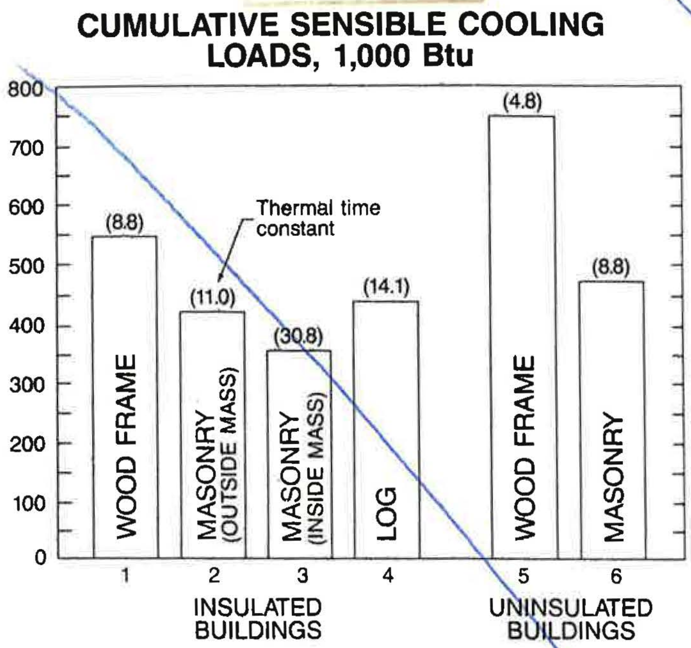

Figure 2
Cumulative Space Cooling Loads for the 76° F (25° C) Summer Cooling Test

The time constant characterizes the indoor temperature response of a building after space-conditioning equipment is suddenly turned off. It is sometimes described as a measure of "thermal inertia." Technically, it is defined as the time required for the indoor temperature to decrease (or increase) 63% from an initial temperature level to a final temperature level after the heating (or cooling) plant is suddenly turned off during a period of constant outdoor temperature. The greater the time constant, the longer the cooling off (or warming up) period. The time constant depends on the amount of thermal mass in the building AND the R-value of the building thermal envelope. In other words, increasing the amount of thermal mass OR increasing the R-value of the exterior skin increases the time constant of a building.

Figure 2 shows the time constant of the six test buildings. Notice that the greater the time constant, the lower the cooling load.

The Question - In the NBS tests, was it thermal mass alone, or the time constant (combination of mass and R-value) which caused the reduced cooling load? If it was the time constant, then increasing the R-value should have an effect similar to increasing the thermal mass. In other words, a house with high R-value and low mass might perform similarly to a house with low R-value and high thermal mass. The most important implication here is that high R-value insulation might reduce energy consumption more than is indicated by simple steady-state heat loss calculation. We asked Doug Burch at NBS about this hypothesis. He was unable to speculate as to its validity without further testing.

This report was presented at the annual meeting of the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and will be published in the ASHRAE Transactions 1984, Volume 90, Part 2, available from ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329. For more information, one may also contact Doug Burch, National Bureau of Standards, Washington, DC; (202)921-1000.

FEATURE LOW COST DO-IT-YOURSELF BLOWER DOOR

Editor's note -- As the importance of airtight construction becomes more evident, builders have an increasing need for access to air leakage testing equipment, such as a blower door. But blower doors are expensive to buy and testing services are hard to find (where would they be in the Yellow Pages?). The following article, written by Rob Dumont, staff engineer at the Canadian National Research Council, describes a low-cost method for building your own blower door. Although it may not be as sophisticated or accurate as the more expensive ($2000 to $5000) commercially available instruments, it should suffice for the average builder who is merely looking for a rough evaluation of his/her air sealing process.

In many cities across Canada and the U.S. there are now companies that will do pressure tests on houses. A typical price for a test is about $100 to $150. However, for those who would like to have their own apparatus, there are two inexpensive ways to fabricate such a unit.

The "Bare-Bones" Model

The first is a bare-bones super-economy model that will not provide quantitative measurements of house air leakage, but can be used to provide a good qualitative check. As shown in figure 1, it is a 5/8"-thick piece of plywood cut to a standard door size, (2'8" x 6'8") with an inexpensive fan attached.

