AN INTRODUCTION TO Static Pressure

Understanding and properly measuring static pressure can provide clues as to why a system is not performing efficiently to quickly get HVAC units healthy again.

BY DAVID RICHARDSON

Images courtesy of the author.

Measuring static pressure is a quick test that can help you evaluate an existing duct system and its installation conditions. Across the country this very day, equipment is unknowingly installed on drastically undersized duct systems that hinder them from operating to their full potential.

By properly utilizing static pressure testing, you can uncover problems associated with this type of installation that are invisible to your competition. You will find that once you begin to measure static pressure that there are more messed up duct systems than you will ever be able to correct. Consider how many of your service agreements include the duct system.

If you see duct pressures that exceed 0.10 in. wc, rest assured there is a restriction somewhere on that side of the duct system.

Static pressure 101

Static pressure is the amount of pressure a fan has to push and pull against to move air through a duct system. Static pressure is exerted equally on all sides of a duct system. This pressure is similar to that found by blowing up a balloon. When measuring static pressure, the unit of measurement used is inches of water column, which is often shown as an abbreviation such as "in. wc," "in. wg" or "in. H_2O."

One key to interpreting and diagnosing static pressure is to first understand how pressures change throughout an HVAC system. Pressure on the supply side of the duct system will be highest at the discharge of the fan in the equipment. The lowest pressure on the supply side of the duct system is usually found past the supply register as air enters a room. Pressure on the return side of the duct system will be highest at the inlet of the fan in the equipment. The lowest pressure on the return side of the duct system is usually found right before air enters the return grille.

An instrument used to measure pressure is called a "manometer." The most common manometer is a Magnehelic gauge. The 0–1-in. wc Magnehelic gauge works perfect for most testing, including residential and most light-commercial testing. The top port of this gauge measures positive pressure while the bottom port measures negative pressure.

Another style of manometer is a digital manometer. For static pressure testing, make sure the manometer is equipped with two pressure ports. Digital manometers should have a range from 0 in. to 5 in. and display pressure to 1/100 of an inch.

To complete the measurement of static pressure, you will need to have static pressure tips and tubing for making connections to the manometer. One manufacturer's static pressure tip is used to cancel out any effects of total pressure and velocity pressure on the manometer resulting in inaccurate pressure readings. You will also need 3/16- in.

tubing for testing. Neoprene tubing is a favorite of many who test static pressure on a regular basis due to how well it handles field abuse.

Testing steps/considerations

Static pressure testing normally requires five steps to complete:

1. Identify the locations you plan on drilling your test holes;
2. Drill your test holes in the equipment and/or duct system;
3. Take the needed static pressure readings;
4. Determine total external static pressure and system pressure drops; and
5. Compare your pressure readings to manufacturer's pressure ratings or look for the component that has the highest pressure drop to identify potential problems.

Per steps 1 and 2, you will need to drill test holes into the equipment and duct system in order to measure static pressure. To be safe, always use a drill bit sheath or step bit when drilling static pressure test holes in equipment. This will avoid damage to electrical components, drain pans, coils and heat exchangers. This also helps you avoid the dreaded hissing sound made from a refrigerant line or coil that has been hit. Make sure you know what is behind your test location to prevent any unnecessary headaches.

In step 4, you will need total external static pressure and system pressure drops. Total external static pressure is the total of pressures taken where air enters the equipment—or suction pressure (–)—and where air exits the equipment—or discharge pressure (+). These two pressures are then added together to indicate the total of the two pressure forces that the fan has to push and pull against.

The "+" and "–" signs represent the type of pressures found in these two locations, they are not mathematical symbols, so disregard the + and just add the two static pressure values together. Comparing this pressure to the rated fan pressure found on the equipment nameplate can tell you if repairs or modifications are needed to the system. This pressure can also be used with manufacturer's fan performance data to approximate the amount of air the air handling equipment is moving.

On a gas furnace, pressures are typically measured after the air flow exits the filter and before the airflow enters the coil. With most gas furnace/split A/C systems, the coil and filter are excluded from the pressure drop of the equipment. You can verify this in the manufacturer's engineering data.

« When drilling test holes in equipment, using a drill bit sheath or step bit will help to avoid damage to electrical components, drain pans, coils and heat exchanges.

When measuring the total external static pressure of an air handler, or packaged unit, the coil is included in the internal pressure drop specifications of the equipment by the manufacturer, just like a heat exchanger is on a furnace.

