TAB Journal

AABC

THE MAGAZINE OF THE ASSOCIATED AIR BALANCE COUNCIL • WINTER 2014

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- Chilled Beams
- Troubleshooting HVAC Systems
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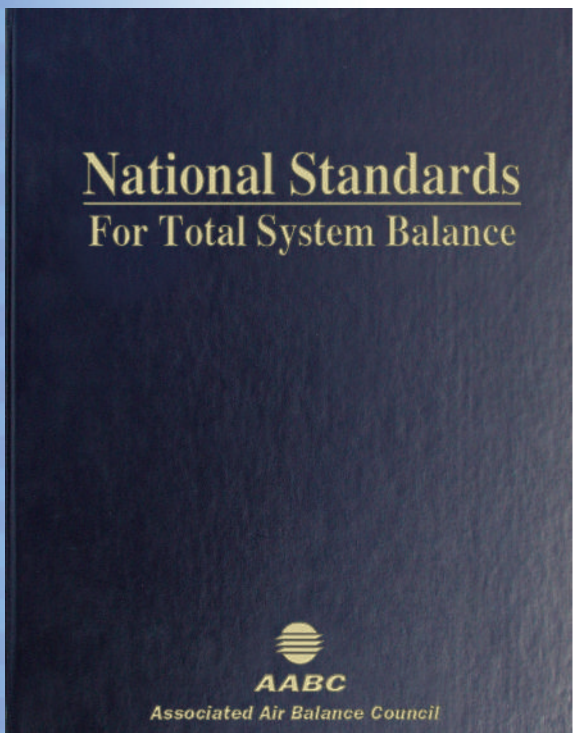

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From the Publisher

The winter 2014 issue of *TAB Journal* encompasses a range of topics from the Test and Balance field. The feature story by John Osheroff, TBE of Penn Air Control examines the challenges and planning involved when balancing a project that occurred across multiple phases in a hospital expansion and remodel.

Also in this issue, Timothy S. Nuckols, TBE of C&W – TESCO, Inc. looks at the correct operation and application of chilled beams, while AIR Engineering and Testing, Inc.'s Muslim Nazarali, TBE, CxA provides the correct procedures for testing and balancing smoke dampers.

Joseph K. Hardy, TBE of Augusta Air Balance Company, LLC, discusses Mean Time Between Failures and how test and balance can prevent early failure and extend the useful life of a piece of equipment.

Don Butler, TBE, CxA of Butler Balancing Company, Inc. goes over precautions to keep in mind when working with pressure gauges and other steam-related equipment.

PEBSCO, Inc.'s Michael Carrillo recounts a case study where technicians encountered low airflow, and the troubleshooting skills that are essential when unexpected situations arise.

This issue's Tech Talk answers a question regarding the recommended way to confirm sensor calibration. And finally, Brian Kaupp, TBE of Southern Independent Testing Agency, Inc. outlines the parameters involved when thermally tuning an image.

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!

Chilled Beams: Principle And Practice

TIMOTHY S. NUCKOLS, TBE
C&W - TESCO, INC.

This is a summary of the operation and application of chilled beams, and will detail the manner in which test and balance companies may use a combination of the manufacturers' testing procedures and conventional TAB readings to balance an active chilled beam.

There are two types of chilled beams: passive and active *(Figure 1)*. The passive chilled beam relies on natural convection to accelerate warm air through a finned cooling coil. For this reason it should be located near a heat load source to assist in natural convection. A passive chilled beam should be used in cooling applications only. It is not effective as a heating source because the warm air will not make its way down to the occupied zone, due to the same convection that makes it work for cooling. Passive chilled beams are best used in open areas and to supplement other ventilation systems. A separate ventilation system is needed to provide outside ventilation air and building dehumidification.

The active chilled beam uses conditioned air from a central system to pass over the cooling coil. A chilled beam HVAC system, when balanced correctly, has several advantages over a conventional variable air volume (VAV) system. With active chilled beams, primary airflow and duct size can typically be reduced because a portion of the air flow is from induced air. Smaller duct sizing reduces the above ceiling space needed. Supply air volume can be minimized by as much as 65%. Fan energy, maintenance cost, and noise are reduced as well.

The primary air system must deliver air to the chilled beam that is dry enough to offset the space latent load and maintain the indoor dew point low enough to avoid the formation of condensation on the chilled beams

C&W-TESCO has been involved in several projects using chilled beams over the last few years. The first project using active chilled beams was in 2009. It became apparent early on that the manufacturers' nozzle pressure/CFM charts did not give an accurate reading 100 % of the time. A traverse was taken for each type of chilled beam and a new flow chart was made for each type. It was necessary to confirm that there was no leakage at the chilled beam or the chart would be inaccurate. Verifying that the correct type of beam and nozzle size was installed was also critical. As with any type of terminal, the correct size/model and location are very important.

On a 2011 project, technicians dealt with a newer model of the chilled beam. In addition to finding the same idiosyncrasies as before, there were also issues with leakage around the seams on the chilled beam itself. It was determined that not replacing the cap on the air flow measurement tap would affect the pressure reading on the next chilled beam.

Since their inception, there have been additions to the chilled beam design such as adjustable slots, capped measurement taps, and various styles and lengths. There are also four-pipe as well as two-pipe systems *(Figure 2)*.

FIGURE 1.

