TAB Journal

AABC

THE MAGAZINE OF THE ASSOCIATED AIR BALANCE COUNCIL • SPRING 2014

Environmental Considerations

When Balancing Buildings

IN THIS ISSUE:

- Balancing in the Southwestern United States
- Case Study: Beachfront Hotel

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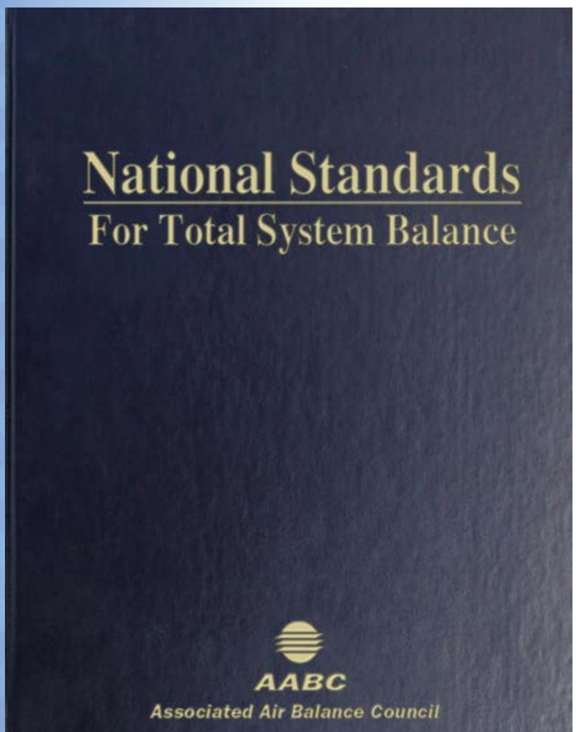

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From the Publisher

In the spring 2014 issue of *TAB Journal*, several articles explore the role the environment can play when testing and balancing. "Environmental Considerations of the Southwest," by Michael Ziegler, TBE of TAB Technology, Inc., addresses the concerns of balancing in a desert climate, while Jeffrey Wicka, TBE, CxA of San Diego Air Balance Co., Inc. looks at the way ocean breezes affect a beachside hotel in "Chasing the Air."

Also in this issue, Dustin Fielden of Systems Commissioning & Testing, Inc. discusses a method by which air volume can be determined indirectly when ductwork changes make a direct read impossible.

Charles Brown, TBE of Technical Air Balance, Texas goes over the correct calibration and balancing of Phoenix Valves in laboratory environments.

R.H. Cochran and Associates, Inc.'s John A Balanik, TBE, talks about "canned specs" and the role they play in the industry.

Tim Sibinski, TBE, of SMB of Minnesota examines considerations to take into account when installing airflow measuring stations that can affect the operation and comfort within a building.

Joseph Danis, TBE of Danis Test and Balance, Inc. looks at some common misconceptions regarding rotation of single-phase motors, and how those issues can be addressed.

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!

Indirectly Determining AIR VOLUME

Dustin Fielden
Systems Commissioning & Testing, Inc.

What can be done if an airflow measurement is needed, but there is no way to directly take a reading? Occasionally, there are situations that arise where it is necessary to determine creative ways to measure air volume. The following situation is a recent example where this was encountered.

This scenario involves a 2 story, 72-room long-term care/rehab facility. Each of the 72 patient rooms had a split heat pump unit (HP) above the ceiling with no access to the ductwork. The outside air to the 72 units was supplied by two ERV's (energy recovery ventilator), one serving the west side and one serving the east side of the building. Each ERV was specified to provide 90 CFM (cubic feet per minute) to 36 (typical) split HP units with two supply outlets and one return inlet; 18 units per floor (3240 CFM total for each ERV).

> Occasionally, there are situations that arise where it is necessary to determine creative ways to measure air volume.

During the initial walk through of the jobsite, it was observed that each outside air duct was run using 6" round flexible duct. The flex duct was used because there was very limited space above the ceiling grid for the ductwork. Since flexible ducts are difficult to accurately traverse, the solution would have to be somewhat inventive to determine the air volume at each outlet.

