# TAB Journal

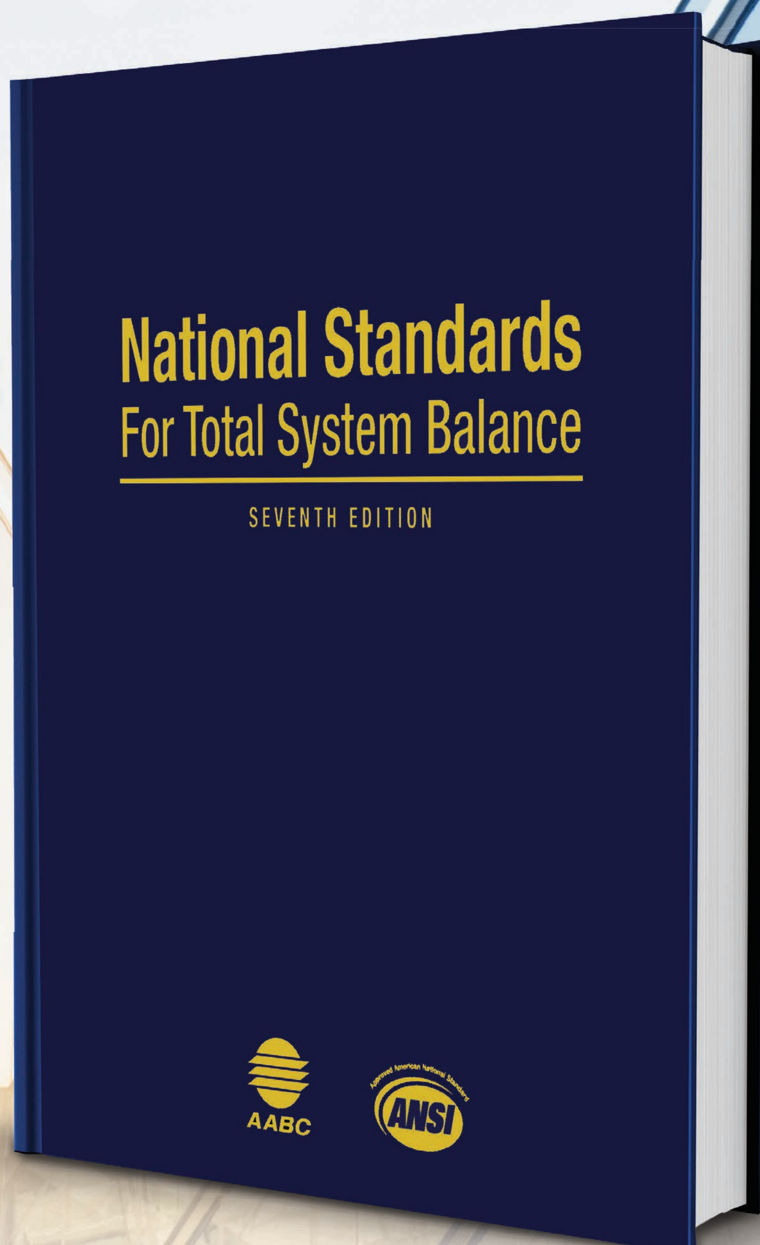
AABC

THE MAGAZINE OF THE ASSOCIATED AIR BALANCE COUNCIL • WINTER 2016


Introducing the Seventh Edition of the

## AABC National Standards *for* Total System Balance

ALL NEW!




- ANSI Approved
- Expanded and revised content
- And more!

# TAB Journal



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## From the Publisher

The Winter 2016 issue of TAB Journal introduces the seventh edition of the National Standards for Total System Balance. The newest version is ANSI approved, with revised and expanded content and important industry updates. Also in this issue, Sean Bunting, TBE, LEED AP, of National Air Balance Company, Inc., discusses the importance of the test and balance agency as advancements in the industry are made.

William W. Stanaland, TBE, of The Phoenix Agency of North Carolina looks at the importance of verifying submittal data is accurate, and the financial burden that can result if this information is accepted as correct without additional testing. Raymond D. Hardesty, TBE, of Environmental Balancing Corporation addresses the difficulty in estimating time needed to balance a system when unforeseen challenges arise.

Alan Sandoval, TBE, of Air Balance Company, Inc., examines the challenges posed by pneumatic controls for those unfamiliar with this technology. Michael Warren, TBE, of Thermal Balance Inc., talks about how technicians must rely on their own experience and awareness to anticipate possible obstacles on projects.

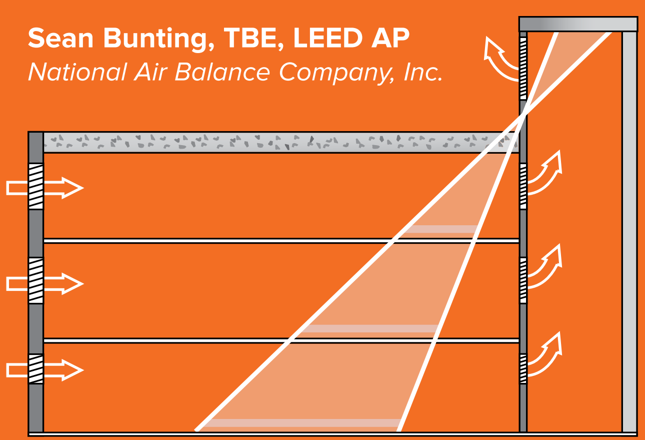
In this issue's Tech Tip, Daniel Alvarado, TBE, of Precisionaire of the Midwest, details a situation that required the balancing of displacement diffusers. And finally, Chris Weisman, TBE, of Chesapeake Testing & Balancing Engineers, Inc. discusses the how to prevent improper sizing of VAV boxes.

We would like to thank all of the authors for their contributions to this issue of TAB Journal. Please contact us with any comments, article suggestions, or questions to be addressed in a future Tech Talk. We look forward to hearing from you!

# THE IMPORTANCE OF A TAB AGENCY

## AS TECHNOLOGY ADVANCES AND EVOLVES

**Sean Bunting, TBE, LEED AP**
*National Air Balance Company, Inc.*



As technology advances and evolves, so does HVAC design and control schemes. As an example, in the San Francisco Bay Area, with the increased emphasis on energy efficient buildings, "Buoyancy-Driven Natural Ventilation Systems" have emerged.

