2866



# SPECIAL REPORT

## TESTING FOR AIRTIGHTNESS—A GUIDE TO THE BLOWER DOOR DEPRESSURIZATION TEST

A typical house consists of thousands of components that are nailed, glued, caulked, taped, or otherwise assembled to form a more or less airtight "envelope" around the conditioned living space in a house. Achieving an appropriate level of airtightness is important for several reasons:

1) to reduce energy consumption due to air leakage;
2) to avoid moisture condensation problems;
3) to avoid uncomfortable drafts caused by cold air leaking into the living space; and
4) to assess the need for mechanical ventilation.

But what is an "appropriate level of airtightness" and how does a builder know whether or not that level has been attained? These questions and others are easily answered by performing a simple and inexpensive blower door depressurization test.

WHAT IS THE BLOWER DOOR TEST?

The blower door depressurization test is an analytical procedure in which a powerful fan, temporarily mounted in an external doorway, is used to draw air out of a house, creating a partial vacuum inside. The lowered indoor air pressure causes outdoor air to flow into the house through all unsealed cracks and openings (Figure 1). By measuring the amount of air flowing through the house and out through the fan, the overall house tightness can be evaluated. Also, by using a leak detection device, such as a smoke pencil, major leakage points can be identified and, if necessary, sealed.

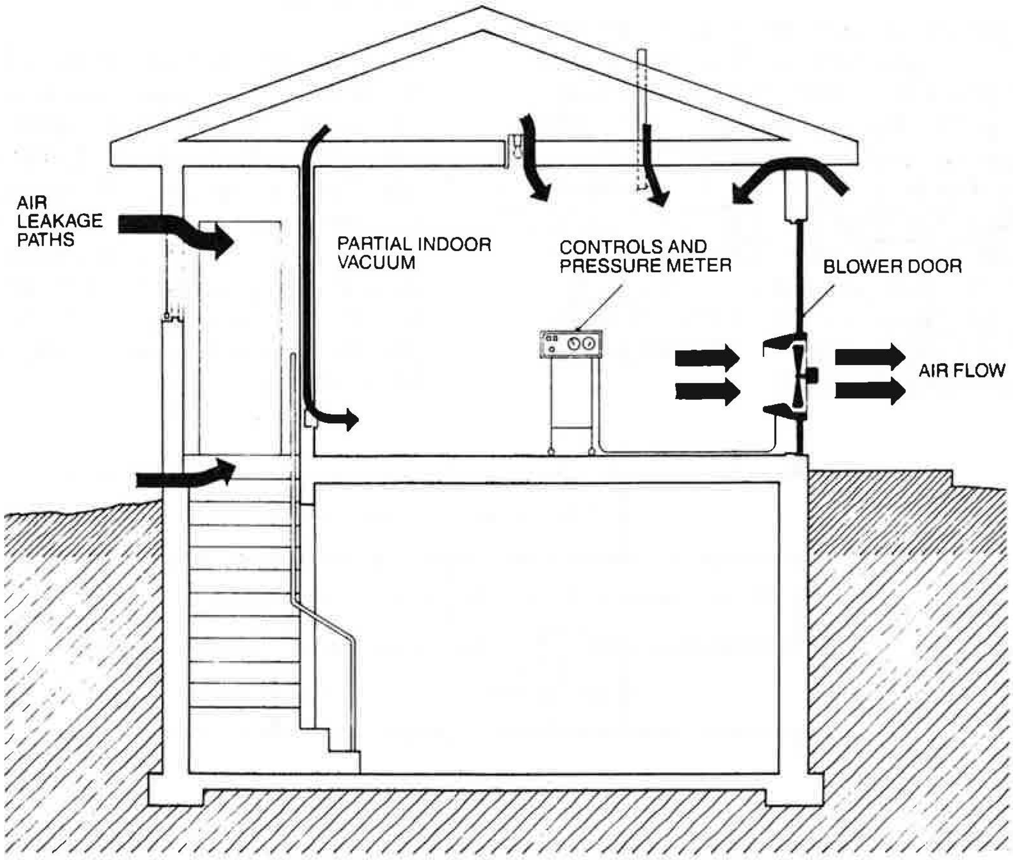



**Figure 1**
**Schematic of blower door depressurization test.**

Commercially available blower doors vary somewhat, but all include several necessary components:

1) A door panel which fits snugly into an exterior doorway and accepts a fan element.
2) A fan, usually vane-axial (propeller type), with maximum capacity up to 5,000 cfm.
3) A variable speed controller for the fan.
4) A pressure gauge to measure "house pressure" -- the negative pressure that is induced inside the house by the fan.
5) Some mechanism for measuring air flow through the fan; either
   A. a tachometer that measures fan speed, or
   B. a pressure gauge that measures pressure drop in the moving airstream at the fan.
6) A calculator or computer to calculate ACPH or LR. (Optional)

Some blower doors have long cylindrical nozzles attached to the fan (Figure 2); some have short nozzles; some have no nozzles at all. The difference among those units has to do with the way they measure airflow through the fan.

When air flows through a constricted tube, such as a flow nozzle, the air pressure at the constriction is reduced by an amount proportional to air speed (see Figure 3). By measuring air pressure at the constriction (nozzle pressure), we can calculate air speed and volumetric air flow. The calibrated blower door nozzle in Figure 2 has four taps around the perimeter. The taps are connected by rubber tubing to a pressure gauge mounted on the instrument stand.

Figure 2
The Minneapolis Blower Door with calibrated flow nozzle.

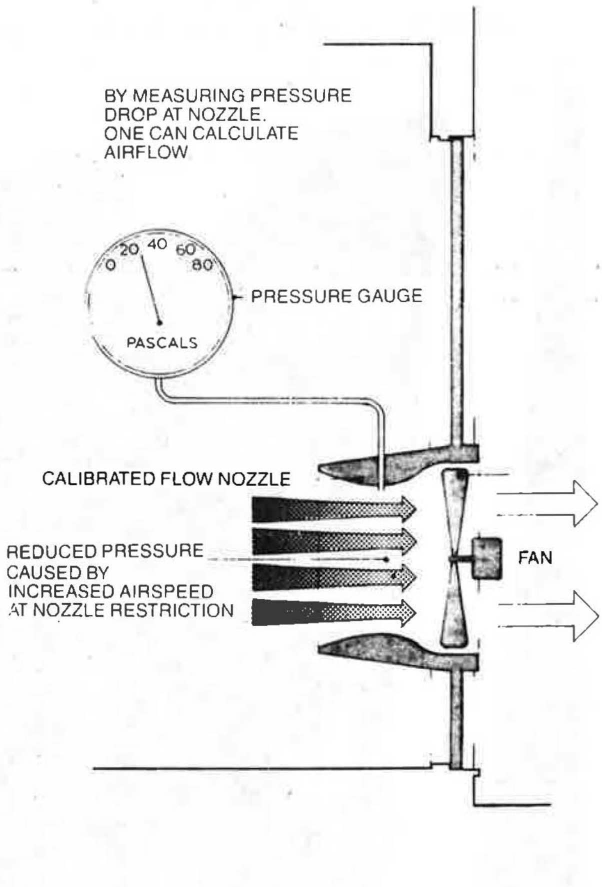



Figure 3
Schematic of calibrated flow nozzle.

Blower doors without nozzles measure airflow by one of two ways: either they use an "orifice plate" (Figure 4), which works by pressure; or they use an "RPM calibration," which allows one to calculate airflow by measuring fan speed with a tachometer. An example of an RPM door is the Enerpressure door (Figure 5). The instruments on the tripod include a digital tachometer (not clear in photo).

