TAB Journal

THE MAGAZINE OF THE ASSOCIATED AIR BALANCE COUNCIL • FALL 2015

Optimizing Testing & Balancing Results

IN THIS ISSUE:

- Title-24 Changes
- DDC Startup
- Certification under Generator Power

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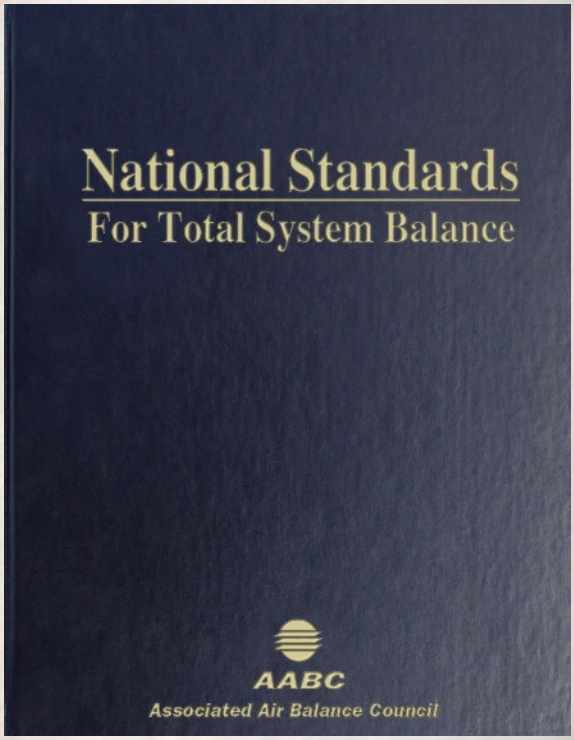

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From the Publisher

The Fall 2015 issue of TAB Journal looks at ways to optimize testing and balancing results. Dean Ferreira, TBE, CxA, of MESA3, Inc. discusses newer energy efficiency standards and how that has affected the design and testing of HVAC systems.

Bret Privitt, TBE, CxA, of Air Balancing Company, Inc. talks about how test and balance engineers, working in conjunction with the Commissioning and Energy Management Process, can create the best results for the benefit of building owners.

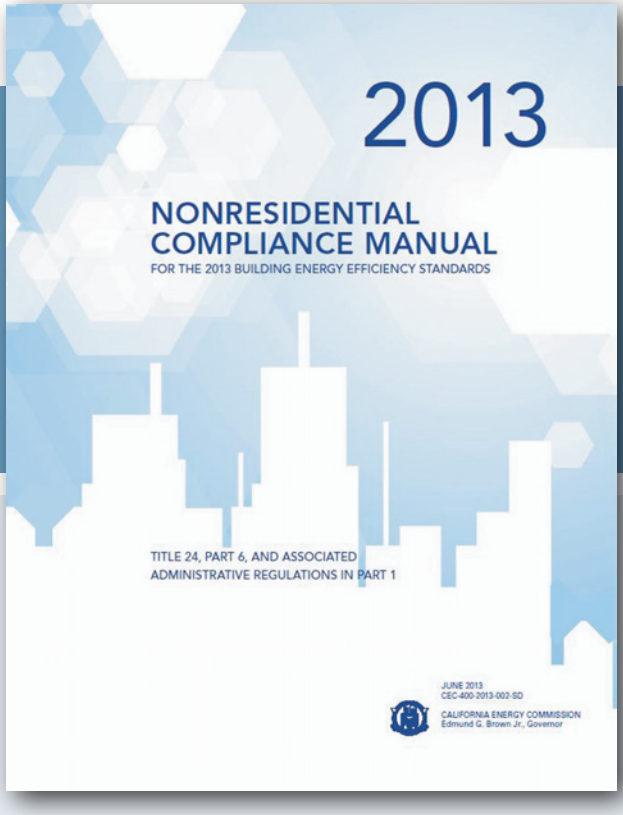
Guy W. Griffin, TBE, of Engineered Air Balance Co., Inc. details the startup of DDC-controlled terminal boxes.

Branden Johnson, TBE, CxA, of Mechanical Data Corporation, makes a case for residential testing and balancing.

Joe Sieber, TBE, of American Air Balance Co., Inc., highlights the importance of a pre-balance checklist when preparing to balance a system.

Denny Whitzel, TBE, CxA, of Pacific Coast Air Balancing, details a case study which included the certification of a smoke control system.

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!



Dean Ferreira, TBE, CxA
MESA3, Inc.

Changes to Efficiency Standards *and Effects on Balancing*

In California the energy efficiency standards are becoming more stringent, which is affecting the design and testing of HVAC systems. The 2013 NONRESIDENTIAL COMPLIANCE MANUAL FOR THE 2013 BUILDING ENERGY EFFICIENCY STANARDS *has been helpful in understanding these new changes.*

The first change is the requirement to have 2 speeds of fan control to reduce the indoor fan's electrical draw in a satisfied mode (see page 4-37 in the manual). Single-zone systems are required to turn down to no more than 66 percent speed and multiple-zone systems to turn down to 50 percent speed or less. This affects the balance effort in many ways.