### OVERVIEW OF THIS TYPE OF SYSTEM:

- The Buoyancy-Driven Natural Ventilation System is designed to induce air across a CHW/HHW coil to maintain room temperature of a space without the use of any mechanical HVAC equipment moving air. This is done using OSA dampers on the roof that modulate based on wind speed and the CHW/HHW valve position for an associated coil.

With this said, the specifying Mechanical Engineer of Record (MEOR) is not always aware of the testing required by a TAB agency to ensure these types of systems are set up, validated, optimized and operating as intended in their installed/integrated states.

Our firm was recently asked by a local MEOR to review their TAB specification for a project with this type of design. What was found was concerning. The original TAB specification called for very little TAB work. The deficiencies were pointed out along with items and activities considered imperative for a TAB agency to perform.

***Below are key items added to the final draft of the project TAB Specification.***

### SYSTEM INSPECTIONS/PREREQUISITES TO TAB:

- Building architectural integrity must be complete (exterior/interior). Note, ALL doors must remain closed throughout the entire TAB process.
- Architectural shafts must be airtight.
- Controls must be operational and functionally checked out.
- Balancing of all intake shafts must be complete.
- HHW/CHW systems must be able to maintain design loop temperatures (TAB agency to perform proportion balancing).
- Controls must be programmed with correct design perimeters.
- Outside Air (OSA) and relief air dampers must be checked out by the controls contractor and be confirmed operating correctly.
- Underfloor ACDs (automatic control dampers) and AFMS (air flow monitoring stations) must be checked out by the controls contractor and be operating correctly (calibration to take place with the TAB agency).
- Controls contractor must be complete with calibration of the wind speed and direction transmitters (calibration to take place with the TAB agency).

**BASIC TAB PROCEDURE:**

- All testing must be performed with supply, return and toilet exhaust systems running in their normal operating conditions.
- Airflow measurements will be performed (using a ADM/Velgrid assembly) at each cooling coil (CC) located at the top of each intake shaft, ACDs, AFMSs at the intakes to rooms (interior/perimeter zones), relief air through the dampers at the top of the atrium and transfer ducts (related to the buoyancy-driven system).
- Read and record system static pressures and plenum differential pressures.
- Read and record intake damper positions.
- Read and record wind speed and direction.
- Read and record OSA flow rates in full cooling mode (artificial load applied via the BMS). This is to be performed one shaft at a time. After all shafts are tested, all other modes will be trended over a 48 hour period. Data will be reviewed with the MEOR to determine if further testing is required.
- Read and record EAT/LAT/RH at each CC and ACD.
- Read and record space temperature while simultaneously recording OSA Temperature.
- Install filter media upstream of each CC creating a drop equal to 0.1" WG. Under this condition, trend the AFMS/temperatures over 48 hours.
- Read and record airflow rates of each diffuser in the raised floor (utilize the manufacturer's flow charts to calculate CFM).
- Read and record building pressure (balancing of shafts must be complete with all associated systems operating in "Automatic").

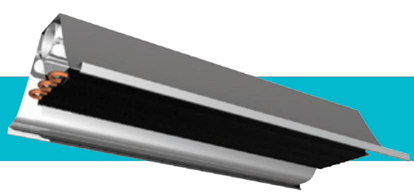
Now more the ever, it is vital to the TAB industry and the AABC for each member firm to be more proactive in the bid process by developing professional/working relationships with local MEORs in an effort to preserve, promote and expand the required services specified within the contract documents. With a collective effort, we can educate the MEORs and increase their awareness of TAB and AABC's value within the construction process.

# Submittals

**William W. Stanaland, TBE**
*The Phoenix Agency of North Carolina*

**In this ever-changing world of exploratory engineering and building design, the test and balance technician's attention to detail must be sharper than ever. New products are being engineered, manufactured, and implemented on projects at an alarming rate. Unfortunately, with this race to conquer energy costs and also deliver a "green" project, issues are being found with manufacturer-submitted data. This article will discuss a few problems with individual products and how they affected the project.**

First, look at chilled beams. While this technology has been around for some time in Europe, the project in question was a chilled beam system encountered four years ago on a new research laboratory project. A submittal flowchart was provided for the chilled beams that showed the ΔP (plenum pressure) required to achieve the desired airflow. For the project, a constant volume (CV) box was used to provide supply air to up to six chilled beams. After setting the cfm on the first few chilled beams using the manufacturer's flow chart, it was noted the chilled beams were extremely noisy. This was atypical, as chilled beams are famed for their efficiency and ability to operate quietly. It was decided to do a careful duct traverse of every size chilled beam after it was set to the required ΔP (based on the manufacturer's flow chart). In every case, the test cfm was much higher than the cfm that was indicated on the submittal. When the airflow was reset to the chilled beam based on the duct traverses, the air noise was eliminated. The flow charts were recalculated based on the test results, and the project was successfully balanced. Thankfully the problem was noticed in the beginning as there were over 1,000 chilled beams on this project.



On another project, problems were encountered with a system design involving chilled beams. The chilled beams from some manufacturers require a much higher pressure drop than others. Unfortunately, the design engineer was not aware of the higher static pressure requirement of the selected chilled beams, and consequently the higher static pressure that the air handling unit would need to produce in order to satisfy the large pressure drop across the chilled beams.

In another example of a submittal deficiency, a TBE recently encountered a new type of circuit setter that was manufactured in Europe. After the flow rate for the coils was set with the circuit setters (using the manufacturer's flow charts), the coil performance was found to be deficient. Test results indicated low water flow. The coil pressure drop (water side) and heating capacity test based on airside delta T was much less than what was specified. After the same low coil capacities and coil pressure drops were observed at several terminal units, there could be no explanation for this other than the circuit setter flow curves were not correct. The mechanical contractor had an extra circuit setter, and it was taken back to the office to test. A small ¾ inch copper recirculating loop was built and the circuit setter was installed in the loop. Two different transit-time ultrasonic flow meters were used as the test standard. The circuit setters were tested at 20 different settings and compared the ultrasonic flow readings with the flow rates in GPM derived from the circuit setter flow charts. In every case, the GPM calculated from the manufacturer's flow chart was almost 4 times the actual flow as measured by the ultrasonic meters. It was suspected that although the chart was labeled GPM, it was actually giving liters per minute. The manufacturer's representative was contacted to let them know about the findings. It took about 3 weeks, but they did respond with corrected flow curves that validated the tests. They explained that the error occurred due to a "conversion factor error."