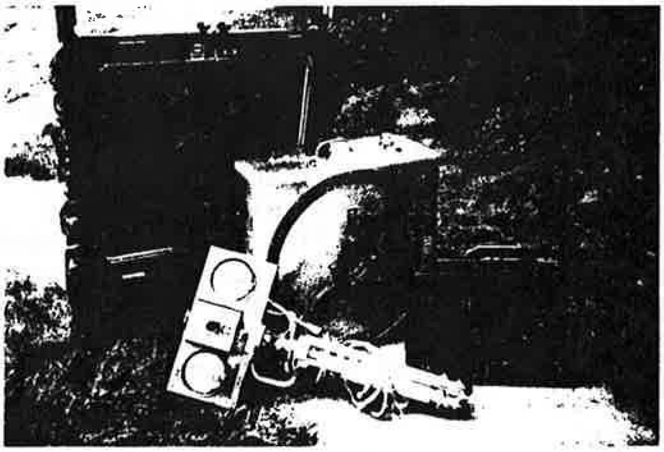


Figure 4
The Infiltec Blower Door with calibrated orifice plate.

Although considerable controversy exists within the blower door industry as to which is the best way to measure airflow, it needn't concern the average end-user. Any good calibrated door will be sufficiently accurate and consistent to measure the airtightness of new houses.

HOW IS THE TEST PERFORMED?

The blower door test is quite simple. The following is an outline of the procedure:

1. <u>Prepare the house.</u>

Since you want to locate and measure <u>unintentional</u> leaks, all <u>intentional leakage openings</u>, such as <u>vent fans</u> and fireplace flues should be sealed over. In a new house, all plumbing traps should be filled with water to prevent air from flowing down the vent stack and into the house through the drains. Fuel burning appliances <u>must</u> be turned off and their exhaust flues should be stoppered. All interior doors and the door to the basement should be left open.

For new construction, pay attention to the air/vapor barrier. If you are using a polyethylene air/vapor barrier, you may want to perform the test <u>before</u> the drywall goes up in order to find and fix leaks. But be careful. Unless the poly is well sandwiched to the studs by strapping or other structural support, it may get pulled off the wall by the fan suction.

The above procedure may vary somewhat. For example, some researchers don't close off intentional openings such as bathroom vent fans. Others don't include the basement in the test. The procedure outlined here is most appropriate for general evaluation of new house airtightness.

2. <u>Install the blower door.</u>

3. <u>Depressurize the house.</u>

Using the variable speed controller, fan speed is gradually increased until the house pressure gauge reads about 60 pascals. (Pascals are the metric unit of pressure measurement. 50 pascals is

Figure 5
The Enerpressure Blower Door with RPM calibration.

equivalent to about 0.2 inches W.G.) When the pressure stabilizes at that point, airflow through the fan is measured and recorded. Fan speed is then decreased in increments and the corresponding house pressure and airflow are measured and recorded. Usually six to eight readings are taken at pressures ranging from about 20 to 60 pascals.

NOTE: The test can be run either in depressurization mode or pressurization mode. Depressurization is more common.

4. Locate and, if necessary, seal individual leakage points.

5. Plot the results or enter them into the computer.

With the test complete, you now have six to eight data points of measured house pressure and corresponding airflow. If you are analyzing the results manually (no computer), the data is plotted on log-log graph paper and the six points should form more or less a straight line. The graph is then used to calculate the final air leakage rate.

Most blower door manufacturers offer hand-held computers that are programmed to perform all the calculations and plot the results automatically. Later, we will look at a sample output from one of those computers.

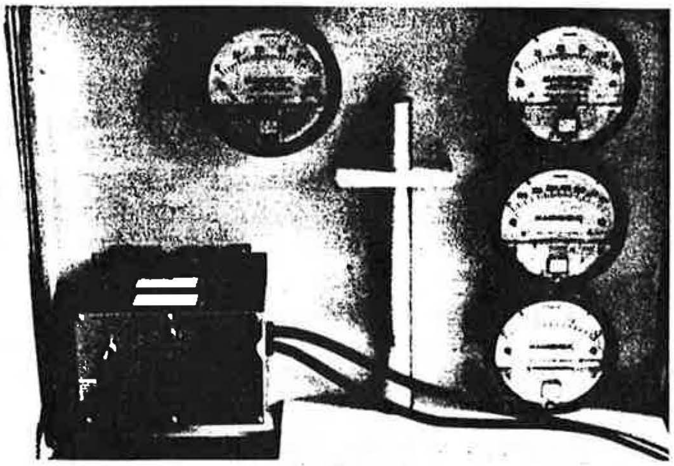


Figure 6
Instrumentation case for Minneapolis Blower Door. The four round gauges measure air pressure.

THE UPPER LEFT GAUGE MEASURE HOUSE PRESSURE. THE THREE GAUGES ON THE RIGHT ARE FOR MEASURING NOZZLE PRESSURE IN THREE DIFFERENT RANGES. THE BOX IN THE LOWER LEFT CORNER CONTAINS ON/OFF SWITCH, FAN ROTATION SELECTION SWITCH, AND VARIABLE SPEED CONTROL.

HOW ARE THE RESULTS EXPRESSED?

Get ready for some alphabet soup. ACPH, ELA, ELA, NLA, and LR are all acronyms for the various ways to express air leakage. (Yes, there are two ELA's -- an American ELA and a Canadian ELA.) For all practical purposes, you only need to understand two of them -- induced air changes per hour (ACPH) and Leakage Ratio (LR).

Induced Air Changes Per Hour (ACPH)

Not to be confused with natural infiltration rate, induced air changes per hour (ACPH) refers to the measured air leakage under depressurization (usually 50 pascals house pressure). Typically one says: "That house has an air leakage of 1.5 air changes at 50 pascals," meaning that, when measured under 50 pascals of pressure, the house leakage rate was 1.5 ACPH.

ACPH is very easy to calculate. Given the airflow in cfm at 50 pascals, one simply multiplies by 60 to get cubic feet per hour, then divides by the house volume in cubic feet. For example, if the measured airflow at 50 pascals was 800 cfm for a 2,000-square-foot house with 8-foot ceilings, the leakage, Q, would be:

$$Q = (800 \times 60) / (2{,}000 \times 8)$$
$$= 3 \text{ ACPH}$$

Reporting in air changes per hour (ACPH) is currently the most common practice in the U.S., Canada, and Sweden. Figure 7 shows some typical ACPH values for various types of houses.

One shortcoming of this method of reporting is that it tends to make larger houses look better. If you compare a 1,000-square-foot house with a 2,000-square-foot house of comparable construction tightness, the larger house will have a lower air leakage when measured in ACPH at 50 pascals. Another objection, expressed by some researchers, is that the 50-pascal pressure is too high, that some of the leaks induced at that pressure may rarely leak under natural conditions. This objection is often answered with the fact that 50 pascals is approximately

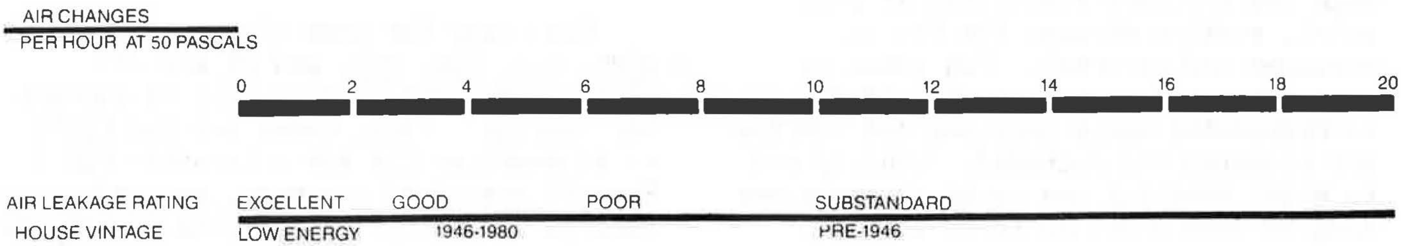



Figure 7
Typical range of air leakage rates, in air changes per hour (ACPH), for various types of houses.

equivalent to the pressure exerted by a 20 mph wind acting perpendicular to the surface of a house.

The Leakage Ratio (LR)

Initially referred to as the normalized leakage area (NLA), the leakage ratio (LR) eliminates some of the inaccuracies and limitations of the ACPH method and may very well become the accepted norm in the U.S. and Canada. To understand LR, one must first look at the ELA.

