Tech Bulletin: CAS-TB3.2-2006

System Leakage Comparison

Table 1: Rectangular vs. Spiral Flat Oval Duct System Leakage Comparison

			Rectangular Duct			Sprial Flat Oval Duct		
Duct System	Pressure Class (in wg)	Seal Class	Leakage Class	Duct Surface Area (sq ft)	Leakage (cfm)	Allowable Leakage Rate	Duct Surface Area (sq ft)	Leakage (cfm)
AHU to VAV	+3	B	12	2858	686	½ of 1%	2624	31
VAV to Grille	+1	C	24	4898	1176	½ of 1%	4264	51
Return	-1	C	24	2043	490	½ of 1%	1926	36

When is the last time you chose to design a rectangular duct system instead of a flat oval system because you were working under the premise it would cost 10 to 20 percent less and provide equal airflow performance? Well, that premise is just not correct. This bulletin provides information that shows flat oval duct systems have much lower leakage rates than rectangular systems, which adds up to considerable energy savings over the life of the system. With ever increasing energy costs, building owners and engineers are encouraged to consider this information carefully.

To illustrate the energy savings a flat oval duct system can provide over a rectangular system, McGill AirFlow performed a system comparison of a project done for a public library. The project incorporated a 16,385 cfm, 5-inch wg TSP, 15-BHP rooftop air-handling unit. The original duct system design was comprised of 3-inch wg, rectangular supply ductwork between the AHU and variable-air-volume (VAV) boxes and 1-inch wg, supply rectangular and round ductwork from the VAV boxes to the diffusers. The return duct system was negative 1-inch wg rectangular. TDC joint connectors were used for the rectangular duct system and slip-connectors for the round. McGill AirFlow specified Uni-Flange™ light-gauge connectors, which are rated as T25 connectors, for its alternative flat oval duct system design. The following are the results of the comparison.

Technical Bulletin 3-1 explained that many allowable leakage specifications are erroneously written around a SMACNA leakage class. Leakage class is not an allowable leakage specification and should not be used as such. SMACNA does not publish an allowable leakage specification.

Table 1 shows the leakage rates that would result in the sample system for both the rectangular and flat oval duct designs. For comparison, the SMACNA leakage class was used as the allowable leakage specification for the rectangular system based on operating pressure. For the flat oval system, McGill AirFlow applied its proven 50-year old axiom of "½ of 1 percent of system cfm" for leakage as opposed to the industry's best accepted, leakage class 3.

As shown is Table 1, the complete rectangular supply system is predicted to leak a total of 1862 cfm (11 percent by system cfm) based on the two systems' leakage classes 12 and 24. The flat oval supply duct system is predicted not to leak more than 82 cfm (½ of 1 percent by system cfm). The rectangular return system is predicted to leak 490 cfm (7 percent by system cfm) compared to 36 cfm (½ of 1 percent by system cfm) for the flat oval.

This sample system is representative of many small, low-pressure commercial systems. Today's building owners can no longer afford leakage rates exceeding even one to two percent by system cfm. McGill AirFlow is seeing an increasing number of specifications requiring all duct systems be sealed to SMACNA leakage class 3, or better, in order to reduce energy consumption. Unfortunately, specifying more stringent sealing does not guarantee a low-leakage system. Remember that the SMACNA leakage class system shows the best rectangular duct systems with seal class A have a leakage class 6 or higher. A leakage class 6 for the sample system results in a 637 cfm (3 percent by system cfm) leakage for the supply side and 122 cfm (1 percent by system cfm) for return side. This may be considered acceptable by some of today's industry standards, but there is still substantial leakage.

One of two things must occur in order to ensure the designed cfm is available to maintain occupant comfort; either the system cfm must be increased to overcome the leakage, or the duct must be sealed to a much lower allowable leakage specification. Increasing the fan cfm requires an increase in fan BHP, a function of the cube root increase in cfm. The sample system leakage of 11 percent requires a minimum increase of 37 percent in BHP, or 15- to 20-BHP in this case, resulting in $3,900 more per year in energy costs for one fan to get the designed airflow to the occupants. Most engineers select a fan cfm that is 20 percent greater than what the design specifies in order to account for leakage and other design issues such as system effect. This practice gets the designed air volume to the register and the occupant, but in the case of the sample system, it results in $8,600 more per year in operating costs. How much over-design is justified in these days of increased energy costs? Why not specify a proven low-leakage flat oval duct system and save $3,900 to $8,600 per year?

SMACNA states that the cost of leak testing cannot be justified, especially for low-pressure systems. McGill AirFlow believes that all duct systems should be sealed to a specified low-allowable-leakage rate that is clearly noted in the specifications along with procedures about how and where to test for leaks to ensure conformance; ½ of 1 percent is not unreasonable for spiral duct systems. (More on these topics are coming in future technical bulletins.) Rectangular duct system construction is not less expensive than spiral flat oval duct systems, nor can rectangular duct be efficiently sealed to provide equal airflow performance. The designer should consider the material, installation, and operating costs when making a proper assessment. Specifying spiral flat oval duct systems for their low-leakage and energy-efficiency can save money. The next time someone says 20 percent or more could be saved on material costs by switching from a flat oval duct system to a rectangular one and still get the same equal airflow performance, ask them if they have factored in the significant increase in operating expenses that will be incurred due to the greater leakage. Controlling leakage controls energy costs. It is the only way to ensure maximum occupant comfort while maintaining low operating costs over the life of the building.

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