Session IX-B: HVAC

Wednesday, December 8, 2004
10:30 a.m. to 12 noon
Grand Ballroom – Palm

Session Chair:

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10:30 a.m. to 10:40 a.m. Introduction
Collin Olson

10:40 a.m. to 11:00 a.m. *"Uses and Misuses of Duct Board: Understanding the New High- Performance Materials"*
Brad Oberg

11:00 a.m. to 11:20 a.m. *"Insulation Buried Attic Ducts—Analysis, Laboratory and Field Evaluation Findings"*
Dianne Griffiths

11:20 a.m. to 11:40 a.m. *"Reducing Uncertainty for the DeltaQ Duct Leakage Test"*
Iain Walker

11:40 a.m. to 12:00 p.m. *"HVAC Sizing for Insulated Concrete Homes"*
Martha VanGeem

Uses and Misuses of Duct Board: Understanding the New High-Performance Materials

Brad Oberg – *IBACOS, Inc.*

This paper is based on a white paper developed at the author's firm, which discusses the appropriate uses for fibrous glass duct board for residential HVAC applications. Here the author describes the characteristics and benefits of fibrous glass duct board and addresses issues specific to fibrous glass duct construction, including the concern that fiberglass ducts collect water and support growth of mold.

Insulation Buried Attic Ducts—Analysis, Laboratory and Field Evaluation Findings

Dianne M. Griffiths and Marc Zuluaga – *Steven Winter Associates*

The Building America program, funded by the Department of Energy, applies a systems engineering approach to residential construction. The ultimate goal is to improve energy and resource efficiency without increasing the builder's cost. A key element of the systems engineering approach for most Building America projects has been to improve space conditioning system efficiency by reducing or eliminating duct losses or gains. The Consortium for Advanced Residential Buildings (CARB), one of five Building America industry teams, has been researching the benefits of burying attic ducts under loose-fill attic insulation. Research has included analysis using finite element modeling, laboratory testing using Oak Ridge National Laboratory's climate simulator test facility, and field testing in California homes.

Initially, a finite element analysis was used to determine the effective R-value that conventional hung ducts must be wrapped with to achieve the same thermal performance as buried ducts. This effective R-value could then be applied in energy simulation tools to assess the peak energy demand and annual energy use benefits of the buried duct concept. The analysis results were simplified, as presented in Table 1, and became the basis for Table R4-12 of the Residential ACM Manual proposed for California's 2005 Building Energy Efficiency Standards. Simulation results from small ducts and large ducts were combined, making these guidelines applicable to ducts of all size commonly encountered in residential applications. This simplification is valid since for a particular buried duct classification, the impact of duct size on effective R-value was found to be small.

For the simplified results, the buried ducts are classified as either "deeply," "fully," or "partially" buried. Deeply buried indicates that the depth of the loose-fill insulation is at least 3.5 in. higher than the top of the insulating duct wrap. Fully buried indicates that the depth of the loose-fill insulation is even with the top of the insulating duct wrap. Partially buried indicates that the depth of the loose-fill insulation is 3.5 in. lower than the top of the insulating duct wrap. The duct wrap is 1.25 in thick with an R-value of 4.2 ft2ÞhÞ°F/Btu, representing standard construction practice at the time of this study. A schematic illustrating these classifications is presented in Figure 1. Laboratory and field test results suggest that the analytical results provide a reasonably accurate estimate of duct performance.

Reducing Uncertainty for the DeltaQ Duct Leakage Test

Iain Walker, Max Sherman, and Darryl Dickerhoff – *Lawrence Berkeley National Laboratory*

The thermal distribution system couples the HVAC components to the building envelope and shares many properties of the building envelope including moisture, conduction, and, most especially, air leakage performance. Duct leakage has a strong influence on air flow rates through building envelopes (usually resulting in much greater flows than those due to natural infiltration) because unbalanced duct air flows and leaks result in building pressurization and depressurization. As a tool to estimate this effect, the DeltaQ duct leakage test has been developed over the past several years as an improvement to existing duct pressurization tests. It focuses on measuring the air leakage flows to outside at operating conditions that are required for envelope infiltration impacts and energy loss calculations for duct systems. The DeltaQ test builds on the standard envelope tightness blower door measurement techniques by repeating the tests with the system air handler off and on. The DeltaQ test requires several assumptions to be made about duct leakage and its interaction with the duct system and building envelope in order to convert the blower door results into duct leakage at system operating conditions. This study examined improvements to the DeltaQ test that account for some of these assumptions using a duct system and building envelope in a test laboratory. The laboratory measurements used a purposely built test chamber coupled to a duct system typical of forced air systems in U.S. homes. Special duct leaks with controlled air flow were designed and installed into an airtight duct system. This test apparatus allowed the systematic variation of the duct and envelope leakage and accurate measurement of the duct leakage flows for comparison to DeltaQ test results. This paper will discuss the laboratory test apparatus design, construction, and operation, the various analytical techniques applied to the calculation procedure, and present estimates of uncertainty in measured duct leakage.

HVAC Sizing for Insulated Concrete Homes

John Gajda, Medgar L. Marceau, and Martha G. VanGeem

Construction Technology Laboratories, Inc.

Insulated concrete walls such as insulating concrete form (ICF) walls, cast-in-place insulated concrete walls, insulated pre-cast walls, autoclaved aerated concrete (AAC) walls, and insulated concrete masonry (CMU) walls are increasingly being utilized as an alternative to wood frame walls in residential construction.

Houses constructed from these insulated concrete walls are energy efficient because of the inherent thermal mass, high levels of insulation, and low air infiltration of these walls. Considerable work has been performed to compare the energy performance of concrete homes to that of wood-framed alternatives. Because of the inherent energy saving properties of insulated concrete walls, heating, ventilating, and air conditioning (HVAC) systems can be downsized by as much as 15 to 40% in concrete homes compared to similarly insulated wood framed homes.

Unfortunately, widely used HVAC sizing methods do not correctly account for the thermal mass, high levels of insulation, and/or low air infiltration of the insulated concrete walls. Even worse, many builders and HVAC contractors size HVAC systems based on a “rule-of-thumb” developed for wood framed homes that equates equipment size with square footage of living space. The net result is an inefficient HVAC system that is typically over- or undersized. An improperly sized HVAC system can result in occupant comfort issues, increased energy use, and moisture-related problems.

A sizing methodology and desktop tool was developed to properly size HVAC systems for concrete homes across North America. The methodology was based on extensive modeling that utilized hourly energy analyses for a range of climate types. The methodology was designed to be both easy to sue and accurate. Inputs are primarily based on the orientation and area of walls and windows.