To begin, for consistency, it was verified that all 36 split units had their fans running. Both the supply and exhaust fans for the ERV were running, with the exhaust already balanced. Exposed ductwork on the roof was reviewed for traverse locations. The main supply duct was then traversed, with a recorded CFM of 3310. The first floor drop was traversed; however, there was no accurate place to traverse the second floor drop. Balancing the first floor drop was conducted using the branch dampers that were installed to 1690 CFM. The second floor drop airflow was determined by subtraction to be:

1620 CFM (3310 CFM – 1690 CFM = 1620 CFM)

Now that it was confirmed the system was supplying equal air to each floor, an accurate place to traverse one of the terminals was sought. A section of hard duct near the end of the run on the second floor was traversed and recorded 80 CFM. Next, using a velgrid, an average air velocity of 185 ft/min was recorded through the return inlet for the split HP. The supply totals had already been balanced for the split units and this particular unit total was 690 CFM. The actual return total was 610 CFM:

(690 CFM – 80 CFM = 610 CFM)

From that, an Ak of 3.3 was calculated for the return inlet from the following equation:

(610/185 = 3.3 or 185 x 3.3 = 610)

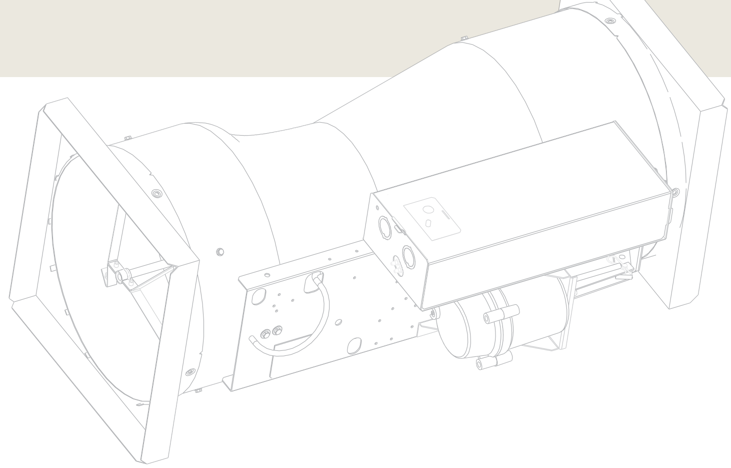
For the second ERV the same method above was used and found a slightly lower Ak of 3.2. For the remainder of the project the systems were balanced to the designed criteria using the following equations:

The units supplied by ERV-1:
Outside Air = Supply total of the split HP – (Return grill velocity x 3.3)

The units supplied by ERV-2:
Outside Air = Supply total of the split HP – (Return grill velocity x 3.2)

This method made what seemed like a difficult situation manageable after all. Often, changes are made to ductwork during construction that can make it almost impossible to determine the air volume. Sometimes, it is possible to indirectly determine air volume using some simple calculations.

The more toxic the substance being tested, studied or created, the stricter the need to maintain reliable pressure hierarchies.



Calibration and Balancing of Phoenix Valves in Laboratories

Charles Brown, TBE
Technical Air Balance, Texas

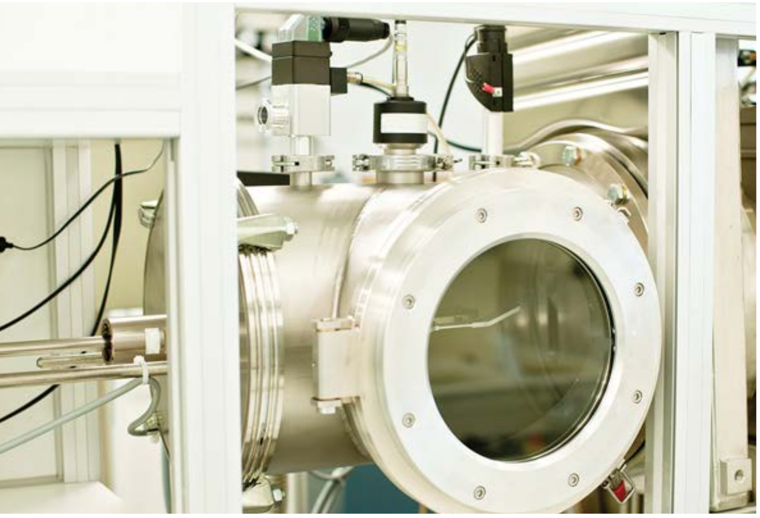
The majority of firms that have been in the air balance industry for any length of time have encountered balancing in some sort of laboratory facility. Balancing a lab poses some of the most challenging air balance work a technician can encounter, and it is not uncommon for an air balance technician to deal with just about every type of air flow issue or problem possible. Depending on the type of system installed, the balance work may be made much harder if the incorrect device and/or system for the application is utilized.