While submittal data is normally accurate, these are just a couple of examples of what could have been a financial catastrophe if not for the wherewithal to perform additional testing and discover the true performance versus pressure loss.

# HOW MUCH **TIME** IS NEEDED TO **BALANCE A SYSTEM?**

**Raymond D. Hardesty, TBE**
*Environmental Balancing Corporation*

**Asking this can raise more questions than it answers. What is the size of the job? How much equipment is there? Is it done in phases? Is it air balance or air and water balance? Is it a constant volume system or a VAV? If a VAV system, what are the controls? The reality is that there are a lot of unknowns.**

As balancing contractors, the time needed to balance pieces of equipment is estimated, with additional time added for rechecks for deficiencies corrected. Sometimes these estimations work out and sometimes not.

This is how estimating time for balancing is supposed to work. According to others (those that make the schedule), time for balancing is too little or not taken into consideration at all. The strange thing is at the end of the project, the balancing contractor is the most important part of the project, but in reality not mentioned much throughout the job. Of course there are exceptions to this, but for the most part this is how it is done.

## JUST ONE EXAMPLE OF MANY PROJECTS THAT DID NOT GO AS PLANNED:

**Total bid: two nights.**

The company was contracted to do a project about a year and half ago. The scope of work was to pre-read two VAV boxes before they were relocated and air balance eight additional VAV boxes and diffusers once the work was completed.

The job was night work which in itself presents its own set of issues. Upon arriving on the job, the AHU was checked to ensure it was running properly. The display on the VFD was found to be not functioning, and the control contractor technician was unfamiliar with the control system. Nevertheless, readings were taken on the VAV boxes and outlets and a report was submitted on the findings. The cfm and static pressure readings were very low.

> The balancing contractor is the most important part of the project, but in reality not mentioned much throughout the job.

Once the findings were reported, the TAB agency was instructed to take readings on the AHU. (not part of the original work estimate). Since the submittals for the AHU were not available at that time, the cfm for each terminal was added to get an approximate design cfm.

After the display on the VFD was fixed, a traverse was taken as well the information on the AHU.

The AHU discharge static pressure was found to be high. The VFD was set at 60 hertz, with the actual amps 7.6 versus design of 12.9. Blockage was apparent in the ductwork, but the TAB agency was instructed to take readings anyway. Readings were also taken on the now relocated and existing VAV boxes and diffusers. During this visit the owner indicated they wanted the return to be 1000 cfm more than design with no ductwork changes.

After many months, access could finally be obtained to determine the blockage issues. A sound attenuator was found, the same size as the ductwork. The ductwork was 36" x 20" and the inside dimensions of the sound attenuator was 36" x 10".

This was reported and three months later the contractor was issued a change order and access to remove the sound attenuator, replace with a 36" x 20" piece of ductwork, and add two additional return grills. The sound attenuator was determined to not be needed. The change order also included the relocation of two more VAV boxes, adding them to this system and balancing them.

At this point, the contract had stretched over eighteen months. It is unclear if the system was ever balanced to begin with, or was balanced under different conditions, but it is apparent that for years the system had not been working properly or been maintained.

To date, the TAB agency worked 6 nights into this job. Fortunately they were issued changed orders for additional work (though this is not always the case). The point is, on this small project as well as large projects there was no way to determine the correct amount of bid time or anything close.

Further, due to tight schedules, the workmanship is getting worse and jobs are going way over bid hours. Even the jobs that are commissioned have problems that are fixed as they go, which adds more time to complete.

**So, how much time is needed to balance a system?**

*When you find out, let everyone else know.*

# KEEPING UP WITH THE TIMES, WHILE HOLDING ON TO THE PAST

**Alan Sandoval, TBE**
*Air Balance Company, Inc.*

**The decline in work due to the extended recession has forced many mechanical contractors out of the residential market. The mechanical contractors who have historically done residential work are now pursuing commercial work. The primary issue encountered is that residential contractors do not understand the more complex commercial systems.**

Building owners and building operators are deciding to retrofit/repair their existing HVAC system rather than install new updated controls due to the economy. Many contractors can hang fans, install ductwork, piping, electronic controls, etc. Pneumatic controls, however, can pose a struggle. Some air balance contractors believe that pneumatic controls are a dying technology, but as an Association there is a responsibility to train and educate the future while maintaining the past.

Here are some of the basic procedures all technicians should know when working with pneumatic controls. Begin with direct-acting and reverse-acting thermostat action. As shown below, in direct-acting thermostat action, as the room temperature increases above setpoint, the output pressure increases. In reverse-acting thermostat action, as the room temperature increases above setpoint, the output pressure decreases. *See Figure 1 below.*

Some buildings may have older existing volume reset controllers such as Titus, UPC, Staefa, or KMC. The internet is a great place to get item-specific information. Many building operators/mechanical contractors are choosing to install KMC CSC-3000 Series Reset Volume Controllers because they can be a multi-function controller. These controllers can be set up direct-acting or reverse-acting, normally open or normally closed. The control range of the controller can be set to the desired setpoints. Standard setpoints for direct-acting action is an 8 psi start point and a 5 psi span point. Standard setpoints for reverse-acting action is a 3 psi start point and a 5 psi span point. The start and span points can be set so that there can be a dead band on a dual duct VAV system, or it can be set so that there is a mix of cooling and heating to meet minimum CFM requirements. These setpoints do not come factory set and must be set in the field with calibrated gauges. The figure below shows an example of how these setpoints are used, notice how there is a dead band at 8 psi. This means that the thermostat is satisfied. *See Figure 2 above.*

Common problems seen in the field are that mechanical contractors are not sure of which hot water valves to use; they come in normally open or normally closed. On a direct-acting system the hot

