NIST Report:
Continuous Air Barrier Systems Reduce Energy Costs

by ABAA

A ground-breaking report from the National Institute of Standards and Technology (NIST), *Investigation of the Impact of Commercial Building Envelope Airtightness on HVAC Energy Use,* confirms that continuous air barrier systems can reduce air leakage by up to 83 percent and energy consumption for heating and cooling by up to 40 percent.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1 Envelope Subcommittee is looking to update the building air leakage requirements in the standard to include a continuous air barrier system. The NIST report was prepared in part to show that committee the potential energy savings and cost effectiveness of an air barrier requirement.

The study was conducted by Steven J. Emmerich (Building and Fire Research Laboratory, NIST), Timothy P. McDowell (TESS Inc.) and Wagdy Anis (Shepley Bulfinch Richardson and Abbott). It evaluated the energy savings of an effective air barrier requirement for non-residential buildings in five cities representing different climate zones (Miami, Phoenix, St. Louis, Bismark and Minneapolis).

The methodology included blended national average heating and cooling energy prices and cost effectiveness calculations matching the scalar ratio method employed by ASHRAE SSPC 90.1. The report states that:

"Despite common assumptions that envelope air leakage is not significant in office and other commercial buildings, measurements have shown that these buildings are subject to larger infiltration rates than commonly believed. Infiltration in commercial buildings can have many negative consequences, including reduced thermal comfort, interference with the proper operation of mechanical ventilation systems, degraded indoor air quality, moisture damage of building envelope components and increased energy consumption."

In the cost calculations, the research team included upgrades to air barrier systems with components that met material air tightness levels of 0.02L/m^2 at 75Pa (0.004 cfm/ft^2 at 0.3 inH_2O) and were judged to be consistent with the proposed new air barrier requirements.

The NIST study's findings show that the inclusion of an air barrier system in non-residential buildings can reduce air leakage by up to 83 percent, representing a large reduction in energy consumption and operating costs: potential gas savings of greater than 40 percent, and electrical savings of greater than 25 percent.

Annual Energy Cost Savings for 24,200 ft^2 Office Building at Target Air Leakage Level

City	Gas Savings $	Gas Savings %	Electrical Savings $	Electrical Savings %	Total Savings
Bismarck	$1,854	42%	$1,340	26%	$3,195
Minneapolis	$1,872	43%	$1,811	33%	$3,683
St. Louis	$1,460	57%	$1,555	28%	$3,016
Phoenix	$124	77%	$620	9%	$745
Miami	$0	0%	$769	10%	$769

Annual Energy Cost Savings for 12,100 ft^2 Retail Building at Target Air Leakage Level

City	Gas Savings $	Gas Savings %	Electrical Savings $	Electrical Savings %	Total Savings
Bismarck	$1,835	26%	$33	2%	$1,869
Minneapolis	$1,908	28%	$364	18%	$2,272
St. Louis	$1,450	38%	$298	9%	$1,748
Phoenix	$176	64%	$992	14%	$1,169
Miami	$6	98%	$1,124	14%	$1,231

Annual Energy Cost Savings for 36,864 ft^2 Apartment Building at Target Air Leakage Level

City	Gas Savings $	Gas Savings %	Electrical Savings $	Electrical Savings %	Total Savings
Bismarck	$2,187	40%	-$116	-9%	$2,071
Minneapolis	$2,421	43%	-$165	-14%	$2,256
St. Louis	$1,794	57%	-$232	-12%	$1,562
Phoenix	$133	65%	$0	0%	$133
Miami	$31	63%	$380	9%	$411

Summary of Calculated Scalar Ratios (< 8 = cost effective)

	Bismarck	Minneapolis	St. Louis	Phoenix	Miami
Office					
Cost energy x Scalar 8	$25,701	$25,701	$24,122	$5,956	$6,153
Average Scalar	1.77	1.77	2.6	7.6	7.3
Retail					
Cost energy x Scalar 8	$14,946	$18,174	$13,985	$9,345	$9,840
Average Scalar	1.8	1.47	1.93	2.87	2.7
Apartment 1					
Cost energy x Scalar 8	$16,567	$18,045	$12,498	$1,067	$3,294
Average Scalar	1.4	1.3	1.8	21.35	6.9
Apartment 2					
Cost energy x Scalar 8	$16,468	$17,067	$12,326	$994	$3,286
Average Scalar	1.4	1.35	1.85	22.9	6.9

ASHRAE 90.1 committee uses pass-fail criteria for including energy conservation requirements in the Standard based on cost-effectiveness of the measure proposed. The cost of implementation of the energy conserving measure (in this case the air barrier improvements) needs to be equal to or less than the annual energy saved due to the measure multiplied by 8; that is the “pass” criterion for the measure to qualify being included in the Standard. “8” is termed the “Scalar Ratio”. The table above shows the “Cost of annual energy savings x 8”, in other words, what can be spent on the air barrier improvements within the guidelines of the Standard. The calculated scalar is the actual multiplier based on the annual energy saved divided by the cost of the upgrade to an air barrier using the different airtightening strategies delineated in the report.

The NIST study recommends further study of building envelope air tightness, including:

- Analysis of costs and potential energy savings from tightening of existing buildings and development of recommendations for existing building stock
- Development of more refined (climate specific, etc.) air tightness targets
- Extended study of other building categories

- Examination of potential interaction between air tightness and other building parameters
- Testing of air tightness in buildings built to a tightness standard (i.e. MA) to determine if standards are met in practice
- Development of diagnostic protocols for failures of envelopes that deteriorate IAQ and energy efficiency