TAB Journal

AABC

THE MAGAZINE OF THE ASSOCIATED AIR BALANCE COUNCIL • SUMMER 2015

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IN THIS ISSUE:

- Static Pressure Safeties
- Exhaust Air Terminals
- Fan Filter Units

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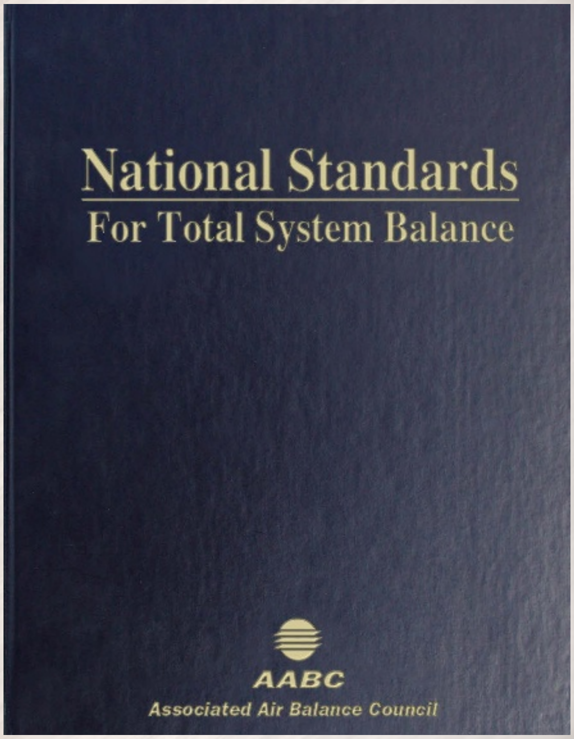

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From the Publisher

The summer 2015 issue of *TAB Journal* examines the challenges encountered when balancing air systems.

Terry Wright, TBE, of Engineered Air Balance Co., Inc., discusses the limitations of fan filter units in spaces such as hospitals, pharmacies and clean rooms.

In “Behind Grille Opposed Blade Dampers: Buyer and Balancer Beware,” AHS Testing & Balancing looks at several of the issues associated with using opposed blade dampers.

Systems Management & Balancing, Inc.’s James E. Hall, PE, TBE, talks about balancing valve strainer effect, an issue that can arise in systems with low water flow requirements.

Alan Little, TBE, of Engineered Air Balance Co. Inc., goes over how to prevent duct damage from occurring with the proper installation and programming of static pressure safety devices.

Eric V. Schneider, TBE, of American Testing, Inc., discusses a case study involving the supply and exhaust air terminals serving an existing laboratory suite.

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!

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> "Fan filter units are a popular choice of designers when room air changes per hour requirements are high… What is often overlooked is that fan filter units with certain constant volume ECM fan motors are not recommended for use with all systems."

LIMITATIONS of Fan Filter Units

Terry Wright, TBE
Engineered Air Balance Co., Inc.

Testing in hospitals, pharmacies and clean rooms often requires testing and adjusting fan filter units. Fan filter units consist of a fan, a motor and a filtration system in a single unit which is used to provide particle-free, laminar airflow to the room or working space. They may have an optional ECM fan motor available which is designed to adjust the fan torque and speed to maintain a constant airflow and compensate for filter loading. The fan filter units are designed to be installed in a T-grid ceiling system or sheetrock ceiling; 2x4 or 2x2 sizes are available.

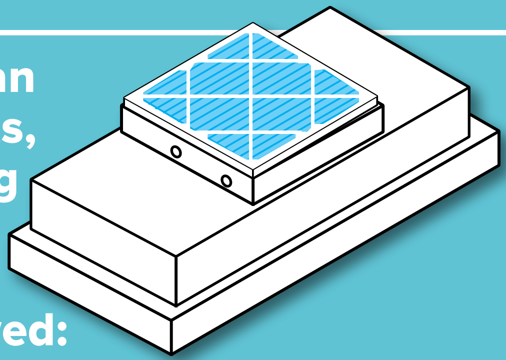
Fan filter units are a popular choice of designers when room air changes per hour (ACH) requirements are high, when the primary air handler is not HEPA filtered but a space it serves requires HEPA filtration or when the primary air handler performance is not capable of overcoming the HEPA filtration resistance. What is often overlooked is that fan filter units with certain constant volume ECM fan motors are not recommended for use with all systems.

Manufacturers' notes in their operation and maintenance manuals caution about directly connecting the supply ducts of terminal units, constant or variable volume, to their fan filter units. The airflow serving the fan filter units needs to be balanced and that a start-up sequence needs to be considered. The problem with the constant volume ECM motor is that the motor is easily stalled if over or under pressurized. Once an ECM motor stalls, it will shut itself off and requires a voltage cycle for restart. One manufacturer states that a neutral static state at the fan filter inlet is the best condition.

Stalled ECM motors were encountered on a recent hospital pharmacy project. The fan filter units were served by venturi constant volume terminal units. Contrary to typical balancing where the design airflow is the target, when balancing to pressure sensitive and specific ACH requirements, balancing to the design airflow is only the start. Once at design airflow, the room pressures and airflow directions dictate if further adjustments are required. The room ACH requirements are just as important but should have been calculated prior to balancing that they are sufficient.

The pharmacy was balanced and all room requirements were met. The following Monday, it was reported that the pharmacy was experiencing room pressure alarms. A quick check of the airflows indicated that the supply airflow was low and the supply duct static pressure serving the fan filters was high, an indication that the fan filters were not operating. The area surrounding the pharmacy was now occupied so the option of shutting down the AHU, cycling the fan filter breakers and AHU restart was not possible. After several tries, the AHU was able to be slowed down to a speed that allowed the fan filters to reset and regain operation.

For future fan filter projects, the following items are suggested to be reviewed:



- Determine if the submitted fan filter is acceptable for operation with the AHU supply system. If terminal units are being used and the fan filter submittal states that it is designed to compensate for filter loading (constant volume, variable torque motor), it is not the correct application. A constant torque fan filter motor is suggested.
- If the fan filter is direct connected to the duct system, what is the start-up sequence for the supply system and fan filter? A constant torque fan filter will overcome additional pressurization/ under pressurization but not in all cases. An interlock to start and stop the fan filters dependent upon the AHU status is suggested.
- In most fan filter installations, the ceiling is hard (sheet rocked) and access to the fan filter controls are often not considered until required for testing. If the accessory fan filter remote control is not installed, access will be required for the fan filter controls and also access to the duct for static pressure measurements. Duct static pressure values are required to determine if the supply terminal/system is set up properly.
- BAS fan filter status monitoring and having all test data available when troubleshooting pressure or airflow problems is very helpful. If the space is experiencing pressure issues with the same system static pressure being maintained but the terminal unit control damper is 100% open instead of 75% noted in the test and balance report, there is a good chance the fan filter is not operating.
- In the case of a hospital, inquire as to the procedure for routine generator and fire alarm testing. The method by which this testing is performed can have undesirable effects on the mechanical systems besides just fan filter motor stalls such as duct failures, unexpected AHU shutdown and smoke fire damper closure during AHU operation, which is another subject in itself.