ELA stands for equivalent leakage area. It describes the area of hole that would exist if all the cracks and leakage openings were gathered into one location. In other words, it is a measure of the combined area of all cracks and openings in the house, expressed in square centimeters or square feet. It is calculated using the same test data as the ACPH reporting method, but ELA uses the measured leakage at 10 pascals rather than 50 pascals. (Even though only the 10 pascal reading is necessary, measurements are still taken at several pressures. If only one reading were taken, the results would be unreliable.) One of the greatest values of ELA has been as a marketing tool in retrofit work. The homeowner can easily relate to the fact that the leaks in his/her house are the equivalent of a round hole with, say, an area of 2 square feet!

Actually, there is quite a bit of uncertainty as to whether the ELA is accurate. Are the leaks in the house really the same as a 2-square-foot hole? The equivalent leakage area model was developed by the National Research Council of Canada. Another model, the effective leakage area (also called ELA), developed at Lawrence Berkeley Laboratory (LBL), attempts to calculate the same thing -- the combined area of all the leakage holes in a house. But the two methods give substantially different results. The Canadian ELA is always significantly higher. But even if neither ELA model gives an accurate measure of the actual area of all leaks in a house, they do give a relative measure of the airtightness of the building skin. As long as everyone uses the same measurement and calculation procedure, so that we are all comparing apples with apples, the test will be sufficiently useful. So far, the Canadian ELA model has gained the most acceptance and is the basis for deriving the leakage ratio.

The leakage ratio is simply the ELA divided by the total skin area of the house, in 100-square-foot units, including basement walls and floor. For example, if the measured ELA is 160 square inches and the total surface area of the house envelope is 5,560 square feet, the LR is (160 / 55.60), or 2.87 square inches per 100 square feet of surface.

Since LR is expressed in terms of leakage area per unit of wall area, it is independent of house size. If one house has a lower leakage ratio than another, it is more airtight, regardless of the relative size of the two houses. Figure 8 shows some typical LR values for different types of houses.

Computer Printouts

Most blower door manufacturers supply small hand-held computers and software

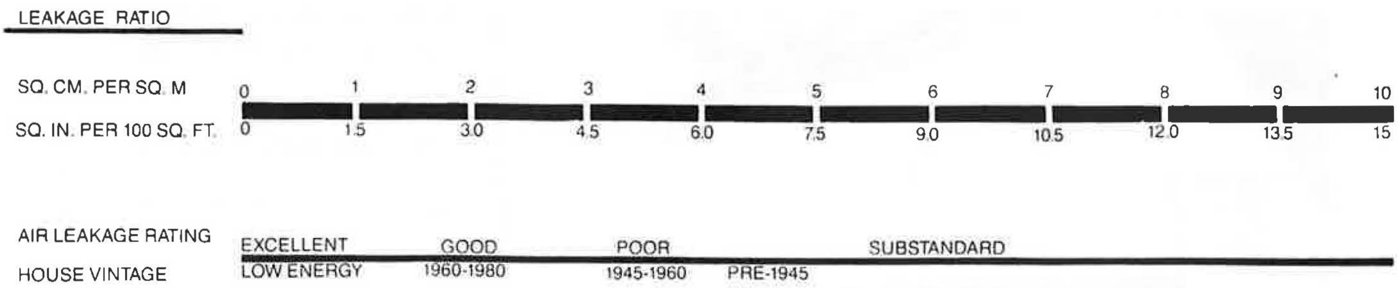



Figure 8
Typical range air leakage rates, expressed in Leakage Ratio (LR), for various types of houses. Source: Retrotec Door Fan Operating Manual.

for performing calculations automatically. (Two manufacturers provide computers that control the entire test. You simply push one button and wait for the results.) Figures 9 and 10 show one such computer and a sample printout.

The printout includes four sections (boxes): 1) The top box is a summary of the test conditions. 2) The second box shows the actual test results (which you input into the computer) -- house pressure (first column), fan pressure (second column), airflow (third column), and percent calculated error. (Percent error indicates how much the data deviates from a straight line correlation.) 3) The third box shows a plot of the five measurements with a "best fit" line drawn through all the points. If all five points had zero error, the line would pass exactly through the center of each circle. As you can see, this test was pretty close. Sometimes, for various reasons, one measurement point will fall way off the line. Typically a fluke, that data point would be eliminated. The other four or five should be enough to derive the line of best fit. This is the reason why taking only one measurement would be unreliable. 4) The fourth box is the most important. Notice that it lists ELA in square feet and square inches. It also lists SLA (which is the same thing as leakage ratio), as well as ACPH at 50 pascals.

## Finally, Let's Get Rid of Some Old Baggage

When referring to building air leakage, people commonly refer to an "average natural infiltration rate." As the term implies, this is the average amount of air, expressed in air changes per hour, that leaks into and out of a house under natural conditions.

Since the average infiltration rate is useful for projecting annual energy consumption, and since it is difficult and expensive to measure directly, researchers have been trying to develop methods for predicting infiltration rates using blower door test data and local weather conditions. But the calculations are very ambiguous. Common sense alone tells us that no calculation method can accurately predict average annual infiltration rate. First of all, wind is a dominant driving force on infiltration, but windspeed data for specific locations are very unreliable. Secondly, occupant interaction, particularly operation of interior doors, significantly affects infiltration rate. How do you model people's door opening habits into a computer? Research efforts have produced a variety of methods ranging from complex computer programs, like CIRA, developed at Lawrence Berkeley Labs, to the "divide by 20 rule," a simple estimating method, developed at Princeton University, in which the ACPH at 50 pascals is simply divided by 20 to get average annual infiltration rate. All in all, any number we assign to an average infiltration rate will probably not be accurate within 100 percent.

For characterizing building airtightness, ACPH or LR are much better than average infiltration rate. For example, if someone tells you that a certain house has a leakage rate of 2.0 ACPH at 50 pascals, or a LR of 4.2 square inches per 100 square feet, you know that the building was actually tested and you

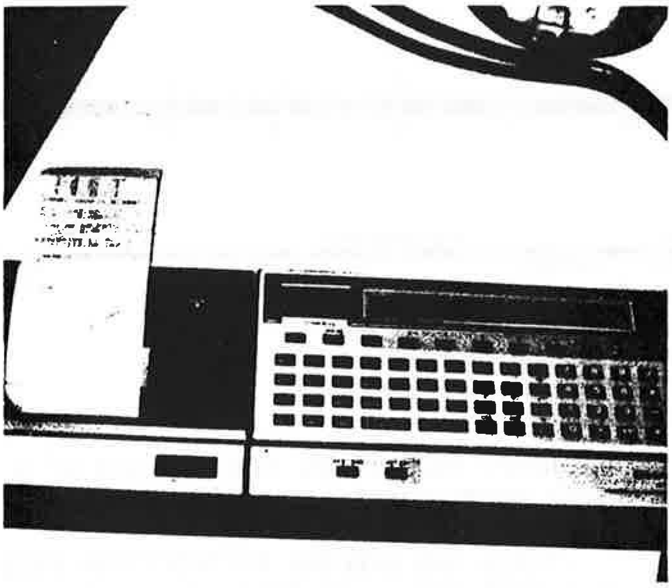


Figure 9
Sharp computer supplied as an option with the Minneapolis Blower Door.

get a fairly precise picture of the building's tightness. But if, on the other hand, someone says a certain house has a natural infiltration rate of 0.7 air changes per hour, you have to ask a series of questions to determine how that number was obtained and how valid it may be.

What about projecting annual energy consumption? Yes, the natural infiltration rate is necessary for those calculations, but if the house is built very tightly, the infiltration rate will be insignificant, compared to the mechanical ventilation rate, and can often be ignored. In less tight houses, it will have to be estimated by some means.

HOW ACCURATE AND REPEATABLE ARE BLOWER DOOR TEST RESULTS?