Although there are several different types of air volume control devices and systems used in the construction of laboratories and vivariums throughout the country, the Phoenix Valve is one of the most popular, and is the preferred choice for the exhaust side.

The Phoenix Valve is a very forgiving volume control device. It doesn't require the typical four duct diameters prior to the inlet or two duct diameters after the discharge in order to ensure proper functionality. The device controls airflow by virtue of the cone assembly system inside the valve body. The cone assembly has the ability to quickly compensate due to changes in static pressure. This fast-acting capacity allows the Phoenix Valve to respond quickly to a rise or drop in pressure, and this is critical in maintaining the necessary pressure hierarchies needed to ensure the safety of the occupants in or around the lab areas.

As stated, the Phoenix Valve is forgiving of the usual installation requirements as well as having the ability to respond quickly to any rise or drop in system pressure. These two features are what make it a desirable volume control device. Laboratory rooms are extremely pressure sensitive due to whatever is being tested, studied or created in the lab. The more toxic the substance being tested, studied or created, the stricter the need to maintain reliable pressure hierarchies.

Years ago, maintaining pressure hierarchies was a simpler process as the areas in which laboratories were placed consisted of much smaller spaces. That isn't the case today, especially with universities constructing elaborate lab environments for conducting research, which may have up to five or more floors in a mid-rise building. The amount of laboratory rooms and the variety of studies and tests being run in these rooms demands a strict pressure hierarchy to ensure the safety of occupants from lab to lab, floor to floor as well as those outside the building. It is not uncommon to have ten or fifteen labs per floor across five



floors. Further issues arise depending on whether the majority of the labs or only a small percentage are used at any given time. This places a great responsibility on the system that is selected and installed to maintain the pressure hierarchy. It also places a great accountability on the company responsible for setting up the air flow and pressure hierarchy values. An improperly balanced system can cause adverse effects on lab occupants' health, even death in extreme cases.

In balancing the Phoenix Valve, there are two types: low and medium pressure, determined by the design engineer. The low pressure valve requires a minimum of 0.3" WC (water column) across the valve body. The medium pressure valve requires a minimum of 0.6" WC across the valve body. Although Phoenix Valves are fast-acting, this does have a drawback. For instance, if the operating pressure fluctuates up or down it can cause a flow alarm on the Phoenix Control System, which in turn will cause a CFM (Cubic Feet of air per Minute) default value to show up. For example, one might encounter a high CFM value that is a default number and not an actual CFM flow value; as a result the Phoenix Lab Valve (PLV) will begin to adjust even though a high number is registered, which normally indicates enough air or true air flow in the system. As the PLV begins to hunt, the valve fluctuates from a fully open to a fully closed position causing "hammering". This could incur damage to the internal cone resulting in the PLV not working properly. Understanding this will help save time and extra steps during the setup of these valves. This can be applied to all fast-acting valves.

In balancing the Phoenix Valve, there are two types: low and medium pressure, determined by the design engineer.

For the exhaust system, while the valve is at maximum air flow, set the initial static pressure at the last exhaust valve to 0.8-1.2" WC pressure drop across the exhaust lab valve to determine system static set point for the exhaust fans. For the supply system, initially set the first supply lab valve, after the 2/3 static sensor, while the lab valve is at 0.8-1.2" WC across the supply lab valve to determine the static set point for the supply air manifold.

Before balancing could begin, all flow alarms were eliminated by adjusting the static pressure setpoints. It was determined at the beginning that an abnormal quantity of valves were not meeting required airflow and required adjusting. This was confirmed with two separate air meters with measurements varying 8-15% high on the exhaust lab valves and 3-8% high on the supply lab valves.

The TAB technician and the Phoenix lab control contractor took static readings across the lab exhaust valve where the discrepancies were the worst and determined that there was a 0.56" WC pressure drop across the lab valve, the valve differential pressure (DP) sensor was made and not sending a flow alarm. It was found that by reducing the static pressure by 0.1" WC, the DP sensor generated an alarm condition with 0.53"

