TAB Journal

AABC

THE MAGAZINE OF THE ASSOCIATED AIR BALANCE COUNCIL • WINTER 2013

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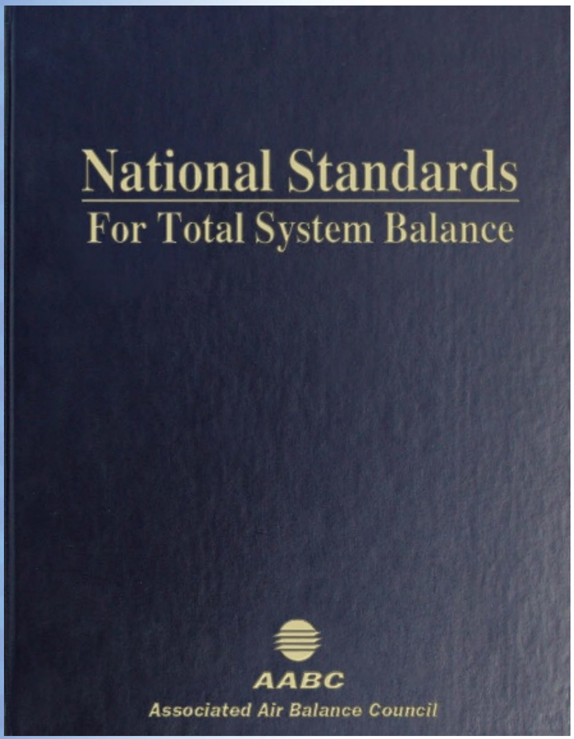

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From the Publisher

The winter 2013 issue of *TAB Journal* features articles on variable speed pumping, temporary flexible ductwork, techniques for balancing valves properly, emphasizing customer service, and methods of duct leakage testing.

A special report, "Test and Balance in Buildings," highlights trends in the profession based upon survey data provided by AABC members that identifies TAB projects by the frequency of service performed and by building type.

"Variable Speed Pumping: Setting and Documenting Flows" by Christopher C. Dennis, TBE, provides information on how to balance a pump controlled by VFD, and how the procedure has changed over the years.

"Testing Issues with Temporary Flexible Ductwork" by Bryan Lacy, TBE, is a discussion of the possible challenges that may arise during a project that includes installing temporary flexible ductwork.

"Tech Tip: The Dirt on Balancing Valves" by Medard Leblanc, TBS, shares insight about how to properly size a balancing valve—including some methods that should be avoided.

"Pay Attention to the Patient," by Bradley J. Steiskal, TBE, CxA, focuses on customer service, as it pertains to the test and balance customer and common concerns they might have.

"Duct Leakage Testing," by Mike Van Wiechen, TBS, touches on the different methods that may be used to determine acceptable leakage rates when performing duct leakage testing during a project.

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!

TAB Journal

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VARIABLE SPEED PUMPING: SE

Christopher C. Dennis, TBE, *C&W Tesco, Inc.*

The procedure that many test and balance professionals were originally instructed to use when setting pump flow was simple. The process began by dead-heading the pump to determine impeller sizing, and then throttling the discharge balance valve to get the pump plotted at the selection point of the curve. This seemed to be a logical procedure—setting a maximum flow by generating the design system resistance with the discharge balance valve.

It is difficult to argue that balancing a pump controlled by a VFD in this fashion is as sound today as it was 10 years ago. Early challenges to this "old school" pump balance method have since been discovered. Some TAB professionals resisted change, citing the fact that the pump plotted to its highest efficiency at the selection point whenever the engineer of record had made a good pump selection. Eventually, the science and research studies caught up, disproving the logic that closing the discharge valve did not waste energy by building unnecessary head pressure.

There are three pump laws, and they give clear direction in this matter:

Pump Law 1: The volume of flow relates directly to pump impeller diameter or speed.

Pump Law 2: The pump head pressure has a square relationship to pump impeller diameter or speed.

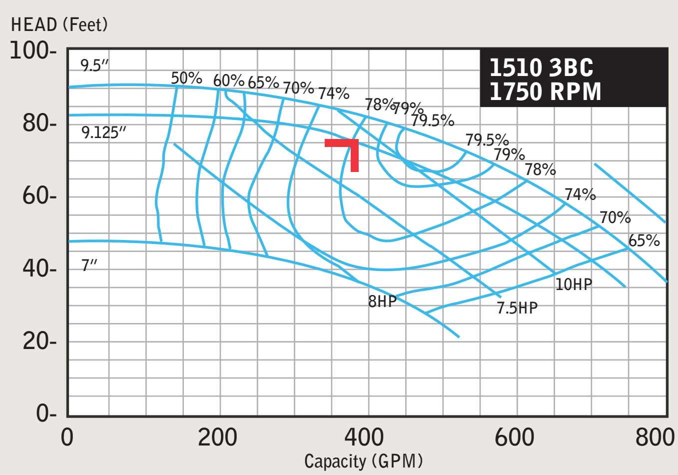
Pump Law 3: The pump brake horse power has a cubed relationship to pump impeller diameter or speed.

Pump speed has a linear relationship to flow, while power has a cubic relationship to flow. How can a good TAB technician set flow without plotting the pump to the old familiar pump curve?

A definitive answer was provided in the form of a pump curve given to a fellow TBE, named Thomas Goodman. The pump curve he provided was from Bell and Gossett and showed multiple performance curves at various speeds for a pump he was balancing. As Goodman began digesting this new information, he grasped the underlying relationship and how it correlated to Pump Laws One and Two. Goodman quickly devised a way to accurately measure flow (it is verified with various means, including an ultrasonic flow meter) and consistently set the pump to design flow using nothing but the pump, a single speed curve, and a little math.

Figure 1-1 is a standard pump curve that was provided to Goodman at the outset of his eye-opening project, which is very much like the curve we have seen on every other TAB job. It is possible to obtain a curve like Figure 1-1 from most manufacturer web sites, which is useful when the mechanical or general contractor does not have one. Figure 1-2 is the variable speed pump curve that Goodman later discovered. Note that the full speed curve from Figure 1-2 matches Figure 1-1 properly. If the variable speed curve is not provided, as is common, there is a way to plot out a variable speed curve, and therefore set flows without closing a discharge valve.