> "Variable torque motor fan filter units work very well in applications where high air changes are required but the room temperature loads are normal."

So why did the fan filter motors stop operating? During a discussion with the maintenance staff it was found that there was a generator test over the weekend. A true power outage would have a better outcome than the generator test procedure. Shutting down one panel at a time instead of all panels may have an adverse effect on mechanical system operations. If the fan filters are shut down after the AHU and smoke dampers are shut, the fan filters have nowhere to pull air from, and if there are multiple fan filters on a system, the weakest fan filter will stall and shut down. If the fan filters are started up after the AHU, there is the likelihood that all the fan filter motors will stall which was the case with this project.

The fan filter manufacturer was contacted for a possible strategy to eliminate the fan filter motor shutdown during generator testing. The manufacturer had not experienced this problem previously. However they noted that problems with fan filter hunting was an issue and that is the primary reason that they do not recommend having terminal units supply fan filter units. If there is any fluctuation of airflow in either the fan filter or the terminal unit, hunting results due to two devices trying to control to the same airflow. They suggested that on systems served with terminal units that constant torque motors be used instead of variable torque motors. Although it is not published, it was suggested that operation outside of ± 0.20" wc static pressure at the fan filter inlet may stall a variable torque motor.

The ECM motors on the project were reprogrammed for constant torque operation. The automatic fan filter speed adjustment for filter loading was lost but the terminal device should open to compensate. This has reduced the fan filter stalls significantly, but not in every case. During generator testing, the sequence of the electrical panel's shutdown is changed every month which results in a different condition every month.

Variable torque motor fan filter units work very well in applications where high air changes are required but the room temperature loads are minimal. The supply terminal serves the fan filter at a reduced airflow, and the remaining fan filter airflow is made up from a return air grille. If the fan filter is under-pressurized by the supply terminal, additional airflow from the return source will make up the difference, over pressurization may continue to be an issue if backdraft dampers are installed in the return duct to prevent unfiltered air from entering the space.

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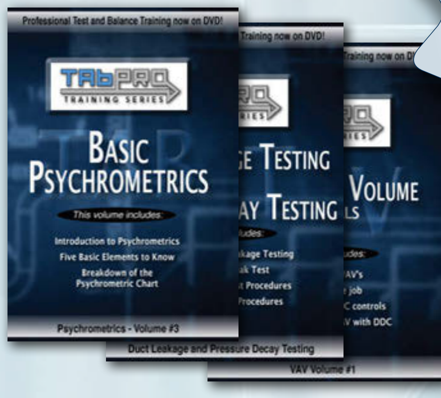

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DVD format
Run time: 45 minutes
List price: $200.00
Member price: $150.00

This volume consists of two lessons covering standard VAVs and parallel fan-powered VAVs, both using DDC controls. These lessons take the viewer through an introduction to VAV terminals, essential job preparation, instrumentation used during testing, general procedures for testing and balancing, and final reporting.

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BEHIND GRILLE OPPOSED BLADE DAMPERS:

Buyer and Balancer Beware

AHS Testing & Balancing Ltd.

"A good system air balance is one that can comfortably distribute air throughout, keeps noise/drafts to a minimum while maintaining the balance of the system over time!"

Whether it is due to design constraints, space restrictions or lack of proper access to ductwork, opposed blade dampers are often the only option available to test and balance a system. Some of the many problems associated with using opposed blade dampers are:

NOISE: Opposed blade dampers run the risk of creating undesirable noise in the occupied space. This noise is created at the outlet(s)/inlet(s) when throttling back the damper to reduce airflow.

INACCURATE READINGS: Grille factors (AK) are calculated with an open damper; as opposed blade dampers are closed, the change in the effective area of the outlet/inlet results in airflow jetting. This causes the AK factor to change and the jetting creates difficulty in determining the actual airflow.

LACK OF A LOCKING MECHANISM: After systems are balanced using opposed blade dampers, the problem of locking the damper into position becomes an issue. The turning of a setscrew through the grille performs adjustment of the damper. Over time as the fan system is started/stopped the damper(s) can eventually begin to close.

DIRT BUILD UP: In exhaust systems, particularly in washrooms or other damp/dirty locations, the opposed blade damper gives dirt a place to collect and over time can even block the airflow completely. As grilles get cleaned during scheduled maintenance, the initial setting of the opposed blade damper changes, which can cause a problem of "too much air in one area and not enough in another".

COMBINATION FIRE DAMPER/ OPPOSED BLADE DAMPER: Problems arise when the fire link breaks and is reset, not knowing where the damper was originally set to to achieve design airflow.

Opposed blade dampers often come from manufacturers as a package with the grille. The sheet metal contractor sometimes sees this as an option to not install branch dampers in duct mains. Because of this, they are often required to return to site to install balancing dampers where required to properly balance the system. Opposed blade dampers do have a place from a balancing standpoint. They are a means of balancing when it is physically impossible to provide a volume damper. They can be beneficial when fine-tuning is required to distribute/equalize air volumes; the benefits, however, may be outweighed by the above.

Balancing Valve Strainer Effect

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

What is "Balancing Valve Strainer Effect"?

"Strainer Effect" is the term that has been utilized to describe the situation when a balancing valve has been closed to a point that the valve opening is so small that dirt and debris in the water system get caught in the opening and eventually prevent water flow from passing through the valve. The valve now is acting as a "strainer". This situation is most common for low water flow requirements such as reheat coils, chilled beams, fan coil units, and convectors.

Mr. Jeff Jones of Pro Hydronic Specialties has performed the calculations of the opening size for a standard globe style manual valve and that of a variable orifice balancing valve. The calculations show that opening of these valves can be smaller than the opening of a 10 mesh strainer. Reference the calculations in the provided chart.

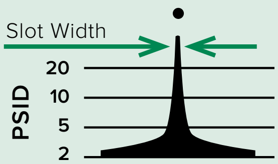
The balancing valve can become plugged in as little as a couple months or possibly a year or more. It is all dependent upon how far closed the valve is set and the cleanliness of the water system. If an element is not performing (heating or cooling), the position of the balancing valve serving the element in question should be checked. If the balancing valve is closed more than 40%, the valve should be cycled to 100% open. This should clear the dirt/debris from the balancing valve and the balancing valve can be reset to its original position. If possible, the balancing valve should be set slightly more open to prevent the valve from acting as a strainer in the future.

A balancing valve with a variable orifice could give an erroneous differential pressure reading when debris starts accumulating in the valve opening and restricting water flow. The differential pressure across the variable orifice will increase in this situation and the water flow will decrease. The higher differential pressure reading implies increased water flow, which is incorrect.