Passive and Active Chilled Beams

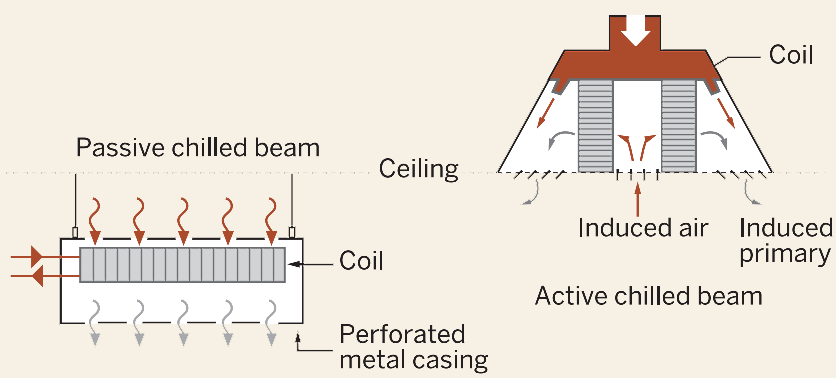
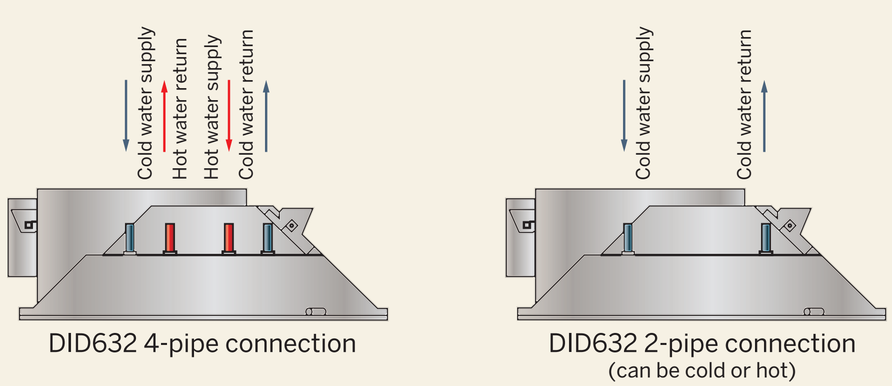


FIGURE 2.

Active Chilled Beam Pipe Configurations



Since their inception, there have been additions to the chilled beam design such as adjustable slots, capped measurement taps, and various styles and lengths.

FIGURE 3.

Project: Office Building											
System: AHU-1											
AREA/ SERVICE	OUTLET/INLET				DESIGN		PRELIMINARY		FINAL		Note*
	No.	Type	Size	A_k	Velocity	CFM	Velocity	CFM	Velocity	CFM	
VAV-1											
101	1	CHB-C	4'	N/A	0.62 (NP)	110	0.72 (NP)	119	0.67 (NP)	114	
102	2	CHB-C	4'	N/A	0.62 (NP)	110	0.72 (NP)	117	0.65 (NP)	113	
103	3	CHB-C	4'	N/A	0.62 (NP)	110	0.60 (NP)	108	0.62 (NP)	110	
						330				337	

Nominal Length L_n	Nozzle Type	Primary Air			Cooling				Heating		Isothermal Throw[6]	NC[7]
					2-pipe system		4-pipe system		4-pipe system			
		Vpr	Δpt	QPr1	Q_{cw}[2]	Δp_w[3]	Q_{cw}[2]	Δp_w[3]	Q_{HW}[4,5]	Δp_w[3]		
ft.		CFM	in.H_2O	Btu/h	Btu/h	ft.H_2O	Btu/h	ft.H_2O	Btu/h	ft.H_2O	ft.	
		25	0.21	545	1,161		1,051		1,976		3-4-6	16
	A	35	0.42	763	1,461		1,324		2,500		3-5-7	26
		45	0.70	981	1,711		1,552		2,942		4-6-10	33
		45	0.26	981	1,501		1,360		2,570		4-5-7	18
4	B	60	0.46	1,308	1,790	4.35	1,624	3.35	3,081	1.26	5-6-9	26
		75	0.72	1,635	2,044		1,857		3,536		6-7-12	32
		70	0.29	1,526	1,584		1,436		2,717		5-6-10	19
	C	90	0.49	1,962	1,848		1,677		3,184		5-8-13	26
		110	0.62	2,398	2,084		1,893		3,607		6-8-17	32

In conclusion, a traverse for each type of chilled beam compared to the pressure/CFM chart *(Figure 3)* is the best way to obtain accurate air flow measurements. After the initial readings are taken for each type of beam, take a selection of traverses to ensure pressure readings at each beam are consistent. The balancer should take the time to record and report the correction factors, just like grille correction factors. The example in Figure 3 shows the manufacturer's pressure/CFM chart, and how from field tests a nozzle pressure of 0.62" indicated an actual airflow of 110 CFM rather than the catalog data of 0.72".

References:

(1) TAB Journal, Spring 2012

(2) The Balancer Group via LinkedIn

(3) Murphy, J. and J. Harshaw 2009 "Understanding Chilled Beam Systems"

(4) Engineers Newsletter 38-4, Trane.

