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Selecting a Duct Leakage Test Apparatus

Technical Bulletin 3.1, *What Is An Allowable Leakage Specification*, compared some interesting findings in the area of allowable leakage specifications and explained that many allowable leakage specifications are erroneously written around a SMACNA leakage class.

Technical Bulletin 3.2, *System Leakage Comparison*, showed that leak testing low-pressure systems is just as important as testing medium- and high-pressure systems.

This technical bulletin will revisit how specifying to a leakage class, in cfm/100 sq ft, versus leakage as a percent of system cfm, can affect the selection of duct leakage testing equipment. It will also provide guidance in how to properly select that equipment using the sample duct system comparison project presented in Technical Bulletin 3.2.

The *SMACNA HVAC Air Duct Leakage Test Manual* is a document that predicts certain leakage rates of duct types and outlines procedures for testing ducts for conformity with allowable leakage rates that are (supposed to be) set forth in a designer's project specification. Section 3 of this manual, under *General Procedures* paragraph 3.10 *Precautions*, recommends the steps to be taken when selecting a leak test apparatus. The following outline details several of the initial steps.

Table 1: Standard Tubes and Capacities

Leak Detective Orifice Tube	Approximate cfm Range
LTK-4	5 - 50
LTK-5	50 - 500
LTK-6	120 - 1200
LTK-8	200 - 2000

A) "Verify that an adequate and matched electric power source is available for the test apparatus."

- The electrical requirements vary from country to country and should be verified and specified when ordering the test apparatus. For example, in the United States, 60 Hz is the standard, but in many countries, 50 Hz is the standard.
- Depending on the capacity of the testing apparatus, its fan motor will generally require 115-volt or 230-volt, single phase power, although others are possible. Be sure to check the voltage and related circuit breaker amperage available at the test site.

B) "Determine that the capacity of the test apparatus is suitable for the amount of duct to be tested."

We are using the sample duct system comparison project in Technical Bulletin 3.2, as the basis for the selection of the testing apparatus (McGill AirFlow's Leak Detective™ Duct Leakage Test Kit). For review, the system was an AHU handling 16,385 cubic feet per minute (cfm) with 3-inch wg SP of supply air. The complete system had nearly 1,900 lineal feet of duct with a total of 9,800 sq ft of duct surface area, of which 2,858 sq ft was for the 3-inch wg supply duct.

- Assuming that a SMACNA leakage class 12 (25 cfm/100 sq ft at 3-inch wg static pressure) is the allowable leakage for the rectangular duct system, the results are an allowable leakage of 646 cfm. This would require a leakage test kit with a 6-inch diameter orifice tube and a 5-hp, 230-volt, 30-amp fan to test the complete system. Alternatively, the system can be divided into approximately two 323 cfm test sections and a leakage test kit with a 5-inch diameter orifice tube and a 1-hp, 115-volt, 20-amp fan can be used. This would reduce the cost of the kit by ½ .

Applying McGill AirFlow's proven 50-year old axiom of "½ of 1 percent of system cfm" for leakage, the spiral flat oval duct system will not leak more than ½ of 1 percent of system cfm or 31 cfm, at 3-inch wg SP. The 4-inch test kit can be used to test the complete system.

- There are several varieties and sizes of leak test kits to choose from. Table 1 shows a list of McGill AirFlow standard Leak Detective orifice tubes and their cfm ranges. Located on the McGill AirFlow web site, mcgillairflow.com, is an on-line tool (Figure 1) that helps you to determine what standard test kit best suits your requirements based on the allowable leakage in cfm and test pressure in inches wg. Keep in mind the test kit pressure is based on the test pressure plus the pressure drop across the orifice for the selected cfm.

Figure 1 - Online Tools

C)"CONSIDER ACQUIRING EXPERIENCE WITH LEAKAGE RATES IN THE TYPE OF CONSTRUCTION USED BEFORE FORMALLY CONDUCTING FIELD TESTS."

- Technical Bulletins 3.1 and 3.2 discuss how rectangular duct rarely meets leakage rates below leakage class 6. A review of the *SMACNA HVAC Air Duct Leakage Test Manual,* Appendix A, shows a leakage class 6 to range between 3 and 6 percent of system cfm at 3-inch wg SP. The more a given size duct system leaks, the larger the test apparatus will need to be to quantify exactly how much more leakage there is above the specified leakage rate; unless the system is divided up into multiple test sections, which will cost more to test. The system may have to be divided up into multiple systems anyway.

- **Note:** The leak test apparatus instruction manual should be studied before use. It is suggested that anyone using leak testing apparatus be trained at an American Air Balance Council (AABC) or a National Environmental Balancing Bureau (NEBB) Certification Workshop.

D)"ISOLATE EQUIPMENT (FANS, IN-LINE FAN COILS, VAV BOXES, DAMPERS, ETC.) FROM THE TESTED DUCTWORK. THE SYSTEM DESIGNER SHOULD HAVE INDEPENDENTLY ACCOUNTED FOR LEAKAGE IN EQUIPMENT."