- **The single stage AC unit now has to be calling for cooling/heating to provide full fan performance. No longer can just the fan be energized for balance purposes.**
- **The plans or specs have to clearly define if the minimum outside air is to be set in the reduced fan speed and have excessive minimum outside air flow when in cooling/heating modes, or if the economizer controls have multiple minimum outside air settings. On VAV systems the minimum outside air also has to be dynamically controlled to allow for minimum OSA in all VAV modes of operation.**
- **These changes to the code will increase the amount of effort that is required to properly test, adjust and document the supply, return and minimum outside air in both modes of fan operation.**

Another change is the increased use of Demand Controlled Ventilation & Occupant Sensor Ventilation Control design schemes (see page 4-45 in the manual). The benefit is to reduce the minimum ventilation rates when the space is not being used which saves on heating, cooling and fan consumptions. This affects the balance effort as well.

- **The increased use of demand controls require both minimum flow setpoints be tested, adjusted and recorded.**
- **Verify and record that the economizer damper opens on high demand if design requires economizer override.**

There are also changes to VAV ZONE CONTROL design schemes (see page 4-81 in the manual). The benefit is to reduce the minimum ventilation rates when the space is satisfied which saves on heating, cooling and fan consumptions. This affects the balance setpoints.

- **For DDC zones:**
  - *o Primary air that is reheated is less than 50 percent of peak (or design zone outside air flow if greater).*
  - *o Primary air is less than 20 percent of peak airflow in deadband (or design zone outside air if greater)*
  - *o First stage heating now uses the deadband airflow and modulates the reheat valve to allow up to 95 degrees supply temperature.*
  - *o Second stage heat increases the supply airflow from deadband to maximum heating setpoint while still maintaining a maximum supply temperature of 95 degrees.*

The complete manual can be found at: *http://www.energy.ca.gov/2013publications/CEC-400-2013-002/CEC-400-2013-002-SD.pdf*

- **The effect of these changes is the additional maximum setpoint for each VAV reheat zone which adds to the balance effort.**

In conclusion, these and other code compliance changes affect work performed in California and is expected to be adopted in other states in the near future. It will be our responsibility to work closely with the mechanical engineering staff to describe what information we require to be able to have a code compliant system. The owners and mechanical contractors have to be educated that it will take more time and effort to properly perform our balance tasks to be code compliant.

The complete manual can be found at: **http://www.energy.ca.gov/2013publications/CEC-400-2013-002/CEC-400-2013-002-SD.pdf**

High Performance Team

Bret Privitt, TBE, CxA
Air Balancing Company, Inc.

AABC has long been the premier certifying agency for test and balance firms. The dedication to quality and independence has placed AABC and member firms at the forefront of HVAC testing, adjusting, and balancing. Through the continued endeavor for quality, independence, and improved knowledge of the HVAC industry, AABC created the AABC Commissioning Group (ACG) which in turn created the Energy Management Process (EMP).

ACG's mission is similar to that of AABC with respect to quality and independence. ACG's member firms' persistence to provide building owners with operable and maintainable "High Performance Buildings" has escalated ACG to be associated with excellence in the commissioning discipline. The ACG Commissioning Guideline was created to give direction to certified commissioning providers and allow owners to understand the commissioning process.

The creation of the EMP has improved the opportunity for owners to have energy efficient high performance facilities. The systematic approach outlined in the EMP Guideline is similar to that required by AABC and ACG. Independence and quality are shown to be requisites for success. Testing and balancing (TAB) and Commissioning (Cx) are vital components for every energy management project and are both outlined in the EMP process.

AABC member firms can and should be utilized for both the Cx and EMP processes. The knowledge and field expertise of

Continues on Page 6

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Both the Commissioning and Energy Management Process benefit from the high standards created by AABC Test and Balance Engineers.

a TAB professional has proven to save time and improve the quality of gathering actual building performance data. The TAB professional has the ability to accurately collect data for required surveys all the way through functional performance testing.

The ACG Commissioning Guideline lists the 5 Phases of Commissioning: Pre-Design, Design, Construction, Acceptance, and Post-Acceptance. The Construction and Acceptance Phases render the most beneficial opportunity for utilizing the expertise of an AABC firm. Listed are examples of tasks required of commissioning that can be performed by a TAB professional.

1. **Witness installation tests**
2. **Validate automated control systems point to point checks**
3. **Verify System Verification Checklist (SVC) completion**
4. **Review automated controls system programming**
5. **Assist with the Functional Performance Tests (FPT)**
6. **Assist with owner training**

The EMP Guideline lists the 7 Phases of Energy Management Process: Project Assessment, Energy Use Exploration, Site Investigation, ECM/FIM EBCx Analysis, Implementation, Final Acceptance, and Continuous Energy Management. The Site Investigation, EBCx Analysis, and Implementation phases can utilize the TAB professional in the various steps for each phase. Examples:

1. **Gather operating performance data**
2. **Gather energy consumption data for baseline**
3. **Equipment schedules and set points**
4. **Required data for Energy Model simulation**
5. **Functional Performance Testing during EBCx Analysis**
6. **M & V calibration**
7. **Final control sequence verification**
8. **Final Test and Balance after all implementations are complete**

Both the Commissioning and Energy Management Process benefit from the high standards created by AABC Test and Balance Engineers. Utilizing the knowledge and expertise of TAB professionals greatly increases the magnitude of success for Cx and EMP. Having an AABC member firm on board at the early stage of both processes will insure the proper operation of a "High Performance" building or facility.

