Reducing duct leakage in large commercial & institutional buildings

Air distribution systems are often overlooked when considering HVAC system efficiency, yet they play a crucial role in the efficient delivery of ventilation air and thermal comfort in commercial and institutional (C&I) buildings. Typically made of sheet metal construction, air distribution systems (or ductwork) are generally not air tight. Air leaks from ductwork are proportional to the size of the leaks and the pressure difference across the duct wall.

Leakage from distribution ductwork wastes energy by increasing fan power and discarding conditioned air. In extreme cases, excessive duct leakage can increase fan power by more than 50%. Assuming even a modest 5% rate of duct leakage, approximately 380 GWh of fan power is wasted per year in Minnesota C&I buildings. Duct leakage also results in significant heating and cooling energy penalties when leaked conditioned air is discarded from the envelope in exhaust or relief air systems.

Duct leakage has historically been viewed as a performance issue rather than an energy efficiency issue; thus there has been little effort in the past to target duct leakage with efficiency measures. The recent development of a novel sealing process (Aeroseal) makes it possible to tightly seal ductwork in retrofit applications because it requires significantly less access than traditional methods and incorporates its own validation measurement. The Aeroseal method injects sealant into the ductwork which accumulates at the small, distributed leaks throughout the duct system (Figure 1).

Figure 1: The Aeroseal SmartSeal System

The Center for Energy and Environment (CEE) received a CARD grant to conduct a field study to:

- characterize and measure duct leakage in several types of Minnesota C&I buildings;

- complete retrofit duct sealing on a subset of duct systems and estimate the energy savings and cost-effectiveness of retrofit sealing measures; and
- develop and test screening criteria in a small pilot program.

CEE surveyed and interviewed C&I air distribution design engineers and field personnel to develop expectations for air distribution systems in C&I buildings. This information was used to develop selection criteria to identify a representative sample of buildings to participate in the study. Sixty-three systems were screened for inclusion in the study, and duct leakage was measured on 27 systems using a combination of the pressurization method, tracer gas measurements, and a powered flow hood. Twenty of these systems were then sealed using both conventional methods and the Aeroseal method.

Duct leakage for the measured systems averaged 7%. Retrofit duct sealing was successful in 75% of systems using both the traditional and Aeroseal methods. An average of 81% leakage was sealed. The Aeroseal method was especially effective in sealing systems, often reducing leakage effectively to zero in a variety of scenarios inaccessible to traditional duct sealing measures. Overall, the pressurization method employed during the Aeroseal process is capable of accurately measuring sealed leakage when conducted at the correct operating pressure.

In most sealed systems, about 64% of energy saved was from heating (natural gas), 29% was from fan energy (electrical), and 6% was from cooling (electrical) (Figure 2). Cost savings come from reduced fan energy due to the higher cost of electricity. For a typical system, 66% to 75% of cost savings are from reduced electricity, and 25% to 33% of cost savings are from heating (natural gas) (Figure 3).

Figure 2: Energy savings from retrofit duct sealing

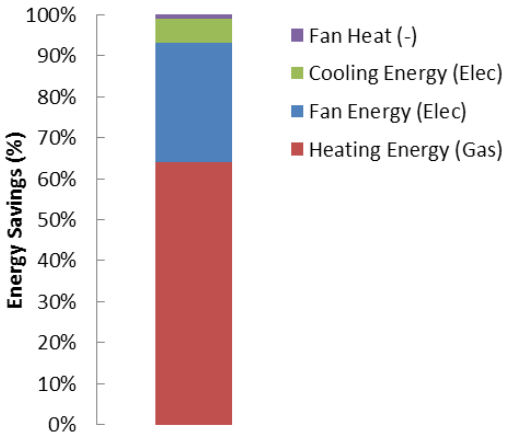
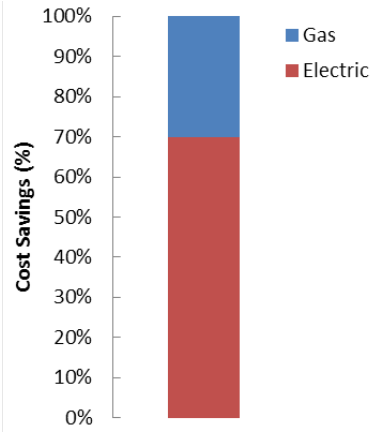


Figure 3: Cost savings from retrofit duct sealing



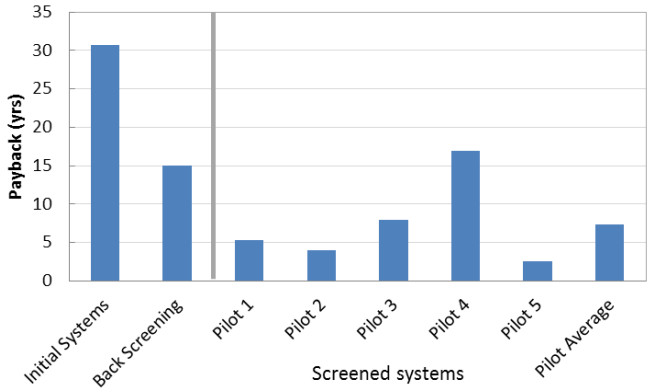
Project results also showed that accurately measuring duct leakage was comparable in labor and cost to duct sealing with the Aeroseal method. Hence, screening criteria thought to eliminate systems with poor payback and to identify systems as good candidates for cost-effective retrofit duct sealing could eliminate the need for initial duct leakage measurements. The four identified criteria are:

1. system type,

2. operating pressure,
3. design flow, and
4. apparent tightness.

Screening potential systems according to these four simple criteria in lieu of measuring duct leakage reduced the average payback from 31 years to 15 years for the original 20 systems, and to 7 years when used as the basis of system selection in a pilot program (Figure 4).

Figure 4: Simple payback of initial systems, initial systems back-screened, and pilot systems sealed on screening criteria.



Duct leakage in existing buildings has emerged as a new opportunity for savings. Project results suggest that about 10% to 15% of C&I buildings have leakage rates high enough to justify retrofit duct sealing work with moderate to good payback of 7 years or less. The following are potential utility program opportunities:

1. Incorporate retrofit duct sealing into existing commercial auditing, recommissioning, and turn-key savings programs.
2. Conduct outreach to inform and educate vendors and trade allies about the benefits of retrofit duct sealing measures.
3. Integrate Aeroseal duct sealing into new construction sealing and testing practices.

Read the full report, "Duct Leakage and Retrofit Duct Sealing in Minnesota Commercial and Institutional Buildings," for complete details on the results. In addition, a webinar summarizing the results will be presented by CEE on May 18 (see details under the "Webinars" section of this newsletter). For more information, contact project manager and CARD program administrator Mary Sue Lobenstein.