**FIGURE 1:** *Direct and Reverse Acting Thermostat Action*

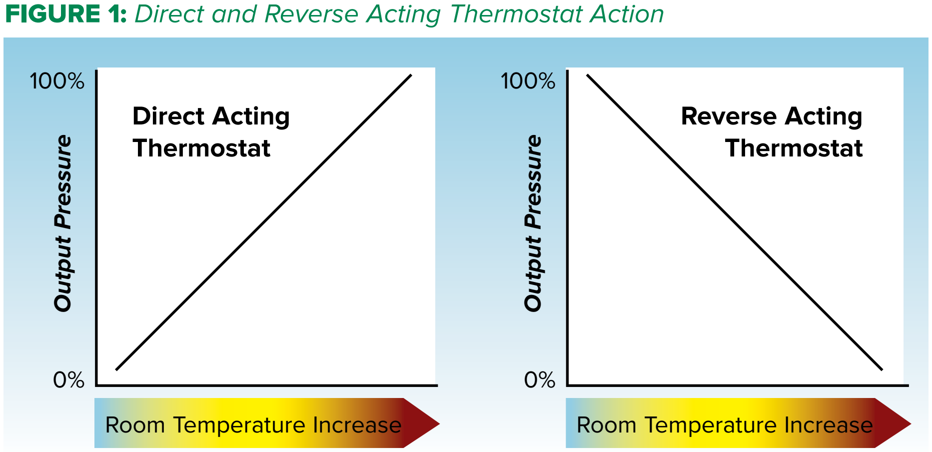
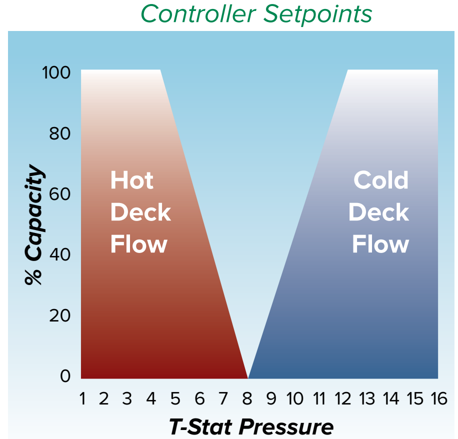



**FIGURE 2:** *Reset Volume Controller Setpoints*



water valve must be normally open, and in a reverse-acting system the hot water valve must be normally closed. Also, hot water valves come in many spring range varieties. In a direct-acting system the common setpoints are 8 psi start and 5 psi span. This means one would have to use a normally open hot water valve with a spring range of 3 psi to 8 psi. That way when the thermostat sends a signal to the controller beyond 8 psi (when the VAV goes into cooling), the hot water valve will be closed 100%. If there is a valve with a spring range of 5 psi to 10 psi, the hot water valve would be partially open when the VAV box is in cooling, creating comfort problems along with excessive energy usage.

One practice that helps get to the proper CFM setpoint is Fan Law #2. Notice how the magnehilic is tied into the high and low inlet sensor tubes below. Say that there is a 10 inch inlet and the system has a maximum CFM setpoint of 750 CFM and a minimum CFM setpoint of 225 CFM. After taking a reading on the individual supply diffusers the total actual CFM is 820 CFM at a 0.72" WC differential pressure reading on the magnehilic gauge. Using Fan Law #2, the exact differential pressure to get to the design CFM setpoints can be found.

Example:
$(750/820)^2 \times 0.72$" WC = 0.60" WC and
$(225/820)^2 \times 0.72$" WC = 0.045" WC

First, always set the minimum CFM setpoint (direct-acting thermostat action) using the lo-stat knob and then set the maximum CFM setpoint using the hi-stat knob. If they are set opposite, the setpoints will not repeat. In a reverse-acting system the lo-stat knob must be set first and used as the maximum CFM setpoint, and then the hi-stat knob must be used to set the minimum CFM setpoint. Always set the lo-stat knob first, regardless of reverse- or direct-acting thermostat action.
*See Figure 3 below.*

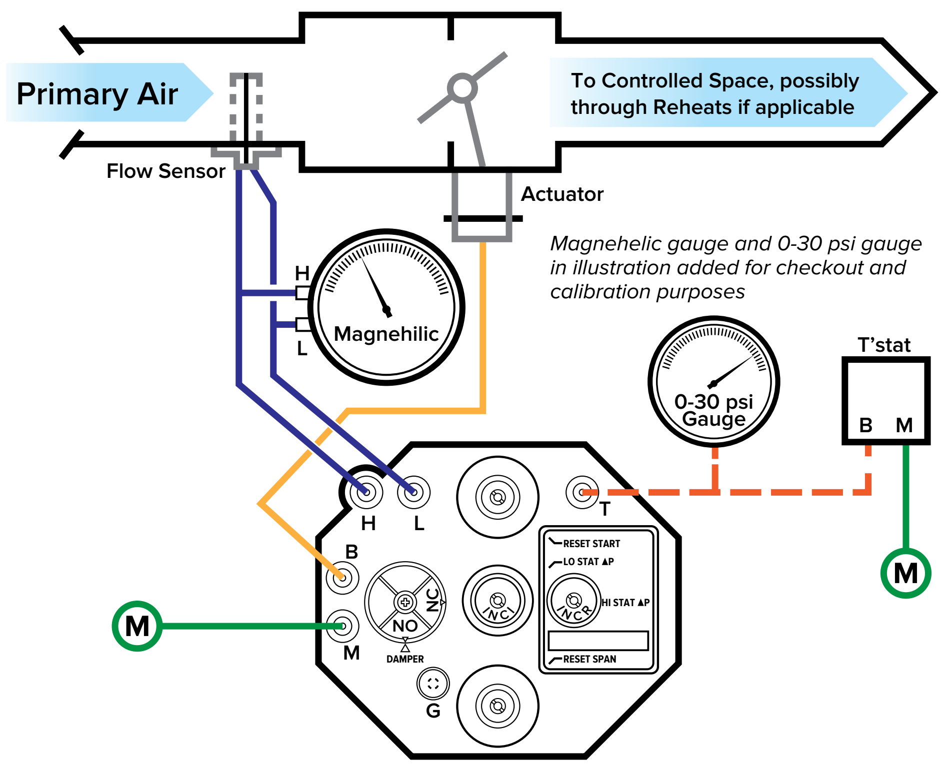
Pneumatic-electric relays are used to energize components such as fan-powered boxes or electric duct heaters. Pneumatic-electric relays typically come with a spring range of 2 psi to 20 psi. They also can be made normally open or normally closed. These can be easily adjusted so that the components in the system react at the proper time. Example: reverse-acting system with electric duct heaters. Start and span setpoint are set to a 3 psi start and 5 psi span. From 0 to 3 psi the VAV is in full cooling, at 8 psi the VAV is in its minimum position. If the pneumatic-electric relay is set to normally open and 9 psi, the electric duct heater will energize at 9 psi and beyond. The VAV will be in full heating. Many electric duct heaters are being reused in buildings. Without a survey being done of the existing system there is no way of designing the proper CFM values for the space. The design temperature differential must be known in order to pick the proper kW for the electric duct heaters (below).