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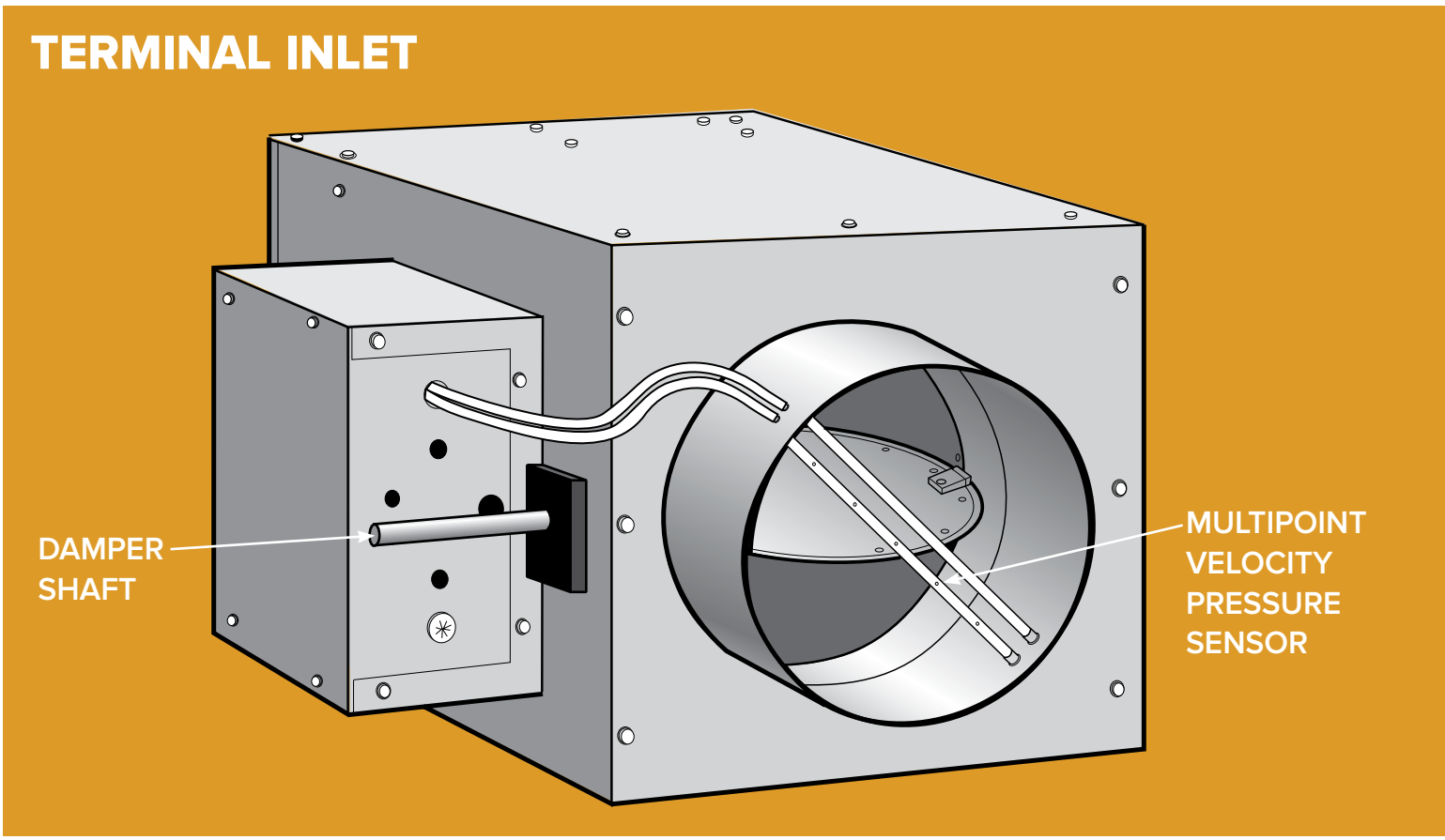
TERMINAL BOX DDC CONTROLS STARTUP

Guy W. Griffin, TBE
Engineered Air Balance Co., Inc.



The startup of DDC-controlled terminal boxes by the controls contractor can make the test and balancing of a system go very smoothly if done by an experienced and detail-minded control technician. On the other hand if the control technician is inexperienced and has not been properly trained or is a seasoned veteran who just doesn't care to perform to a high standard, the job can be very challenging.

On a recent test and balancing project of a hospital addition, the control technician was very inexperienced and was not given the support and training he needed prior to performing the startup of the terminal boxes. The first box that was balanced had the following problems; damper rotating backwards, heating water valve rotating backwards, cap missing on the high port of the velocity sensor test ports and the DDC controls indicating zero airflow. After finding similar issues with the next few boxes it was determined that the all of the boxes on the floor had the dampers and heating water valve actuators rotating backwards.

When testing and balancing VAV systems it is imperative that the balancing technician thoroughly troubleshoot the box prior to moving on, so all the deficiencies can be identified. When a job is not performed correctly by the mechanical or controls contractor it is the balancing technician's obligation to the owner to identify why the system is not operating correctly and performing to the engineer's specifications.

