How ductwork affects energy use. This newsletter briefly examines the oft neglected component of an HVAC system: ducts. Discussions of energy efficiency in buildings usually focus on the heating and cooling plant, with the air distribution system rarely mentioned. This is unfortunate because research has shown that in commercial buildings, between 10% to 20% of total air provided by the supply fan is lost to leaks, which can add 4% to 9% in heating and cooling energy consumption.\(^1\)\(^2\) Leaky ducts increase the load on the plant and fan motor resulting in increased utility costs.

Sealing HVAC duct systems saves cooling, heating, and fan energy. Since the purpose of ductwork is to deliver heated or chilled air to a conditioned space, any leakage in the duct means that extra air must be supplied so that enough air reaches the conditioned space. Sealing any leaks in a duct system reduces the amount of heated or chilled air the supply fan must handle in order to deliver the same amount of air to the conditioned space.

Providing the most efficient air distribution system begins during the design stage of a building. Properly sizing ducts, minimizing and properly designing bends, locating ducts within the thermal envelope, and addressing duct connections all need to be considered during the design stage. Thereafter, during the construction process, duct systems need to be installed and sealed properly. Fortunately, commissioning of duct systems is gaining attention.

Properly sealing return air systems is just as important as sealing ducts for the supply side. If return ducts are leaky, the leaks can allow air from unwanted sources to become entrained in the return air stream (to then be distributed throughout the building) and can place locations that the return air ducts are drawing air from under negative pressure -- all undesirable conditions.

Ducts located outside the thermal envelope are of particular concern. Heat gain and losses can be significant in unconditioned spaces. Proper insulation and sealing is imperative in these situations. Leaking ducts within the thermal envelope are also of a concern since zones being supplied by these ducts are not receiving their proper air volumes which can also precipitate a host of balancing and thermal condition problems.

Signs of leaky ducts. During SEDAC energy assessments, it is common to find leaky duct systems. SEDAC auditors have on several occasions witnessed significant leakage from duct systems, and sometimes completely disconnected ducts. Telltale signs that ducts or seals around access doors are leaking are streaks of dust on duct surfaces at leakage locations. These are the extreme leaks; more subtle leaks aren’t as visible.

\(^1\) http://www.tiaxllc.com/aboutus/pdfs/ashrae_0501-03.pdf
\(^2\) http://eetd.lbl.gov/ie/pdf/LBNL-42339.pdf
Fixing leaky ducts. There are various ways to seal duct systems. Liquids, mastics, gaskets, and tapes have their appropriate uses. Ducts that are easily accessible can be sealed with liquids or mastics that are spread over connections or be sealed with special tapes that are made specifically for duct sealing. Ducts located within inaccessible building cavities can be sealed using more sophisticated, and costly, aerosol duct sealing techniques.

The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), the International Energy Conservation Code (IECC), and the Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA), all address duct design and construction. The IECC states that ductwork shall be constructed and erected in accordance with the International Mechanical Code.

ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings, specifies minimum duct sealing levels. Sealing levels are based on static pressure and the duct location: outside, in an unconditioned space, or in a conditioned space. Naturally, the higher pressures a duct will be exposed to, the greater the importance of sealing. SMACNA's HVAC Duct Leakage Test Manual provides information on duct system design, performance and testing procedures.

Finally, since duct sealing can be a labor-intensive process that can cost $0.40/SF of floor space, simple paybacks can range from seven to fourteen years based on an assumed annual HVAC operating expense of $0.60/SF. Benefits however can extend beyond economics to include occupant comfort and extended HVAC system life since HVAC components don’t need to work as hard to maintain comfort conditions. Also important to remember is that sealing ducts during new construction is far simpler and less costly than after construction has been completed. “Seal tight, ventilate right” does not only apply to the envelope of a building. It can just as well apply to the duct system too.