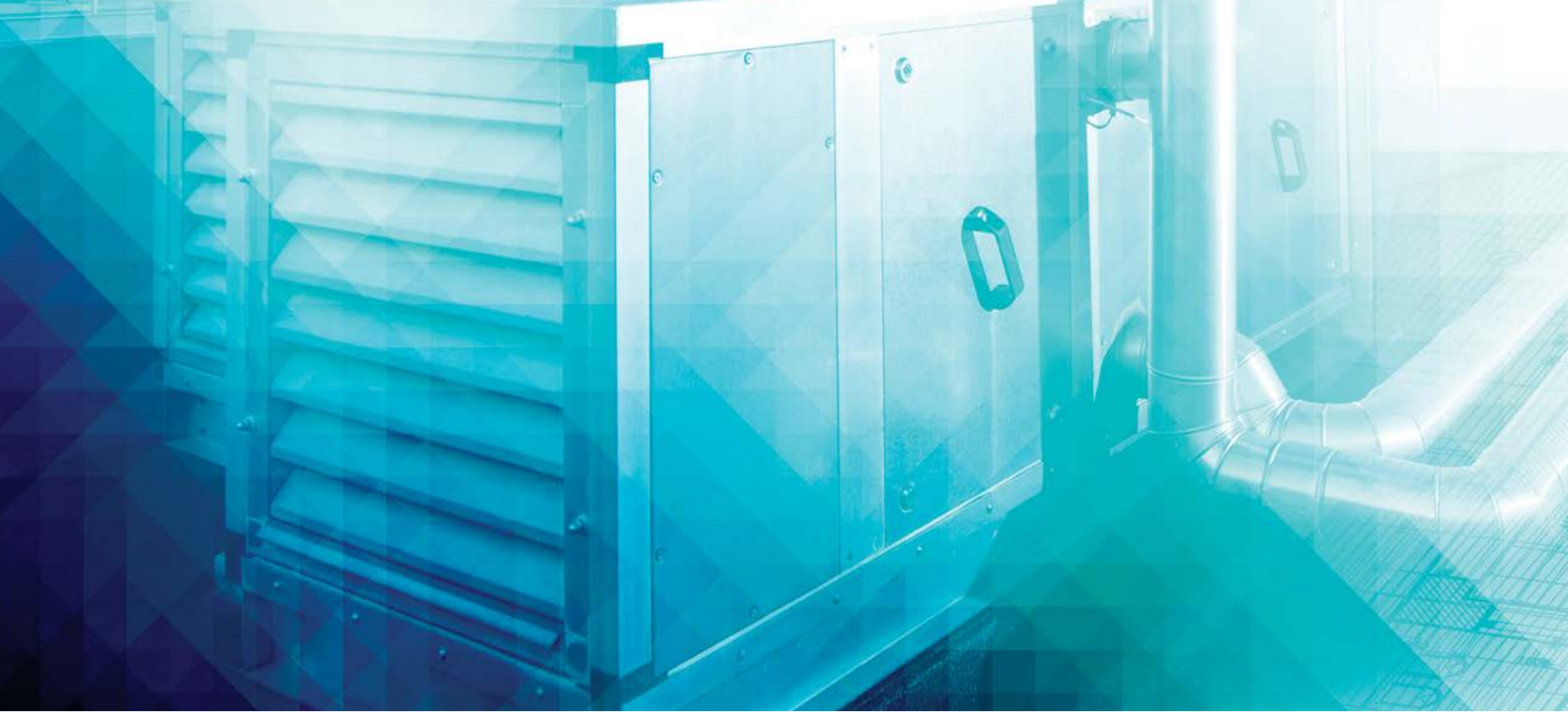
WC pressure differential measured across the lab valve. Similar testing was performed on the supply lab valve, on the area with the most out-of-tolerance lab valves. The DP across the supply lab valves was measured and were found to be the same as the exhaust.

The exhaust valves that were controlling within 2% of their design set points at maximum and minimum airflows and had DPs in the range of 0.9-1.3" WC. The same test was performed to the supply valves and it was determined that the DP across these valves were in the range of 0.85-1.2" WC.

The static set point for the lab exhaust fans was increased so that the pressure drop across the critical exhaust valve was 0.8" WC. Initially, the DP setpoint was 1.5" WC and the final setpoint required to satisfy the alarm condition through all the exhaust valves was 2.1" WC. For the supply system, the controlling static pressure setpoint was increased so that the DP across the lab valve after the 2/3 static sensor was measured at 1.0" WC resulting in a DP across the critical supply valve in the system of 0.8" WC. The initial static setpoint was 1.1" WC; after adjustments, the final static setpoint was determined to be 1.6" WC.