There has not yet been any comprehensive testing of commercially produced blower doors. However, according to limited tests directed by Andrew Persily at the National Bureau of Standards and Sonny Poole at the City of Austin, most blower doors on the market are accurate to within ten percent. Buffalo Homes in Butte, Montana, ran some informal side-by-side tests of the

MAINE ALTERNATIVE

AIR LEAKAGE TEST

* * * * * * * * *

Joe Blow

100 Windy Lane

DATE: 11/16/84
TIME: 16.51

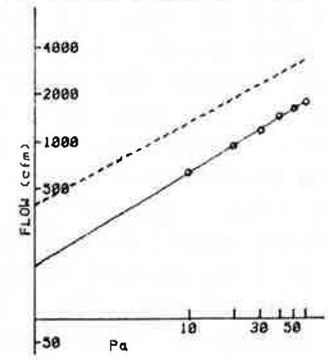
TEST # 2
ON-SITE WIND CALM

TEMP OUT 42 F
TEMP IN 68 F

EXP AREA 3552 ft2
VOLUME 18700 ft3

| Pa | DATA(12) | FLOW(cfm) | %E |
|---|---|---|---|
| 60 | 250 | 1654 | -0.5 |
| 50 | 210 | 1514 | 1.3 |
| 40 | 181 | 1324 | 1.0 |
| 30 | 109 | 1087 | -1.7 |
| 20 | 69 | 862 | -1.0 |
| 10 | 32 | 584 | 0.9 |

PROFILE




ANALYSIS

FLOW = C*par n
n= 0.588
C= 149.313
CORRELATION %= 99.946
STND. ERROR %= 1.440
* * * * *
ELA ft2= 1.181
ELA in2= 170

% CHANGE= -52

SLA in2/100ft2= 4.79

ACH/HR @ 50Pa = 4.84

Figure 10
Typical blower door computer printout. Source: Retrotec.

Minneapolis Blower Door and the Infiltec Blower Door. As can be seen from the following test results, they found very good agreement between the two doors:

| | Minneapolis | Infiltec |
|---|---|---|
| ELA (Canadian) | 49 sq. in. | 44 sq. in. |
| ELA (LBL) | 26 sq. in. | 21 sq. in. |
| ACPH (50 pascals) | 1.6 ACPH | 1.7 ACPH |

(Notice the difference between the Canadian and the LBL values for ELA.)

What about repeatability? Unless the door or instruments are damaged, a calibrated blower door should provide repeatable results. However, tested airtightness of a single house may vary considerably due to changes in the house. In one study, performed by Persily at NBS, in which a house was tested weekly for one year, the air leakage varied over 25 percent (see Figure 11). According to Persily, another study in Canada showed similar results. In both cases, the houses showed greater leakage in the winter than in the summer, evidently due to materials shrinkage in the dry winter air.

Two factors which can affect the accuracy of the blower door test are air density and windspeed. Air density is affected by temperature, barometric pressure, and humidity. Blower doors are calibrated at standard temperature, pressure, and humidity. Unless correction factors are applied, any deviation from standard conditions will result in some loss of accuracy. Most of the software that comes with commercial blower doors includes correction routines for temperature and barometric pressure. Humidity is a minor concern.

Wind can obviously affect the test significantly. Since the 50 pascal test pressure is roughly equivalent to a 20 mph wind, an outdoor windspeed of 20 mph could double the pressure on the windward

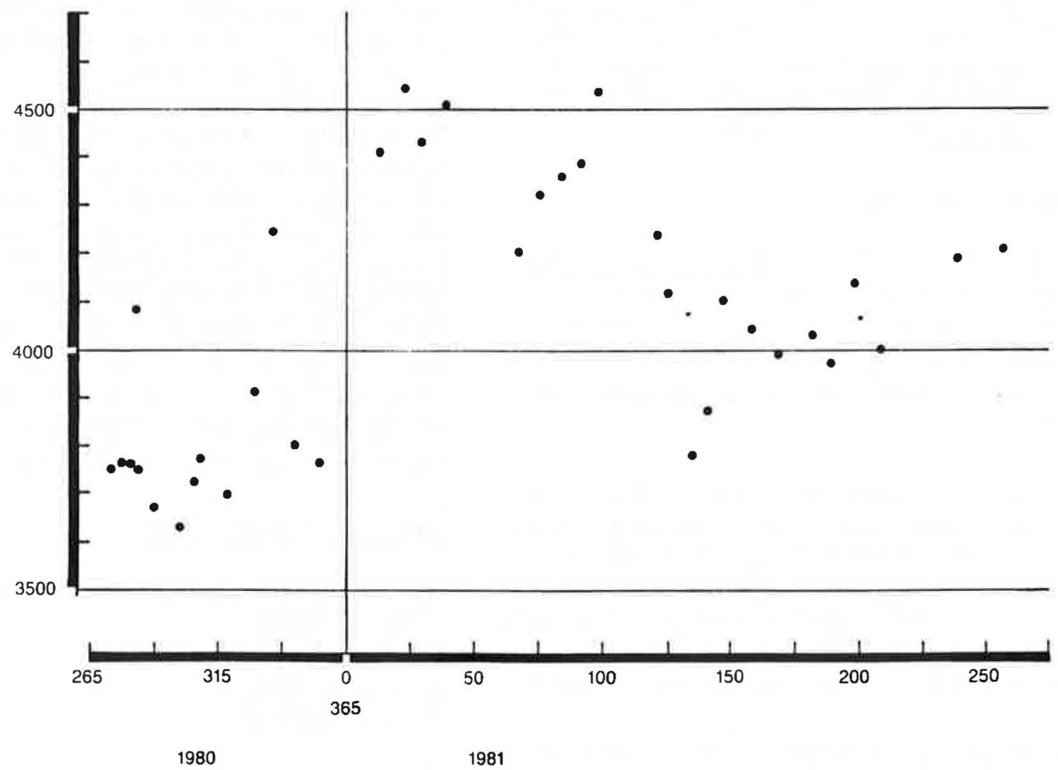



Figure 11
Measured leakage of one house over a year.
SOURCE: PERSILY, ANDREW, "REPEATABILITY AND ACCURACY OF PRESSURIZATION TESTING," PROCEEDINGS OF THE ASHRAE/DOE CONFERENCE ON THE THERMAL PERFORMANCE OF THE EXTERIOR ENVELOPES OF BUILDINGS II.

side of the house and perhaps nullify the pressure on the leeward side. According to ASTM Standard E779-81, the blower door test should not be performed in winds greater than 5 mph. For most practical field work, that figure is probably somewhat low, but the accuracy of the test will be severely affected in winds greater than 10 mph.

HOW TO GET A BLOWER DOOR TEST

There are probably several hundred businesses around the country that offer blower door testing services. Most of them are retrofit contractors, but they can easily perform a test on a new house. The cost for a test usually runs around $100 to $150.

The problem is that blower door contractors are hard to find. They aren't under "B" in the yellow pages. The first place to look is under "insulation contractors." The next best bet is to write to us at EDU; we may have someone listed from your area in our Professional Referral Service. As a follow up to this report, EDU will publish a directory of businesses which offer blower door testing services. Watch for it.

HOW TO BUY A BLOWER DOOR

An alternative to getting a test done by an outside service is, of course, to buy your own door. As you will see in the following guide, you can pay anywhere from $1,000 to $15,000 for a calibrated blower door.

If you are a builder looking to test your houses, the most important selection criteria, other than price, is ease of use. Look for a door that is lightweight and easy to install and operate. How long does it take to set up and take down? How much space will it take up in the truck?

How about appearance? Some doors are very slick looking, others have a homemade look. If you are out to impress your clients, the slick door may be worthwhile; it's quite impressive to have a technician set up a scientific looking device to test your house. It could be used as a marketing tool.

As for accuracy, all of the good quality calibrated doors are accurate. Typically, when you pay more for a blower door, you are paying for features other than accuracy.