Above is a diagram of a terminal inlet noting the Multipoint Velocity Pressure Sensor and the damper shaft.

When testing and balancing VAV systems it is imperative that the balancing technician thoroughly troubleshoot the box prior to moving on...

The following items should be verified prior to balancing a DDC controlled VAV box:

a. *Correct box size installed.*
b. *Correct box size programmed in controller.*
c. *Correct design CFM programmed in controller.*
d. *Caps installed on VAV velocity sensor test ports.*
e. *All balancing dampers are installed and open.*

Here are some of the more common problems found and possible causes of DDC controls not functioning properly.

No communication to the box controller:

a. ***Is the box electrical disconnect switch on?*** Do not turn on the switch if it is off. Contact the controls contactor or electrician. The switch may be off due to a problem.

b. ***Thermostat wiring may have a bad connection.*** Can you plug into the box controller for communication to set up the box?

c. ***Box is not wired or the breaker is off.*** Contact the electrician.

DDC controls indicate zero CFM with a 100% open damper command:

a. *Are the caps installed on the velocity sensor test ports?*

b. *The damper shaft set screw is not secured to the shaft and the box damper has blown shut.*

c. *The damper actuator is rotating backwards.*

The DDC controller will not control to the design CFM or the CFM will not repeat when changing from max CFM to Min:

a. *Poor duct inlet condition. Less than 3 duct diameters of straight duct entering the box.*

b. *The controller velocity transducer is bad.*

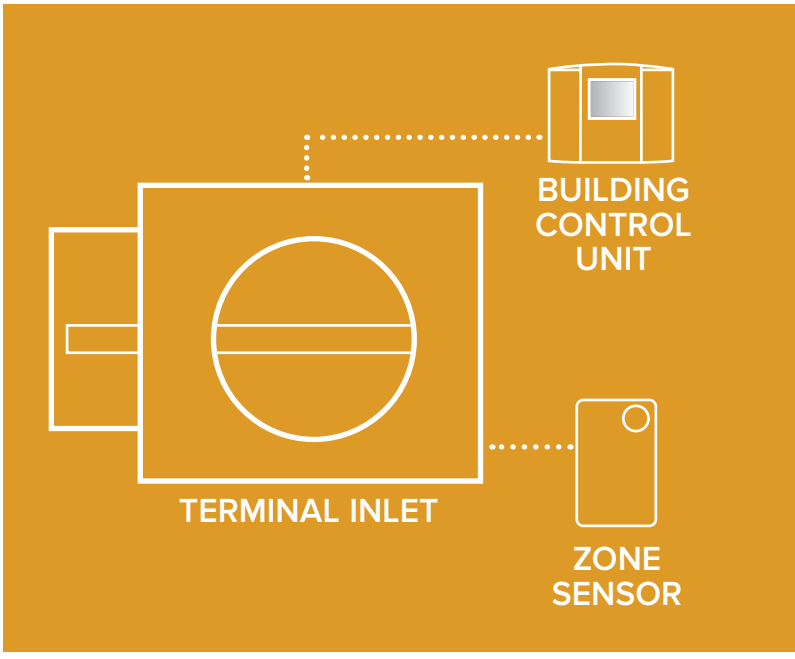
The box will not control to minimum CFM:

a. *Poor inlet conditions*

b. *Box velocity too low to control.* Test the box for the lowest repeatable airflow.

c. *Duct static pressure is excessively high.* If the box damper has to approach the closed position to obtain design airflow it may hunt when trying to control the airflow.

In closing it should be noted that it is not the balancing technician's job to do the DDC startup of the VAV controls, but is their responsibility to identify all of the deficiencies associated with the box controls.



The Case for RESIDENTIAL TESTING AND BALANCING

Branden Johnson, TBE
Mechanical Data Corporation

In the beginning of time when man lived in caves, there was little concern about the conditions in which they lived. Man then built structures of wood, mud and thatching in an attempt to increase comfort. While more comfortable, the elements remained intrusive. At the time there was little knowledge or concern about contaminates such as mold, radon, or pollutants such as carbon monoxide.

Over time tools and technology improved the comfort and efficiency of dwellings. From plaster to plywood, plywood to sheetrock, wood to masonite, masonite to vinyl. The amount of insulation was increased to save energy and windows were improved to insulate rather than ventilate the home. In the 1970's and 1980's, air barriers that wrapped the entire home were developed to reduce drafts and increase energy efficiency. Increasing efficiency meant saving electricity, and saving electricity meant saving money.

Why Ventilate?

What was overlooked in the quest for energy efficiency was the operation of the mechanical systems and the affect they had on the homes. The appliances we use every day to make our lives easier operate without replacing the exhausted air. Range hoods now have the ability to exhaust more than 1000 cfm and the capacity of clothes dryers' exhaust has recently increased to 225 cfm.

When this equipment is operating without a source of makeup air, there is a negative condition within the residence. Some of the issues this creates include backdrafting of carbon monoxide from water heaters and the introduction of moisture that can lead to mold and mildew.

Adding a source of fresh air to residences eliminates odors and excessive moisture, provides combustion air for the water heater, and replaces exhausted air from exhaust systems (range hoods, dryers, bathroom exhaust).