The following equation gives the relationship for CFM, ΔT, and kW:

$$kW = \frac{CFM \times \Delta T}{3160}$$

These are some of the basic components and proper procedures of a pneumatic-controlled system. Each component serves its purpose and is critical to a comfortable building. The proper setup can save energy and the bottom line... money. Without the proper training these systems cannot be set properly. Nothing comes set up right out of the box, it is the job of test and balance technicians to both understand and troubleshoot these systems. With that understanding, mechanical contractors can be assisted in their selection of efficient components.

**FIGURE 3:** *Minimum and Maximum CFM setpoint diagram*



*Introducing the*

# AABC National Standards for Total System Balance

## *7th Edition Attains ANSI Approval; Adds, Expands and Revises Content*

**AABC is proud to announce the publication of the AABC National Standards for Total System Balance, 7th Edition. The manual has been completely rewritten and reorganized to reflect the latest advancements in the test and balance industry. Originally published in 1967 and last updated in 2002, the book is unparalleled in its comprehensive approach to providing the end user with the information required to ensure that HVAC systems are properly tested, adjusted and balanced.**

The Standard contains 28 chapters that describe and detail important aspects of Total System Balance (see box p. 12) and more than 200 pages of appendices that include sample report forms, test sheets, equation conversions and tables.

The publication establishes what is required to perform Total System Balancing for all heating, ventilating, and air conditioning systems; smoke control systems; and domestic hot water systems through all stages of the building design, construction, acceptance phase, and post-acceptance phase. The ultimate purpose is to provide the end user a process to accept the final report with a standard that has well identified tolerances and a process to verify the end results.

For the first time, this newest edition is American National Standards Institute (ANSI) approved. ANSI approval signifies that the procedures used by AABC in connection with the development of the standards meet the Institute's essential requirements for openness, balance, consensus and due process.

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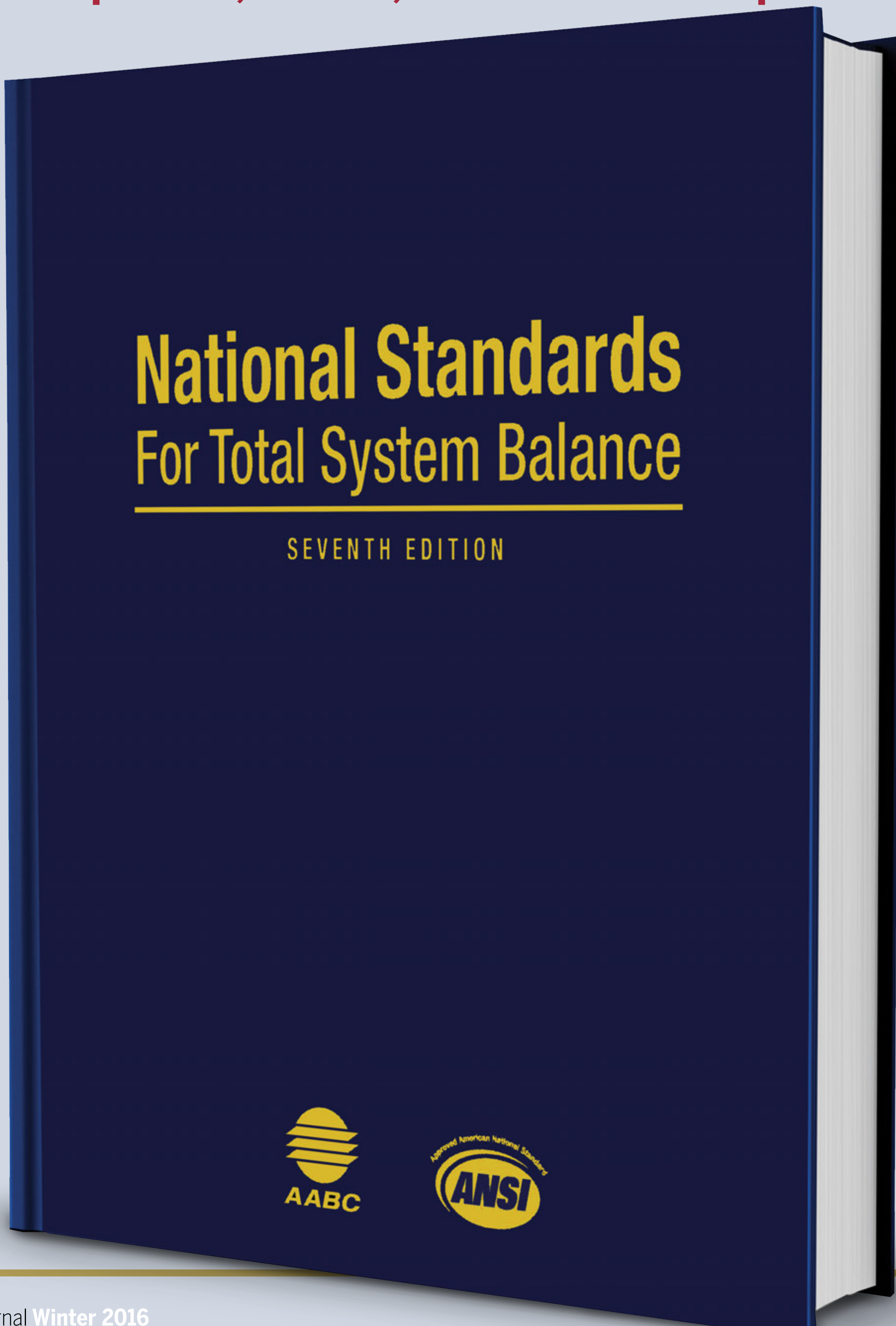