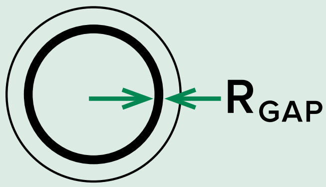
A balancing valve with a fixed orifice (a true venturi) will provide a correct differential pressure measurement for flow determination. As the pressure increases across the venturi, the flow increases. As the pressure decreases across the venturi, the flow decreases. If "strainer effect" is occurring in the valve located downstream of the venturi, the venturi will measure a low pressure differential indicating low water flow.

To minimize the chance of strainer effect, the balancing valve should be sized for water flow and not pipe line size. This will help prevent having to close a balancing valve more than 40% to 50%.

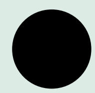
Variable Orifices Strainer Effect under Low-Flow Conditions



Slotted Design



Globe or Disk Design

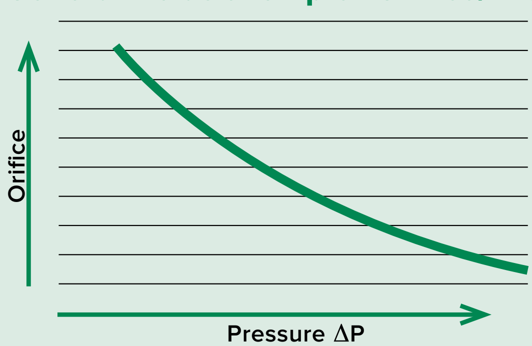

Static Orifice Design

1.0 GPM Flow - Calculated

Estimates of Area which vary depending on Coefficient of Discharge

Pressure ΔP	Slot Width	Disk Gap (R-GAP)	Diameter of Static Orifice	Area in²
2	0.350	0.0108	0.165	0.0186
5	0.060	0.0085	0.165	0.0118
10	0.015	0.0072	0.165	0.0083
20	0.008	0.0060	0.165	0.0059
30	0.002	0.0054	0.165	0.0048

General Relationship of Orifice/Pressure for a Given Flow



For a Given Flow;

As the Pressure increases, the Orifice decreases.

Inversely, as the Orifice increases, the Pressure decreases.

The calculations on this document are generalized due to the Flow Coefficient (K) being unknown and varying for diverse flow orifice conditions. While changes in K do affect the orifice size, these orifices are still very small for low flows. It is the purpose of this reference to demonstrate that these orifices are often smaller than the strainer mesh openings, not to determine the exact size of the orifice for a given flow. The physical configuration of a Slotted Orifice or the gap from the Globe Design is smaller than the mesh opening for low flow requirements. A Static Orifice Pressure Independent design allows for optimal orifice size for an automatic flow limiting valve.

WARNING: Cascade Failure Can Occur with a Variable Orifice Design!

Why? These are pressure dependent for position (P1, P2). As the orifice becomes clogged, the differential pressure increases, resulting in the piston closing further with even smaller orifices that clog more quickly. Cascade failure is imminent with total stoppage of flow once clogging begins.

Equation to Determine Approximate Orifice for a Given Flow

$$A = \frac{Q}{26K\sqrt{\Delta P}}$$

Equation to Determine Max Gap using Disk or Globe Restriction

$$R_{GAP} = R - \sqrt{R^2 - \frac{A}{\pi}}$$

Q=Flow

A=Area

K=Flow Coefficient=1

•**P**=Pressure Differential

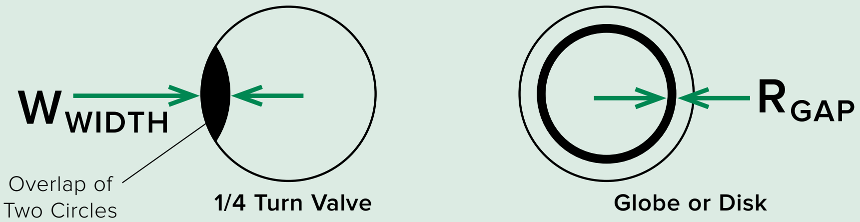
R=Radious of Orifice

NOTE: Actual orifice dimensions will vary depending on the flow coefficient.

Equation to Determine Gap / Width of Slotted Design

Taken from Actual Measurements

Strainer Effect on Low-Flow Globe Style Manual Valves



1.0 GPM Flow - Calculated

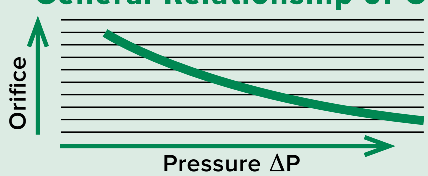
Estimates of Area which vary depending on Coefficient of Discharge

Pressure ΔP	Area in²	Max Gap 1/4 Turn Valve	Max Gap Globe Style
2	0.0186	0.074	0.0108
5	0.0118	0.054	0.0085
10	0.0083	0.042	0.0072
20	0.0059	0.034	0.0060
30	0.0048	0.030	0.0054

All smaller than 10 mesh screen

The calculations on this document are generalized due to the Flow Coefficient (K) being unknown and varying for diverse flow orifice conditions. While changes in K do affect the orifice size, these orifices are still very small for low flows. It is the purpose of this reference to demonstrate that these orifices are often smaller than the strainer mesh openings, not to determine the exact size of the orifice for a given flow. The physical configuration of a the gap from the Globe Design is smaller than the mesh opening for low flow requirements while a quarter turn valve allows for optimal orifice size for a manual balancing valve.

General Relationship of Orifice/Pressure for a Given Flow



For a Given Flow;
As the Pressure increases, the Orifice decreases.
Inversely, as the Orifice increases, the Pressure decreases.

According to ASTM E 11-04 Specifications

Approximate Opening:
U.S. No 10 Test Sieve - 0.078"
U.S. No 20 Test Sieve - 0.033"

Equation to Determine Approximate Orifice for a Given Flow

$$A = \frac{Q}{25K\sqrt{\Delta P}}$$

Equation to Determine Max Gap using Disk or Globe Restriction

$$R_{GAP} = R - \sqrt{R^2 - \frac{A}{\pi}}$$

Q=Flow
A=Area
K=Flow Coefficient=1
•P=Pressure Differential
R=Radious of Orifice
NOTE: Actual orifice dimensions will vary depending on the flow characteristic.

