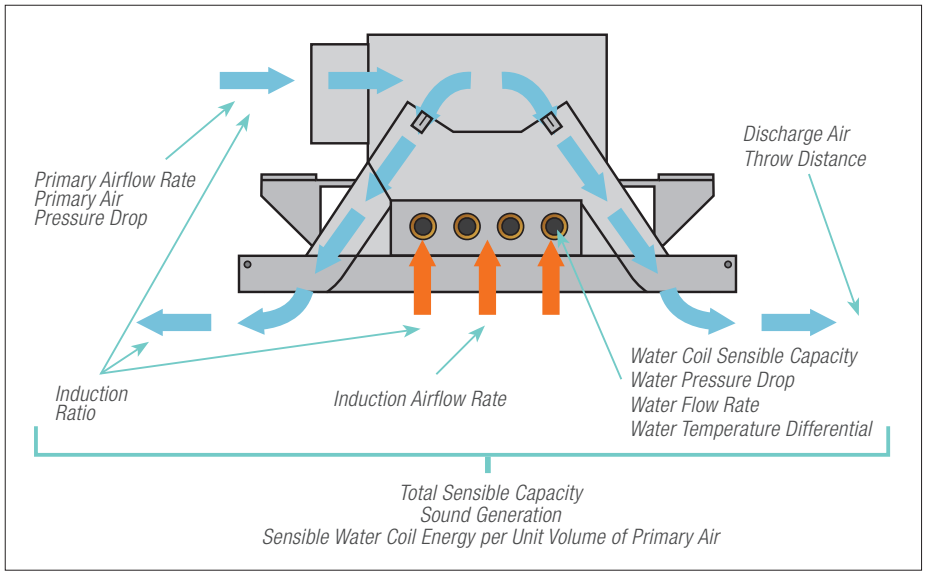
AHRI Standard 1240-2014 (IP) and Standard 1241-2014 (SI) Standard for Performance Rating of Active Chilled Beams

Purpose: The purpose of this standard is to provide, for active chilled beams: definitions, classifications, standard equipment, testing requirements, rating requirements, minimum data requirements for published ratings, marking and nameplate data, and conformance conditions.

Scope: This standard applies to active chilled beams, including multi-service active chilled beams and room air induction units. This standard doesn't apply to active chilled beams employing volatile-refrigerant coils, condensing coils or steam coils. It doesn't apply to passive beams.

AHRI is a globally accredited organization for HVACR and water heating certification. In the North American market, the Environmental Protection Agency, U.S. Department of Energy, Federal Trade Commission, Natural Resources Canada, and California Energy Commission all recognize AHRI.

The AHRI 1240/1241 certification program is voluntary and all participants must provide ratings for all models they manufacture in order to claim their active chilled beams are certified. Each year, 20% of all of a manufacturer's basic model groups are independently tested in a third-party lab (not AHRI).



ASHRAE 200 Data Points

Rated in Accordance	AHRI-Certified
• Conforms to Standard (self-verified)	• Conforms to Standard (third-party verified)
	• Subject to rigorous and continuous testing
	• Manufacturer's performance ratings independently measured
	• All products within program scope
	• Provides marketplace clarity

Table 2: Comparison between Rated in Accordance and AHRI-Certified

This independent verification of the performance ratings ensures that the manufacturers are held accountable for their performance data. Should a manufacturer not participate in the 1240 certification program, they can still rate their products in accordance, but the data isn't independently third-party verified. **Table 2** shows the difference between Rated in Accordance and AHRI-Certified.

The certification program is newly established, and is expected to be implemented over the next three years, starting in 2016. The remaining task is the selection of a means of certifying performance. Until the program is initiated, designers are cautioned to verify any claims to performance data and certification. Remember you can always ask for a mock-up witness test, or specific lab testing for your projects. We will keep you informed as to the status of ASHRAE 200 / AHRI 1240 Certification.

For more information on acoustics or active chilled beams, please see the Price Engineer's HVAC Handbook or visit priceindustries.com.