Equipment for Ventilation

Homes in Minnesota are built with the motto: "build it tight and ventilate it right". Since April of 2000, the state of Minnesota has required a residential mechanical ventilation system in newly constructed homes due to insulation and tight air sealing and this may be the case in other areas of the country as well. This is accomplished with a heat recovery ventilator (HRV) or an energy recovery ventilator (ERV). The ventilation is vitally important so the home warranty is not voided due to loss or damage from dampness and condensation from poor ventilation.

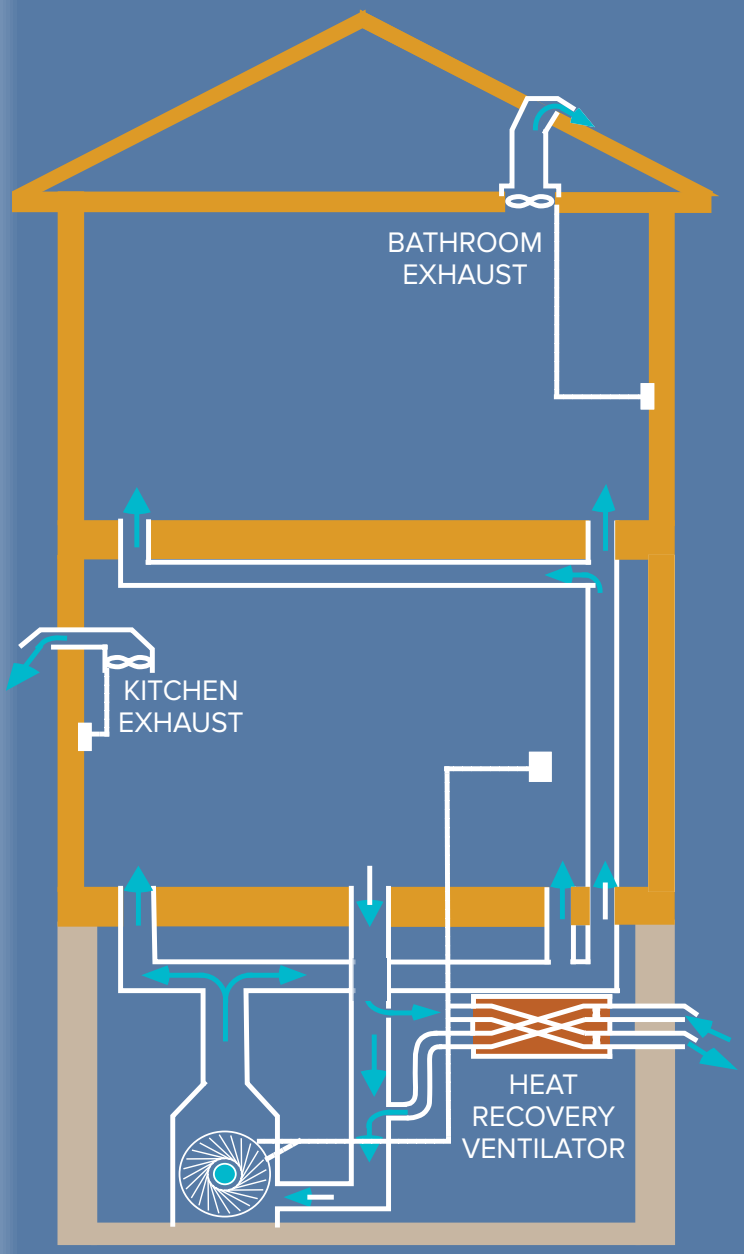
Heat recovery ventilators (HRVs) are typically used in cold climate applications because they use the warm indoor air to heat the incoming outside air using a heat exchanging core. This can recover up to 85% of the heat in the outgoing air stream. This is accomplished using two fans that require balancing to ensure the exhaust volume and outdoor air intake volume are the same.

Energy recovery ventilators (ERVs) are typically used in climates with higher humidity because in addition to the heat exchange capabilities, they also use the dry indoor air to reduce the humidity in the incoming outdoor air.

Why Test and Balance?

There are ASHRAE requirements for residential ventilation rates that have been adopted by most states. The ASHRAE standard 62.2-200 for residential ventilation rates requires approximately one third air changes per hour (0.35) for high occupancy or moisture producing activities. The amount needed for the remainder of the time is referred to as around the clock requirement, and uses a minimum of 45 cfm and 15 cfm for each bedroom.

These requirements, along with the need to verify fan volumes and operation, strongly indicate this work should be completed by a test and balance professional. Test and balance professionals have the proper equipment, knowledge of correct testing methods, and the ability to correct issues as they arise. At a time when the commercial construction industry is contracting, residential balancing has the potential to produce another revenue stream.



Works Cited:

- Minnesota Residential Energy Code, Chapter 1322
- How It Works: Heat Recovery Ventilator, Thomas Klenck, Popular Mechanics
- Home Energy Guide, Minnesota Department of Commerce
- Minnesota Code: Keeping the Heat In While Taking the Pressure Off, Bruce Nelson, Senior Engineer, Minnesota Department of Public Service
- ASHRAE Residential Ventilation Standard 62.2-200 (Max Sherman, Former Chair)

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THE IMPORTANCE OF *PRE-BALANCE CHECKLIST*

Joe Sieber, TBE, CxA
American Air Balance Co., Inc.