(5) www.troxusa.com

(6) www.halton.com

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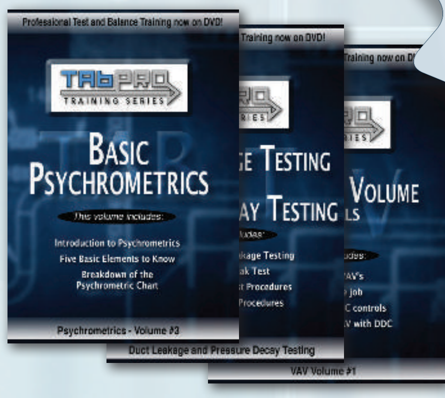

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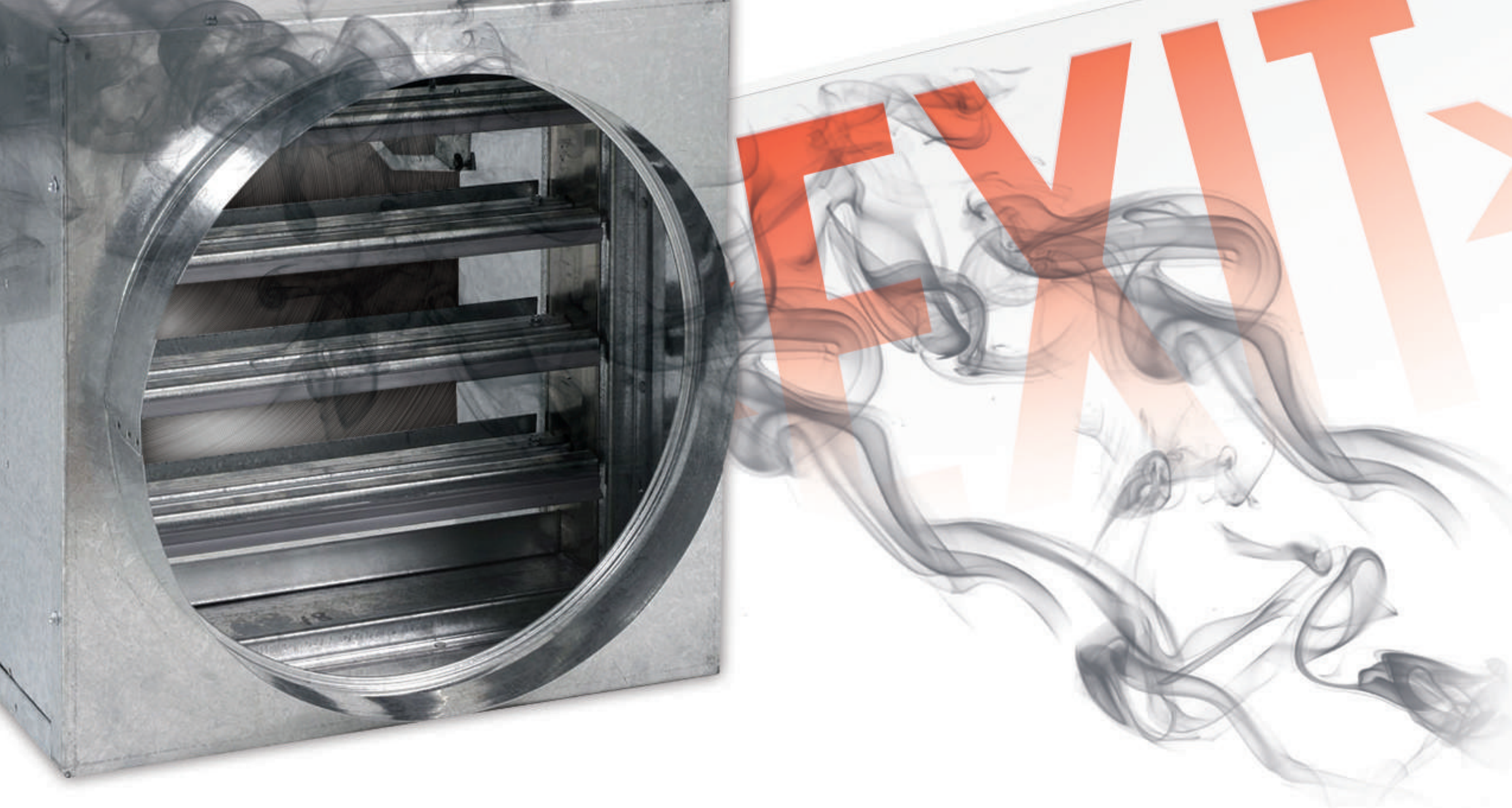


Smoke Damper Testing Procedures

Muslim Nazarali, TBE, CxA, *AIR Engineering and Testing, Inc.*

The following are steps and procedures to take when testing smoke dampers and systems. Testing of such systems is of vital importance, as smoke dampers serve to prevent the spread of smoke from a place of origin to other spaces in the same building.

Smoke Damper

1. Is it powered?
2. Is it controlled?
3. With airflow off, activate damper and observe full closure.
4. *Note:* for smoke dampers in supply ducts; check to verify that air handler or fan goes off before damper closes.
5. Check for inspection and maintenance access panel for each smoke damper.

Smoke Control Fan-Exhaust or Supply

1. Does fan have power?
2. Check rotation, amps, volts, RPM, etc.
3. *Note:* Fan must have one more belt than design minimum (2 belts or more) since it is a life safety system.
4. Activate fan, measure air flow and pressure.
5. If the fan is variable speed / flow / pressure, validate controls operation.

Smoke System – Special Inspection

1. Check operation of fireman's control panel.
    - **a.** Switch controls correct fan and / or dampers.
    - **b.** Red / Yellow / Green lights work properly.
    - **c.** Panel face diagrams match actual configuration.
2. Place system in full automatic, activate smoke detector or flow switch, check system start and continuous operation. *Note:* In some cases the Fire Marshall or Inspector may want the system activated by smoke / smokeless candles or theatrical smoke.
3. Test pressures during operation at smoke perimeter to verify minimum negative pressure (usually .05" WG) toward the exhausted zone.
4. On stairwells and exit path doors, measure door opening force (usually 30# at the handle) to validate access by people with limited strength or with handicap.
5. Provide report per Fire Marshall and / or code requirement.

Fire and smoke dampers are an integral and essential part of a building's passive fire protection system. With the listed procedures, test and balance technicians can ensure such systems maintain their effectiveness.

