Research Highlights

Abstracts from LBNL reports that will be published soon.

Thermal Distribution Losses in Light Commercial Buildings

W.W. Delp, D.J. Dickerhoff, J. McWilliams, M.P. Modera, D. Wang

ABSTRACT
This paper summarizes the results of our field characterization of the performance of thermal distribution systems in light commercial buildings. The measurements reported include: 1) supply- and return-duct leakage area, 2) temperature rise between the supply plenum and the registers, 3) fan and register flowrates, 4) duct-system and building-space operating pressures, 5) the locations of the air and thermal barriers relative to the ceiling plenums with ductwork, and 6) the capacity and cycling characteristics of the cooling/heating equipment. This data is similar to the data taken in 1996 and 1997, and the 1998 data is compared with the earlier data, without any big surprises. The analyses performed for this paper include a characterization of the leakage by ASHRAE/SMACNA Leakage Classes. The results are quite dramatic, the average leakage class being 450 cfm at 1 inch H_2O per 100 ft^2 of duct surface area. This should be compared to 48 for unsealed ductwork, according to ASHRAE. This paper also includes simulations of energy-use impacts.

Duct Systems in Large Commercial Buildings: Physical Characterization, Air Leakage, and Heat Conduction Gains (Lawrence Berkeley National Laboratory Report No. LBNL-42339)

W.J. Fisk, W.W. Delp, R.C. Diamond, D.J. Dickerhoff, R. Levinson, M.P. Modera, M. Nematollahi, D. Wang

ABSTRACT
This paper summarizes the results of our field characterization of the performance of thermal distribution systems in large commercial buildings. The results presented are based upon field measurements and analyses of building plans. It includes a comparison of different methods for measuring/estimating air leakage rates. The effective leakage areas ranged from 0.4 to 2 cm^2/m^2 floor area, and the corresponding ASHRAE leakage classes ranged from 60 to 270, as compared to the 3-12 range reported by ASHRAE for quality duct construction and sealing practices. Most of the measured leakage flows ranged between 10% and 20% of fan flow, with a minimum of 0% and a maximum of 30%. The temperature rises between the outlet of the coiling coils and registers averaged between 0.6 and 2 ^oC. These temperature rises correspond to sensible capacity losses due to conduction of 10-25%.

Sealing Ducts in Large Commercial Buildings with Aerosolized Sealant Particles

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ABSTRACT

This paper reports on the first application of the aerosol sealing technology to seal duct leaks in a large commercial building. The sealing, measurement and characterization process was performed in two buildings. In brief, this process involves blocking all of the usual openings in a duct system (i.e., diffusers) such that when the system is pressurized with the aerosol fog, the only place for the air carrying the particles to exit the system is through the leaks. The principal finding from this field study was that the aerosol technology is capable of sealing the leaks in a large commercial building within a reasonable time frame. In the first building, 66% of the leakage was sealed within 2.5 hours of injection, and in the second building 86% of the leakage was sealed within 5 hours. We also found that the aerosol could be blown through the VAV boxes in the second building without impacting their calibrations or performance. Some remaining questions are: 1) what can be done to bring the sealing rates to the levels experienced in smaller residential systems, and 2) what tightness level can these ducts systems practically be brought to by means of aerosol sealing.

Impact of Duct Air-Leakage on VAV Distribution System Performance

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ABSTRACT
The purpose of this study was to evaluate the effect of duct leakage on air distribution system performance in a typical large commercial building. A model was developed under the TRANSYS simulation engine, and was used to evaluate the impacts of duct leakage on the annual and peak performance of a Variable Air Volume (VAV) distribution system with constant static pressure control serving an office space in Sacramento. Using leakage comparable to those found in our large-building field studies, the increase in annual fan energy was estimated to be 55% for a system with an overall leakage class of 137 compared to a system with no leakage. The increase in total HVAC energy was approximately 14%. Increased operating costs were estimated to be approximately $\$0.22/ft^2$ of duct surface area. Industry-suggested one-time sealing costs range from $0.00 to $0.25 per square foot of duct surface area. Based on the higher sealing cost value, the simple payback for duct sealing is 1.1 years. Assuming that we can accomplish this sealing after construction, retrofit duct sealing in commercial building VAV systems should also be cost effective.

Field Measurements of Efficiency and Duct Retrofit Effectiveness in Residential Forced Air Distribution Systems (Lawrence Berkeley National Laboratory Report No. LBL-38537)

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Proc. 1996 ACEEE Summer Study, August 1996, Asilomar, CA

SYNOPSIS Field tests were performed on duct systems in 24 houses pre- and post-retrofit to determine the potential savings due to sealing and insulating the duct system.

ABSTRACT
Forced air distribution systems can have a significant impact on the energy consumed in residences. It is common practice in U.S. residential buildings to place such duct systems outside the conditioned space. This results in the loss of energy by leakage and conduction to the surroundings. In order to estimate the magnitudes of these losses, 24 houses in the Sacramento, California, area were tested before and after duct retrofitting. The systems in these houses included conventional air conditioning, gas furnaces, electric furnaces and heat pumps. The retrofits consisted of sealing and insulating the duct systems. The field testing consisted of the following measurements: leakage of the house envelopes and their ductwork, flow through individual registers, duct air temperatures, ambient temperatures, surface areas of ducts, and HVAC equipment energy consumption. These data were used to calculate distribution system delivery efficiency as well as the overall efficiency of the distribution system including all interactions with building load and HVAC equipment. Analysis of the test results indicate an average increase in delivery efficiency from 64% to 76% and a corresponding average

decrease in HVAC energy use of 18%. This paper summarizes the pre- and post-retrofit efficiency measurements to evaluate the retrofit effectiveness, and includes cost estimates for the duct retrofits. The impacts of leak sealing and insulating will be examined separately.

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