- This is probably the greatest contributor to "wasted" time spent sealing duct systems. Often such equipment is not held to the same leakage standard as the duct and contractors are often forced to further seal the duct system in order to compensate for leaky equipment. Duct system performance is only as good as the manner in which it was sealed. If you want low leakage for a cost saving, energy efficient duct system, make sure all the components are held to the same standards of performance and that a low allowable leakage rate is included in the specifications.

- Lower allowable leakage specifications require fewer temporary caps and plugs during testing. This reduces the excessive time it takes to install, seal, teardown, and reseal before moving to another test section. McGill AirFlow believes that the four Leak Detective test kits, as shown in Table 1, are capable of testing entire systems, or at least whole floors of larger buildings, provided spiral ductwork is specified and installed. Appendix F of the *SMACNA HVAC Air Duct Leakage Test Manual* shows the square feet of duct (SFD) surface area that can be tested by a leak test apparatus of given flow capacity as a function of leakage rate cfm/100 SFD to be measured.

E)"ANTICIPATE DIFFICULTY WITH ANY TEST OF DUCTWORK THAT HAS NO PRESCRIPTION FOR SEALING YET IS REQUIRED TO MEET AN ALLOWABLE LEAKAGE LEVEL."

- Engineers are encouraged to specify seal class A (all joints, seams and penetrations) for all duct types (supply, return, exhaust) regardless of pressure class in order to meet lower allowable leakage for the entire system. Why buy larger and more costly leak test apparatus to quantify duct system leakage when smaller and less costly equipment is all that is required to verify a tight leakage specification?

- Engineers are encouraged to specify that all duct systems, regardless of pressure class or duct construction, be tested using a leak test apparatus.

F)"DO NOT OVER PRESSURIZE DUCTS."

- Engineers are encouraged not to specify leakage testing at pressures that exceed the system operating pressure. It is also recommended to provide entering static pressures at branch takeoffs as test pressures when testing long duct runs or systems on multi-story buildings. Higher test pressures result in the need for heavier duct gauge/reinforcement and more expensive leak test apparatus. Over pressurization can cause structural damage and failure of the duct, which in turn can result in the failure of building components (ceiling tile, dry wall) in tight spaces.

- Most test apparatus have a means of choking off air to the test section and most instruction manuals advise they be choked at start-up to avoid over-pressurization.

Figure 2 -
Leak Detective Test Kits

Flow Measuring Device

There are several types of test apparatus available, including flow nozzles, venturi meters, laminar flow meters, etc., but the orifice tube is the simplest and least expensive to construct. The orifice tube is difficult to damage due to lack of moving parts, and with proper care does not require recalibration. McGill AirFlow's 50 years of experience has shown that simple orifice tubes made with punched, burned, or laser cut orifices, and calibrated against a master standard orifice tube, are just as accurate and durable for simple HVAC duct system leak tests as other test apparatus. Our orifice tubes are individually calibrated and certified traceable to NIST standards. We provide a graph and table noting the applicable leakage and pressure range of each orifice tube and an equation showing the leakage rate as a function of the pressure drop across the orifice tube. McGill AirFlow keeps the Certificate of Calibration and the Calibration Chart for each tube for a period of ten years and can forward you copies of them upon request.

Pressure Measurement Device

There are numerous pressure differential instruments available, including water and oil manometers, magnehelic gauges, digital manometers, and others. McGill AirFlow can supply any of these devices but has found the inexpensive U-tube water filled manometers work best because they have no moving parts and require no calibration service. This eliminates the worry about the device going out of calibration or the expense to repair or replace it if it is damaged.

Air Mover

There are several types of air movers to choose from and McGill AirFlow recommends using the more common centrifugal fan. Remember to consider the frequency, voltage, and circuit breaker capacity; and to order a flow control device such as a blast gate, ball valve, or volume control damper for choking the flow at start-up in order to prevent over-pressurization of the system.

When followed, the steps and considerations outlined in this bulletin will greatly assist in selecting the proper leakage testing apparatus. Leakage testing is key in controlling duct leakage and assuring that duct systems perform at the levels specified. As this series about leakage has demonstrated, controlling leakage is a multi-faceted process. Well designed duct systems require a good knowledge of duct types and their performance and leakage characteristics and understanding how to construct a viable allowable leakage specification. Verifying that specification with the best leak testing procedures and testing apparatus completes the process. Adhering to those practices is the way to ensure we are designing and installing the most cost effective and energy efficient duct systems possible.

This concludes McGill AirFlow's series about duct leakage. Refer to the McGill AirFlow *System Pressure Testing for Leaks* manual on our web site for procedures regarding how to use the Leak Detective Test Kit in qualifying leakage in a duct system. Contact the McGill AirFlow sales engineering office nearest you for more information about our products and services.

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