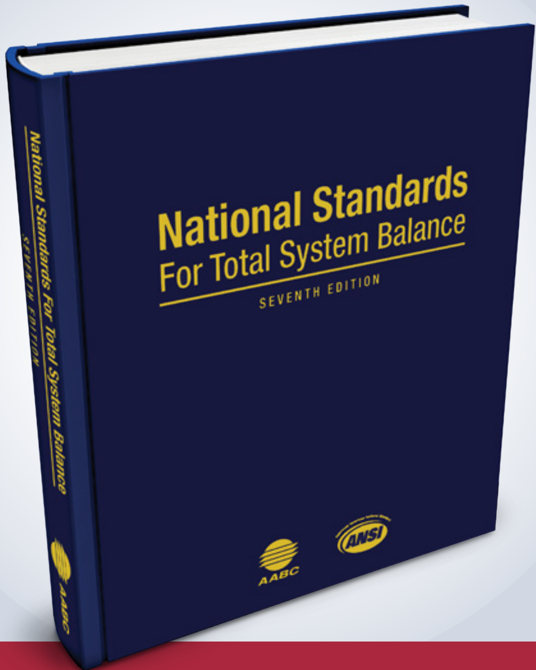


**"The AABC National Standards for Total System Balance represent the gold standard in the proper approach to testing, adjusting, and balancing HVAC systems."**

*– AABC Standards Committee Chairman Gaylon Richardson*

### *What's New in the AABC National Standards for Total System Balance 7th Edition:*

- *All-new sections on testing energy recovery systems and chilled beams*
- *Updated sections on constant volume and variable volume air systems*
- *New sections on terminal boxes for constant and variable Volume*
- *Revised recommendations for duct leakage testing*
- *Recommendations for air handling unit pressure testing including deflection testing*
- *Expanded chapters on hydronic balancing and new chapter on domestic water balancing*
- *Updated testing tolerances for air, hydronic, pressure and temperature*
- *Updated temperature control testing with documentation requirements*
- *New chapter on "Testing and Balancing Health Care Facilities"*
- *Recommendations for room, floor and building pressure testing*
- *Important updates to laboratory and kitchen systems.*

ANSI approves standards that are developed by other standards organizations, government agencies, and various consumer groups. An ANSI approval indicates AABC has applied a rigorous review process to the standards to ensure stakeholders that its standards are consistent with current industry practices and its definitions and terminology are generally accepted by industry professionals.

The new publication was made possible by the AABC National Standards Consensus Body, a committee whose members graciously dedicated their time and expertise to developing the consensus-based standards (see box p. 13).

"The AABC National Standards for Total System Balance represent the gold standard in the proper approach to testing, adjusting, and balancing HVAC systems," said Chairman Gaylon Richardson. "This new, ANSI-approved edition will make a tremendous contribution toward consistent, high quality industry practices that benefit all parties.

"The Standards will guide the design professional in achieving design intent, provide a better understanding of the scope of work required of the TAB agency, and ensure that proper methods and procedures are followed in the test and balance process," said Richardson.

Preordering for the 7th Edition of AABC's National Standards for Total System Balance is available online at ***www.AABC.com***. The Standard will ship by mid- to late February, 2016. For more information contact AABC Headquarters at ***(202) 737-0202*** or email ***headquarters@aabc.com***.

***AABC wishes to express sincere appreciation for the outstanding effort and technical contributions made by members of the AABC National Standards Consensus Body, members of the committee are:***

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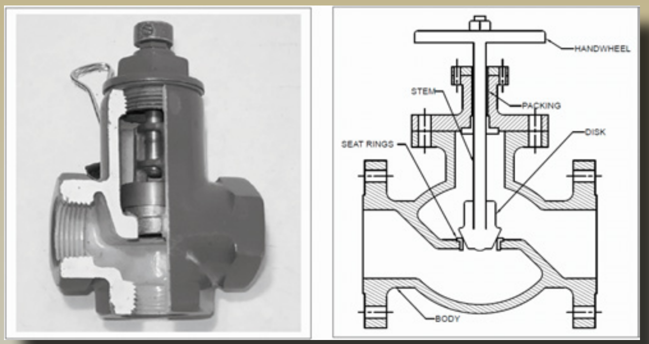
Louisville, Kentucky

***The AABC National Standards for Total System Balance, 7th Edition applies to total system balancing of HVAC components and HVAC systems including:***

- control systems
- airflow systems (constant and variable volume
- supply/return/relief/exhaust fan systems
- energy recovery systems
- hydronic systems (constant and variable)
- chiller testing
- cooling tower testing
- boiler testing
- steam systems
- capacity testing
- domestic hot water systems
- kitchen systems
- laboratory systems (constant and variable volume)
- sound testing
- vibration testing
- smoke control testing (including stair pressurization)
- hospital systems
- interfacing with the commissioning process
- how to develop a Total System Balancing Specification
- report verification and analysis



# AWARENESS

**Michael Warren, TBE,** *Thermal Balance Inc.*

HVAC systems have become increasingly complex with the advent of so many new technologies, including innovations in engineering design. Testing and balancing challenges have increased in unison with the complexity of these systems, but completing projects on-schedule is perhaps the greatest challenge facing TAB firms today. Test and balance technicians consistently deal with issues such as dampers missing, inadequate fan performance, duct leakage and less than favorable designs. While these types of problems have always been part of the process, compressed project schedules have left less time to find and address these types of issues and have increased the difficulty of meeting deadlines. To not add to a project's complexity and to meet schedule deadlines, a technician needs to be systematically aware of a project's characteristics from the earliest possible moment and maintain this awareness throughout the project's entirety.