FIGURE 1-1



Design Capacity = 380.0 GPM
Design Head = 75.0 Feet

Suction Size = 4″
Suction Velocity = 9.8 fps
Discharge Size 3″
Disc Velocity = 16.5 fps

Min. Imp. Dia. = 7″
Max. Imp. Dia. = 9.5″
Cut Dia. = 9.125″

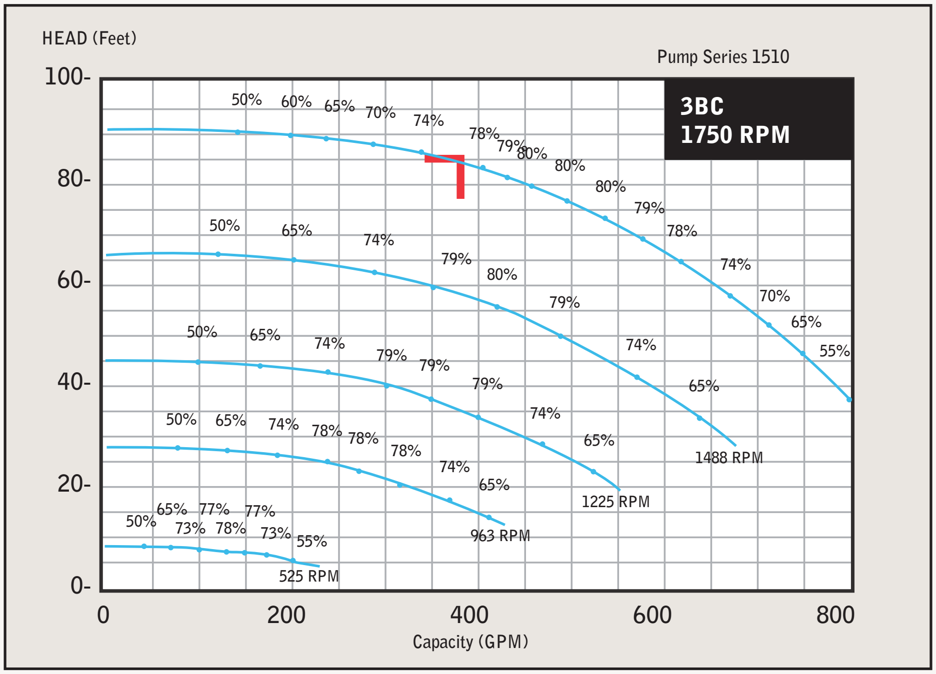
Max. Flow = 754 GPM
B.F.P. Flow = 474 GPM

Eff.@Duty-Point = 78.1%
Motor Size = 15HP

B.H.P. @
Duty-Point = 9.31 BHP
Max. B.H.P. for
Imp. Cut = 11.92 BHP

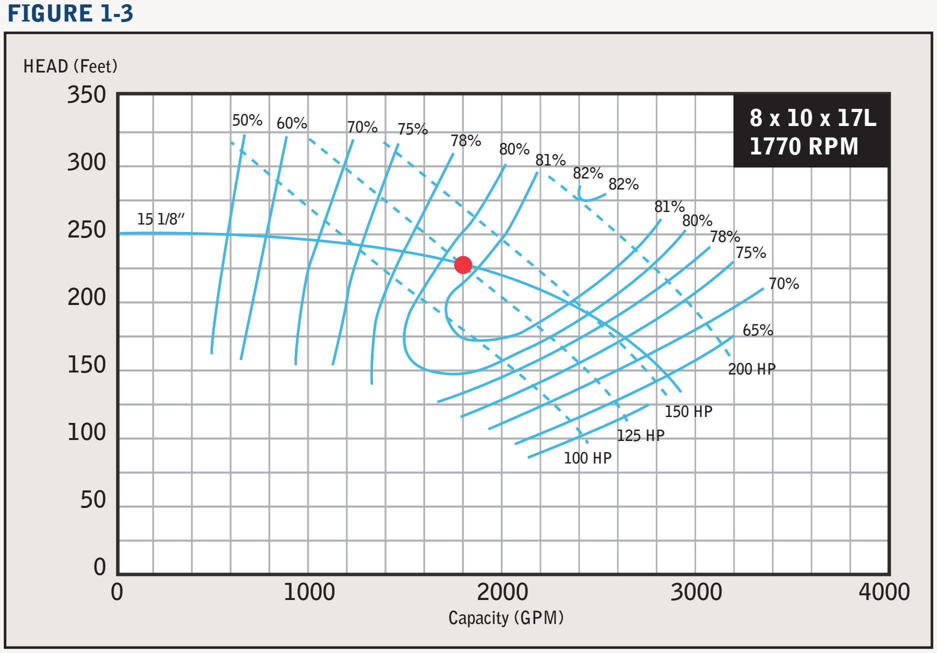
TTING AND DOCUMENTING FLOWS

FIGURE 1-2



For clarity, a different B&G curve (Figure 1-3) is included in this article to show multiple impellar sizes. This example displays a pump design of 1800 Gallons @ 225 feet of head. The engineer has selected this pump and a 15 1/8" impeller. The selection point is noted in red.

FIGURE 1-3



First pressure readings are measured at dead-head and full flow. In this example, a pump differential pressure of 205 feet at full flow and 246 feet at zero flow is observed. The dead-head tells us we are very close to the curve for this pump, allowing us to safely use the point of 2200 GPM at 205 feet as a benchmark to begin the exercise. It is not necessary to restrict the discharge to get to 1800 GPM, as it can be slowed down. To determine how much it can be slowed down, Pump Law 1 enables computation of the speed as follows:

$$RPM_2 = \left(\frac{GPM_2}{GPM_1}\right) \times RPM_1$$

$$RPM_2 = \left(\frac{1800}{2200}\right) \times 1770 = 1448 \text{ RPM to reach a flow of 1800 GPM}$$

Drop the VFD to 49Hz or 81.8% (1448 RPM/1770 RPM). This is the pump maximum RPM and the full-flow head differential pressure can be predicted.

$$H_2 = \left(\frac{RPM_2}{RPM_1}\right)^2 \times H_1$$

$$H_2 = \left(\frac{1448}{1770}\right)^2 \times 205$$

H_2 = 137 feet of head at 1800 GPM running at 82% speed.

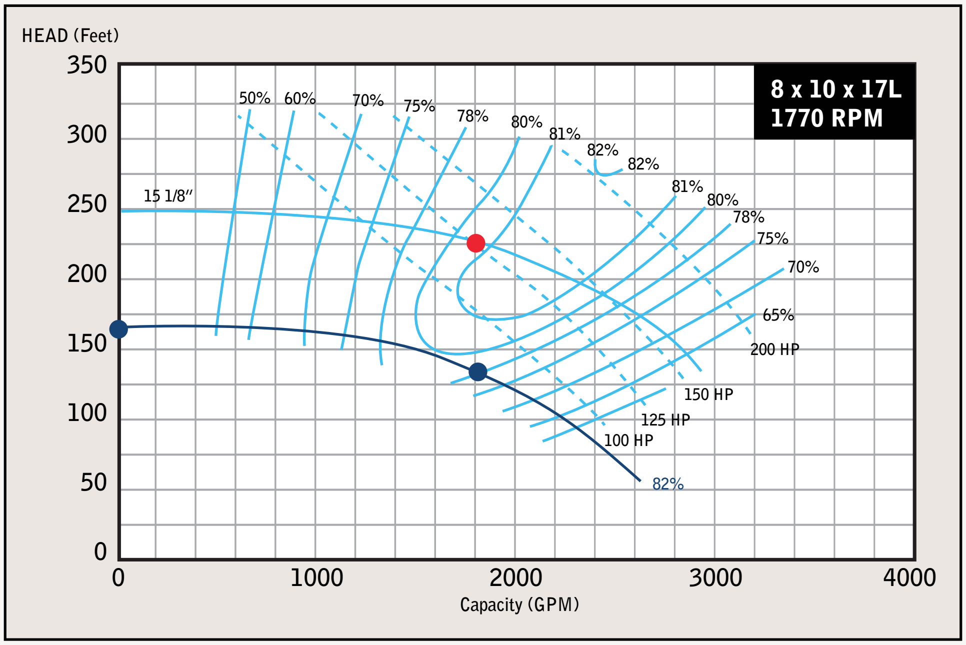
To get the zero flow number, substitute the no flow from our readings.

$$H_2 = \left(\frac{1448}{1770}\right)^2 \times 246$$

H_2 = 165 feet of head at 0 GPM running at 82% speed.