A suitable fan for this application should be capable of providing about 1.5 air changes per hour at a pressure differential of 50 pascals (0.2" of water). For a typical house volume of about 17,600 cubic feet, the fan should have a flow capacity of about 440 cfm at 50 Pa -- about the size of a blower on a 50,000 Btu/hr furnace. Thus, if you really wanted to keep the cost down, you could scrounge a used blower from a dead furnace. If you can get a direct-drive blower rather than a belt-drive unit, the mounting procedure is a little simpler. If you don't know any local furnace dealers who will provide such a fan, call up one of the mechanical equipment suppliers in the yellow pages and ask for a fan with a flow capacity of about 450 cfm at 0.2 inches of static pressure. This is a fairly common type of ventilating fan. One good unit is the Dayton 4C566, a two-speed medium-volume shaded-pole squirrel-cage blower. (Available for about $60 from W.W. Grainger, Inc., 5959 W. Howard St., Chicago, IL 60648 (312)647-8900.) Mount

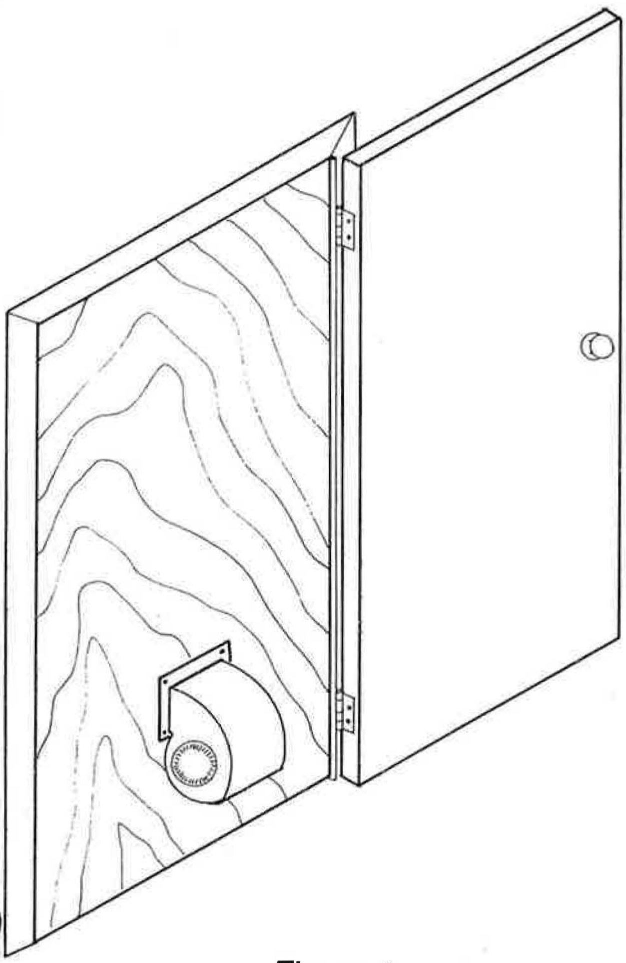

Figure 1
Plywood Panel and Fan

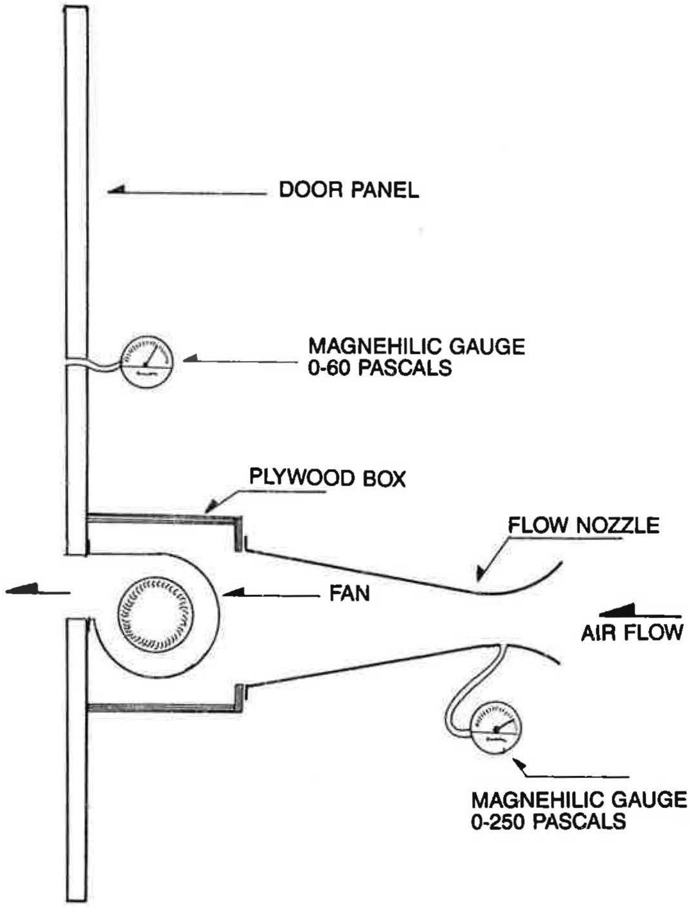

Figure 2
Section: Door Panel With Fan and Flow Nozzle

the fan in the door panel so the air exhausts to the outdoors. As with any fan, it is important to cover the inlet and outlet ports for safety, using a bird screen or other suitable material.

When the fan is running, air will leak into the house through various holes in the air/vapor barrier and through cracks around doors and windows, electrical fixtures, etc. With a smoke pencil or incense stick you can readily determine leakage spots. It is extremely valuable to have the framing crew, the vapor barrier installer, and other members of the construction crew around while the test is underway. (The contractor in Canada who consistently produces the tightest houses does this.) It should be mentioned that in tighter houses this fan unit will easily cause a chimney to backflow, so make sure that the furnace and gas water heater are turned off while the test is under way. (Incidentally, this unit can also serve as an excellent ventilator for the house during periods when it should be heavily ventilated -- such as after taping gypsum board, stippling ceilings, or while curing concrete slabs.)