After the necessary changes were integrated, the air devices were re-measured resulting in airflow adjustments needing to be made to only 14 of 132 laboratory valves that exceeded the 5% tolerance requirement. Performing these steps saved the laboratory controls contractor time required to adjust the flow curve for each of the lab valves and balancing firm time re-testing after the flow curves were modified.

It should be noted that most laboratory projects utilize two different controls contractors, one for the laboratory valves and a second for the building automation system who is typically responsible for providing the duct static pressure control logic and the outputs controlling the variable frequency drives of the air handlers and exhaust fans.



The Trouble With Canned Specs

John A Balanik, TBE
R.H. Cochran and Associates, Inc.

Many times in the industry, the same specifications are being applied to several different projects. These can be referred to as "canned specs". For whatever reason, whether to save time or money or both, a very involved specification will be applied to a straightforward job. What applies to a school or library may not work for a furnace project.

Recently, testing and balancing was conducted at a veteran's homeless shelter, which utilized several residential-type furnaces. The furnaces served VVT boxes with bypass type static pressure control. These units were equipped with outside air duct connections at the return air to each furnace. Overall, it was a straightforward project. The units were balanced with some minor complications that were corrected by the installing contractor, allowing work to be completed in a timely manner.

Several months after completion, word was received from the mechanical contractor that the architect would not release the retainer to the contractor. His reasoning was that according to the specifications, a building flush was to be performed prior to occupancy.

Most times a building flush is performed with air handling units that have an economizer function, The economizer is placed into a very high outside air setting to flush the building of odors, VOC's and toxins from drying paints and adhesives. Normally, the economizer is set to 60-100% outside air for a set period of time. The amount of time required is determined by the Engineer or Commissioning Authority. During this time, the unit or units must run continuously without being disrupted. If the units are shut down for any reason, the flush begins again from the beginning.

Many times specifications are generalized to cover many types of projects using the same language.

In this instance, the furnaces were equipped with fixed amount of outside air. This makes it very difficult to perform a flush when the units typically provide 15-25% outdoor air. Especially when the fixed outdoor air quantities were achieved with all VVT zones at maximum with the bypass dampers closed. Once the VVT boxes are released and air is once again re-circulated through the bypass, it is very difficult to determine accurately how much outside air is actually being supplied to the building.

Many times specifications are generalized to cover a variety of projects using the same language. Often what is written in the specs does not apply to every project every time.

It is up to the design professionals and contractors involved working together to apply what is reasonably required. Sometimes this may not involve adhering to every letter of the specification. Common sense needs to be applied to determine what is relevant for a project.

Realizing that it may not be practical to write a separate specification for each project, there needs to be certain flexibility in the interpretation of the written rules. By cooperating together to complete each project in a timely manner, the next challenge can be faced.

The Southwestern United States is not as dry as people may believe, wreaking havoc on unprepared HVAC systems.

Environmental Considerations of the Southwest

Michael Ziegler, TBE, *TAB Technology, Inc.*

The Southwestern United States is not as dry as people may believe. In the wintertime, dew points range from less than 10°F to 50°F. In the summertime the region is subject to summer monsoons, with dew points from 50°F to 70°F plus. Moisture comes from the south courtesy of the Bermuda High pressure that is over the mid-north Atlantic Ocean.

This Bermuda High is what ushers the weather that causes hurricanes from the west coast of Africa to the Caribbean, the southeastern United States, and across the Gulf of Mexico. It's the moisture from Mexico that gives the Desert Southwest its summer weather dew points.

Out-of-state design professionals will design to a 30-day dew point average, meaning that 15 days are below the average, with 15 days above. It's these 15 days above the 30-day average where troubles can arise. The following are some examples of issues that have been encountered from this lack of familiarity with regional weather patterns.

1 CASE STUDY

A hospital in the Phoenix metropolitan area had an issue with their main tower air handler not maintaining a proper comfort level during the summer monsoon season. They installed above-ceiling package AC units in an attempt to cool critical areas, but the heat rejection above the ceiling also included the compressor heat and it exasperated the cooling issues of the air handler for the rest of the main tower.

The director of the hospital's physical plant department called in technicians to troubleshoot the cooling issues with the air handler. Tests conducted included traversing the unit for airflow, taking dry bulb and wet bulb temperatures of the air entering and leaving the cooling coil, measuring cooling coil pressure drops for water flow determination and obtaining chilled water temperatures.