The zero flow number and full flow number for the curve are now known. These should be verified with actual pump differential readings. This is an important number and should be recorded somewhere in the pump data sheet for final full flow readings, carefully noting the method used, devices driven, etc. The next step is to plot them, noting what the pump curve is for this system when the pump is at 82% speed. The no-flow and full-flow points are blue, for clarity. Once this is done, the curve can be plotted in a nice blue line with the same contour as the design curve (see Figure 1-3a). The project team can then proceed with the system balance, with reasonable confidence that the pump has been set correctly. The pump will be operating on a new curve for 82% that would look something like this:

FIGURE 1-3a



"No Flow" readings can be plotted at various speeds to begin to recreate the variable speed curve, for instance 82% (since we know it is our maximum), 70%, 55%, and 40%.

$$H_2 = \left(\frac{1448}{1770}\right)^2 \times 246 = 165 \text{ feet of head at 82\%}$$

Save a step by substituting the RPM multiplier directly.

$H_2 = (.82)^2 \times 246 = 165$ feet of head at 82%

Therefore:

$H_2 = (.7)^2 \times 246 = 121$ feet of head at 70%

$H_2 = (.55)^2 \times 246 = 74$ feet of head at 55%

$H_2 = (.40)^2 \times 246 = 39$ feet of head at 40%

We can now plot our no flow points to anchor our curves. We can use a few reference points by using Pump Law 2 to determine pressures with the "operating maximum" 82% speed numbers (1448 RPM, 1800 GPM, 137 feet) as our reference. We could just as easily use the full speed numbers (2200 GPM, 1770 RPM, 205 feet). So at 70% speed (1239 RPM), we may expect the following based on previous readings and calibrations.

$$H_2 = \left(\frac{RPM_2}{RPM_1}\right)^2 \times H_1$$

$$H_2 = \left(\frac{1239}{1448}\right)^2 \times 137$$

$H_2 = 100$ feet of head running at 70% speed.

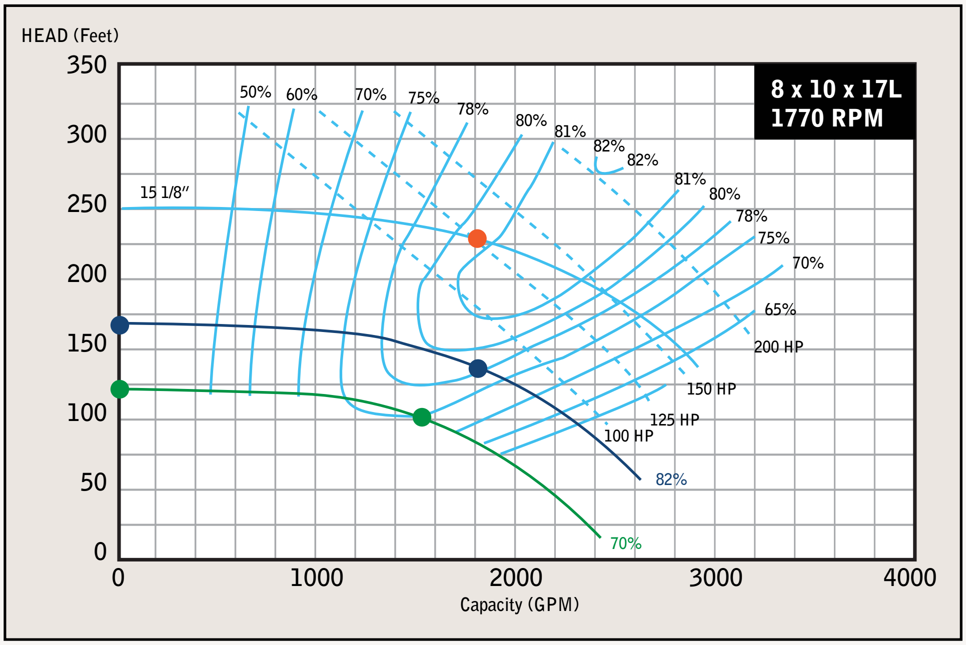
And now Pump Law 1 for the flow, again referencing the 82% speed numbers above:

$$GPM_2 = \left(\frac{RPM_2}{RPM_1}\right) \times GPM_1$$

$$GPM_2 = \left(\frac{1239}{1448}\right) \times 1800 = 1540 \text{ GPM at 1239 RPM}$$

The calculated 1540 GPM at 1239 RPM will produce a 100 foot differential. Without complex and problematic math procedures there are two points at 70% speed to use to draw in the curve below the original, gradually "shortening" the curve to maintain distance between curves. The 70% curve might resemble what is demonstrated below with both the points and the line in green.

FIGURE 1-3b



There are two operating points for the pump. If just one more is added, an improvement can be made that one rarely sees in a TAB report—calculating full flow at 55% (974 RPM) speed and plot this point.

$$H_2 = \left(\frac{RPM_2}{RPM_1}\right)^2 \times H_1$$

$$H_2 = \left(\frac{974}{1448}\right)^2 \times H_1$$

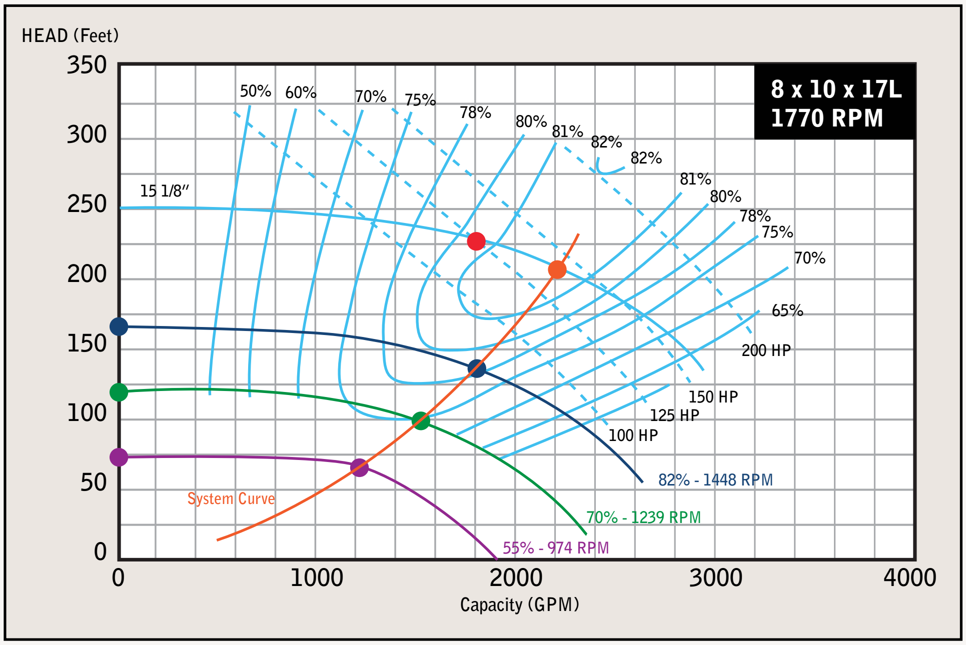
$H_2 = 62$ feet of head running 55% speed.