A concept that helps to understand where to measure total external static pressure is "as shipped." To apply this term, think about how the equipment comes from the factory as-shipped in the box. What is included in the box as it is shipped from the factory? Once you have that answer, you will have a pretty good idea as to what is included in the total external static pressure measurement for that piece of air-handling equipment.

System pressure drops

The possibility exists for many of the high-efficiency air filters on the market today to degrade the performance of an HVAC system. These restrictive air filters have the potential to turn a 16-SEER system into a 10-SEER system. By measuring the pressure drop over the air filter, you can identify if the filter is too restrictive for the application in which it is being used.

The pressure drop of an air filter is found by measuring the pressure on each side of the filter, then by subtracting the two pressures to find the pressure difference. Example: drill a test hole on each side of a filter, and measure the pressure in each test hole. Say the pressure before the filter measures 0.11 in. wc and the pressure after the filter measures 0.31 in. wc. Subtract 0.11 in. wc from 0.31 in. wc to find the pressure drop over the filter at 0.20 in. wc.

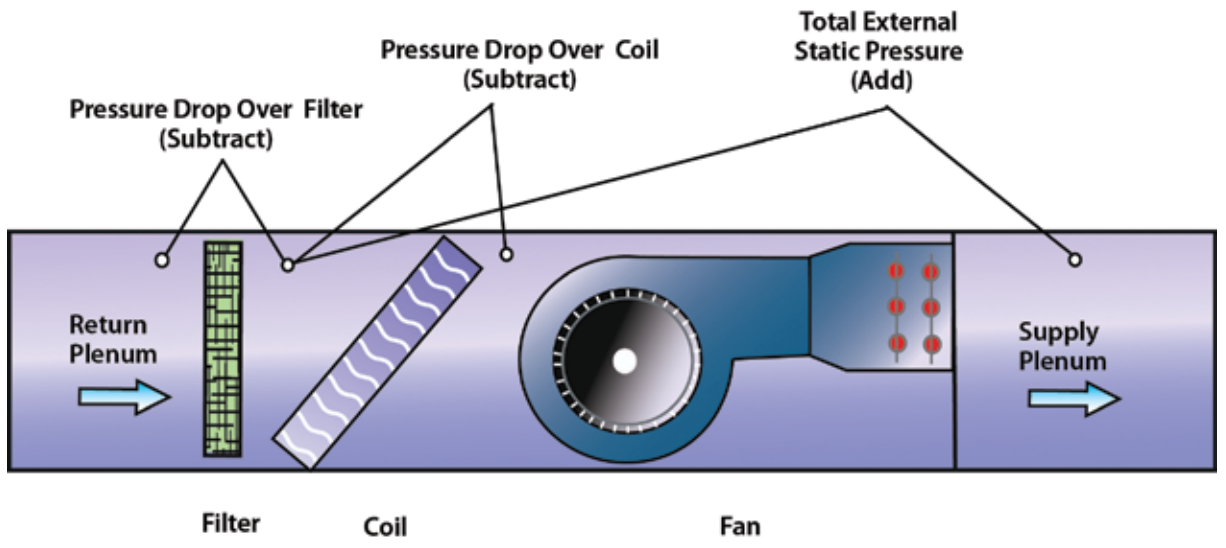

Figure 1 **Horizontal air-handler static pressure test locations.**

Measuring the pressure drop over the indoor coil of an HVAC system is performed in a manner that is similar to measuring the pressure drop of an air filter. Many service technicians will not perform this test as they are afraid of the methods involved with obtaining the readings since it involves drilling test holes in the equipment in certain instances. Most equipment manufacturers unintentionally put holes in their equipment, so these can be utilized for pressure testing if you know where they are.

> **You can compare the actual coil pressure drop to the manufacturer's rated coil pressure drop at the rated air flow to determine if the coil is clean.**

The coil pressure drop is found by measuring the pressure on each side of a coil, and then subtracting the two pressures to find the pressure difference. Example: drill a test hole on each side of the indoor coil, and measure the pressure in each test hole. Say the pressure before the coil measures 0.41 in. wc and the pressure after the coil measures 0.11 in. wc. Subtract 0.11 in. wc from 0.41 in. wc to find the pressure drop over the coil is 0.30 in. wc.