The unit was delivering the proper airflow and the BTU transfers of the air to the water were essentially the same. Upon plotting the data on a psychrometric chart, all points were above the design engineer's scheduled data. When the engineer's data was also plotted on the psychrometric chart, it was observed that the cooling was a straight line with no latent cooling taken into account. The horizontal cooling line followed a dew point that was well below the actual dew points that we were experiencing during the summer, by about 15°F.

After reviewing the data, a report was issued and a larger cooling coil that would fit the actual characteristics for summer weather patterns in the Southwestern region was recommended. The hospital contacted a local design professional who agreed with the recommendations and the coil was installed. Fortunately, the piping to the air handler was large enough to handle the approximately 30% increase in required water flow. Two days after the work and testing of the coil performance was completed, the director of the physical plant department reported that the tower was finally under control.

2 CASE STUDY

There was a nationally known semi-conductor plant that was having issues with keeping the relative humidity in their main assembly area within the specified range for the product during the summer, particularly after a thunderstorm had moved through as the main assembly rooftop unit was 60% outside air. After testing, it was discovered that after

the rain, the sun came out and evaporated the rain water standing on the flat roof and drove the dew point to close to 80°F. With rooftop mounted units drawing their outside air off of the roof, it was easy to see the issue.

A report was written recommending that a preconditioning cooling coil be installed for the outside air to remove as much of the ambient moisture as possible so the existing cooling coil would ‘see’ its actual design coil inlet condition. Unfortunately, it was an expensive fix as new piping had to be run for the coil and this additional coil taxed the existing physical plant. An expansion chiller, tower and related pumps had to purchased and installed well before planned and for the existing system, not for an expansion. This was a very expensive fix that resulted from not understanding weather conditions of the Southwestern US.

3 CASE STUDY

A printing plant for newspaper ad inserts, news stand tabloids, etc., faced setbacks on their summertime issue where the negatives were ‘burned’ onto a roller for printing. The high moisture level caused the negatives to warp, and as a result the transfer to the rollers was incorrect and the printing was not lining up. Ambient moisture wasn’t being wrung out of the outside air designed for the area.

This required additional coils and piping. It was discovered during the review of the design that the piping was large enough to accommodate an additional coil. The piping for the outside air coil was tied into the original unit piping and the pump was run at maximum capacity.

The initial fix was less expensive than the fix for the semi-conductor plant, but it required that the physical plant be run at 100% during the summer with no stand-by equipment if there was an equipment failure. Additional equipment has since been added to rectify the issue.

Understanding climate conditions in the Southwestern US, such as how dew points can vary during the summer, can help anticipate equipment problems. A quick check of cooling coil characteristics on projects can catch any potential issues and be brought to the engineer’s attention.

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Airflow Measuring Station CONSIDERATIONS

Tim Sibinski, TBE
SMB of Minnesota

Airflow measuring stations are commonly used in building automation systems for fan tracking of air handling units and sometimes to control outside air dampers to maintain minimum outside air. If the airflow measuring stations are not installed per the manufacturer's instructions, field verified for accuracy, and then maintained there will be issues that could affect the operation and comfort in any building.

In a typical air handling unit that serves VAV boxes, the supply fan is most often controlled with duct static pressure control. As VAV boxes open and close the supply fan will speed up and slow down to maintain the pressure in the duct. Airflow measuring stations are installed to measure the total supply and total return airflow of the unit. The return fan speed will then track based on the supply and return airflow measuring stations.

Typically the return airflow should be less than the supply because of exhaust air removed from the building. The airflow measuring stations play a big part in this control sequence and it is essential they be accurate. The airflow measuring stations—especially on the outside air and return air ductwork—are usually installed upstream of filters and have a tendency of getting plugged. Periodic cleaning should be part of any preventative maintenance program to sustain accurate airflow readings for control.

If the supply airflow measuring station sensor is dirty, the return fan will operate at a slower speed which could cause excessive building and/or room pressures.

In this condition the doors that open out may not close. If the return airflow measuring station is dirty, which is more common, the automation system will operate the return fan at a faster speed which could cause negative building and/or room pressures. In this condition the doors that open into the rooms may not close because the return airflow will be higher than the supply.

Sometimes the outside air damper of an air handling unit is controlled with an airflow measuring station. In this scenario the installation instructions need to be followed to have accurate airflow measurement. Typically the instructions will indicate that the airflow measuring station be upstream of the outside air damper. If the airflow measuring station is installed just downstream of the outside air damper it will not work very well, if at all. It may provide accurate readings with the damper wide open but will not be correct when the damper is modulating.