And now Pump Law One for the flow, again referencing the 82% speed numbers above:

$$GPM_2 = \left(\frac{RPM_2}{RPM_1}\right) \times GPM_1$$

$GPM_2 = (.55) \times 1800 = 990$ GPM at 974 RPM

FIGURE 1-3c



This RPM curve can be plotted in purple, giving three operating points for the system. When this is complete, there is sufficient information to plot a system curve for this pumping system. Here is what the example looks like with the new System Curve in orange.

This certainly gives a reasonably good indication of the types of flows that can be anticipated at a given speed and with a known pump differential. This is the sort of effort that will endear the project team to the Engineer of Record reviewing the report, highlighting the technical prowess. This also can be a way to separate an agency from its competitors.

Digital graphics are not necessary to use the technique, since it can be simply drawn by hand in the field as you go. Please note that the RPM curves have a smaller operating range in the higher efficiencies as the motor slows. It is important to note that from 70% to 100% throughput, little efficiency is lost[1]. Losses of efficiency do increase at lower speeds, primarily because of the linear progression (not cubed) of mechanical losses in seals and bearings, which generally represent less than five percent of total power[1]. A wider range of speeds can be used without seriously compromising efficiency. Motor efficiency losses are generally gradual until the speed drops to 30-40% as is the case in Figure 1-2. The efficiency curves are extended in Figure 1-3b to demonstrate this effect.

It is worth noting that building excess head pressure can still be useful when a system is first started, as this creates large pressure differences between supply and return piping when venting the water system. It is often found that a large differential will help the water overcome coil and piping air traps and force the air either to vents or back to the air separator where it belongs. Once the system is free of air, the discharge valve can be reopened, and balancing can begin.

Given the fact that there are reasonable assurances of the accuracy of pump volumes in the full open configuration, it does lead to one question: Why would the Engineer of Record ever specify a balance/triple duty valve on a pump that is controlled by a VFD? These devices have never been particularly accurate at measuring flow, and are more expensive than an alternative shut off valve and check valve. It certainly appears that an isolation valve would be sufficient for the owner's staff pump maintenance needs.

It is easy for an individual to allow their thinking to stagnate as they become accomplished balancers. If a procedure has been used for years, it is natural to continue on an unchanged course. Every once in a while, a new perspective comes into view and provides an opportunity to look at things in a new way. TBEs have a responsibility to learn new techniques and tools to improve the science and practice of Testing Adjusting and Balancing. It is our challenge to remain receptive to new possibilities so that we can keep our eyes and minds open for the next opportunity.

References:

[1] *Design Considerations for a Hydronic Pump System – A. Bhatia*

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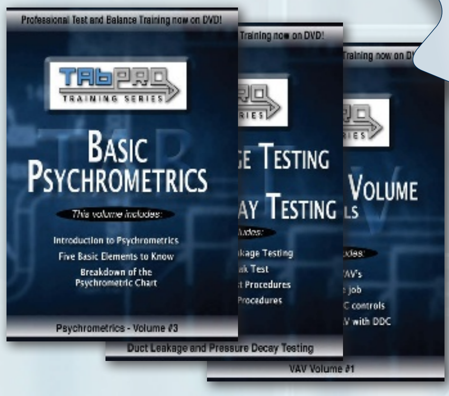

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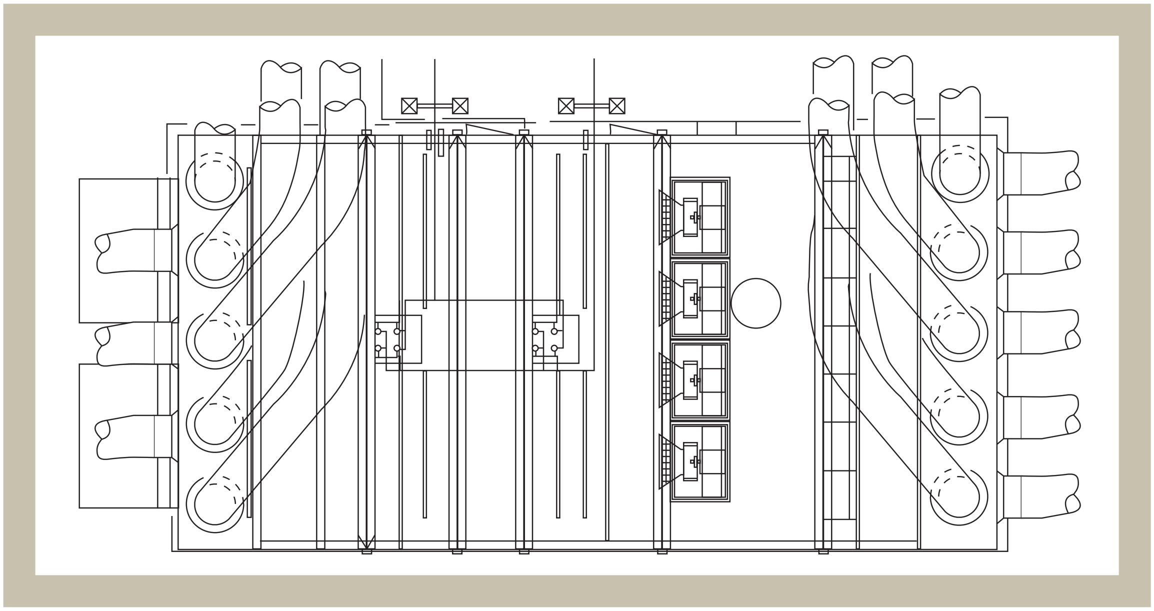
Testing Issues with Temporary Flexible Ductwork

Bryan Lacy, TBE
Engineered Air Balance Co., Inc.

During a recent project in a hospital facility, the team encountered several problems resulting from the initial design of the temporary ductwork being used. The project involved five existing AHUs located in a hospital basement that were selected for replacement. The five AHUs served different zones in the building, which was occupied at the time and had 11 levels.

The initial project plan was to place a temporary AHU outside of the building in a nearby courtyard, run the temporary ductwork through a common outside air intake breezeway, and tie the temporary ductwork into the existing supply and return air ductwork until the permanent AHU installation was complete. The duct diagram below shows the sketch taken from the mechanical drawings indicating the return ductwork with eight round temporary ducts, and the supply with ten round temporary ducts. The unit was equipped with outside air louvers, and dampers were installed to assist in proportioning the quantities between return and outside air.

