Fan-Outlet Static Control

It is often convenient to mount the duct static pressure sensor at the supply fan outlet, and set the static pressure controller to maintain the static pressure required at design flow. The sensor can either be mounted cost effectively and reliably at the factory, or in the field at a somewhat higher cost and without benefit of a factory run test. Reliable sensor installation and operation entails proper static pressure sensing and signal routing. If fire dampers are included in the supply ducts, fan outlet sensing assures that the static pressure sensor is on the fan side of the fire dampers so that ducts are protected from high pressures. Also, depending on the design and layout of the duct system, this method may eliminate the need for multiple duct-mounted sensors.
The ANSI/ASHRAE 110 test is a method of testing the performance of laboratory fume hoods. The Kanomax Dif-Kit is ideal for use in performing the Tracer Gas test in accordance with the ANSI/ASHRAE Standard 110-1995. Kanomax also offers alternative tracer gas systems due to concerns to prevent greenhouse gas emissions.

**Features:**
- The diffuser is placed in the fume hood and tracer gas is injected at a supply pressure of 30 psi
- Alternative tracer gas systems are available - SF6, NO2, or FM-200 (HFC-227)
- Built to the specifications of Standard drawing #110-83M

**Options:**
- Thermal anemometer for face velocity testing
- Commercial fog machine for flow visualization

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When the duct static pressure sensor is located at the outlet of the fan, the static pressure controller, SPC in our system example, must be set to 1.40 in. wg so that the pressure at the inlet of the VAV terminal unit is 0.80 in. wg at design airflow. Figure 4A shows the system resistance curves, fan modulation curve, and the new fan curve at partload flow. They indicate that at zero airflow, fan static pressure is the duct static pressure set point, SPC = 1.40 in. wg. At our part-load airflow, the inlet guide vanes are repositioned and a new fan curve is created so that 18,000 cfm is delivered and the duct static pressure at the fan outlet is constant at 1.40 in. wg. The fan now operates at the intersection of the fan modulation curve and new fan curve, Point C. As the pressure gradient curve in Figure 4B shows, fan static pressure drops to 2.13 in. wg, duct static pressure is constant at 1.40 in. wg, and the static pressure at the inlet to the terminal unit rises to 1.06 in. wg. The terminal unit must close to introduce a 0.78 in. wg pressure drop, but fan brake horsepower is reduced to 13 bhp.

**Supply-Duct Static Control**

The most commonly recommended static pressure sensor location is a point in the supply duct at which the duct static pressure at design flow is approximately two-thirds of the duct static pressure drop from the fan outlet to the terminal unit inlet. The sensor is field-installed and the controller is set to maintain the duct static pressure at the value required at design flow conditions. Of course, field installation and adjustment of one (or possibly several) static pressure sensor not only raises first cost and installation cost, but may lower system reliability as well. An additional high-pressure sensor is usually needed, too, if fire dampers are used in the duct system. However, even though first cost and installation cost are higher, and installation/operation reliability may be compromised, the operating cost of this method is decidedly lower than that of fan outlet static control.

In our simple example system, since we only have one terminal unit, supply-duct static-pressure control is best implemented by locating the supply-duct static-pressure sensor in the inlet to the terminal unit itself, rather than “two-thirds down the duct.” This is the “critical terminal unit,” that is, the terminal unit that always requires the highest pressure. With the sensor at the terminal unit inlet, the controller must be set to 0.80 in. wg (SPC = 0.80 in. wg), the required terminal inlet pressure at design airflow.
Figure 5A shows the system resistance curves, fan modulation curve, and fan curves. At our part-load airflow, the inlet guide vanes are repositioned, creating another new fan curve. The fan operates at the intersection of the new fan curve and the fan modulation curve, Point D, to deliver part-load airflow of 18,000 cfm.

As the pressure gradient in Figure 5B shows, fan static pressure at this point is reduced to 1.85 in. wg, duct static pressure is reduced to 1.12 in. wg, and the static pressure at the terminal unit inlet is held constant at 0.80 in. wg. The terminal unit must close to introduce a 0.50 in. wg pressure drop. The fan now requires only 12 bhp (approximately) to deliver 18,000 cfm at 1.85 in. wg.

Of course, an actual VAV duct system has many terminal units and the critical terminal unit is difficult to identify. Furthermore, it is most likely not the same terminal unit at all flow conditions throughout the day and throughout the year. Therefore, to properly implement supply-duct-static-pressure control—that is, to properly locate the duct-static-pressure sensor—the designer must either:

1. Find a single critical terminal unit, which is seldom possible. Or ...
2. Install multiple sensors, one at each potentially critical terminal unit, and a discriminator circuit, which adds cost and reduces reliability. Or ...
3. Compromise operating cost savings by locating a single static-pressure sensor closer to the fan; two-thirds of the way down the duct, for instance.