WHAT'S AVAILABLE

The following listing includes the blower doors for which we were able to obtain information as of this writing. However, no claims are made for its completeness and EDU would welcome submission of new product information. Listings are alphabetical.

The Care II Fan Door

Air Quality Labs, Inc.
P.O. Box 141296
Spokane, WA 99214
(509)534-6932

Price = $4250

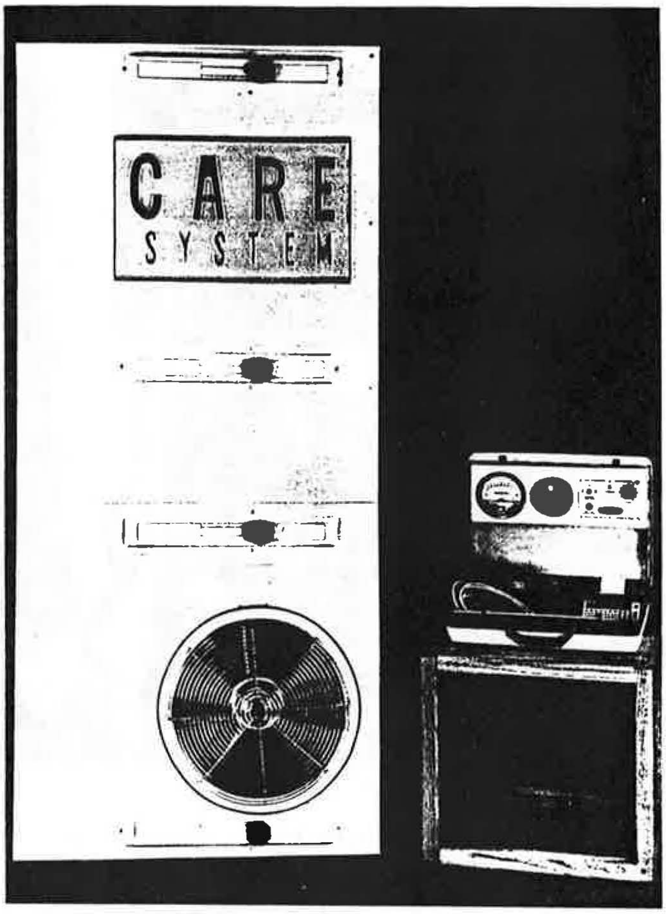
The Care II fan door is a high quality, handsome instrument with a high price tag. It seems to be very well thought out and designed. The door panel is made of expanded PVC and weighs only 28 pounds. Although the photo shows needle gauges, we were told by Larry Edington at Air Quality Labs that their latest unit has a digital display which is mounted directly on the door panel and reads out directly in cfm. They also have a more sophisticated computer controlled model which runs completely automatically. Put it in the door and press the button. Finished. The computerized unit sells for $6,950.

The CMS Blower Door

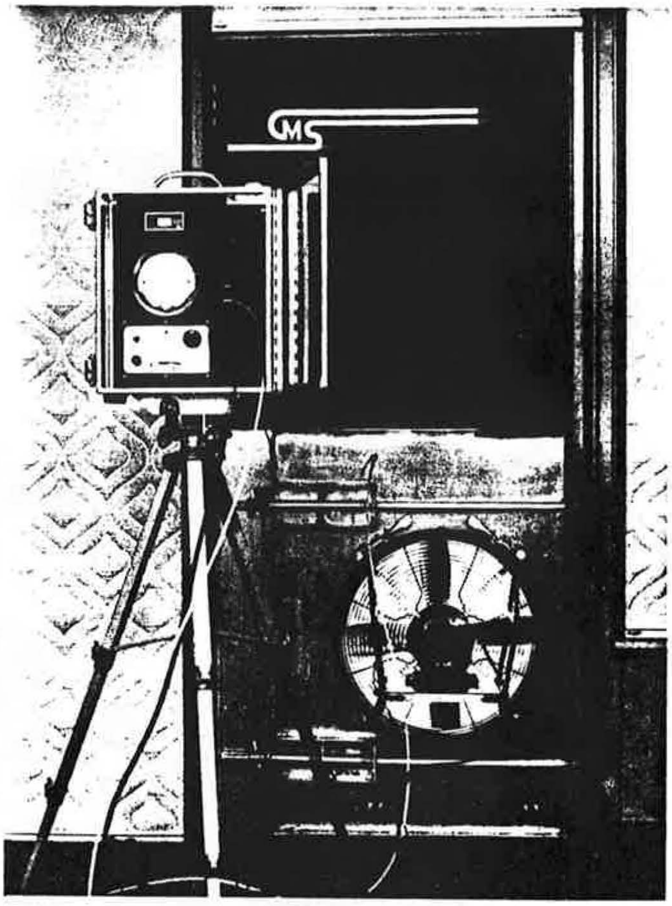
Conservation Management Services, Inc.
1012 NW Wall
Suite 203
Bend, OR 97701
(503)382-2727

325 NW 21st
Suite 201
Portland, OR 97209
(503)227-0400

Price = $4,075




Care II



CMS Blower Door

The Detecdoor

Eder Energy
7535 Halstead Drive
Mound, MN 55364
(612)446-1559

Price = $389 for door panel only
$339 for fan panel only
$695 for door panel with fan
$769 for complete unit with one house pressure gauge

The Detecdoor is a noncalibrated blower door. Even with the single house pressure gauge, it cannot be used to accurately measure airflow through the fan. It is designed for leak detection only. However, the door panel is very lightweight and easy to set up. If you are considering putting together your own door, with a small fan for testing only very tight houses, you may do very well purchasing just the door panel from Eder.

The Draft Arrester

Hy-Temp Energy Plus Systems
3035 Saratoga Street
Omaha, NE 68111
(800)228-7256

Price = $3,500

The Draft Arrester Door comes with a two-piece door panel made with an aluminum frame around a formica plated hollow-core wood door. Calibration is by fan speed.