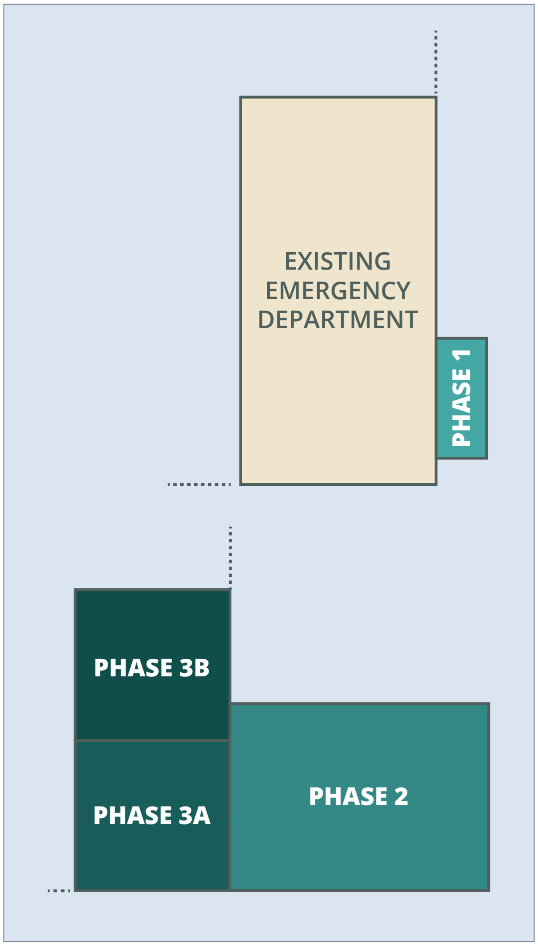
Hospital Improvements:
Balancing Multi-Phase Projects

John Osheroff, TBE, *Penn Air Control, Inc.*

Hospitals continually improve their facilities as new technologies become available.

Often, implementing improvements involves shifting to another area during construction. Projects like this can become a challenge from both an HVAC and test and balance perspective as the area selected for improvement doesn't normally coincide with the existing HVAC system's boundaries.

A hospital improvement project included both an addition and a complete remodel of the existing emergency department. The emergency department remained open 24/7 throughout the entire process, becoming quite busy at times. This project was set up to occur in several phases.



Phase 1 – Demolish the existing entry/waiting room to make way for the addition to be constructed during phase 2. Phase 1 also creates a temporary entrance/waiting room within the existing emergency department adjacent to the original space. This temporary entrance also serves as access to the construction site during phase 3A.

Phase 2 – Construct the new addition complete with a new air handler, exhaust fans, pumps, boilers, and a chiller. These new systems will serve the entire project.

Phase 3A – Completely demolish and remodel about ½ of the existing emergency department. Demolition includes everything from floor to the deck above including walls, HVAC, electrical, etc.

Phase 3B – Completely demolish and remodel the remainder of the existing emergency department.

Phase 2 was all new construction with the supply airflow being controlled by pressure independent CAV boxes while the return system was ducted with no pressure independent control except for in the trauma area. The final two phases posed significant challenges from an HVAC and air balancing standpoint.

The current emergency department was fed by an existing air handler in the lower level of the hospital. This air handler consisted of both a direct drive supply fan and a direct drive return fan that served the spaces to be remodeled during phases 3A and 3B. These existing fans had plugs that originally modulated to maintain airflow as the filters loaded. It was found that these plugs were no longer operational. Without variable frequency drives installed, there would be no way of controlling the airflow being delivered once the ducts were capped off. This necessitated a solution that would allow continuation of appropriate airflow to areas outside the phase 3A area as ducts inside the phase were being cut from this existing system and capped.

The solution devised included the installation of bypass ducts between the supply and return plenums in the mechanical room. As ducts were capped off as part of demolition, these bypass ducts could be opened up to maintain airflow to the occupied areas still being served. Due to space limitations there were several 10” and several 12” bypass ducts installed.

The project design indicated that at the completion of the project this existing air handler would be decommissioned and taken offline. The new addition as well as all of the remodeled spaces would ultimately be served by the new air handler being installed on the addition as part of the second phase.

With a complex project like this, it is important to have an intimate understanding of the scope of work, including what may happen at any point in the process, and under any situation.

A hospital improvement project included both an addition and a complete remodel of the existing emergency department. The emergency department remained open 24/7 throughout the entire process, becoming quite busy at times.

Once phase 2 was complete, air balanced, and approved, the hospital was able to move out of the phase 3A area and into the newly completed phase 2 area. Phase 3A involved demolishing about half of the existing emergency department. During this process, the existing air handler still needed to continue serving the phase 3B area which will still be occupied during the phase 3A work.

Before any duct demolition occurred, flow hood readings were taken at all of the air distribution in the areas that would be affected. There were also existing negative pressure rooms that could be in use and required even closer monitoring. Before any ductwork was touched, reference static pressures were measured in both the supply and return plenums at the existing fan. Fan law 3.2a states that airflow varies as the square of static pressure. In this case, ducts would be capped off, increasing static pressure while decreasing airflow. Maintaining the reference static pressure in the plenums would maintain airflow to the ducts that were still connected to the system.

As the first duct was cut off from the existing air handler and capped in the work area, static pressures were constantly monitored and the bypass dampers were adjusted to maintain the initial reference static pressures. Before moving on to the next cut/cap, the airflows were verified and documented in the occupied spaces with a flow hood with special attention to the negative pressure room's airflow and pressure. This process was repeated each time a duct needed to be cut off and capped in the construction area.