Equation to Determine Center of Two Circles Given Known Area of Overlap

$$A = r^2 \cos^{-1}\left(\frac{d^2+r^2-R^2}{2dr}\right) + r^2 \cos^{-1}\left(\frac{d^2+R^2-r^2}{2dr}\right) - \frac{1}{2}\sqrt{(-d=r=R)(d+r-R)(d-r+R)(d+r+R)}$$

r=**R**=Ball I.D.=0.5

Equation to Determine Width of Overlap

$$W_{WIDTH} = 2R - d$$

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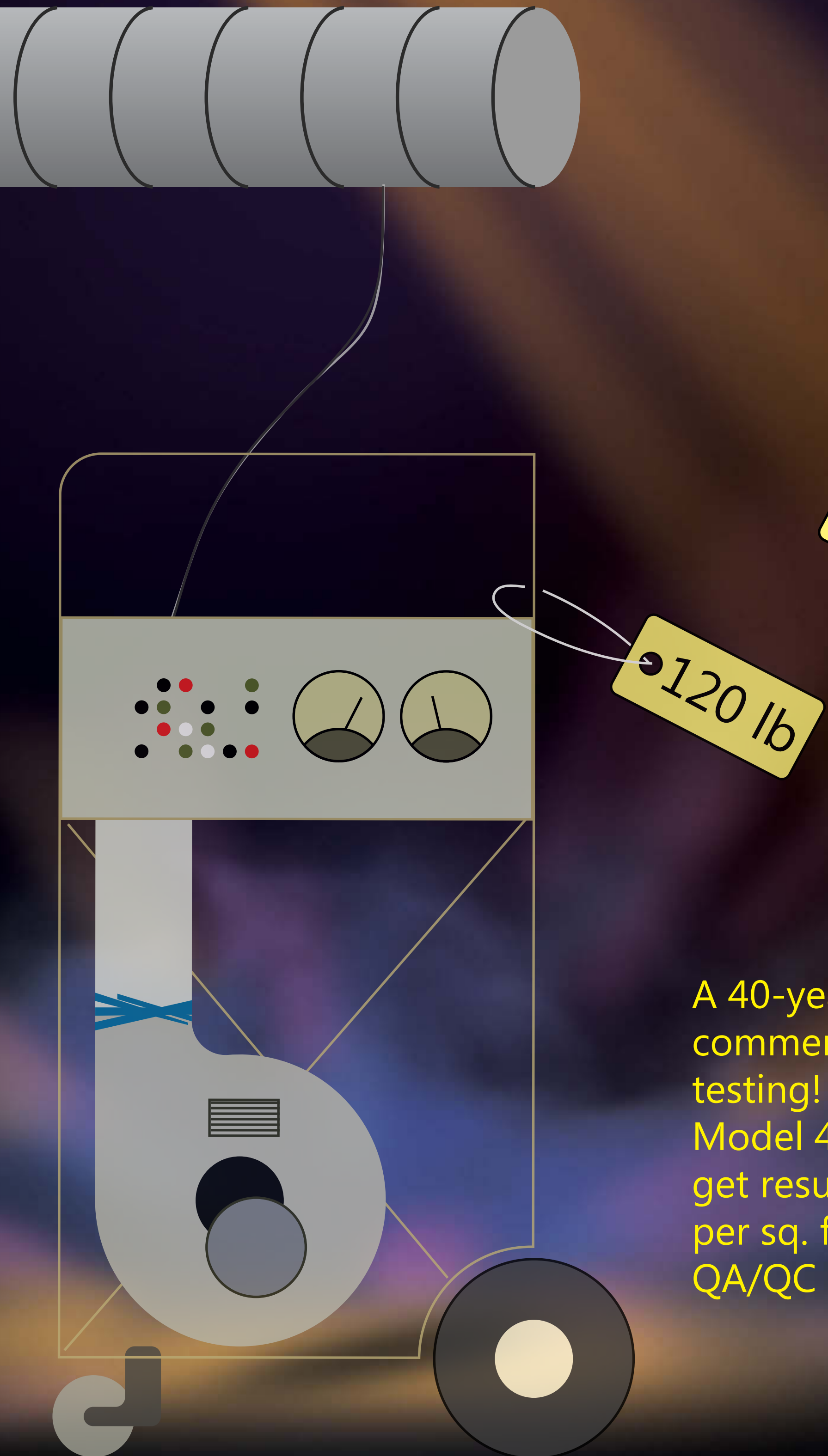

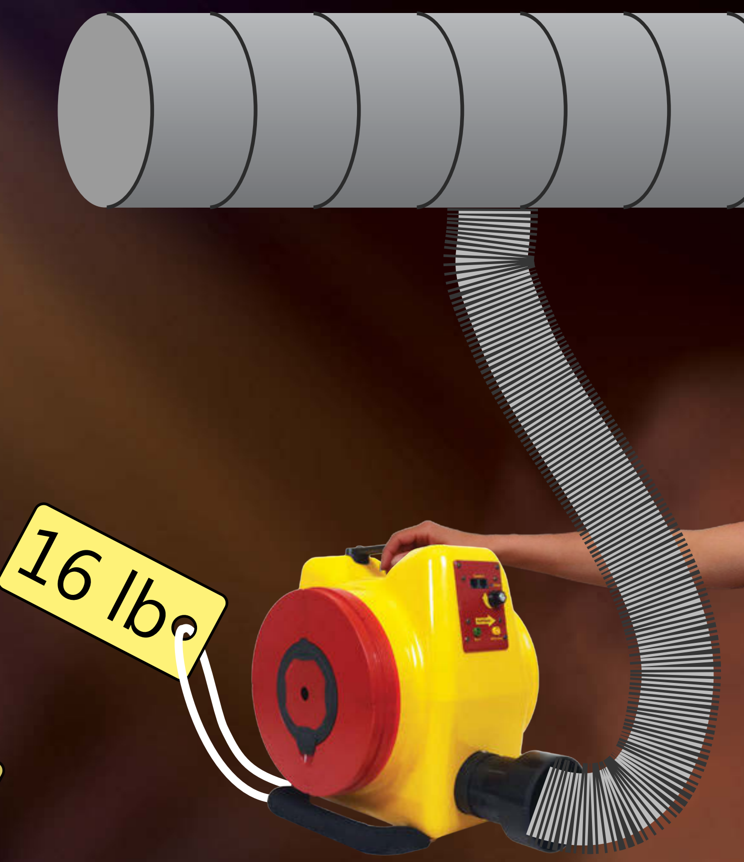

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Static Pressure Safeties Are No Guarantee Against Duct Damage

Alan Little, TBE
Engineered Air Balance Co. Inc.

High or low static pressure safety limit switches are a fairly standard control device in many fan systems, especially variable volume systems. There is a common misconception, however, with these devices. The installation of a static safety switch is not a 100% guarantee that ductwork, dampers or other equipment will not be damaged.

For the purpose of this discussion, the high or low static pressure safety limit switches will be referred to generically as a "static pressure safety." The topics discussed are equally relevant to either supply (positive) fan or exhaust/return (negative) fan systems.

High or low pressure safety limit switches are designed to function just as the name implies. Whenever a static pressure exceeds the static pressure setpoint, the device trips and deactivates the fan or unit.

There are several factors that can affect how quickly a safety limit switch will stop the fan or if the safety limit switch will be able to stop the fan under all operating conditions.