Critical Zone Reset

Both of the preceding control methods, fan outlet static control and supply duct static control, have advantages and disadvantages. Fan outlet pressure control is reliable and first-cost effective, but cannot minimize operating costs. Supply-duct-pressure control is less reliable and has a higher first cost. It reduces operating cost, but cannot minimize operating cost because the terminal unit must always close somewhat to introduce a pressure drop at part load. The “critical zone reset” method, on the other hand, has all the advantages of both previous methods with none of the disadvantages. In addition, it lowers operating costs to the absolute minimum by keeping the critical zone terminal unit fully open at all load conditions.

The critical zone reset method combines the location-related benefits of fan outlet static control with operating cost savings that exceed those possible with supply-duct-static-pressure control. The single static-pressure sensor is located at the fan outlet, and the static-pressure controller is set to control the design flow static pressure. But the actual static pressure set point is continually adjusted (reset) so that
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at least one terminal unit in the system—the terminal unit serving the critical zone—is wide open. The static-pressure controller monitors the position of each terminal unit and resets the duct-static-pressure set point based on the maximum terminal position. (This can be accomplished at virtually no cost penalty when implemented using factory-installed DDC/VAV terminal unit controls.) First cost and installed cost are reduced, reliability is increased, and fan operating cost is at the absolute minimum.

When critical zone reset is used, duct static pressure at any flow condition can be controlled so that the pressure at the inlet to the critical terminal unit precisely matches the pressure drop through the wide-open terminal unit and the downstream ducts and diffusers. The fan unloads following the design system resistance curve, rather than a new system resistance curve created by partially open terminal units. In other words, the fan modulation curve is identical to the design system resistance curve. Fan static pressure and horsepower are always at the minimum required level and duct static pressure never exceeds the level required to keep the critical terminal unit wide open.

Figure 6A shows the fan curves and system resistance curve for our simple system with critical zone reset. At 18,000 cfm, the vanes are repositioned so that the new fan curve intersects the original design flow system curve, Point E, at the lowest fan static pressure possible. As Figure 6B shows, fan static pressure is reduced to 1.52 in. wg, duct static pressure is reduced to 0.79 in. wg, and the pressure at the inlet to the terminal unit is reduced to 0.45 in. wg. The pressure drop across the wide-open terminal unit is only 0.17 in. wg, and the required fan brake horsepower is only 9.5 bhp. (Note: Although the duct static sensor is located at the fan outlet, critical zone reset has the effect of moving the sensor to the critical zone itself.)

Fan static pressure and horsepower requirements for the different control methods discussed, as applied to our simple example system at various flow rates, are summarized in Figure 7. It demonstrates that critical zone reset is the most energy-efficient fan-capacity control method for our system.

**Figure 6B. Pressure Profile with Critical Zone Reset**

**Figure 7. Comparison of Static-Pressure Control Methods**

<table>
<thead>
<tr>
<th>Operating Point</th>
<th>Control Method</th>
<th>Airflow (cfm)</th>
<th>Fan Static (in. wg)</th>
<th>Brake HP</th>
<th>Power Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(Design)</td>
<td>24,000</td>
<td>2.70</td>
<td>22</td>
<td>—</td>
</tr>
<tr>
<td>B</td>
<td>No control</td>
<td>18,000</td>
<td>3.15</td>
<td>18</td>
<td>22%</td>
</tr>
<tr>
<td>C</td>
<td>Fan outlet</td>
<td>18,000</td>
<td>2.13</td>
<td>13</td>
<td>43%</td>
</tr>
<tr>
<td>D</td>
<td>Duct static</td>
<td>18,000</td>
<td>1.85</td>
<td>12</td>
<td>48%</td>
</tr>
<tr>
<td>E</td>
<td>Critical zone reset</td>
<td>18,000</td>
<td>1.52</td>
<td>9.5</td>
<td>59%</td>
</tr>
</tbody>
</table>

Part 3 will be published in the May Newsletter. Trane believes the facts and suggestions presented here to be accurate. However, final design and application decisions are your responsibility. Trane disclaims any responsibility for actions taken on the material presented.
Following is NEBB’s response to inquiries made concerning NEBB’s position regarding permanently mounted flow stations as a substitute for Pitot traverses.