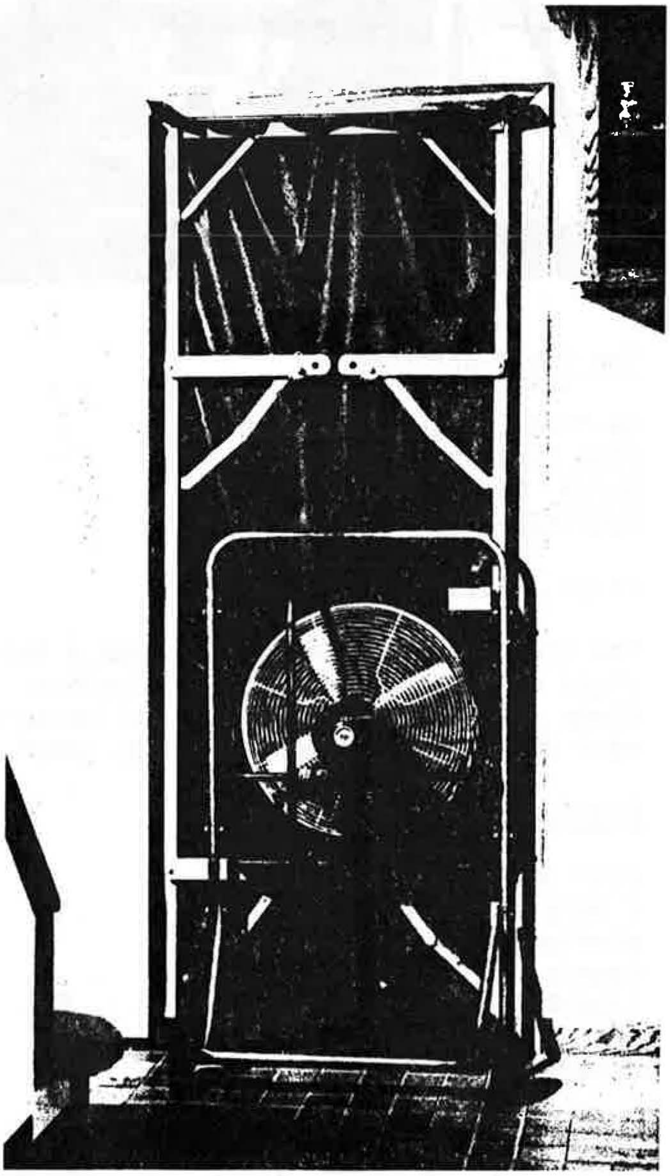
Enercorp Infiltrometer

Enercorp
2 Donald Street
Winnipeg, Manitoba R3L 0K5
Canada
(204)477-1283

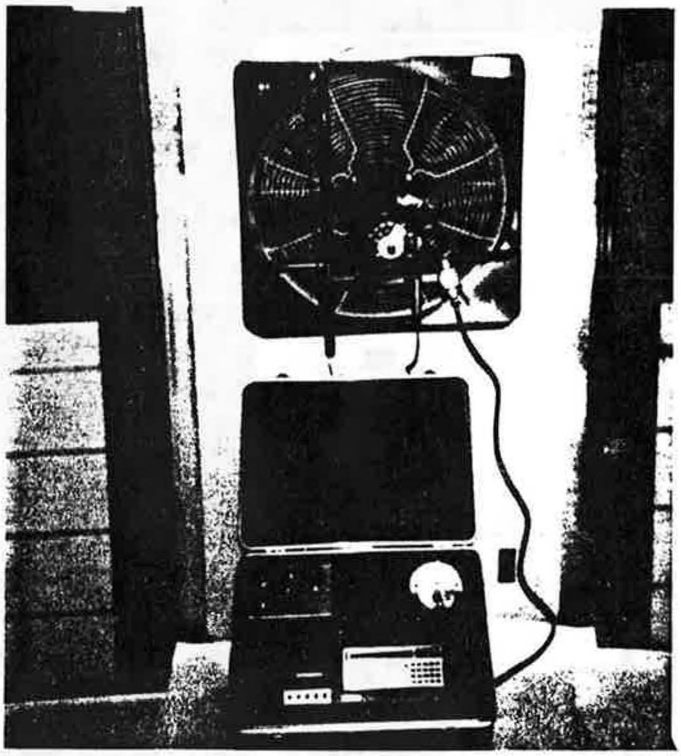
Price = $15,000

As the price tag suggests, this unit is not for the casual user. The Enercorp Infiltrometer is completely computer

The Detecdoor



The Detecdoor



The Draft Arrester

controlled. It automatically varies house pressure and reads flow rate through the fan at the press of a button. Enercorp licenses dealerships and supplies a coordinated system of accessories and training in addition to the blower door unit.

Enerpressure Blower Door

Enerpressure
1701 Greenville Ave.
Suite 1105
Richardson, TX 75081
(214)680-9510

Price = $3,695 with computer and printer

(See Figure 5 for photo.)

Enerpressure sells its blower door separately or as part of a licensee agreement for their "Energy Doctor" program. The blower door is a very rugged unit and comes with a twelve-month warranty. The only possible drawback is weight. At 147 pounds, the Enerpressure door may be cumbersome, especially with the single-piece panel construction. Notice that it comes with inflatable tires that allow the unit to be rolled right up to the house.

Infiltec Blower Door

Infiltec
Division of Saum Enterprises
Box 1533
Falls Church, VA 22041
(703)820-7696

Box 1125
Waynesboro, VA 22980
(703)949-7933

Price = $3,250

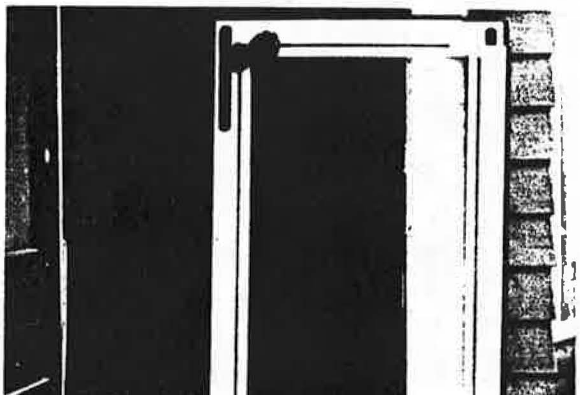
(See Figure 4 for photo.)

The Infiltec door uses a calibrated orifice plate. One advantage of this is that the fan unit is less bulky than those with extended flow nozzles. That, combined with the lightweight aluminum and nylon door panel, makes the Infiltec door very easy to transport. Setup is also quite easy, although not as simple as the Minneapolis Blower Door or the Detecdoor.

Minneapolis Blower Door

The Energy Conservatory
920 West 53rd Street
Minneapolis, MN 55419
(612)827-1117

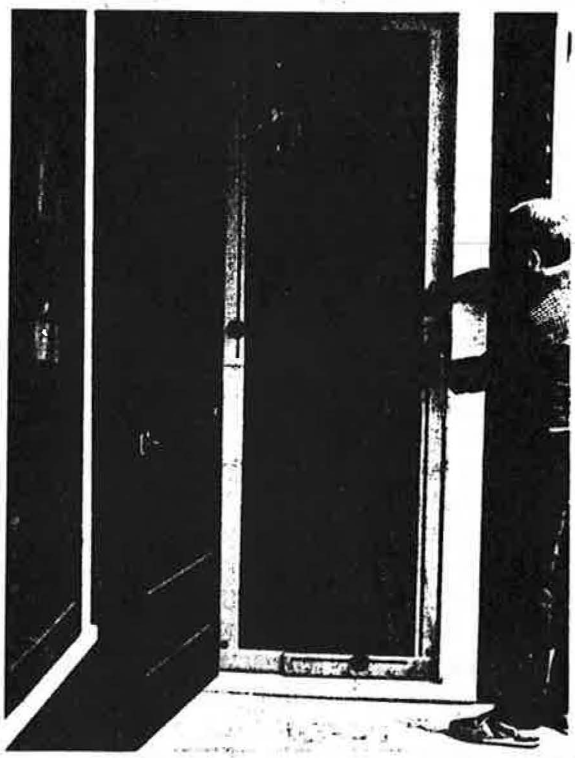
Price = $2,500



Minneapolis Blower Door Assembly

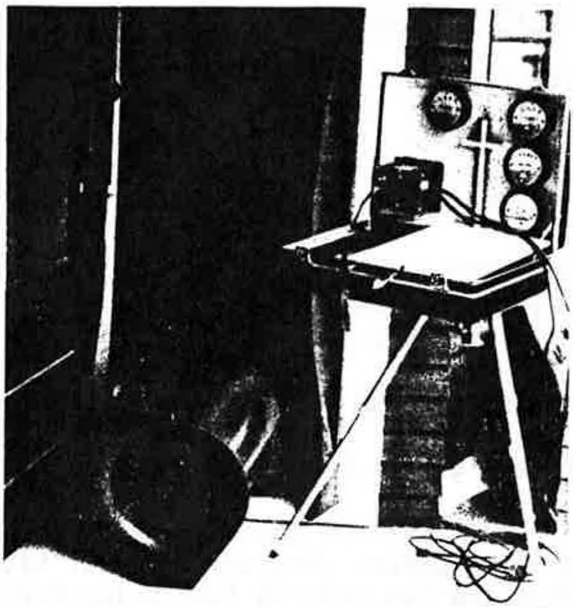
This unit is the easiest to set up of all we have seen. A wooden frame is easily expanded into the doorway; a nylon membrane is stretched over the frame and attached with Velcro fasteners. Finally, the fan unit is slipped into the frame and

Minneapolis Blower Door Assembly



Minneapolis Blower Door Assembly

Minneapolis Blower Door Assembly



Minneapolis Blower Door

connected to the instrument panel. The entire setup takes less than five minutes.

If appearance is important for impressing a client, then you are better off with the Retrotec or Care Doors. But if pure utility is all you are looking for, the Minneapolis Blower Door deserves a close look.