Once the phase 3A area was successfully removed from the existing air handler, the new construction could begin, and eventually it was time to bring the airflow back online. At this point, all of the new ductwork installation had been completed and had been tied into the new air handler, isolated by end caps and closed smoke fire dampers. Bringing the airflow online to this phase was a similar process to the demolition phase, although instead of capping ductwork being served by the existing system, the new ductwork was being opened up to be fed by the new air handler installed in phase 2. Much like during the demolition phase, airflows needed to be monitored and maintained in the occupied areas, phase 2 in this case.

In order to minimize any impact in the occupied phase 2 area, the new air handler was put in an economizer mode so the supply side and return side could be addressed as individual systems.

Before any smoke fire damper was opened, airflow (hood) readings were taken in phase 2 and compared to the balance report from phase 2. Static pressures were also measured at the air handler to be used as reference pressures. After each SFD was opened up, the fan speeds were adjusted to maintain the reference static pressures, and flow hood readings were confirmed in the occupied areas. This process repeated until all of the SFDs were open. During the balancing process, care was taken to maintain airflow at all times in the occupied areas.

At the completion of phase 3A, the air balance was verified for the areas affected by phases 2 and 3A—now being served by the new air handler. Once this was signed off, the hospital was able to move from the final phase area into the newly completed spaces and the process repeated itself for the final phase of the job.

At the beginning of each phase the construction team would get together to come up with a plan. These planning meetings discussed:

- The systems to be worked on
- Which ducts would need to be capped/opened
- What occupied areas would be affected by this work
- How to minimize any impact on the hospital from an airflow/pressure standpoint
- Discussions of what may go wrong and what the impact would be
- Creation of contingency plans in the event that something unforeseen were to happen and how to get the airflows back to a safe condition for the occupied portions of the hospital if issues should occur

With a complex project like this, it is important to have an intimate understanding of the scope of work, including what may happen at any point in the process, and under any situation. The open lines of communication and proper planning ahead of time made this a relatively smooth project, with minimal disruption to the occupied areas of the hospital. In the end, the hospital received a well-functioning and balanced system.

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MTBF AND TAB

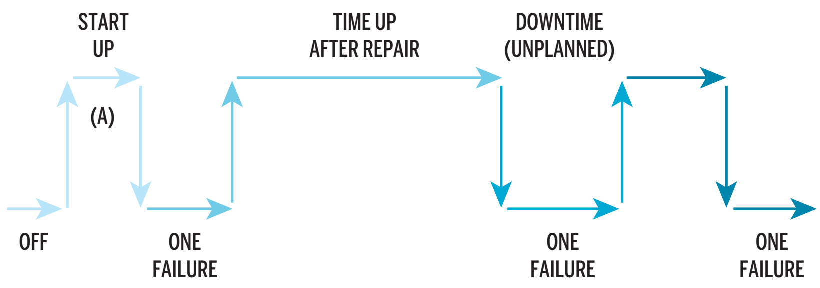
JOSEPH K. HARDY, TBE, *AUGUSTA AIR BALANCE COMPANY, LLC*

"MTBF" and "TAB" are not often encountered in the same context. "MTBF" is a term primarily used by engineers and maintenance managers in a production line application to attempt to forecast failures, predict needed shutdowns for repair/maintenance, and prevent unintended production losses. Simply stated, it is the "**M**ean **T**ime **B**etween **F**ailures" of any given system. For a new system, it becomes Mean Time Before Failure.

A mechanical engineer on a recent project needed the MTBF to be calculated for each of two pumps. The situation required a determination as to which pump to install on an existing primary chilled water system to replace two mismatched existing pumps, one of which had already failed. The pumps circulated chilled water through a loop serving air handlers in an aviation repair bay operating 24/7 and which needed temperature and humidity control. Around-the-clock operation made constant availability of chilled water necessary.

Mean Time Between Failures, while based upon existing operating information, is still affected by many moving parts and variables, either on a production line or in a mechanical system. Simply said, the MTBF is literally the average time elapsed from one failure to the next as shown in Figure 1:

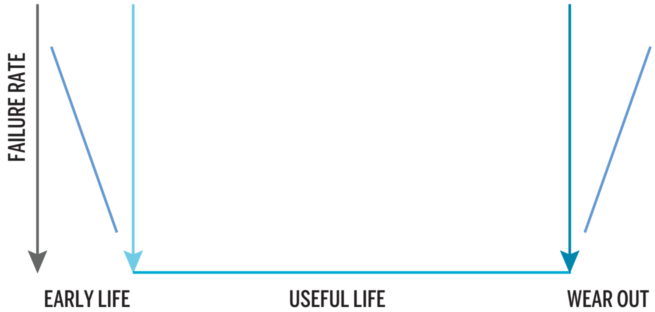
FIGURE 1.



$$\text{MTBF} = \frac{\text{SUM (START DOWNTIME - START UP - TIME)}}{\text{\#FAILURES}}$$

The "bathtub curve" illustrates the life cycle of various pieces of equipment as shown below in Figure 2:

FIGURE 2.



Every piece of equipment has a "bathtub curve"(3). Proper maintenance over time stretches the useful life portion of the curve. Improper start-up procedures, however, can move the "wear out" portion of the curve closer to the "early life" portion, and thereby shorten the useful life of the item.

What does all of this have to do with Test, Adjust, and Balance?