A common experience in the test and balance field is receiving a call from the client stating they are ready for TAB work, and technicians are needed onsite right away. Once the technician has arrived and begun a job walk, issues are found such as missing components in the air distribution system, incorrect filters or no filters installed in the units, equipment not started up correctly, and/or controls that are incomplete or not operating under control. These wasted trips on the start of projects cost the TAB agency money and serve no purpose other than to be another "quality control" set of eyes for other sub-contractors that have not completed their work.

For most projects, the specifications require that all of the above be 100% complete, along with the building conditions being substantially complete with all doors, windows and openings covered or closed up prior to test and balance starting. With LEED/Commissioning requirements on projects these conditions become a priority. Clients need to be educated on what needs to be completed prior to requesting the schedule of the TAB agency.

Using a "Pre-Balance Checklist" or as some call it a "System Readiness Checklist" which is produced during a design review of the project documents, specifications and mechanical drawings, is very helpful. The checklist is standard for both air and water, but can be expanded upon depending on the project requirements to include Duct Leakage Testing, IAQ Testing, Control Verification, Building Pressurization, Stairwell Testing, etc.

This document is forwarded to the client early on in the project, prior to MEP meeting, and sent once the date has been scheduled for TAB to be onsite. The client (GC/Mechanical Contractor) should then provide a check next to each item on the list assuring that the system is ready, and if not, they can provide a note or explanation as to each item and return for the TAB agency's documentation.

The end goal of providing the checklist is to eliminate wasted time by the TAB agency, provide insight to the GC/Mechanical Contractor on what is required of them to have a system that is actually ready for test and balance, without numerous deficiencies, and to provide a better end product to the user in a timely manner.

EXAMPLE OF A PRE-BALANCE CHECKLIST FOR AIR HANDLING SYSTEMS

Yes	No	
		Is the ductwork intact?
		Are any endcaps missing?
		Are the access doors installed and secured tightly?
		Are there openings in the ductwork?
		Are any inlets or outlets missing?
		Is the ductwork, including fan inlets and outlets, installed according to the drawings and specifications?
		Is the ductwork free of debris?
		Are all duct dampers, including fire and smoke dampers, installed and accessible?
		Are the terminal boxes operational?
		Does the return air have an unobstructed path from each conditioned space back to the unit?
		Is the building architecturally complete?
		Are all doors, windows, ceilings, partitions, etc. installed?
		Are the outside walls sealed tightly?
		Are the filters clean?
		Are the correct filters installed?
		Is the filter frame properly installed and airtight?
		Are the coils clean and properly installed?

Yes	No	
		Are the drive componenets installed?
		Are the sheaves properly aligned and tight on their shafts?
		Are the belts adjusted for the correct tension?
		Is the belt guard properly installed?
		Is the motor wired and energized?
		Is the proper starter and overload protection installed?
		Is the motor secured to its frame?
		Have the motor bearings been lubricated?
		Are the automatic control dampers installed and operational?
		Are fan volume controls operational?
		Are the fan housings, plenums, etc. installed according to the drawings and specifications and properly sealed?
		Is the flexible connection installed properly?
		Is the fan wheel aligned properly with proper clearance between it and the housing?
		Have the bearings been lubricated?
		Are the controls complete and operational?
		Are suitable traverse locations available?

Smoke Control Certification under Utility and Generator Power

Denny Whitzel, TBE, CxA
Pacific Coast Air Balancing

While performing a tenant improvement expansion on an existing property, the improvement included the certification of a new smoke zone that tied into the existing smoke control system. The system utilized new Smoke Exhaust Fans (SEF's) to exhaust/contain the smoke from migrating into adjacent smoke zones.

While setting up the smoke zone for "containment" the only criteria was that the pressure differential between adjacent smoke zones and the exterior was negative 0.05" WC. When the preliminary setup of the smoke zone was being performed, the fans were operating near their maximum motor BHP while exhausting the specified airflow provided by the engineer of record and meeting the minimum zone criteria of 0.05" WC. The actual pressure was 0.058" WC. Under these conditions the fire protection engineer, general contractor as well as the balancing contractor believed it had met the requirements to submit the report to the Authority Having Jurisdiction (AHJ).

With the report submitted and approved by the AHJ, a test date was scheduled to certify that all systems were functioning as required. This stage of the certification required all trades involved to demonstrate to the AHJ that the tenant improvement smoke zone was tested and performing to the design intent. When the smoke zone was initiated and determined to be in proper configuration under local utility power, the AHJ requested that the property perform a shunt test to ensure that the emergency backup power system would provide the same test results as it had from local utility power.

> "Certification parties must test every smoke control zone/system... under normal power and emergency generator power."

When this test was performed it was discovered that the system did not meet the minimum criteria of 0.05" WC to adjacent zones. While troubleshooting, it was discovered that the voltage being supplied to the SEF's from the generator power was significantly less than that power being supplied by the utilities company. Due to this difference between utility power and emergency power the fans did not perform to the submitted report data. The actual pressure differential was measured at 0.045" W.C. The AHJ required that the facilities of the existing property had to increase the output of the generator to be the same as that being supplied by the utilities company. After the implementation of that request, the system was retested and the end result was that the zone performed as required by the AHJ and the minimum criteria was meeting with 0.06" WC.