1. ENDORSEMENT – NEBB’s does not endorse any third party products.

2. PERMANENT MOUNT INSTRUMENTS ARE OUTSIDE NEBB’s SCOPE - NEBB’s primary focus is providing timely and accurate field measurements with quality portable instruments. Permanent mount instruments are simply not within the scope of NEBB Procedures and Practices for a number of reasons (see below). Even if they were, a proper pitot traverse would have to be taken to verify they were reading accurately. All too often, initial readings are found to be inaccurate.

3. PERMANENT MOUNT INSTRUMENT CONCERNS:
   a. Location and Orientation - Install is often done by those not familiar with do’s and don’ts of good flow measurements. This includes Mechanical, Electrical, or Controls Contractors.
   b. Setup - Even if perfectly installed, the initial readings can be off by 30% or more until the device can be properly calibrated. In some cases they are off by a factor of 2 or more because the correct instrument range has not been selected in the BAS system. Again, this is not known until a proper pitot traverse is taken by a Certified Technician in the field.
   c. Maintenance - Permanent mount instruments must be cleaned, maintained and recalibrated periodically to insure performance. Like filters, they tend to degrade over time due to neglect. One cannot assume they are reading correctly.

4. NEBB RESPONSE TO SOME SPECIFIC CLAIMS BY PERMANENT MOUNT FLOW STATION MANUFACTURERS:
   a. Manufacturer: Any instrument, permanent or portable, equal to or exceeding the minimum NEBB Procedural Standards requirements should be acceptable for use by Certified TAB firms for system balance and any appropriate TAB activity.
   
   NEBB Response: This is a bad assumption. Instrument accuracy is only part of NEBB’s Procedural
Requirements. Measurement Procedure and Technique are equally or more important. A permanent mount instrument does not satisfy NEBB’s requirements for a proper pitot traverse.

b. Manufacturer: Our instrument accuracy is +/- 2% of reading which is much better than the +/- 5% NEBB Procedural Standards requires.

NEBB Response: This statement is incorrect. The NEBB Procedural Standard for pitot traverse instruments (measuring velocity pressure) is +/- 2%. The +/- 5% allowance noted covers “not for pitot tube traverse” instruments such as rotating vanes, hot wire anemometers and analog instruments.

c. Manufacturer: Permanent mount instruments can have fewer traverse points that are further apart – say up to one per sq. ft.

NEBB Response: NEBB requires that any flow station using the principle of a traverse (average velocity times cross sectional area) must meet the minimum standards outlined in the NEBB Procedural Standards: a minimum of 4 per sq. ft (6 in spacing max in x and y direction). Fewer traverse points than this incorrectly assumes a uniform velocity profile in the duct. A proper traverse does not make this assumption - the more traverse points, the more accurate and reliable the results.

d. Manufacturer: Permanent Mount Digital Instrument drift is minimal

NEBB Response: Drift may be a common problem where permanent mount instruments are concerned however good quality portable instruments that meet NEBB standards are recalibrated every 12 months - drift is typically not a factor. Commonly used Portable Instruments have little or no drift and stay in calibration over very long periods of time.

e. Manufacturer: “Measurement by Pitot traverse is a time consuming process”.

NEBB Response: Accurate Pitot Traverses by experienced NEBB Certified Technicians are routine and can be made in a timely manner and it is sufficient to say that traverse measurements are necessary. It is the opinion of NEBB and the Engineering community that traverse measurements are the most accurate means of airflow measurement and should always be performed when possible.

f. Manufacturer: Outside Air measurement is a problem when the path is not suitable for direct measurement. Pitot traverses yield inaccurate results.

NEBB Response: A proper traverse will be exactly as accurate as any flow station reading that employs the traverse principle; especially one that includes 4 times the traverse points. NEBB understands that flow stations are commonly used in outside air installations as part of the control scheme. This is fine but they should be installed in good straight runs of duct, properly calibrated, and properly maintained if an Owner expects reliable results. Again, the initial set up will involve good pitot traverses by a Certified Technician.

g. Manufacturer: When Outside Air cannot be traversed and the Mixed Air Temperature method is used, results can be very inaccurate.

NEBB Response: Agreed. The mixed air temperature method requires a suitable temperature difference and that is not always available. Also, a single temperature reading where stratification exists will yield incorrect results. This is well understood by Technicians and is overcome in the field by averaging multiple temperature readings across the duct area. When possible, readings should be taken further downstream at a point where the air has had opportunity to adequately mix.
Gaithersburg, MD – The NEBB Board of Directors is pleased to announce the decision to pursue ANSI Accreditation for its certification programs. The Board firmly believes that this decision is in the best interest of the organization and will further strengthen our programs.