The Retrotec Fan Doors

Retrotec Energy Innovations Ltd.
225 St. Anne Ave.
Ottawa, Ontario K1L 7C3
Canada
(613)745-1515
or
P.O. Box 939
Ogdensburg, NY 13669

Retrotec is the oldest and largest company producing blower doors. They produce an extremely high quality line of products and provide comprehensive training and support. As can be seen in the photos, their doors are very professional looking -- an advantage where visual impression for the customer is important. The panel design on the 610 and 620 is well thought out; the system can be set up in only a few minutes, even by an inexperienced technician.

Model 610

Price = $5,350

Retrotec Fan Door 610

This is the top of the Retrotec line. It is probably most practical for retrofit contractors.

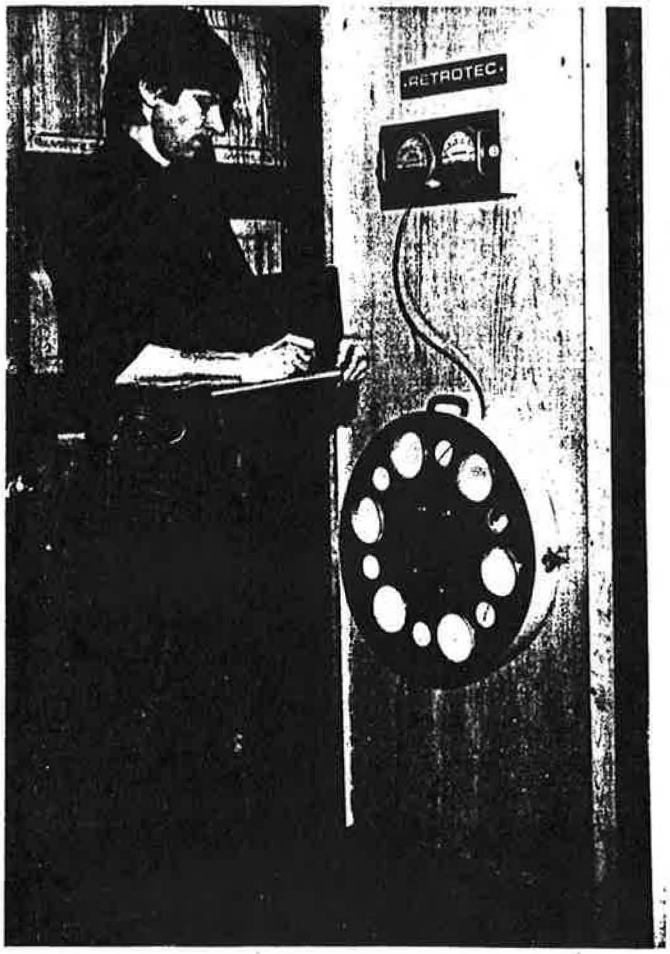
Model 620

Price = $3,250

This model is similar to the 610 except it has an AC fan motor and only one nozzle pressure gauge, mounted directly on the door panel instead of on a separate instrument panel.

Model 640

Price = $1075




Retrotec Fan Door 640

This is the newest and least expensive in the Retrotec line. Designed for low-flow applications, such as in new, tightly built houses, the fan capacity is less than half of the other Retrotec units. The purchase price includes the fan and instrumentation, but not the door panel.

The Y.E.S. Blower Door

Your Energy Service, Inc.
P.O. Box 90034
Nashville, TN 37209
(615)383-9546

Price = $2,400

Y.E.S. Door

According to inventor Bill French, the Y.E.S. door is the "blue-collar" blower door. No white lab coats, no fancy instrumentation. Just a rugged blower door. The Y.E.S. door consists of a large fan mounted on a plywood panel. There is only one pressure gauge which reads out house pressure. Although the Y.E.S. is not a calibrated door in the strict sense of the term, French claims he is able to read ELA directly from the gauge. Since it is only measuring one point and since it probably relies on a rough fan curve, the ELA reading is of questionable accuracy.

HOW ABOUT BUILDING YOUR OWN?

Let's face it. If you build five or six houses a year, you may not want to spend $3,000 or $4,000 on a blower door. The good news is that if you are willing to put in some time on it, you can save quite a bit of money by assembling one yourself. The most expensive component on most doors is the calibrated fan element. Since most blower doors are made for retrofit work, they need a fan with enough capacity to depressurize a leaky old house to 50 pascals. But if you are only going to use your door for testing small to moderately sized, tightly built houses, you can get away

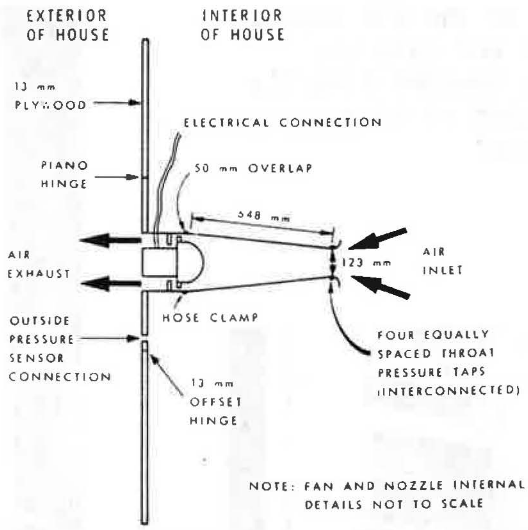



Figure 12
Schematic of homemade blower door. The calibrated flow nozzle is the exact same design as the new Carlson nozzle.
SOURCE: HAROLD ORR AND D.A. FIGLEY. "AN EXHAUST FAN APPARATUS FOR ASSESSING THE AIR LEAKAGE CHARACTERISTICS OF HOUSES" NATIONAL RESEARCH COUNCIL OF CANADA, BRN #156.

with a much smaller and less expensive fan and flow nozzle.

For example, a well-built house should have a leakage rate no more than 3 to 4 ACPH at 50 pascals. If the house has a volume of 16,000 cubic feet, then the maximum required air flow is 64,000 (4 x 16,000) cubic feet per hour, which is 1,067 cfm. So any fan which can produce 1000 cfm airflow against 50 pascals (0.2 in. W.G.) should be fine. If you are building superinsulated houses, the leakage should be less than 2 ACPH at 50 pascals and a 500 cfm fan should suffice.

In the August 1984 issue of EDU, we ran an article by Rob Dumont on how to build a low-cost blower door. Just after publishing that article, we heard that the company which sells the calibrated low-flow nozzles had gone out of business. However, a new calibrated flow nozzle, specifically designed for tight houses, is now available. The new nozzle comes in 124-mm diameter and is suitable for pressure testing average sized houses in the range of air tightness levels from about 0.5 to 5.0 ACPH at 50 pascals. There is also an insert which allows for testing of even tighter houses -- down to 0.05 ACPH at 50 pascals. (They build 'em tight in Canada.) The cost is $175 for the 124-mm calibrated nozzle plus $160 for the extra-low flow insert. It is available from:

Carlson's Structural Glass
2925 Miners Avenue
Saskatoon, Saskatchewan
(306)931-0001 (ask for Dave Harder)

STANDARD PROCEDURES FOR PERFORMING THE BLOWER DOOR TEST

- Housing and Urban Development Association of Canada "Standard Procedure for Determination of Airtightness of Houses by Fan Depressurization Method." Available from HUDAC, Ottawa, Ontario, Canada ASTM E779-81
- "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization." Available from ASTM, 1916 Race Street., Philadelphia, PA 19103.
- Canadian General Standards Board draft standard for "Determination of Tightness of Buildings by the Fan Depressurization Method." Available from CGSB, Ottawa, Canada K1A 1G6.

- Norway Standard NS8200
- Sweden Standard SS021551

The following list of blower doors is arranged according to price. All technical specifications are from the manufacturers; n.a. indicates that the information was not available.