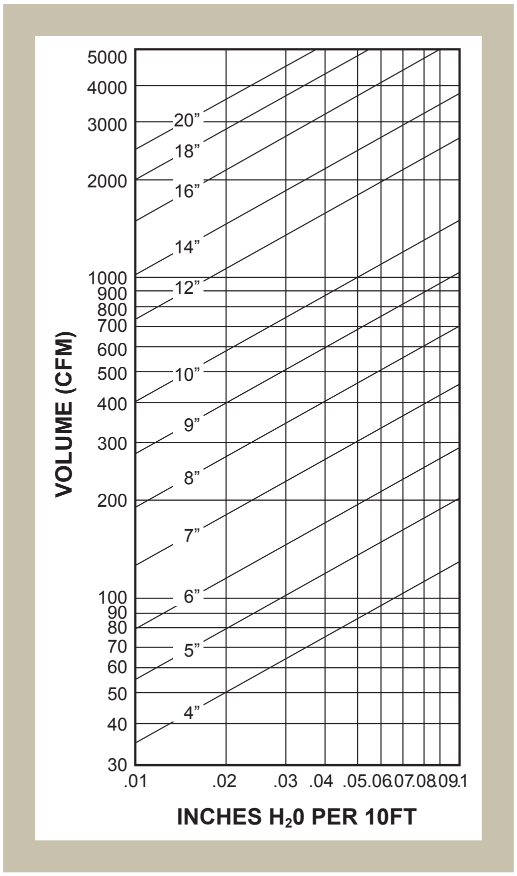
The flexible ductwork was installed on both the supply and return air side of the temporary air handling unit, routed to a rigid piece of ductwork located on the roof (60"x60"x60'), and then back to the flexible ductwork down into the breezeway. At the breezeway, the flexible ductwork had another 400' installed connecting to the existing ductwork taps for supply and return air.



Temporary racks were constructed to keep the flexible ductwork in a fixed location where it could be stacked, allowing access through the mechanical rooms and walk ways. No hard connections or transition pieces were used in this installation, other than coupling pieces to fasten the sections of flexible ductwork together. All flexible ductwork was specified to be 20" round with insulation. It was noted in the manufacturer's specification sheets that the flexible ductwork was rated for 25.0" w.g. for positive pressure and 1.0" w.g. for negative pressure as seen in the chart below.

When the installation was complete and the time came to activate the temporary unit, the project team was prepared for just about anything. The VFDs were slowly ramped up for the fan walls until reaching the scheduled hertz for the fans. At that time, the team needed to set the return/outside air quantities, a process that started with the outside air dampers fully open and then throttling them closed once we had the unit to maximum hertz.

The flexible ductwork on the roof was monitored as the outside air was throttled down, in order to note any signs of deformation in the structural integrity of the flex duct. The outside air dampers were throttled to allow the maximum amount of return air before the flex ductwork started to deform. At that point, the air handling unit was traversed, and static pressures were taken. These new graph measurements revealed a pressure drop of 3.70"w.g. between the discharge of the air handling unit and the traverse location in the 60"x60" ductwork on the roof. At that point we noted that during the three-hour period of testing, we had 12 locations where the flexible ductwork had ripped open because of the high static pressures on the installation and construction of the ductwork. It was determined that the temporary air handling unit would be placed manually at a hertz setting that would not allow the supply ductwork to fail during the night hours until the project engineer could evaluate the situation.



The next morning the building was operating with the temporary unit producing less than the scheduled airflow but maintaining temperature in the spaces which was attributed to the outside air temperature being 47˚ F. The project engineer evaluated the situation and determined that the discharge static pressure drop of

3.70"w.g. could be reduced significantly if the number of flexible ducts on the discharge of the unit could be increased from 10 to 20 as noted in the photo below.

After the installation was complete, a photograph was taken from the crosswalk between the buildings. The project team members then began testing with the added flex ductwork. As indicated in the photo, blue sections on the ductwork determined to be tears in the connections between sections of flex had to be wrapped with a plastic adhesive material to increase the integrity of the supply duct. The testing started again, but was stopped repeatedly stopped due to continuous duct failures over the next several hours. With the added flex ductwork to the temporary unit, the sheet metal contractors found it impossible to access some of the ductwork failures in the supply ductwork in the courtyard because of the close proximity of the flex duct sections. Whenever a ladder was squeezed to reach one tear, another one would be created by the positioning of the ladder.

For the most part, the ductwork failures were now occurring in the breezeway location caused by the increased static pressure from the addition of the 10 supply flex ducts. The owner and project engineer mutually agreed that the VFD serving the fans would have to be reduced to a value that did not create failures

in the supply ductwork. The two discussed what the best solution was, and the project budget was a major component of the talks. All parties recommended installing rigid ductwork from the unit to the breezeway and spiral ductwork at all other locations, but the financing was not allocated for that change.

As the six to eight week period passed with the operation of the temporary air handling unit (while the construction of the permanent unit was in progress), the hospital had to secure several sheet metal contractors to work continuous shifts 24 hours a day, seven days a week to make continuous repairs on flex duct failures. The time and material cost convinced the owner that during the next four AHU replacements a different approach was necessary. The owner decided to have the rigid ductwork constructed and ready to install before the next AHU was demolished and the temporary system was put into operation.

Due to the installation of the rigid ductwork (and minimal flexible duct), the system has virtually no flex duct failures and can achieve an additional 10,000 cfm of return air. It's good to have budget guidelines on a project, except when it puts the systems at risk of failure in critical areas.

Techtips

The Dirt on Balancing Valves

Medard Leblanc, TBS, Scan Air Balance 1998 Ltd.

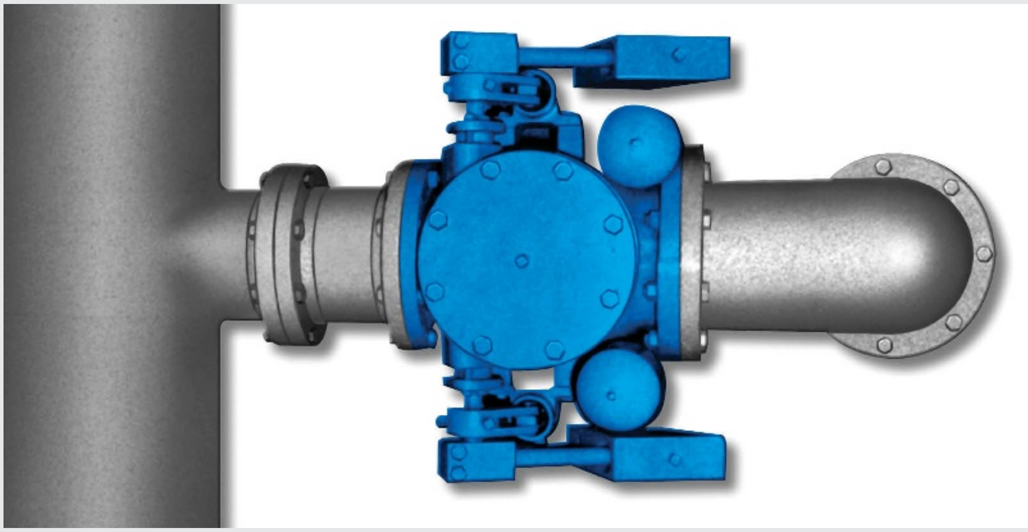
On numerous hydronic balancing jobs, a commonly overlooked aspect is proper sizing of the specified balancing valve. It is incorrect to simply install a valve that is the same size as the line size. In many cases, smaller low-flow valves should be used, especially around radiant panels where there are low-flow requirements.