There are 2 basic methods of installing pressure safety limit switches:

- Hard-wired directly in the fan motor starter safety circuit
- Wired into the Direct Digital Control (DDC) system

Static pressure limit safety devices that are hard-wired are the most dependable static pressure safety device. This type of sensor, when wired directly into the fan starter or VFD safety circuit (including full line bypass contactor), will break the safety circuit signal when tripped and disable the fan, regardless of whether the fan is operated in auto, manual/hand or full line bypass. Short of a mechanical failure in the safety device, it will provide the most dependable control and cannot be over-ridden by the DDC system. This device can be provided with either single or double dry contacts. If this device is provided with a double set of dry contacts, not only will the fan safety circuit be disabled, but the DDC system can also be provided a signal as to why the fan was disabled and/or activate an alarm message.

Static pressure safeties that are wired only into the DDC system have several disadvantages:

1. When the static pressure safety is tripped, the shutdown of the fan is totally dependent upon the DDC software program. There can be serious concerns with the software not functioning properly under all operating modes or scenarios. Even if the point functions properly during initial testing, the software could be accidentally overwritten with a different version of software or modified during a future software revision. There is an inherent lag in time between when the static safety is tripped and a stop signal is actually sent to the fan starter or VFD. This lag can be minimal or depending on the software architecture could be significant. If the static pressure safeties are wired into the DDC system; extra care must be expended to thoroughly test and verify this sequence to make sure it functions as required under all possible scenarios, both automatic and manual.
2. DDC system points, if not programmed properly, can be over-ridden. This type of point should never have the ability to be over-ridden or disabled through DDC system software. If this were to happen, the static pressure safety would be useless.
3. DDC safety devices do not always function as required under all operating scenarios. When a fan is operated in automatic, the safety devices may function properly. However, when the starter or VFD is switched to "manual/hand", the static safety may not be functional. If the VFD is not operational and it is switched to full line bypass, the DDC high limit safety probably will not function. Control contractors can try to use the excuse that "once the unit is switched out of automatic, they are no longer responsible for the control of the unit". If you accept that premise, then no safety device of any type should ever be controlled by a DDC system. Also, if there is ever a problem or failure within the DDC panel controlling the fan, the safety devices would not function. The static pressure limit safety devices are needed the most under non-automatic scenarios, but probably would not be functional in most (if not all) of the scenarios described.

Automatic reset type static pressure safety devices should not be utilized on a fan system. If this type of safety device were tripped, the fan would be disabled and the static pressure would decrease. However at some point, the safety switch would automatically reset and restart the fan, the static pressure would begin to increase, the safety would again trip and the same scenario would continue to reoccur. The repeated cycling could cause serious damage to the ductwork, dampers or other equipment. If there is a trip of the static pressure safety device, the fan should not be re-enabled until someone physically goes to the unit to determine what caused the trip and correct it, make sure no ductwork, dampers or related equipment had been damaged and verify that it is actually safe to restart the unit.

There are instances where static pressure safety limit switches may not be able to prevent damage no matter how fast the fan is disabled. The following are just a few possible scenarios where damage may occur due to rapid changes in the system static pressure:

- Fire and or smoke/fire dampers are activated
- Motorized zone/floor isolation dampers are over-ridden closed
- Variable volume system with VFD is switched to manual, or worse, full-line bypass

As a fan is started, it begins to build pressure in the ductwork. During this initial startup period, the static pressure in the system can vary significantly more than during normal operation, especially in a system that is large and serves multiple floors and/or areas. This is a good reason to have slow acceleration rates on VFDs to allow the static pressure to rise gradually. With VAV systems, you also have the added complication of terminal boxes coming into control, while the fan is still ramping up.

Static pressure safeties have a basic similarity to the old real-estate adage; it's all about location, location, location. Static pressure safety devices should never be installed in locations where dampers are between the fan and the unit static pressure safety device. The closing of any damper should never isolate the safety device from sensing the fan static pressure, such as:

- Fire dampers (fusible link and/or motorized)
- Smoke or combination smoke/fire motorized dampers
- Any motorized or manual isolation damper

Typically, static pressure safety devices are located at or near the air handling unit, supply fan or exhaust fan.

The following are items that are specific to fans with a VFD:

- Under normal start-up, it is recommended that VFDs should have a slow acceleration (90-120 sec.)

to allow the fan to ramp up gradually and allow the system to build pressure slowly. This allows the system to reach the DDC unit static pressure setpoint and without excessive static pressures swings (hunting) and possible nuisance trips of the static pressure safety device.

- All drives have a coast to stop feature, but this may not slow the fan quick enough. Once a high static is tripped and the motor is disabled, the fan momentarily continues to spin at the same speed and static pressure in the system may continue to build well beyond the static pressure safety device setpoint. This is the scenario when ductwork and/ or dampers could be damaged. The quicker the fan can be slowed, the better are the chances that damage may be prevented or minimized. Many drives today have 2 separate acceleration/deceleration modes. One mode can be set to provide a normal start/stop with a slow acceleration/deceleration time and the other mode could be tied into the safety circuit to provide a shutdown with an a quicker deceleration through a braking feature, if a device in the safety circuit was tripped. Situations may be encountered where VFDs trip on over current, if a VFD is slowed too quickly. However, VFDs can typically produce between 15 and 20% braking torque without tripping on over current and without additional external components, such as braking resistors. When motors decelerate, they act as generators, and this dynamic braking makes the VFD produce additional braking or stopping torque. If an emergency or quick shut down sequence is utilized with a VFD, it needs to be thoroughly tested to provide the quickest deceleration (breaking) possible, without tripping the VFD on over current.

There is no 100% guarantee that a static pressure safety will prevent damage to ductwork, dampers or other equipment. However, if the correct devices are in use in the correct locations, are programmed correctly and are thoroughly tested, there is a much better chance of damage not occurring.

- DDC systems should to be programmed and tuned to prevent excessive cycling/hunting of the system static pressure, especially on start-up. Control contractors often want fast acceleration/deceleration rates to be set on VFDs. This can cause excessive hunting of the system static pressure and cause static pressure safety trips. Fast acceleration/deceleration ramp speeds also require a fast response by the control system, which again can lead to excessive cycling in the system static pressure, tripping of the static pressure safety, or worse, damage to the system. If fans have a slow acceleration rate, the static pressure in the ductwork has time to slowly build and even with quick control sequence response tuning, the controls systems can gain control without the over swing often seen on unit start-up.