Manufacturers provide manuals for use in installation, operation and maintenance of their various pieces of equipment. Whether it be a motor, fan, pump, or other moving part, there will be procedures to follow in order to stretch the useful life of the product and prevent early failure. (Mean Time Before Failure)

For example, a review of Bell & Gossetts I.O.M. manual reveals the following items, which if not checked, can shorten the useful life of their series 1510 base-mounted end-suction pumps:

- Make sure the warm-up rate does not exceed 2.5˚F per minute.
- Check rotation.
- Don't overload the driver.
- Avoid excessive vibration levels.
- Check final alignment after pump and driver are at operating temperatures.
- Before starting pump, back-off packing glands until gland is loose. Hand tighten until gland is snug against first packing ring. Tighten gland nuts slowly one at a time. Zero to 4 degrees of angular misalignment is normally acceptable, but check with the coupling manufacturer.
- Check leakage rate for glands: For fluid temperatures of 32-190˚F, the average recommended leakage rate is 60-80 drops per minute.
- Check lubrication. The motor and pump should be lubricated every 2,500 hours of operation or every 6 months at a minimum for run-time alternation.
- Field realignment should be performed. When performing field alignment do not move the pump. Adjust only the driver (motor).
- Base plate should be mounted to a pad 2.5 times the weight of the pump/motor/frame assembly. Base plate should be grouted per I.O.M.
- Check for strains on the pump caused by
  - Lack of support for the inlet and outlet piping
  - Lack of support for the suction diffuser (if used)
  - Lack of 5 pipe diameters of straight pipe downstream of elbow entering the suction(unless suction diffuser used)
- Check all system safeties.

The piping connections to the equipment should also be checked. In addition to checking for straight sections of piping upstream of the suction, the following should also be examined:

- Strong, rigid support for suction and discharge lines.
- Check that suction and discharge lines have not been forced into position.
- Expansion fittings should be installed and properly charged.
- Check for flexible connections if inertia bases are used.
- Triple-duty valve or equivalent should be installed.
- Are isolation valves installed on the suction and discharge lines?
- Is there a drain valve installed on the suction?
- Bearing assemblies and grease fittings are accessible and visible. Is there evidence of lubrication?
- Vent slots on the sides and bottom of bearing assembly are uncovered and completely open?
- Do installed seals match pH and operating temperatures of the fluid being pumped?
- Is there space around the pump for air circulation, inspection, and maintenance?
- Is the unit protected from weather and water damage?

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The Series 1510 pump referenced is coupled with its motor by means of a flexible coupling, in this case one manufactured by SureFlex. The coupling manufacturer provides an alignment chart showing the allowable tolerances for alignment and methods by which to check the field alignment (see chart below). Although most pumps are aligned at the factory, many are out of alignment prior to installation due to shipping shock or mishandling during storage and/or installation. Similar to tire wear on a misaligned automobile, the rubber insert in the coupling wears out more quickly if the two coupling halves are out of alignment. Early wear-out of this coupling drops the pump off-line and out of use.

The goal at start-up should be to verify that all start-up procedures as recommended by the manufacturer are followed so that the "Mean Time Before (initial) Failure" is extended to its optimum value. Proper and efficient use of the AABC pre-tab start-up lists as well as manufacturers' I.O.M. information helps prevent early life failures as well as aid in extending the useful life of equipment.

MAXIMUM RPM AND ALLOWABLE MISALIGNMENT
(Dimensions in inches)

Sleeve Size	Maximum RPM	Types JE, JN, JES, JNS, E & N			*Type H, HS		
		Parallel	Angular	G1	Parallel	Angular	G1
3	9200	.010	.035	1.188	- - -	- - -	- - -
4	7600	.010	.043	1.500	- - -	- - -	- - -
5	7600	.015	.056	1.938	- - -	- - -	- - -
6	6000	.015	.070	2.375 (1)	.010	.016	2.375
7	5250	.020	.081	2.563	.012	.020	2.563
8	4500	.020	.094	2.938	.015	.025	2.938
9	3750	.025	.109	3.500	.017	.028	3.500
10	3600	.025	.128	4.063	.020	.032	4.063
11	3600	.032	.151	4.875	.022	.037	4.875
12	2800	.032	.175	4.688	.025	.042	5.688
13	2400	.040	.195	6.688	.030	.050	6.625
14	2200	.045	.242	7.750	.035	.060	7.750
16	1500	.062	.330	10.250	- - -	- - -	- - -

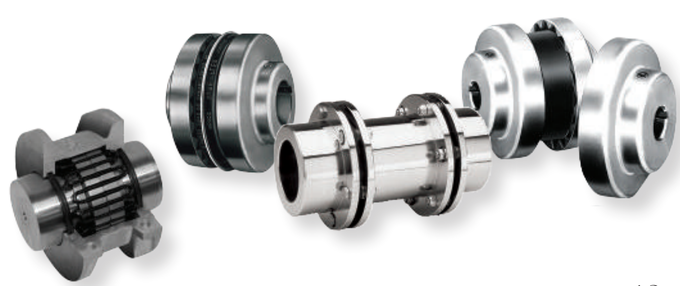
Note: Values shown above apply if the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2.
**Type H and HS sleeves should not be used as direct replacements for EPDM or Neoprene sleeves. (1) Value when using 6J flanges is 2.125.*

References:

(1) file://H:MTBFand MTTRcalculator.htm

(2) Wikipedia, "Mean time between failures", Jones, James V., Integrated Logistics Support Handbook, McGraw-Hill Professional, 3d edition (June 8, 2006, ISBN 0-07-147168-5)

(3) "MTBF and Product Reliability", http://ftp.automationdirect.com/pub/PRODUCT%20RELIABILITY%AND%20MTBF.pdf



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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.