Thermal Balance, Inc. was recently involved with balancing a 3-story building in phases. Early in the process issues were found that helped in avoiding problems that could have been detrimental to the project's schedule. The AHUs located in the attic served VAVs with hot water reheat coils on all three levels below, and it was requested that air balance be performed on the 1st and 2nd floors with the ground floor taking place at a later date. In the spirit of proficiency, it was decided to verify the temperature rise across the VAV reheat coils and the functionality of the 2-way hot water control valves since the water balance had to occur later when all three floors were completed. While balancing the airflow on the VAVs and verifying the discharge air temperatures in heat mode a problem was

immediately discovered. The discharge air temperatures did not meet the design requirements. The usual suspects came to mind; perhaps it was a faulty control valve, an air locked coil, or clogged strainer. Fortunately the two-way control valve had a clutch mechanism that would allow technicians to stroke the valve to both open and closed positions. While stroking the control valve and touching the hot water supply and return lines it was observed that the return line was becoming hotter sooner than the supply line. Now the focus became why this was happening. After numerous VAV hot water coil flows were verified by using the circuit setter, it was determined all the reheat coils suffered from reverse flow. While investigating this issue further it was discovered that the AHU reheat coils served by the same hot water system were piped correctly. The test results and findings were then discussed with the installing mechanical contractor. It was discovered the supply and return lines serving the VAV reheat coils were swapped where they tied into the main lines. Once the lines were swapped and installed to the correct main line, the system functioned as designed. This was good news for everyone involved.

So what does this have to do with awareness? Due to projects having less and less time for completion, test and balance firms are seeing installation and design problems at a higher rate than at any other time before. Mechanical and control contractors are given less time to install and do proper functional checkouts of the equipment and many times TAB firms find problems that should have been caught long before they were onsite. Companies have been forced to approach testing and balancing in a whole new way since the question is not, “Will we find problems?” but, “How many will we find and will there be time to get them corrected and tested again?” The focus has shifted from performing testing and balancing on one system at a time, to how much equipment and systems can a technician get his hands on as quickly as possible to find any potential problem. Thus, staying aware of schedules, installation changes made in the field or known design flaws helps the TAB technician complete their work in a timely manner.

There were two TAB technicians involved in the project described and each one brought a different level of expertise and experience to the table. Instruments alone did not lead to to the discovery of the aforementioned backwards piping issue, rather it was the sense of touch, instincts and awareness of a TAB technician with 30 years’ experience in the field. Whether working on one system or multiple systems, simply taking on active awareness of one’s HVAC surroundings can lead to early detection of potential problems. Early detection may not always equate to an early solution, but it can certainly expedite the process. With the condensed project schedules of today, paying attention to everything in plain sight when looking above a ceiling, walking through a mechanical room or even when reviewing the construction documents can pay big dividends towards a successful project completion.

# Tech tips

## Balancing Titus Displacement Diffusers

**Daniel Alvarado, TBE,** Precisionaire of the Midwest, Inc.

An elementary school was recently balanced that had displacement diffusers installed. Since it was the first time encountering this type of diffuser, the test and balance engineer contacted the manufacturer to receive a cut sheet and submittal data on the diffusers. The submittal data indicated that there is an air volume measurement connection to facilitate balancing along with a K-factor marked on the outlet.

The K-factors were not marked on the diffusers. The manufacturer was contacted again to send a list of the K-factors.

After the correct paperwork was received, the displacement diffusers were read out (using the measurement connection) and the ducts were traversed to compare the two readings. It was found that the measurement connection readings were off by 15 to 30 percent of the traverse readings. The measurement connection is only a single port in the middle of the diffuser baffle plate. Even if the inlet duct was straight, the reading was off significantly.

Therefore, after all the testing, the only way to accurately balance the terminal boxes was to traverse and calibrate every box. It was necessary to get velocities and calculate CFMs in the ducts going to each displacement diffuser to balance the terminal boxes due to very low diffuser velocities.

As everyone in the test and balance industry knows, this is very time consuming. When bidding a project with displacement diffusers, it is recommended to put in the time and money to traverse every displacement diffuser installed. They are great for controlling temperature and are very quiet but, as far as reading the airflow, they are not very test and balance friendly.

**Do you have a "Tech Tip" that you would like to share with our readers? If so, please contact AABC at:**

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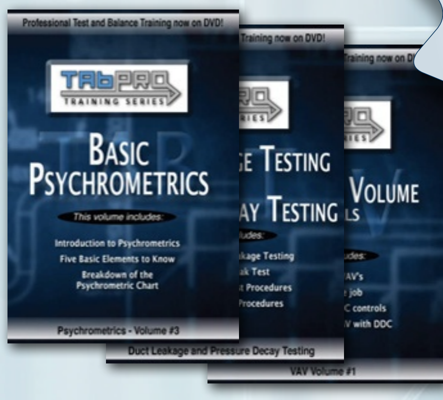


## Basic Psychrometrics

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This volume contains one lesson on basic psychrometrics. This provides the viewer with an introduction to psychrometric fundamentals and takes you through five of the basic elements found on the psychrometric chart. This lesson will break down these elements on the chart and provide fundamental concepts of chart usage.

## Duct Leakage and Pressure Decay Testing

DVD format
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This volume consists of two lessons covering standard duct leakage testing and pressure decay leakage testing. These lessons take the viewer through an introduction to leakage testing, essential job preparation, instrumentation used during testing, general procedures for leakage testing, multiple calculations used during testing and final reporting.