Quite often the outside air damper will have opposed blades which will cause the airflow measuring station to read higher airflow as the damper is closing. If the outside airflow measuring station gets plugged, it will measure lower flows which will make the automation system open the damper further than required to maintain what it thinks is minimum outside air. When this happens energy is wasted and the unit could experience freezing conditions causing the unit to overload and shut down.

In conclusion, if airflow measuring stations are used for control of an air handling unit, these are essential items for their successful use:

- The manufacturer's installation instructions need to be followed, especially in regards to location.
- Field verification is crucial at installation and also on a yearly basis.
- Proper and continuous maintenance (cleaning) will assure AFMS accuracy for the long term.

The unit could experience freezing conditions causing it to overload and shut down.

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Putting the Proper "*SPIN*" on Things

Joseph Danis, TBE
Danis Test and Balance, Inc.

In real estate parlance, a key phrase is "location, location, location." In the world of TAB, it might be "rotation, rotation, rotation". Something so simple and fundamental, yet it can cause many problems if not addressed properly.

Exactly whose responsibility is it to check or verify rotation? Ultimately, in the course of normal work, TAB contractors will make sure the rotation is correct. On jobs where a commissioning authority is used, the rotation should be verified as part of the system verification/start-up checklist. Most projects, however, do not have a commissioning authority. Initial rotation verification is left to the electrician or the installing HVAC contractor. Even with that, correct rotation of all system components can be sketchy.

At least four projects in the last year involved cases where every rooftop unit had its indoor blower rotating correctly because of their single phase motors, however, the three-phase compressors were all running backwards. An electrician typically can't tell if a small scroll compressor is running backwards just by listening to it run, and wouldn't drill holes in a unit's discharge just to verify the temperature.

When encountering these unusual cases over the years, the electrician and HVAC contractors were advised of the anomaly. Responses to the issue have been interesting and varied. Among them:

"I thought rotation was correct, because I could feel air coming out."

"It's a single phase motor; it can't run backwards!"

As amusing as the first comment may be, there is more to the second. Electricians have said on several occasions that a single-phase motor can't possibly be running backwards, and many single-phase motors are designed in such a way that they can't. However, some items of equipment have single-phase motors where rotation is reversible by switching leads on the terminals at the bottom of the motor, according to the wiring diagram affixed to the motor. Several years ago, balancing was conducted at a local branch of a nationwide tire store. There were three large single-phase exhaust fans on the roof above the garage area. Of the three, two were found to be running backwards.

Of course, on the three-phase motors, all one needs to do is reverse any two of the three incoming line voltage wires to the unit to correct rotation. Three-phase units have been found where someone reversed the motor leads rather than the leads where the power enters the unit, resulting in the motor's rotation being correct, but the compressors running backwards. In such cases, repair can be expensive.

> ***ROTATION** — something so simple and fundamental, yet it can cause many problems if not addressed properly.*

Occasionally a fan does not have proper rotation clearly marked on it. It is important that technicians understand the different fan wheels used in equipment to help ensure that rotation is correct, by simply looking at the type of fan that is installed.

Although there are occasions where a pump is seen running backwards, more often than not rotation problems are encountered on the air side, rather than on the wet side. On the larger projects that typically have a commissioning authority working on them, proper rotation probably won't be an issue by the time the systems are ready for balancing. But on the projects that don't use a commissioning agent, it can be beneficial to contact or schedule a meeting with the electrician and mechanical contractors to determine who is going to make sure all the equipment is checked for proper rotation when first starting up.

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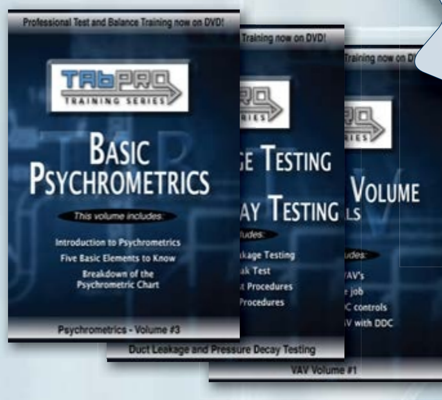

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Chasing the AIR

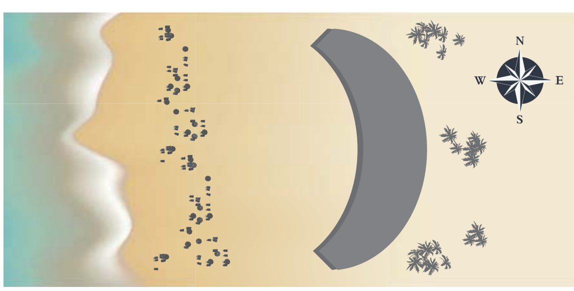
Jeffrey Wicka, TBE, CxA
San Diego Air Balance Co., Inc.