STEAM SAFETY TIPS for Technicians

Don Butler, TBE, CxA, *Butler Balancing Company, Inc.*

Test and Balance technicians typically do not have to make adjustments to steam lines or equipment. Normal duties involve verifying operation, pressures and temperatures related to steam equipment. The following are some considerations to keep in mind when encountering steam lines or equipment.

Technically speaking, in terms of chemistry and physics, steam is invisible. This distinction applies to both high and low pressure, and if underestimated it can be as deadly as high volts/amps in electrical equipment. Low pressure is classified as anywhere from 0 to 15 pounds per square inch gauge (psig) relative to the surrounding atmosphere. Above 15 psig is high pressure.

In common usage, the term "steam" is used most often to refer to visible mist or vapor that forms as water droplets condense in the presence of cooler air. For example, when a tea kettle is boiling. In this instance, steam is actually the small gap between the discharge of the kettle to where the vapors start. The same situation can occur if a steam valve is inadvertently released to the atmosphere.

When changing a gauge to verify pressure accuracy, the following precautions should be kept in mind:

- Ensure a pig tail is installed with the gauge and the shut off valve. The pig tail is a pipe nipple that is bent into a circle in the middle with the threaded ends pointed in opposite directions. The purpose of it is to maintain a leg of water in order to keep the live steam from entering the pressure gauge.
- Use caution when changing a gauge; gloves are a necessity. Loosen the valve slowly and work it gently to ensure there is no escaping steam from the closed isolation valve.
- If a steam leak is suspected, use a whisk broom or brush to test the area. A high pressure leak will cut the bristles. Severe injury or burns can result from using hands to verify a steam leak. Depending on the severity of the leak, live steam can overcome the atmosphere of a room in seconds, causing suffocation and burnt lungs
- When opening any steam valve to go back into operation, do so very slowly—a maximum of one half turn at a time. The larger the line, the slower this process should be. Condensed water may have cooled in the line from when the valve was closed down. Releasing steam into the line gradually prevents a situation called water hammer. If steam is released too quickly severe banging and pipe movement could result, to the point where fittings could become damaged and live steam could escape.
- Do not use a wrench to tighten the valve. If such measures are necessary, the valve's integrity may have been compromised. The valve gate has been driven too far into the seat and is less reliable as a result.

When encountering a situation with steam lines and equipment, use caution. Respect the risks posed and do not be afraid to ask for advice or help when working with it for the first time.

Troubleshooting Skills

Troubleshooting HVAC systems is a continuous and daily experience for test and balance professionals. Now more than ever, TAB technicians must be skilled in troubleshooting for inevitable situations that may arise.

Essential to TAB Services

Michael Carrillo, TBE, *Professional Balancing Services, Inc. (PEBSCO)*

Troubleshooting HVAC systems is a continuous and daily experience for test and balance professionals. Now more than ever, TAB technicians must be skilled in troubleshooting for inevitable situations that may arise.

On a recent project, technicians encountered low airflow that seemed to have a simple explanation, but had been caused by an atypical system deficiency. The system served three floors and consisted of 1 Variable Volume AHU located on the third floor serving a total of 12 parallel fan powered VAV terminal units, 4 on each floor. In terms of complexity, the system was relatively small. Upon arrival, the TAB technicians were informed by the control technician that there were inadequate equipment and design/installation flaws. Initial testing revealed an actual total airflow of 7,072 CFM, 68% below the unit submittal data rating of 10,400 CFM, and insufficient system static pressure. As a result, the control contractor was unable to verify proper primary airflow measurement at the terminal units via the BMS/DDC system. The unit was equipped with VFD controlled direct drive dual fans. In reviewing the manufacturer's equipment submittal data it was determined that the VFD was programmed to operate at the motor nameplate RPM of 1,750 rather than the fan design RPM of 2,437. Corrective action was taken to program the VFD to achieve the rated fan RPM.

Retest of the unit resulted in satisfactory airflow delivery at the unit. However, the control technician continued to indicate inaccurate airflow via the DDC system at the terminal units, therefore troubleshooting continued. Static pressure profiles of the medium pressure ducting system and extensive visual inspection did not reveal any significant leakage at the duct. The actual measurement of individual supply grilles revealed airflow at rates of 50-65% below design, while the DDC system indicated differing airflow rates. The low airflow measurement at supply grilles prompted inspection of the fan powered terminal units.

The first unit inspected was found to have the fan section backdraft damper wedged up against the internal liner, *(Fig. 1)*. Inspection of all other units revealed the fan section was installed upside down resulting in the backdraft dampers of 11 terminal units being open at all times, *(Fig. 2)*. These conditions allowed a significant amount of leakage from the terminal unit heating water coil.

The installing contractor was advised of the equipment conditions and an initial field repair of reinstalling the backdraft dampers on the upper side of the fan cabinet section was attempted. After retesting of one terminal unit it was determined that leakage still occurred at an unsatisfactory rate. The installing contractor was dubious of the test results since there was minimal airflow leakage that could be felt at the heating water coil. The technicians assigned on this project had also noticed this condition during their inspection for leakage, however as a part of the troubleshooting process the technicians had found that the terminal units' accumulative area of the heating coils was substantial resulting in low velocities at the coils. Blanking off a portion of the coils resulted in increased velocities at the coil, providing proof of the continuing leakage problem. Upon witness by the installing contractor the leakage issue was corrected by factory service personnel.

FIGURE 1.