One of the biggest mysteries with measuring the pressure drop of an indoor coil involves knowing if the pressure drop reading you obtained is acceptable. How can you determine if the coil you tested is restricted or plugged up? How can you determine if the reading is acceptable and the coil is perfectly clean? The answer to this is the equipment manufacturer's coil pressure drop tables. You can compare the actual coil pressure drop to the manufacturer's rated coil pressure drop at the rated air flow to determine if the coil is clean. No more tearing the coil cabinet apart to visually inspect a coil for cleanliness.

You can measure the pressure drop over any other system component, such as a duct fitting, internal duct liner, a grille or suspected restriction in the duct system. This can help you track down restrictive conditions in the duct system. The side with the highest pressure is typically going to be the side that is the most restricted.

Static pressure in air-side diagnostics

When using static pressure as a diagnostic tool, it is best to look at pressure readings individually and together. Looking at readings individually allows you to see where the highest amount of resistance is in the duct system.

Fans are rated with a maximum total external static pressure that they should operate against. This rating is typically found on the equipment's nameplate data. If total external static pressure exceeds the rated pressure, the fan typically cannot move the required air flow the system needs.

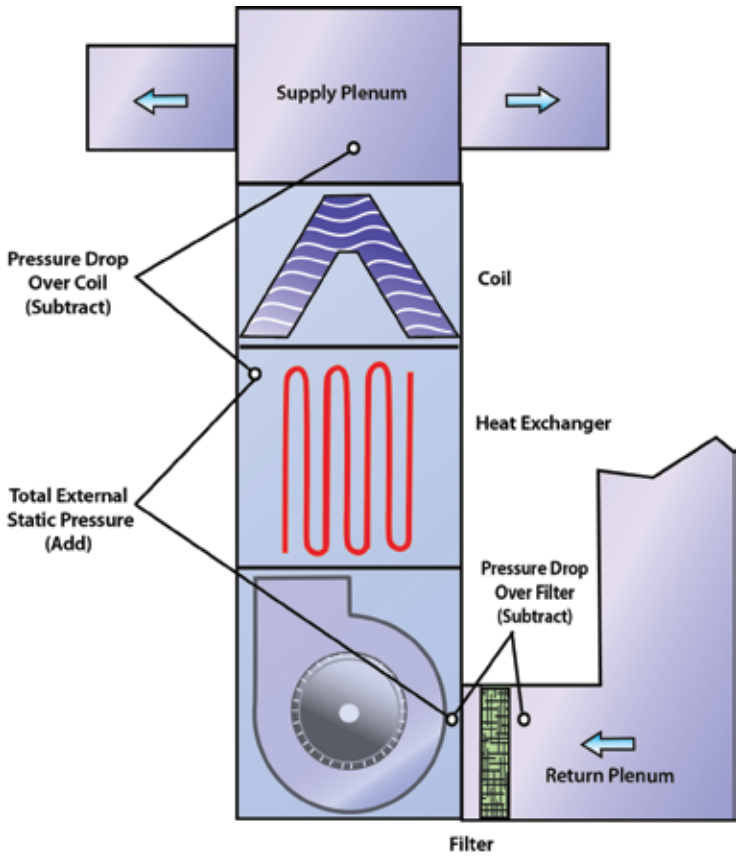

Figure 2 Upflow gas-furnace static pressure test locations.

One of the first tests in air-side diagnostics is to utilize the total external static pressure measurement. This reading is compared to the equipment's rated static pressure. If measured static pressure is higher than rated static pressure, the health of the HVAC system is probably not very good. By looking at individual pressure readings, you can see the side of the fan with the highest pressure is usually where the restriction is located.

The most accurate way to diagnose pressure drops is by comparing each pressure drop reading that you take to manufacturer's rated pressure drops. When this information is not readily accessible you can look for the component that has the highest pressure drop. If you see duct pressures that are over 0.10 in. wc, you can be assured that side of the duct system is restricted somewhere.

As you begin to test, think and speak of static pressure like blood pressure, this helps to keep it simple. High static pressure, like high blood pressure is not healthy and indicates that immediate improvement is needed. Just as high blood pressure is an invisible killer of so many, high static pressure is the same for HVAC systems. Inform your customers and give them the opportunity to improve the health of their HVAC system.

David Richardson serves the HVAC industry as a Curriculum Developer and Trainer at the National Comfort Institute. NCI specializes in training focused on improving, measuring, and verifying HVAC and Building Performance. If you are an HVAC contractor or technician interested in learning more about static pressure, contact Richardson at davidr@ncihvac.com or call 800-633-7058. NCI's website, www.nationalcomfortinstitute.com is full of free technical articles and downloads to help you improve your professionalism and strengthen your company.