When an improperly sized balancing valve is used—depending on the type of valve—the valve must be throttled just to obtain a reading on the meter. At times, valves have been throttled to .5 turn open, and the flow is still above design because of the oversizing of the valve and the low-flow requirements.

Over-sizing may also create another problem. When the valve is at .5 turn open and is being locked down, do not tighten the locking mechanism as noted in the installation literature. Doing so will reduce the opening even more, and too much dirt will completely block it.

One cause of dirt in piping systems is that sometimes, only the main lines are flushed. The supply and return branch lines serving reheat coils, baseboards, radiant panels, etc., are capped at the ends are not joined together as they eventually will be. Therefore, these branch lines are not flushed. Then, when the heating elements are connected on the branch lines, all the dirt in these lines is sent throughout the entire system, plugging up balancing valves, control valves, and other components.

It is very important that a thorough flushing of the entire system is done, and then all the strainers should be removed and cleaned. This will help to avoid any problems with heating.



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Pay Attention to the Patient

The first lesson taught to workers entering the field is the importance of listening to your customer.

By Bradley J. Steiskal, TBE, CxA, ***Kahoe Air Balance Company***

For many people working in test and balance, it is a career that they stumbled upon rather than one they planned to have. Before working in air balancing, many people were unfamiliar with the field and what its professionals do. Then they were hired and instantly amazed by what test and balance professionals do. How did he know to cut that damper? How did he know there was air in that?

In most test and balance agencies, someone serves as a mentor for new employees to show them the ropes. More experienced members of the field are able to diagnose building issues before they pull out the first tool. They get a sense of the patient's needs before they even lift a finger. Experienced test and balance professionals set the bar high for those colleagues who are just entering the field.

Today, many in the field tend to stare at computer screens hoping the building issues will reveal themselves. Most day-to-day balancing involves standard problems, such as closed dampers, unfinished controls or a missing component. However, when considering that energy costs are skyrocketing, it is increasingly important for test and balance professionals to identify existing building issues quickly.

The first lesson taught to those entering the field is the importance of listening to your customer—they wouldn't be talking to you unless an issue existed. This cannot be stressed enough. The next step is to get the customer to walk the building with a test and balance agency representative. Meeting with some of his or her maintenance staff at the same time is highly recommended. Ask a lot of questions, such as: When did this condition start? Is it seasonal? Have you made any equipment changes? Is there a new control system? Again, listening to the customer is crucial. By the end of this walkthrough, the following items should have been addressed in detail:

- What the customer's concerns are;
- Which systems need to be checked;
- What the occupants are experiencing;
- Clues as to what the issues might be;
- What type of systems you will be working with;
- What your customers expectations are; and
- Whether this problem can actually be solved by a test and balance professional.

The walk-through provides the opportunity to act as a good doctor would—listening to the patient, and noticing any symptoms that the patient might be communicating. While the analogy is a bit of a cliché, it is the truth. Every day we hone our balancing skills and gain one more day of experience, but we should also pay close attention to troubleshooting with the clues these systems leave us when they function incorrectly. These are the skills that separate good balancers from the bad, and that allows the customer to trust an agency's expertise.

"One of the clearest descriptions of the commissioning process that we've seen." —Environmental Building News

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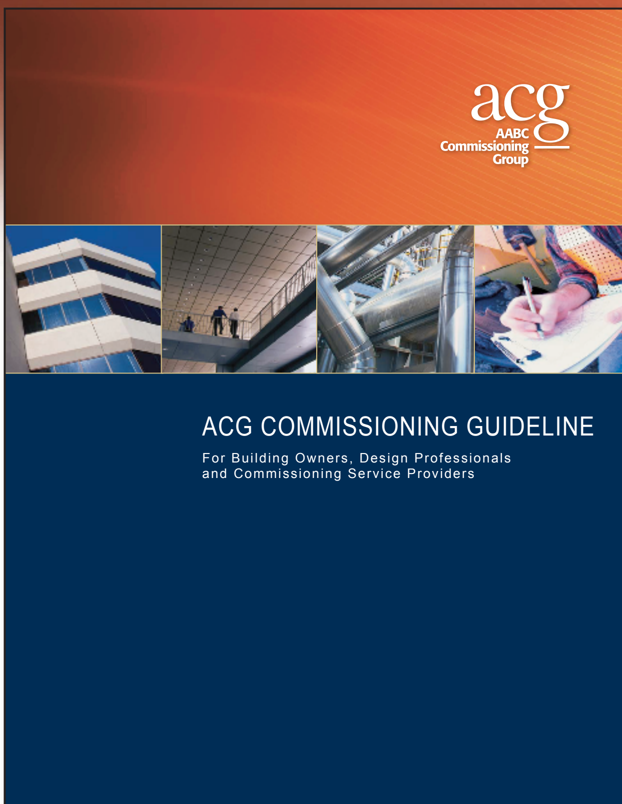

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SPECIAL REPORT:

Test and Balance in Buildings

After navigating rough times for new construction with more work on existing buildings, test and balance firms are cautiously optimistic about the future—and have some ideas to share with engineers.

By Ray Bert and Lexi Gray, *Associated Air Balance Council*

The discipline of testing, adjusting, and balancing (TAB) can be traced back as far as the construction of the Pentagon near the end of World War II, and evolved into an essential part of the modern building construction and renovation process. When done properly, TAB—also called test and balance—has tremendous benefits for building owners, both in direct savings and in proper system performance.

Challenges persist, however. TAB is often incorrectly treated as a strictly end-of-the-project task that can be rushed through, and TAB firms must also navigate providing a professional service that is frequently procured via a low-bid process.

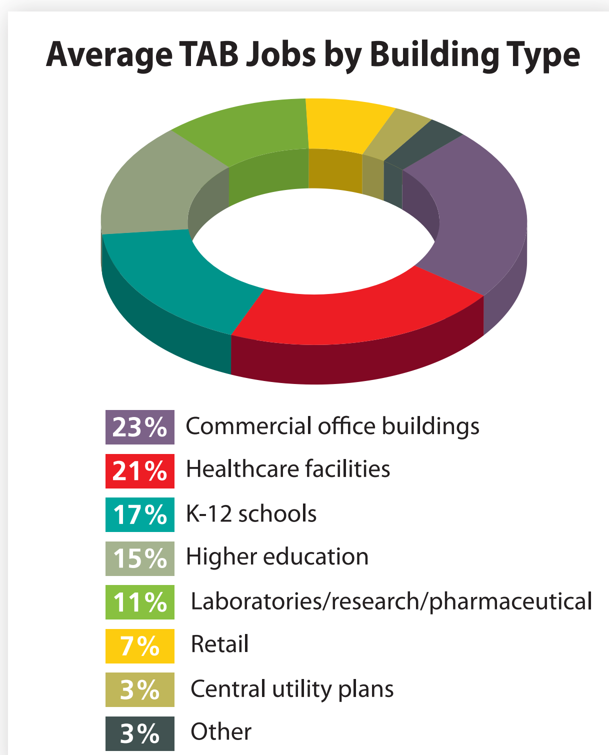
To answer a number of questions about challenges currently faced by TAB firms, and where most of their work is coming from, the Associated Air Balance Council (AABC) conducted a survey of 168 TAB agencies in August 2012, and 69 companies responded. All of the companies surveyed are independent testing agencies with no affiliations with contractors, manufacturers, or design engineers.