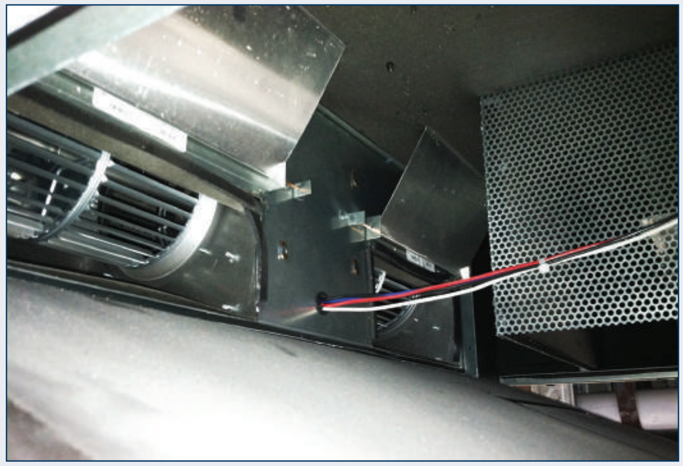
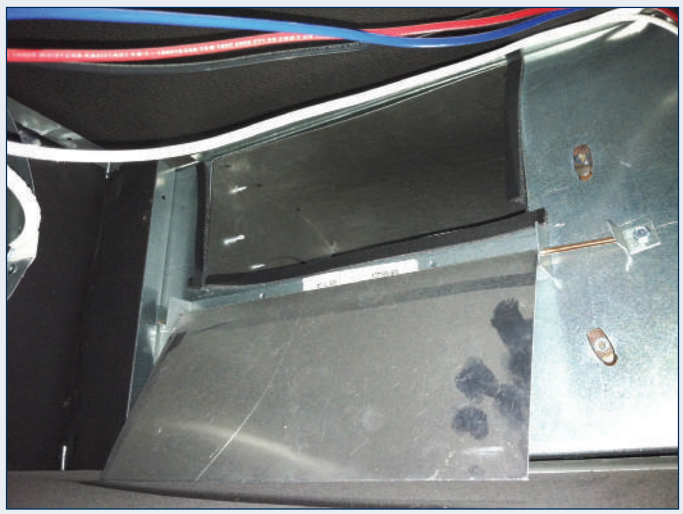


FIGURE 2.



It is not unusual to encounter deficiencies while performing TAB services. The terminal unit issue was a first, and surprising to the installing contractor, the equipment supplier, even to the experienced TAB technicians who encounter system anomalies routinely. In this case, with the exception of one unit the remaining terminal units were improperly manufactured. The installing contractor appreciated the troubleshooting skills of the TAB agency and the identification of a surprising invisible deficiency.

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.

QUESTION: ***We run across the issue of confirming sensor calibration. Of particular interest is how to verify that a temperature averaging sensor (say downstream of a mixing box) is producing accurate temperatures. When T&B measures temperatures at this location, they may be taking anywhere from 1 to 12 readings. We have seen fairly wide discrepancies due to stratification or air flow patterns.***

What is a recommended way to help confirm calibration of an averaging sensor since T&B is using a single point reading at several locations? e.g., one reading every xx feet of sensor?

AABC: Most mixing boxes use a single point sensor. Where averaging sensors are installed a traverse, using thermometry with approximately the same accuracy, must be taken in the same manner as a Pitot tube traverse. The readings are averaged to determine the average temperature. The tolerance should be ±0.5°F of the sensor reading. The sensor reading must be recorded while taking the traverse, if the temperature fluctuates on the sensor the average must be used.

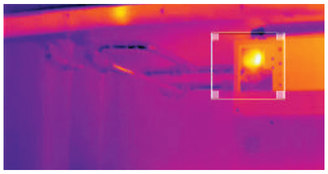
— Gaylon Richardson, TBE, Engineered Air Balance Co.

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).**

UNDERSTANDING



Thermal Imaging

BRIAN KAUPP, TBE
SOUTHERN INDEPENDENT TESTING AGENCY, INC.

What's involved in a good thermally tuned image? **"FORD"**.

In thermal imaging, FORD is not a car or a truck – it stands for FOcus, Range, and Distance. When taking readings or analyzing a piece of equipment or building, certain parameters should be kept in mind. The first step is to make sure there is a good thermogram to analyze. That is where "FORD" is required. The thermogram must be in **focus**, be taken with the correct temperature **range** and with an appropriate working **distance** to the target for the lens and infrared camera being used to capture the image. These factors are required, along with having the correct ***emissivity***—which is the single-most important attribute necessary to obtain an accurate thermal measurement. All the above listed parameters are critical to achieving a thermally tuned image.

So what is "Thermal tuning"? Thermal tuning is the method of manually adjusting specific parameters to produce a thermogram where the colors within the image are spread over the object of interest with the intent of locating fine thermal detail and identifying thermal gradients.

Critical parameters for a thermally tuned image include:

- **Focus** – the clarity or distinctness of an image rendered by an optical system; "in focus", "out of focus".
- **Range** – the lowest and highest temperatures that can be imaged and/or measured with an IR camera's setting.
- **Distance** – the appropriate working distance to the target or object.
- **Emissivity** – the ratio of energy emitted by an object to the energy emitted by a black body at the same temperature.

The benefits of a thermally tuned image could include:

- Reduction of unscheduled power outages.
- Detection of problems quickly, without interrupting service.
- Assessing priorities for corrective action.
- Minimizing preventive maintenance and troubleshooting time.
- Checking for defective equipment while still under manufacturer's warranty.

When obtaining images of mechanical systems, a thermally tuned image can:

- Inspect burners and boilers for flame impingement and burner management.
- Scan and record temperatures in areas of boiler not monitored.
- Assist with mechanical bearing inspections.
- Monitor belts and sheave wear.
- Assist with HVAC equipment evaluation.
- Detect insulation leaks in refrigeration equipment.
- Detect uniform cooling of Dx and chilled water coils.
- Detect potential leaks in ductwork.

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