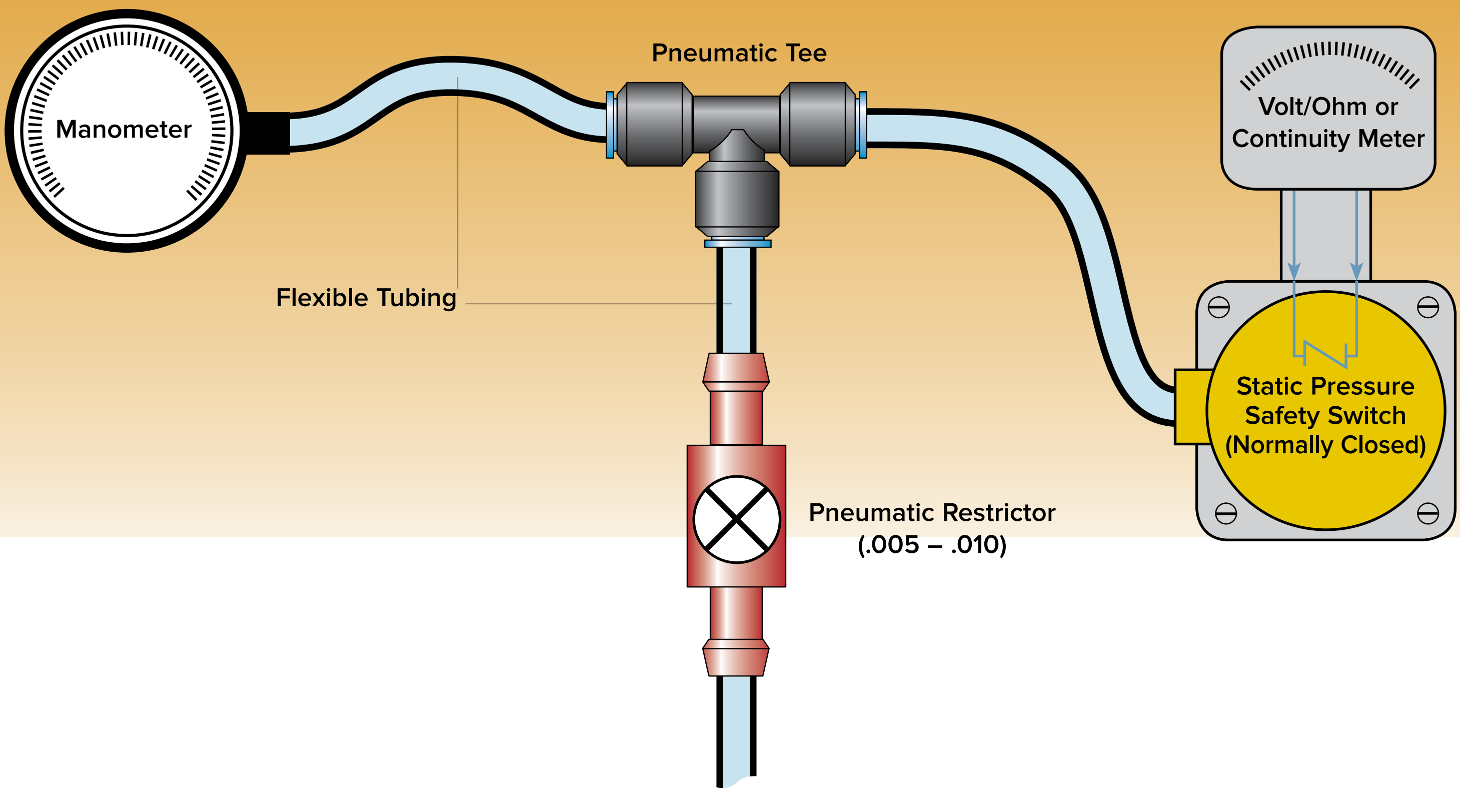
Static pressure safety setpoint values are not a "one size fits all" condition. There is no typical value for a static pressure safety setpoint. The TAB contractor needs to know several things before a static pressure safety setpoint can be determined:

1. The design maximum static pressure rating of the ductwork; the ductwork specifications need to be reviewed. If there is any question, the mechanical engineer should be contacted (RFI) to verify the ductwork rating.
2. This rating should also be verified with the mechanical contractor to make sure the ductwork actually installed can and will safely operate at the design maximum static pressure.

There are several considerations that must be considered to determine and/or set the static pressure safety setpoint:

1. The setpoint of the static pressure safety device should never be set at or above the design maximum static pressure for the ductwork.
2. It is recommended the actual static pressure setpoint for the safety device not be set higher than 90% of the design maximum static pressure.
3. Typically, the static pressure safety setpoint should not be higher than 1.0 inches of water gauge above the required unit DDC control static pressure setpoint*.

   Note: The required unit DDC static pressure controller and the static pressure safety device are not the same device and should not be set at the same



static pressure value. The required unit DDC static pressure setpoint can only be determined by specific testing. During testing and balancing of the terminal boxes, there is always one box that is the hardest one to obtain design CFM. Typically, you may have to increase the unit DDC static pressure setting to get design CFM to this box. This is the box that you use to determine the required DDC unit static pressure setpoint. The required static pressure setpoint is determined by measuring the actual pressure at the unit static pressure DDC sensor when design CFM is barely obtained at this terminal box. The system static pressure need only be high enough to obtain design CFM at this terminal box, without actually bringing the box VAV damper into control. The static pressure actually required to bring the box into control could be significant and is a waste of energy by the fan and that would have to be maintained under all operating conditions in the future.

Once the required unit DDC static pressure setpoint has been determined, the actual static pressure at the static pressure safety device must also be verified under the same test conditions. Once the actual pressure at the static pressure safety device has been measured, about 1.0 inches of water gauge pressure can be added to that value to use for the static pressure safety setpoint. As long as this value does not exceed 90% of the duct design maximum static pressure, there should be a reasonably safe setpoint for the static pressure safety.

After the required setpoint for the static pressure safety device has been determined, the unit static pressure safety needs to be set and tested. Initial setpoint adjustment and testing should be done without the unit operating. This can be done with a volt/ohm or continuity meter across the dry contacts of the static safety and a device to simulate a static pressure increase/decrease at the safety device. This can be done in numerous ways. The illustration above shows a basic static pressure simulating device. The pressure for the static pressure simulating device is provided by blowing (simulating a positive pressure for a supply fan) or sucking (simulating a negative for an exhaust/return fan) on the open end of the tubing. The pneumatic restrictor slows the increase/decrease of the simulated static pressure to provide a fairly stable pressure that will allow setting and testing of the static safety. Once the required simulated pressure at the static pressure safety has been obtained, adjust the static safety device to trip, then drop off the pressure and reset the static safety. Then again increase the simulated static pressure to verify it is tripping at the proper setpoint. If it is not is not set properly, repeat the steps until it is set and trips at the required setpoint.

As noted in the opening of this discussion, there is no 100% guarantee that a static pressure safety will prevent damage to ductwork, dampers or other equipment. However, if the correct devices are in use in the correct locations, are programmed correctly and are thoroughly tested, there is a much better chance of damage not occurring.

EXHAUST AIR TERMINALS

Eric V. Schneider, TBE
American Testing, Inc.