The lesson learned is that certification parties must test every smoke control zone/system in every scenario under normal power and emergency generator power.

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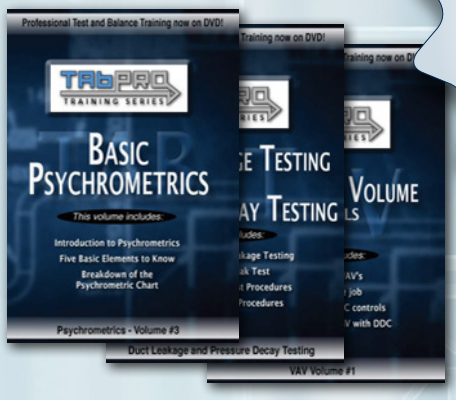

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Duct Leakage and Pressure Decay Testing

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Tech Talk

Facilitating better understanding of proper balancing procedures has been part of AABC's mission for more than 40 years and helps to produce buildings that operate as designed and intended. Tech Talk is a regular feature in which AABC shares questions we've received and the responses from the association's experts. We hope that others have had similar questions and, therefore, will benefit from the answers. Readers are encouraged to submit their own questions about test and balance issues.

Have a Question?

To submit a question for Tech Talk, email us at info@aabc.com

The Associated Air Balance Council frequently fields technical questions from engineers, contractors, owners and others regarding proper air and water balancing procedures.

These questions are answered by the most qualified people in the industry: **AABC Test & Balance Engineers (TBEs).**

Seasonal Recomendations

QUESTION: ***What does your group require/recommend for seasonal TAB items?***

AABC: In Texas we always test for summer conditions and 9 months out of the year we can get 85 plus degrees. That said we generally will verify heating water resets in the summer (OSA>80°F) and winter (OSA<45°F). Economizer cycles and heat exchanger systems must be verified (when the OSA temperature is <45°F). Heat exchangers with enthalpy wheels sometimes slow or stop (when the OSA temperature is between 70°F and 50°F). Chiller and boiler loading must be observed from the start command, when the system brings on another chiller or boiler as the demand increases, and how multiple chillers and boilers are disabled as the demand decreases. Cooling tower controls observed in summer and winter conditions, some chiller systems perform more efficiently with colder condenser water. Air handling unit discharge resets should be observed in the extreme conditions outside. Night setback calibration should be observed in extreme conditions outside. Extreme conditions are within 10°F of the outside design temperature. High rise buildings pressure control must be observed during summer and winter conditions.

During any seasonal visit interviews with the maintenance staff should be conducted to identify areas of concern. Each concern should be surveyed and a report of the findings submitted if the load is greater or less than the system can maintain.

—Gaylon Richardson, TBE, CxA, Engineered Air Balance Co., Inc.

AABC: I think the engineer needs to identify

1. Type of project; this can dictate seasonal testing requirements that differ between high rise vs. low rise, Lab vs. office, etc. What seasonal conditions affect the facility and its usage?
2. Type of systems; as Gaylon states, the seasonal testing requirements depends on the type of system involved. Chilled water and condenser water systems typically cannot be tested in January in Des Moines, IA. Heating hot water systems might be able to be tested for water flow in the summer time in Des Moines, IA, but if a temperature test is required then the boilers will have to be overridden to allow for temperatures to be obtained (depends also on the EAT). ERV's with wheels can have the airflows tested in any season, but the temperature testing would need to be done during the winter and summer seasons.
3. Location of project which dictates the seasonal testing required.

I don't think there is a "standard catch-all" answer. The engineer needs to review the project with the TAB Agency to verify what can and what cannot be tested for the project during the different seasons. In several situations, manual overrides and system manipulation can be performed to allow for testing of systems in the "off-peak" season. It needs to be noted in the report the system overrides and how the system was setup to perform the testing.

—James E. Hall, PE, TBE, CxA, Systems Management & Balancing, Inc.

How does AABC recommend linear slot diffusers be tested for airflow?

QUESTION: ***An AABC certified contractor balanced one of our facilities using a hood, but from the AABC national standards for total system balance 2002 it states:***

Section 3.5.2 "The deflecting vane anemometer is used to measure airflow on slots, light troffers, and diffusers".

Is that the only way recognized by AABC to get an accurate reading from a slot diffuser? Or are flow hoods also allowed under certain conditions?

It is for a very critical space: The cab of an air traffic control tower at a major airport. The initial balance failed for a number of reasons, so the contractor is returning later this week to attempt a 2nd balance.

AABC: Section 3.5 is for flow factors and refers to the development of factors when using the instruments listed in 3.5.1, 2, 3 & 4. The list of uses in 3.5.2 do not exclude the use of other instruments to measure "slots, light troffers, and diffusers". The point in this section is a "flow factor" must be developed for the instrument and diffuser, grille or register measured.

In short, a hood can be used on slots, light troffers, and diffusers, but a flow factor needs to be established.

—Steve Young, TBE, CxA, LEED AP BD+C, The Phoenix Agency, Inc.