Building types and sectors

While new construction accounts for the majority of TAB projects among the companies surveyed, a substantial 39% of their work occurs in existing buildings. This suggests that building owners recognize the ability of an independent TAB agency to verify and improve system performance.

The bulk of TAB work is currently in the private sector (46%), with most of the remainder of work fairly evenly divided between state governments (15%), military projects (13%), nonmilitary federal projects (11%), and municipal projects (11%). Figure 1 shows the distribution of work according to facility type. Leading the way are commercial office buildings (23%), followed closely by health care facilities (21%).

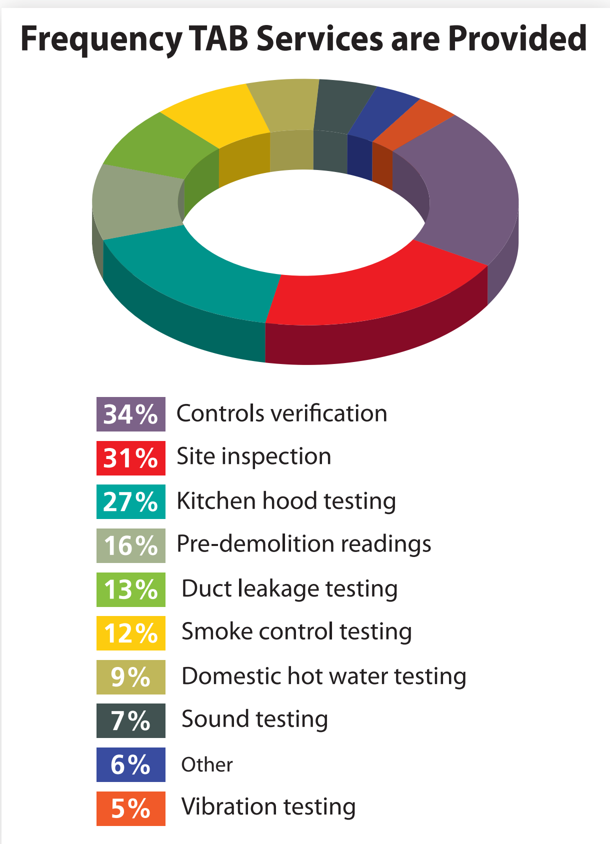
Despite general recognition that this setup is far from ideal, TAB agencies are frequently (56% of the time) subcontracted to the project's mechanical contractor (see Figure 2). An additional 18% of the time, the TAB agency is hired by the general contractor. Only 19% of the time is the agency hired by the building owner, though this situation is considered ideal by many in the industry because TAB is meant to provide third-party verification of system performance on behalf of the building owner.



Independence and TAB scope

Survey respondents were asked to share the approximate percentage of jobs specified to be balanced by an independent TAB agency, and the overall average of responses was 83%. While it would be better if this number were even higher, it does suggest that most specifying engineers recognize that the TAB agency should not be affiliated with other entities that could present a conflict of interest.

Survey respondents were also asked how often over the past 12 months they were asked to perform specific services related to TAB (see Figure 3). Controls verification was reported as the most frequent specific service (34%), followed by site inspection (31%) and kitchen hood testing (27%). Among the other responses, it is notable that at a time when so much attention is devoted to energy savings, duct leakage testing is specified and performed only 13% of the time.



Project timing for TAB services

When TAB agencies are contracted prior to construction, it allows the opportunity to perform a review of systems for balanceability, correcting any issues that would be more costly and time consuming to fix after construction has begun. About 58% of survey respondents said their agency is brought in before construction for at least one-third of their projects, and about 21% of respondents said early contracting occurs as often as 50% of the time.

Significant issues are often uncovered when TAB agencies are brought in early for assessment, according to responses. The frequency with which these findings are acted upon varies, in part because some agencies perform their review with little time remaining before balancing is set to begin. The most commonly reported findings include improperly located or missing dampers and valves, variable air volume (VAV) box sizing, piping issues, and issues with building pressures.

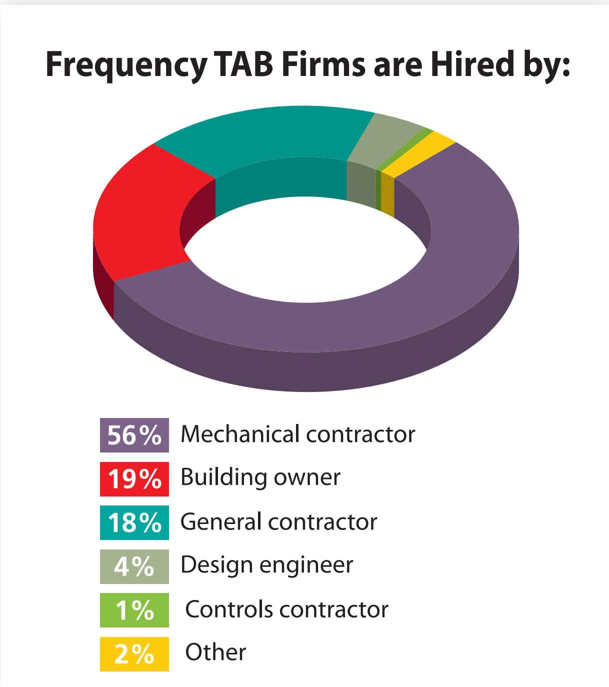
Engineers and the TAB process

Although TAB professionals rarely work for the project engineer, there is no question that the engineer—who controls the content of the TAB specifications, may need to respond to issues discovered during TAB, and is responsible for reviewing the final report—can have a significant impact on TAB procedures.

While engineers have the technical "chops" to understand TAB issues, the fact is that some may not have had the time or the inclination—especially early in their careers—to learn about the specifics and the subtleties of TAB. With this in mind, survey respondents were asked what they wish more engineers understood about the TAB process. A number of common themes emerged, some of them technical in nature but many of them more process-oriented.

- TAB specifications should be developed with the individual project in mind. Detailed specifications that are project-specific avoid confusion and misunderstandings that can lead to delays or unanticipated costs.
- How to read, understand, and effectively use TAB reports. A thorough review of the TAB report can tell engineers a lot about the quality and completeness of the TAB work. An accurate report also provides important information about system performance, any deficiencies, and how to correct them.

"While engineers have the technical 'chops' to understand TAB issues, the fact is that some may not have had the time or the inclination—especially early in their careers—to learn about the specifics and the subtleties of TAB."