American Testing, Inc. was contracted to test and calibrate the supply and exhaust air terminals serving an existing laboratory suite. PPE was required to enter the suite which consisted of a lab coat, gloves, head and shoe covers. The suite had a gowning room connected to an equipment room on one side and an unrated corridor on the other. The equipment room was common to three adjacent laboratories. All laboratory doors were monitored by differential pressure sensors set to alarm when below .025" for more than 30 seconds. The gowning door from the corridor was also monitored by a differential pressure sensor with the same parameters as the laboratory doors. The door between the gowning and equipment room was not monitored and was only required to maintain directional airflow from the gowning into the equipment room. Between the staging area and the gowning room was an autoclave for sterilizing outgoing waste and materials (see the "Design Conditions" diagram for the suite layout, design room air volumes, directional airflow and minimum required door differential pressures).

All supply and exhaust terminals serving the suite were calibrated without issue through the cooperation of the control contractor. Door differential pressure measurements

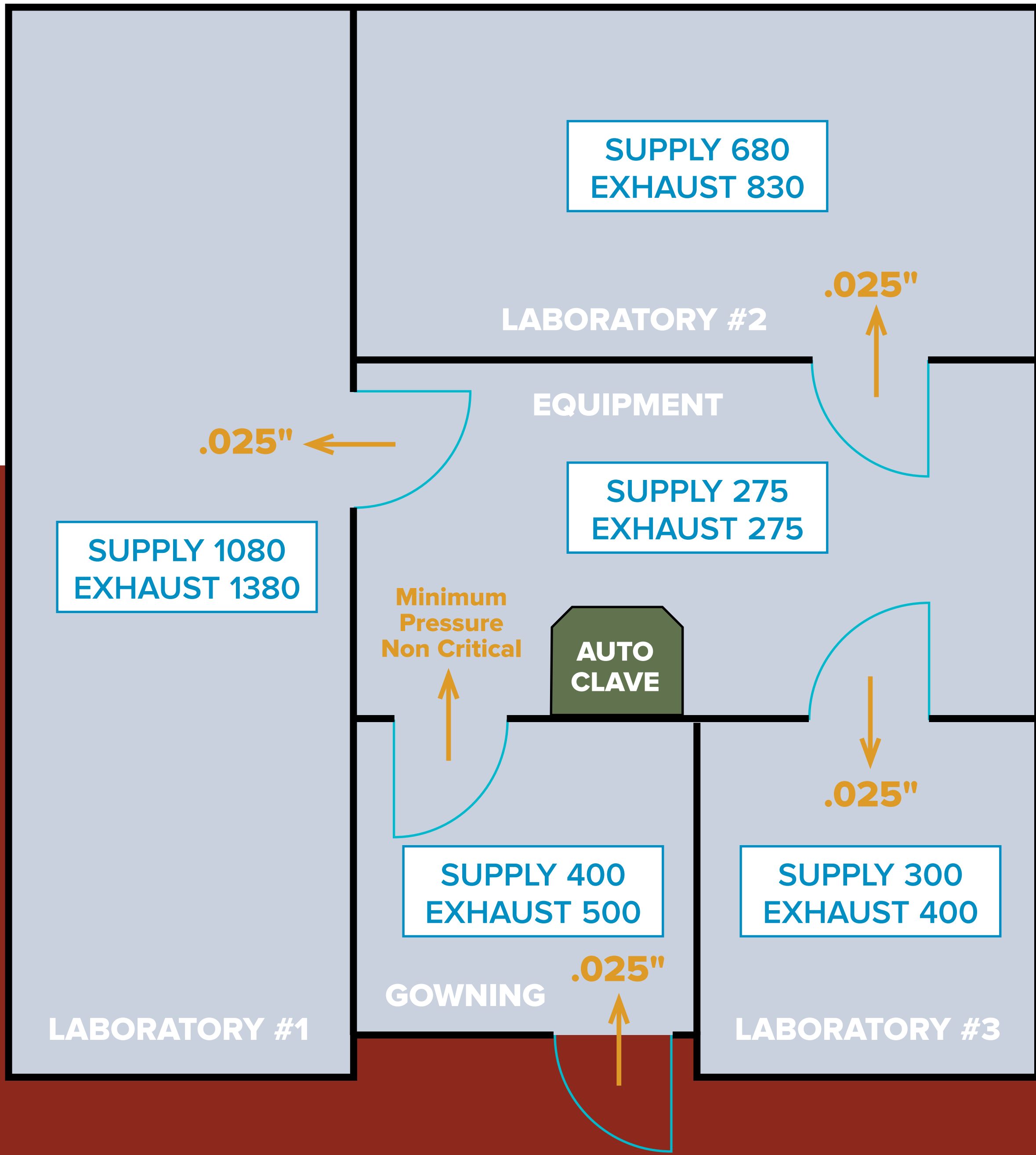


FIGURE 1: *Initial pressure readings*

were then recorded and all laboratory doors were found to be above the minimum alarm points of the monitors and flowing in the correct direction. The entry door to the gowning from the unrated corridor was measured at .008" wc in the correct direction but well below the alarm point of the monitor. The gowning door to the equipment room was found to be nearly neutral but flowing into the equipment room. The supply terminal serving the equipment room was indexed closed and the door pressures were retested; all door pressures remained virtually unchanged leaving us a bit perplexed.

The next course of action was to check the integrity of the walls and ceiling of the equipment room to find an alternate path where the air was entering the room. All access doors were found to be sealed and all walls were found to be solid with all penetrations fire stopped and sealed. The side panels of the autoclave were removed in the equipment room to inspect for unsealed or hidden openings into the walls, there were none. On a whim, a beaker of tap water was dumped into the 4" drain under the autoclave and the door pressures were again measured, the test results were surprising! The laboratory doors were above the alarm points of the monitors and the gowning door from the corridor was maintaining a

.042” wc differential pressure. The supply terminal serving the equipment room was returned to its original set point and final airflow and pressure measurements were recorded (see the “Final Conditions” diagram of the suite).

Questioning the facility manager revealed that the autoclave had been removed from service for several months which permitted the trap to dry completely. Inspection of the drain line from the interstitial space below revealed that it was connected to a laboratory/acid waste line and not to a sanitary sewer. This explained the lack of odor that normally indicates an unprimed sewer trap.

It is the challenging situations and abnormal solutions that require a vigilant eye and attention to detail.