AABC: Agree with Steve. One can use the flow hood for measurement but a flow factor needs to be established, preferably with a duct traverse.

—James E. Hall, P.E., Systems Management & Balancing, Inc.

AABC Lunch & Learn Presentations *For Engineers*

AABC members are always available to meet with your firm to discuss best practices for testing and balancing. Whether you would like a presentation covering a variety of the most important testing and balancing concepts for engineers, or a more specific topic, let us know and we will arrange for an AABC expert to address your team at no charge!

TOPICS INCLUDE:

- Test & Balance Primer for Engineers
- Hot Water Reheat Balancing
- Duct Leakage Testing
- Control Point Verification

…Or Suggest another Topic!

If you would be interested in such a technical presentation, or if you have any other questions or comments, please contact AABC headquarters at headquarters@aabc.com or 202-737-0202.

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AABC INTERNATIONAL MEMBERS

SOUTH KOREA

Awin ENC Co., Ltd.
Soengdong-gu, Seoul
SOUTH KOREA
+82-2-2117-0290

Energy 2000 Technical Engineering Co., Ltd.
Songpa-gu, Seoul
SOUTH KOREA
+82-2-408-2114

KYUNGMIN FNE
Gangbuk-gu, Seoul
SOUTH KOREA
+82-2-7077-9447-33

Penn Air Control, Inc.
Gangbuk-gu, Seoul
SOUTH KOREA
+82-2-982-0431

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Studio S.C.S. Ingegneri Scarbaci-Cuomo
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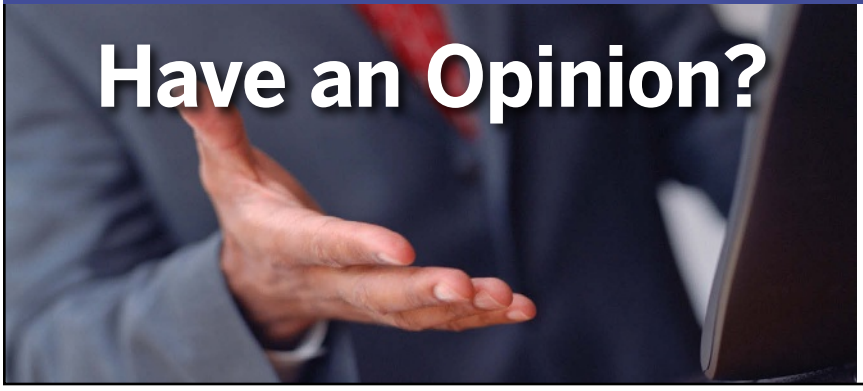

An interesting case study? A new method? Tell us about it.

TAB Journal welcomes submissions for publication. TAB Journal is published quarterly by the Associated Air Balance Council. Send letters or articles to:

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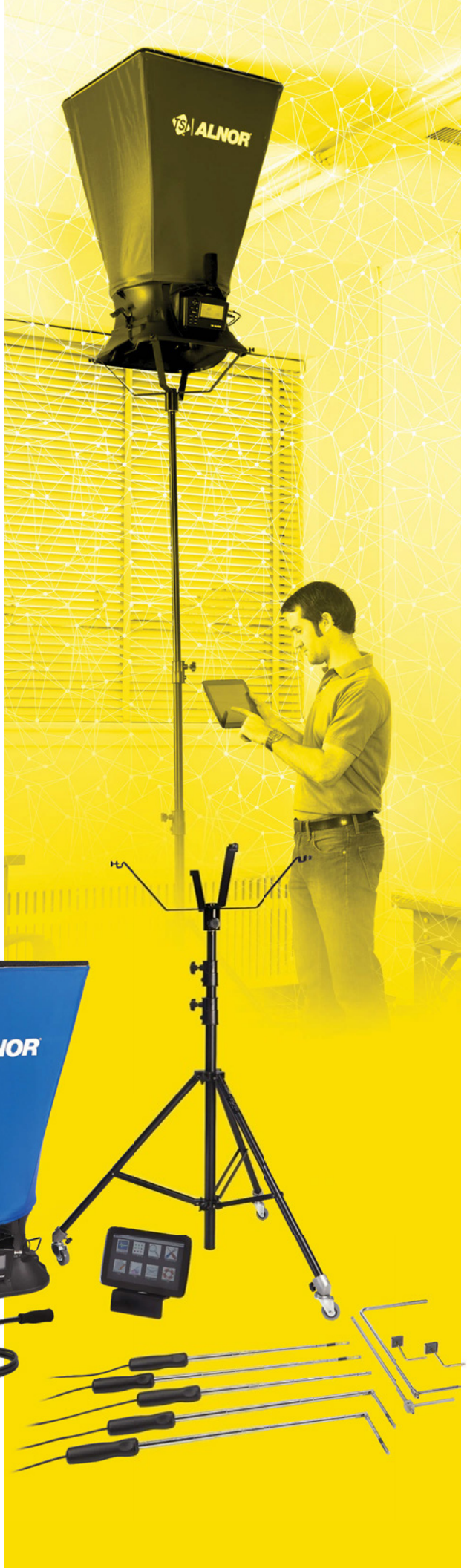

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