The "Deluxe" Version

To provide quantitative measurement of air leakage, a more deluxe version of the pressure-test apparatus may be fabricated by adding a couple of extras. First, an adjustable speed control is added (about $50.00) to vary the speed of the blower. Next, to measure the pressure difference between inside and outside the house, a differential pressure gauge is necessary. A suitable gauge is the Dwyer Magnehelic Model #2000-00 with a range of 0 to 62.5 Pascals (0 to 0.25" of water) ($54.00 from Dwyer Instruments, Inc., P.O. Box 373, Michigan City, IN 46360; (219) 872-9141). To measure the flow through the fan, a flow nozzle is added (available for about $200 Canadian from Saskatoon Fibreglas, 1-826 56th Street East, Saskatoon, Saskatchewan; (306)242-2323) and a second differential pressure gauge with a range of 0 to 250 Pascals (0 to 1" water) (Dwyer #2001, $39.00) is attached to it (see figure 2). Using a simple graph, you can convert the pressure reading on the nozzle to an air-flow measurement through the unit.

The most common test method is to increase fan speed until the indoor-outdoor pressure differential is 50 Pascals, then measure the air flow through the nozzle. In general, a good low-energy house should have a pressure-test reading of less than 1 air change per hour at 50 Pascals.

In summary, a crude but useful pressure-testing device may be assembled for about $150. A more sophisticated device that can be assembled for another $400 gives a quantitative output and will provide an excellent quality control tool for builders of new low-energy houses.

Further sources of information:

"Testing for Airtightness," Sept/Oct 1982 Energy Design Update.

An Exhaust Fan Apparatus for Assessing the Air Leakage Characteristics of Houses, H.W. Orr and D.A. Figley, Division of Building Research, National Research Council of Canada, Building Research Note No. 156, 1980. Available from Publications Section DBR, NRC, Ottawa K1A OR6. No Charge.

Determination of Airtightness of Buildings by the Fan Pressurization Method, Canadian General Standards Board Draft Standard 147-GP-10M, Publications Section CGSB, Ottawa K1A 1G6.

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