- The importance of insisting on an independent agency. If the engineer does not specify otherwise—either by requiring that the TAB agency be certified by AABC or by explicitly requiring that it be independent—the TAB process could be performed by people with direct ties to the installing contractor. An independent TAB agency has no such conflicts of interest that could prevent it from rendering an objective report about system performance.
- The benefits of involving the TAB agency early in the process. "Balanceability" reviews done before installation frequently catch a variety of small problems before they become bigger, time-consuming, and expensive to correct.
- TAB procedures, and what it takes to do the job right. TAB agencies and project engineers should be allies in achieving optimum system performance. Understanding the basics of proper procedures and the time involved makes this alliance stronger.
- The system's design and functionality has a direct impact on the TAB agency's measurements. From proper placement of valves and dampers to how the system was designed, or with regard to outright installation errors, the TAB agency's ability to achieve system balance can depend on factors that are beyond its control.

Challenges and outlook on the future

Survey respondents were asked to identify their agency's current main challenges in the business, technical, or project administration areas of their operations.

Technical: Many survey responses expressed challenges related to sorting out new technologies and reporting software. Another common issue, a longtime one for TAB agencies, is keeping up to date on rapidly changing controls equipment and software.

Project administration: Overwhelmingly, unrealistic timeframes to complete TAB work and related scheduling issues were the most frequent challenges reported in this category. System readiness for TAB and unclear specifications were also mentioned frequently.

Business: Many of these challenges relate directly to the slow economy. Most frequently cited were cash flow issues resulting from slow payment (often by similarly cash-strapped mechanical contractors) for work completed. Others noted that workloads are uneven, not yet rebounding to pre-recession levels—which, in turn, has resulted in intensified competition on pricing for the available work.

While the market is experiencing some difficulty, there is a fair share of optimism for 2013, with 48% of respondents saying they expected their firm's overall TAB work to increase. Nearly as many (45%) anticipate 2013 to look much like 2012, and only 7% anticipate a decrease.

Overall, the vast majority seem to agree that things are at or near the bottom—the only question remaining is when the upturn will arrive.

CONSULTING - SPECIFYING engineer

Duct Leakage Testing

By Mike Van Wiechen, TBS
Airwaso Canada, Inc.

When an agency is performing duct leakage testing during a project, there are a few different methods to determine acceptable leakage rates. This article discusses two typical methods for determining acceptable leakage rates and applying the results to an actual duct system.

The first and most common method to determine acceptable leakage is the "SMACNA method." The allowable leakage is determined by relating the surface area of the duct to duct pressure using the "SMACNA Duct Leakage Testing Manual." The leakage class is selected by the engineer, and the duct test pressure is determined by the pressure class of the duct. The second method is based on the air handling unit's volume, and its typical operating pressure. The specification may state "1.5% leakage of total system volume at 3.0 In.w.c. pressure."

A recently completed project involved a very large, medium pressure supply VAV duct system. Ducts were constructed to a pressure class of 3.0 In.w.c., with standing seam flanges, and a total surface area of 43,740 FT^2. The air handling unit's design volume was specified for 74,000 CFM. Duct leakage tests were performed by separating the ducts into 28 sections. All tests were performed at 3.0 In.w.c., and the system leakage totaled 4278 CFM, or 5.78% of total volume.

The project specified the "SMACNA method," leakage class 6, pressure class 3.0 In.w.c. According to the manual, the allowable leakage is calculated as follows:

LF (Leakage Factor) $= CL(P^{0.65})$
$= 6(3^{0.65})$
$= 12.25$ CFM/100FT^2

Total Leakage Allowed = LF x Surface Area ÷ 100
= 12.25 x 43740 ÷ 100
= 5358 CFM

As it is related to total volume delivered by air handling unit:

5358 ÷ 74000 x 100 = 7.2 %

This project also specified the second method of acceptable leakage, 3% of total volume at 3.0 In.w.c.

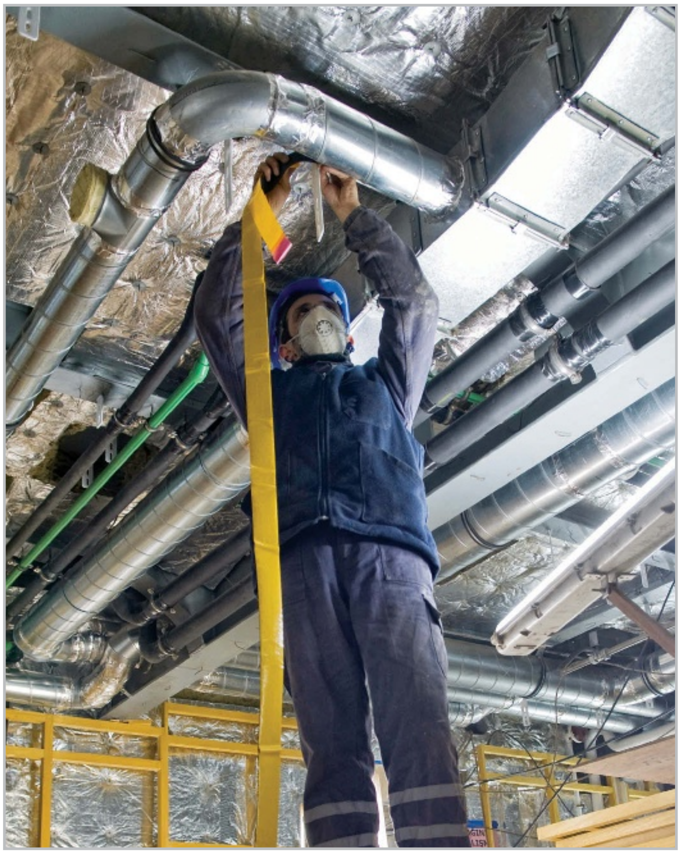
The total acceptable leakage volume is calculated as:

Allowed Leakage = 3% x 74000
= 1110 CFM

Relating this to the SMACNA method, the resulting leakage class is calculated as follows:

LF (Leakage Factor) = Leakage ÷ Area x 100
= 1100 ÷ 43740 x 100
= 2.51

Leakage Class $= LF \div P^{0.65}$
$= 2.51 \div 3^{0.65}$
= 1.23



At a commissioning meeting before duct leakage testing commenced, the commissioning team was made aware of the double spec item. The sheet metal contractor's argument was "if the SMACNA duct construction techniques are used, then the ducts should be leak tested, according to the SMACNA duct leakage manual." The team agreed with this, and the SMACNA method was accepted.

During the leakage testing, several individual tests achieved a leakage class of less than LC=3. Ducts were assembled typically with sealer applied internally on Pittsburgh seams, extra gasket material applied at the corners, and tight clips used to hold flanges together. If all tests achieved class 3, the total leakage would have been 2668 CFM or 3.6% of total unit volume. Many leakage tests also failed the leakage class 6 spec. These tests were resealed and retested until they passed. Generally, it was found that these ducts were missing clips, the internal sealer was missing, or they were assembled with cold ambient temperatures affecting gasket adhesiveness.

In conclusion, it was found that leakage specifications based on 3% volume of air handling units were difficult to achieve without trades applying sealer for several hours. Ducts tested to SMACNA class 3 is realistic, if trade workers are proficient in installation procedures. This should be considered the minimum standard criteria for medium pressure systems. SMACNA class 6 normally involves leakage rates of over 7% of the total system volume, and this is unacceptable to many engineers, who are forced to abide by this standard because of current construction practices.

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