Stanley Fleischer, 2013 NEBB President stated, “We see this as an investment in the future of our Certified Firms, Professionals and Technicians. It is important that NEBB remains the certification of choice for industry professionals and their customers.” Incoming 2014 President Robert Linder, P.E., added, “This aligns perfectly with our recently approved Strategic Plan and I am looking forward to leading our organization through this next logical step in our growth.”

A report will be presented at a special session during NEBB's 2014 Annual Conference, April 3-5, 2014, in Ft. Lauderdale, Florida.

For more information, please contact Mandy Kaur at mandy@nebb.org or 301.977.3698. NEBB is the premier international association of certified firms that perform testing, adjusting and balancing of heating, ventilating and air-conditioning systems in addition to building enclosure testing, building systems commissioning, building systems retro-commissioning, fume hood testing, sound and vibration testing, and cleanroom certification. NEBB is the leading source of industry information through its standards, procedures, publications, specifications, text books, study courses and newsletters. Additional information on NEBB is available at www.nebb.org.
The Northern California/Hawaii NEBB Chapter’s Annual Meeting is set for Thursday, March 27, 2014.

This year’s meeting will take place at The Marriott Fremont Marriott.

We have an exciting line-up of speakers this year and our vendors are:

Instrument Direct

Norman S. Wright

Victaulic

To sign up for the meeting as a participant or another vendor, go onto our website at:

www.nocalhawaiinebb.org

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If you have any questions please contact us.

Mr. John Johnson – Senior Calibration Technician – john@engdynamics.com
Mr. Stuart McGregor – Senior Acoustical Engineer – stuart@engdynamics.com

NEBB 2014 ANNUAL MEETING

The Marriott Fremont provides an elegant and accommodating atmosphere. The Silicon Valley encompasses a region of Northern California from San Francisco to Monterey Bay. Sporting events, museums, golf, shopping and wineries are all within a short drive. Great America theme park, The Tech Museum of Innovation, The Winchester Mystery house, Livermore Wineries and Mission San Jose to name a few.

Log onto www.nocalhawaii.nebb.org for more details on speakers, vendors and local activities.
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- Golfing
- The Winchester Mystery House
- Mission San Jose
- Santana Row
- Livermore Wineries
- The Tech Museum of Innovation
- Santa Cruz Beach Boardwalk

Continuing Education Credit

NEBB Certified Professionals who register for the meeting and attend will receive credit for six hours of CEUs. Certified Professionals must sign all rosters to receive credit.

Important Information

- Registration and Breakfast start at 7:30 a.m.
- The first speaker will commence at 8:00 a.m.
- Multiple breaks will be given throughout the day to take and return phone calls. No calls during the meeting please.
- NO LAPTOPS AT THE MEETING. Thank you for your cooperation.
- Meeting will end at 5:00 p.m. Full credit will not be given for any early leaves.
- Meeting is open to all interested parties, industry professionals, technicians, customers and guests. Registration must be turned in for each individual.

Registration

To register for the annual meeting complete the form and return WITH fee to:

Northern California/Hawaii NEBB
39899 Balentine Dr., Suite 200
Newark, CA 94560

or email form to akearns@nocalhawaiinebb.org and mail check separately.

Seminar Registration Fees (must be received in Chapter office)

Before February 3, 2014 $130 Registration Fee
Beginning February 3, 2014 $200 Registration Fee
Registrant Information

Name: ___________________________  Firm: ___________________________

Email: ___________________________  Phone: ___________________________

Additional Guest Name: ______________________________________________

Vegetarian Meal Required for Lunch Meeting: ___ (check if desired)

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TOTAL $ 

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Registration Contact Information

For Help please email akearns@nocalhawaiinebb.org or call 510/386-1270.

Make check out to: NEBB

Return Form to akearns@nocalhawaiinebb.org and mail check to:

No. Calif/Hawaii NEBB, 39899 Balentine Dr., Suite 200, Newark, CA 94560

Cancellation Policy

The registration fee will be refunded in full—less a $25 processing fee—if your cancellation notice is received by NEBB prior to February 3, 2014.

Cancellations after February 3, 2014 will receive a 50% refund up to February 27, 2014.
No refunds will be granted after February 27, 2014.

All cancellations must be in writing and sent to akearns@nocalhawaiinebb.org
Upcoming Events

Northern California/Hawaii NEBB Chapter Annual Meeting

Thursday, March 27, 2014, 7:30 a.m.—5:00 p.m.
Fremont Marriott Hotel

Contact the NEBB Chapter Office to sign up or to receive more information

2014 NEBB Annual Conference

April 3-5, 2014
Hyatt Regency Pier Sixty-Six, Ft. Lauderdale, Florida

Contact the NEBB office to sign up or to receive more information

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