Testing and balancing was conducted at a 26-story beachside hotel located on the West Coast. Complications arose while attempting to adjust the exhaust in the hotel's restrooms. Numerous exhaust shafts served two restrooms per floor. By traversing the fans on the top floor, a total flow for each shaft could be set, beginning with approximately 120% air flow.

In attempting to proportionally balance the air flow in the restrooms, it became clear around midday that there was an increase in grille air on the west side of the building, while the east side decreased. Upon rechecking several floors the following morning, the reverse seemed to be true, with airflow decreased on the west side. The exhaust inlets were proportionally balanced again to correct the issue. Around 11:00 a.m., however, exhaust on the west side was increasing with the east side decreasing. Returning the settings to where they were in the morning didn't seem to help the system proportional balance. What was causing the imbalance?

While standing at a window that looked westward to the ocean, it was noticed that air could be felt moving through a ventilation slot on the window. The vent had a manual control, and when the door into the corridor was open, air flow increased. When the corresponding window vent was opened on the east side of the building, it was found that rather than air flowing in, the vent was exhausting air from within the building. Upon checking these vents in the morning, it was found there was no breeze created from the west side. The cause of the imbalance was the ocean breeze, which typically picks up on the West Coast around 11:00 a.m.

To further the imbalance created by breezes coming from the ocean, the building was not a standard rectangle shape. It was curved, with the inside of the curve facing the ocean.



The mechanical contractor and engineer were informed of the issue regarding the building's proportional balancing. Upon verification that the ocean breeze was the cause of the exhaust imbalance, all the window vents were closed and balancing was completed on the building.

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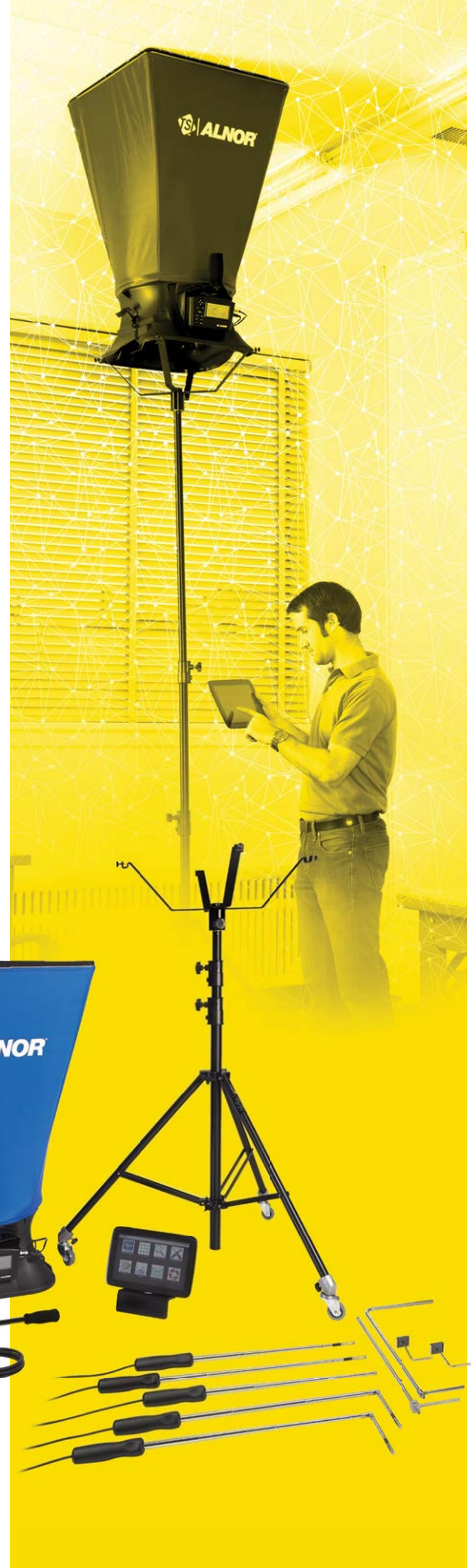

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