## Variable Air Volume (VAV) Terminals

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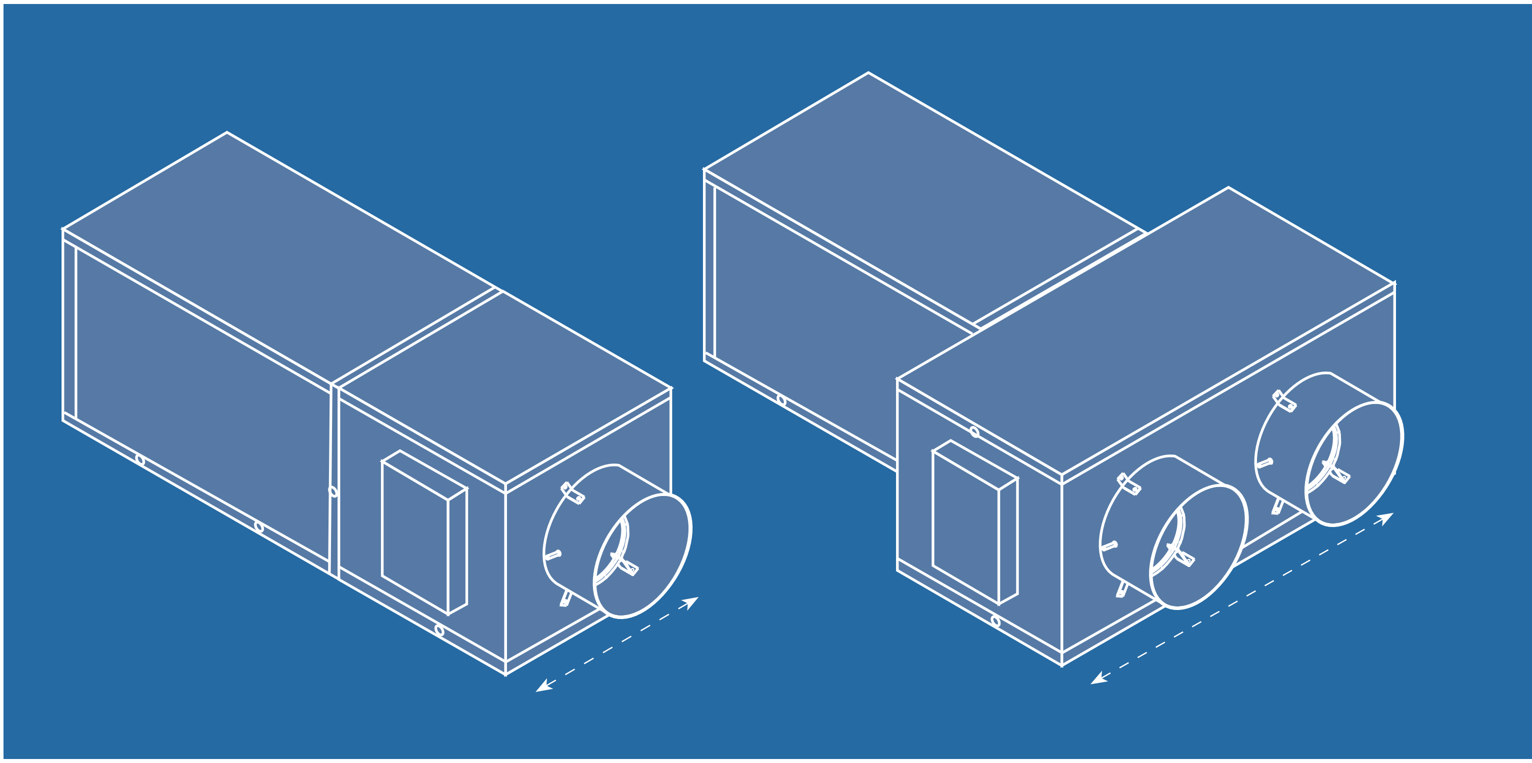
# Sizing VAV Boxes

**Chris Weisman, TBE**
*Chesapeake Testing & Balancing Engineers, Inc*



This article discusses improper sizing and what can be done to prevent this early in the submittal process. Too many times when trying to balance a VAV box sizing problems are encountered. Why didn't the engineer go to the next size up, or increase the minimum CFM so that the box would control at minimum flow? If in the submittal process the manufacturer would include the inlet probe differential information at max and min CFM, these problems could be prevented.

Each submittal should include a box inlet calibration chart. This information is rarely seen in a submittal, but they are commonly found stuck onto the side of each box. This chart correlates to airflow vs. probe differential pressure. Referring to the calibration chart, the differential pressure air flow sensor has an amplified signal that is 2.5 times the equated velocity pressure signal obtained from a conventional pitot tube.

### A good rule of thumb when sizing a VAV box should be the following:

- Minimum inlet velocity pressure of .03"
- Maximum inlet velocity pressure of .75"

***This range would allow for effective control and obtainable air flow.***

Minimum: At 450 FPM the amplified signal would be =.03"

This is calculated by using the velocity pressure former.

$$\text{Velocity Prssure} = \left(\frac{Velocity}{4005}\right)^2$$

$$\text{Minimum VP} = \left(\frac{450}{4005}\right)^2$$

Minimum VP = .0126

Probe differential pressure:
.0126 x 2.5 times amplifying = .03"

Maximum at 2200 FPM, the amplifier would be .75"

## Parameters to consider when selecting a VAV Box:

1. The pressure drop across the box
2. Physical space constraints
3. Ability to control max and min set points
4. Installation and energy cost
5. Noise letter, etc.

This is calculated by using the velocity pressure former.

$$\text{Velocity Prssure} = \left(\frac{\text{Velocity}}{4005}\right)^2$$

$$\text{Minimum VP} = \left(\frac{2200}{4005}\right)^2$$

Minimum VP = .032

Probe differential pressure: .032 x 2.5 times amplifying = .75"

It is recommended that the design engineer review this information and size the boxes based on the following ranges: .03” to .75”

### Case Study Problem

During the balancing the following problem was encountered:

| | |
|---|---|
| Box Number | VAV-1 |
| Manufacturer | JCI |
| Model | TSS |
| Size | 6 |
| Design CFM Max | 530 |
| Design CFM Min | 175 |
| *Actual CFM Max | 355 *Note: Inlet damper wide open |
| Actual CFM Min | 170 |
| Systematic Static Pressure | +1.25 |
| Area | .196 ft2 |
| Required Inlet Velocity | 2704 fpm @ Max flow |

The 6” inlet size too small.

Refer to JCI Figure 6 flow crossing calibration chart. A 6” inlet would need more than a 1.5” probe differential pressure. This box size should be increased to an 8” inlet. The design velocity is decreased to 1497 FPM with an 8” box. A flow cross differential pressure of .42” at max and a .047” min within rule of the range (.03” to .75”).

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