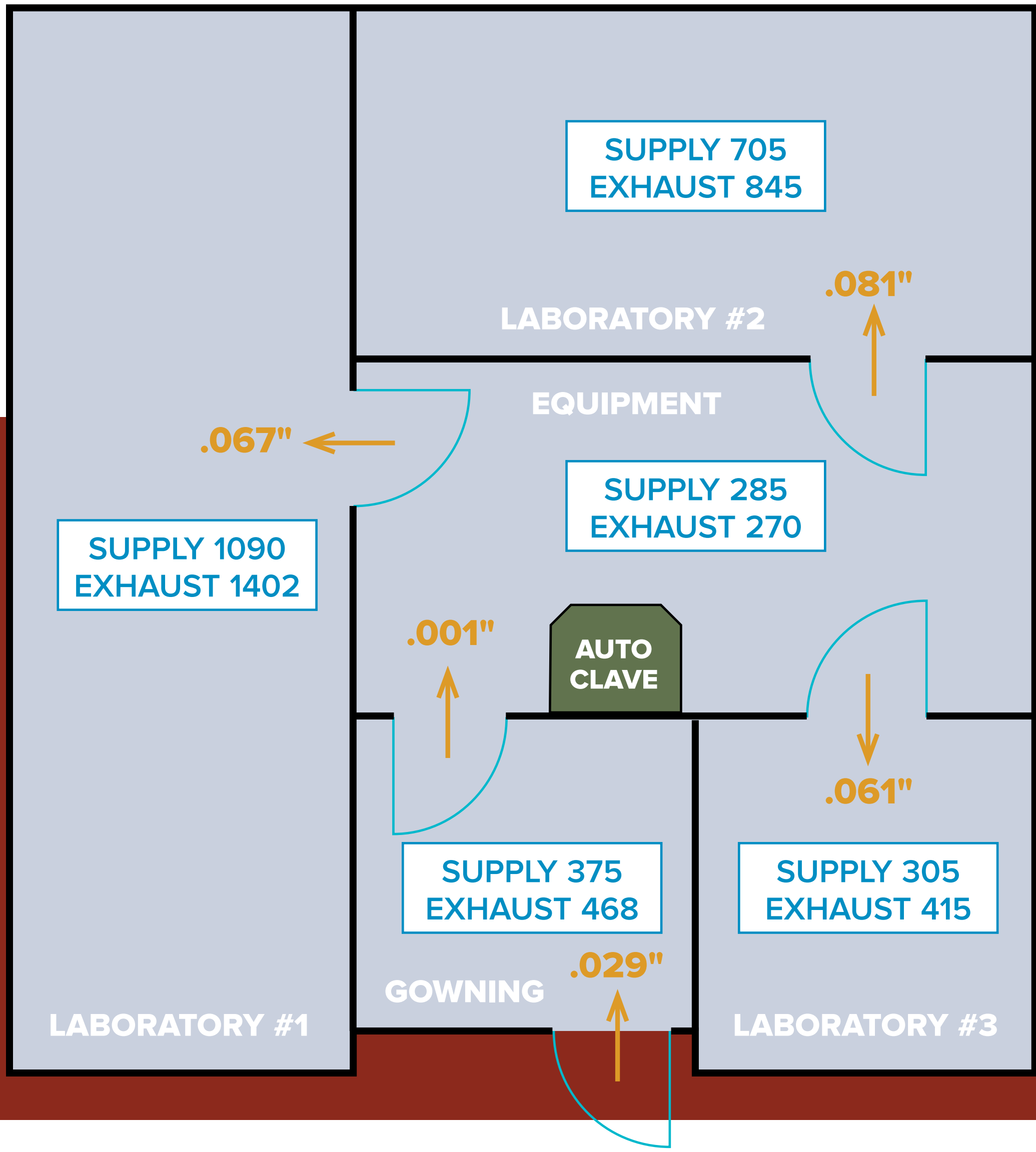


FIGURE 2: *Pressure readings after filling the autoclave drain with water*

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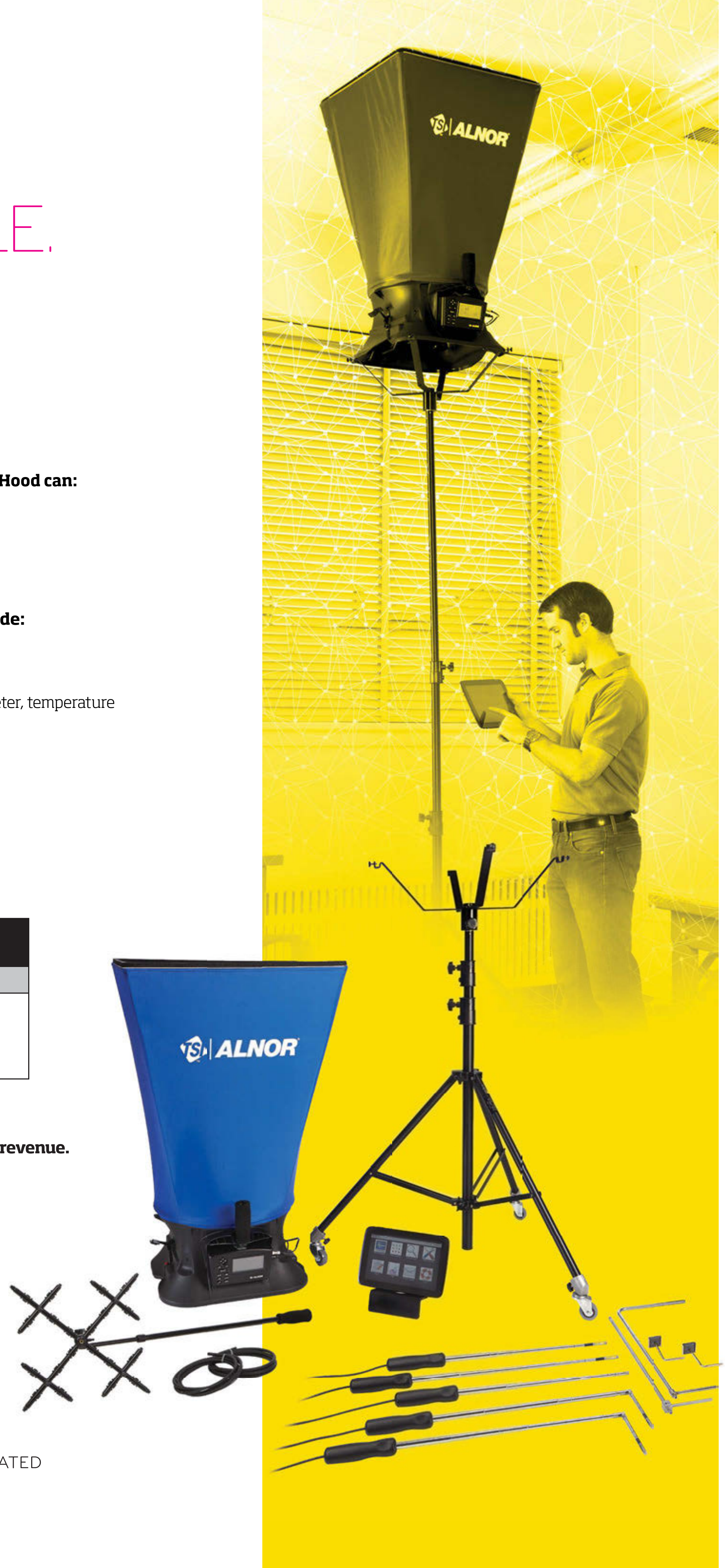

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