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## Improved Duct Sealing

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*This is the third article covering one of several new energy-saving technologies evaluated in a recent U.S. Department of Energy report. The complete report is at [www.eren.doe.gov/buildings/documents](http://www.eren.doe.gov/buildings/documents).*

Nothing is certain but death and taxes—and perhaps, leaky ducts. All ducts have some degree of air leakage but, unlike taxes, keeping leakage levels down to a reasonable level is possible. In practice, however, ducts leak more than they should. Measurements made by Lawrence Berkeley National Laboratory (LBNL) of commercial building duct systems found, on average, duct leakage exceeded the ASHRAE recommended leakage classes by roughly a factor of 20.<sup>1</sup>

Researchers also noted that light commercial building duct systems are particularly prone to problems, riddled with faults ranging from torn and missing external duct wrap, poor workmanship around duct take-offs and fittings to disconnected ducts, and improperly installed duct mastic.<sup>2</sup> Even with properly sealed ductwork, thermal cycling can damage sealant adhesives—especially the rubber-based adhesive in duct tape—increasing leakage over time.<sup>3</sup> Pressure cycling also may wear out duct seals over time, particularly with inadequately supported ductwork.

One way to minimize duct leakage is to install ducts properly. Accordingly, plan ahead so that ducts line up, supervise installation to ensure proper support and connection (using duct tape as hangers does not count), properly apply mastic to joints (again, no duct tape), and test for leakage during commissioning.

In practice, most newly installed ducts leak excessively, and many leaky ducts are already installed in the field—then what? Aerosol duct sealant systems can be used to patch holes and cracks in existing ducts using an adhesive-aerosol spray. To start the process, workers remove diffusers and block all of the ends to isolate the duct system, taking care to protect any coils, dampers, etc., to prevent fouling. Then, they spray a suspended adhesive mixture into the ductwork. The aerosolized adhesive flows throughout the pressurized duct system and exits through cracks or holes, depositing around the edges of holes and gradually filling them. If the root problem of the leakage was poor quality installation, additional manual repairs sometimes are needed before the sealant is applied. First commercialized in the 1990s, only a few companies currently offer aerosol duct sealing services.

### Energy Savings Potential

Repairing and patching leaks in HVAC duct systems saves cooling, heating, and fan energy. In air-based systems, ducts

deliver all of the heating and cooling to conditioned spaces. Any duct leakage translates into extra air that must be supplied so sufficient heating or cooling reaches the conditioned space. This not only increases effective heating and cooling loads, it also increases fan energy due to increased flow and/or run time. Sealing duct leaks reduces the amount of heated or cooled air the supply fan must handle to deliver the same amount of air to the conditioned space.

Researchers report that, on average, between 10% and 20% of the total air provided by the supply fan is lost to leaks in commercial buildings.<sup>1,2</sup> Measurements reveal that light commercial buildings tend to have significantly higher duct leakage rates than large commercial buildings. Light commercial buildings typically are not commissioned (unlike larger buildings), so duct leakage problems are not identified and fixed. In addition, smaller commercial building projects may not involve an HVAC design engineer and are more focussed on minimizing first costs, which can lead to inferior construction practices.

Measurements have demonstrated that aerosol duct sealing systems can reduce duct leakage rates to between 2% and 3% in commercial buildings.<sup>3</sup> Thus, improved duct sealing reduces heating and cooling energy consumption in air-based systems by at least 4% to 9%.\* As noted earlier, the air “lost” to the unconditioned space also increases the fan energy to deliver the required heating or cooling, increasing supply, return, and exhaust fan energy consumption by roughly 4% to 9%. These combined savings translate to potential primary energy savings of at least 0.23 quads in the U.S.

### Market Factors

Aerosol duct sealing is a labor-intensive service that costs on the order of \$0.40/ft<sup>2</sup> (\$3.71/m<sup>2</sup>) (of floor space), with light commercial buildings costing slightly less and large commercial buildings costing slightly more (due to system complexity). As the average commercial building spends approximately \$0.60/ft<sup>2</sup> (\$5.57/m<sup>2</sup>) each year on HVAC energy consumption,\*\* aerosol duct sealing will payback in about 10 years. This estimate does not take into account any impact on peak electricity demand which, due to the strong correlation between air-conditioning loads and peak electricity demand,

\* The 4% to 9% estimate reflects that duct leakage rates typically range from 10% to 20%, which duct sealing can reduce to 2% to 3%, i.e., the difference equals 8% to 18%. However, approximately 50% of leaked air ends up in the occupied (and conditioned) space,<sup>2,4</sup> that halves the difference, to 4% to 9%.

\*\* Based on detailed energy consumption information per ft<sup>2</sup>.<sup>6,7</sup>

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would tend to improve the economics of duct sealing. In addition, aerosol duct sealing came to market only recently, indicating that cost reduction opportunities likely exist.

In contrast, an HVAC industry consultant<sup>5</sup> who designs HVAC systems for higher-end residential construction estimates that taking the extra time to properly seal ducts during installation will add on the order of \$0.20/ft<sup>2</sup> (\$1.85 m<sup>2</sup>) to the installation cost of residential and light commercial systems versus common construction practice. However, ensuring proper installation may require testing and commissioning, adding as much as \$1/ft<sup>2</sup> (\$9.29 m<sup>2</sup>) to the construction cost. The cost premium associated with duct sealing or improved duct installation will dissuade many building owners from ensuring their ducts are not leaky. In many cases, such as light commercial buildings, owners with the “leakiest” ducts, i.e., those who have most to gain from reducing duct leakage, also face the greatest pressures to keep first costs down.

Changing common practice in duct installations may be difficult, but together with aerosol-sealing technology, the potential exists for higher performance ducts in new and existing buildings.

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