BLOWER DOOR CROSS COMPARISON CHART

| NAME | PRICE | WEIGHT (DOOR PANEL AND FAN ONLY) (lbs) | CALIBRATION | COMPUTER | FAN CAPACITY AT 50 PASCALS (cfm) | MOTOR TYPE | COMMENTS |
|---|---|---|---|---|---|---|---|
| Detecdoor | $690 | n.a. | not calibrated | no need | 2,900 | AC | For leak detection only; will not measure acph or LR |
| Retrotec 640 | 1,075 | n.a. | flow nozzle | optional | 2,200 | AC | |
| Y.E.S. | 2,400 | n.a. | house pressure | not avail. | n.a. | AC | Reads out in ELA; calibration questionable |
| Minneapolis | 2,500 | 70 | flow pressure | optional | 4,000 | DC | |
| Infiltec | 3,250 | 61 | flow pressure | optional | 5,000 | AC | |
| Retrotec 620 | 3,250 | 78 | flow pressure | included | 4,000 | AC | |
| Draft Arrester | 3,500 | n.a. | RPM | included | 4,500* | AC | *(at free flow) |
| Enerpressure | 3,695 | 147 | RPM | included | 3,500 | DC | |
| CMS | 4,075 | 86 | RPM | not included | 4,500 | DC | |
| Care II | 4,250 | 70 | RPM or Flow | included | 5,000 | DC | Also available with fully automatic computer control |
| Retrotec 610 | 5,350 | 82 | Flow pressure | included | 5,000 | DC | |
| Enercorp | 15,000 | n.a. | Flow pressure | included | 4,500 | AC | |

# CALENDAR

## NORTHEAST

***Building Better Foundations—A 'Roll Up Your Sleeves' Seminar.*** April 20, Brattleboro, Vermont. Contact Alex Wilson, New England Solar Energy Association, Box 541, Brattleboro, VT 05301; (802) 254-2386.

***Building Thermal Energy Coordinating Council (BTECC) Research Coordinating Committee on Air Infiltration.*** April 22-23, Pittsburgh, Pennsylvania. Contact BTECC, 1015 15th St. N.W., Suite 700, Washington, DC 20005; (202) 347-5710.

***Thermography Training Courses.*** April 23-25, May 21-23, June 25-27, Bedford, Massachusetts. Contact Susan Maloney, Inframetrics, 12 Oak Park Drive, Bedford, MA 01730; (617) 275-0659.

***Energy Saving Construction Techniques and Passive Solar Concepts.*** April 26-27, Ithaca, New York. Contact Jim Atkins or Jackie Skibitski, Office of Communications, New York State Energy Office; (518) 473-3480.

***Three-Week Homebuilding Course.*** May 27-June 14, June 17-July 5, July 15-Aug. 2, August 12-30, Washington, Massachusetts. Contact Heartwood School, Johnson Road, Washington, MA 01235; (413) 623-6677.

***Infra-Red Scanning Course.*** May 6-10, July 22-26, August 19-23, Econolodge Conference Center, Burlington, Vermont. Contact Paul Grover, Infraspection Institute, Hullcrest Drive, Shelburne, VT 05482; (802) 985-2500.

***Program Planning Workshop for Building Air Infiltration and Ventilation.*** April 22-23, Pittsburgh Hilton, Gateway Center, Pittsburgh, Pennsylvania. Contact Patricia Prue, Building Thermal Envelope Coordinating Council, 1015 15th St., N.W., Suite 700, Washington, DC 20005; (202) 347-5710.

***Northeast Construction Exposition and Conference.*** May 6-8. Bayside Exposition Center, Boston, Massachusetts. Contact Robert T. Slater, Northeast Construction Expo, 163 Highland Avenue, Needham Heights, MA 02194; (617) 449-3916.

***Energy-Efficient Lighting, A 'Roll Up Your Sleeves' Seminar.*** May 9, Valley Forge, Pennsylvania. Contact Alex Wilson, New England Solar Energy Association, Box 541, Brattleboro, VT 05301; (802) 254-2386.

***Solar Business Forum.*** May 15, Sturbridge, Massachusetts. Contact Alex Wilson, New England Solar Energy Association, Box 541, Brattleboro, VT 05301; (802) 254-2386.

***Photovoltaics: Into the Marketplace.*** June 17-19, MIT, Cambridge, Massachusetts. Contact Alex Wilson, Conference Director, New England Solar Energy Association, Box 541, Brattleboro, VT 05301; (802) 254-2386.

## SOUTHEAST

***1985 Moisture and Humidity International Symposium.*** April 15-18, Washington, DC. Contact Instrument Society of America, Moisture & Humidity Conference and Exhibit, Box 3561, Durham, NC 27702.

***Solar Greenhouses and Sunspaces Course.*** April 21-22, Atlanta, Georgia. Contact Georgia Solar Coalition, Box 5506, Atlanta, GA 30307; (404) 525-7657.

***Solar Merchandising.*** April 25-26, Ft. Meyers, Florida; May 23-24, West Palm Beach, Florida. Contact Ken Sheinkopf, Program Director, Florida Solar Energy Center, 300 State Road 401, Cape Canaveral, FL 32920; (305) 783-0300.

***Housing Retrofits for Energy Savings.*** May 2, Orlando, Florida; May 15, Ft. Meyers, Florida; June 7, Stuart, Florida. Contact Ken Sheinkopf, Program Director, Florida Solar Energy Center, 300 State Road 401, Cape Canaveral, FL 32920; (305) 783-0300.

***New Home Construction for Energy Savings.*** May 3, Orlando, Florida; May 16, Ft. Meyers, Florida; June 8, Stuart, Florida. Contact Ken Sheinkopf, Program Director, Florida Solar Energy Center, 300 State Road 401, Cape Canaveral, FL 32920; (305) 783-0300.

***Tenth National Passive Solar Conference.*** October 15-20, Raleigh, North Carolina. Contact North Carolina Solar Energy Association, Box 10431, Raleigh, NC 27605; (919) 832-7601 or 832-5798.

***Thermal Performance of the Exterior Envelopes of Buildings III.*** December 2-5, Clearwater Beach, Florida. Contact American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), 1791 Tullie Circle N.E., Atlanta, GA 30329.

## MIDWEST

***Kansas City Energy and Home Improvement Expo.*** April 12-14, Kansas City, Missouri. Contact Mary Jo Doherty, Energy Exposition, 4210 Johnson Dr., Suite 306A, Shawnee Mission, Kansas 66205; (913) 384-3976.

***Air Pollution Control Association, Annual Meeting.*** June 16-21, Detroit, Michigan. Contact Air Pollution Control Association, Box 2861, Pittsburgh, PA 15230; (412) 621-1090.

***Fenestration World '85, 2nd Annual Exposition and Conference for Manufacturers and Fabricators of Windows, Doors, Entrances, Etc.*** July 9-11, Milwaukee, Wisconsin. Contact Dame Associates, Inc., 51 Church St., Boston, MA 02116; (617) 482-3596.

***Window Energy Systems, 1985 Show.*** August 9-11, Hyatt Regency, Chicago, Illinois. Contact Gretchen Artig, WES, 345 Cedar Bldg., Suite 450, St. Paul, MN 55101.

## WEST

***Conservation in Buildings: Northwest Perspective.*** May 19-22, Butte, Montana. Contact Gerry Durkin, National Center for Appropriate Technology, Box 3838, Butte, MT 59702; (406) 494-4572.

***Renewable Energy Technologies Symposium and International Exposition (RETSIE).*** June 3-6, Anaheim Convention Center and Marriott Hotel, Anaheim, California. Contact Linda Ladas, TMAC, 680 Beach Street, Suite 428, San Francisco, CA 94109; (415) 474-3000.

***1985 Pacific Coast Builders Conference/Expo.*** June 19-22, Moscone Center, San Francisco. Contact Mary Ann Carmichael, 605 Market Street, #1010, San Francisco, CA 94105; (415) 543-2600.

***Sealed Insulating Glass Manufacturers Association, Summer Meeting.*** August 11-14, Red Lion Motor Inn, Portland, Oregon. Contact SIGMA, 111 E. Wacker Drive, Chicago, IL 60601; (312) 644-6610.

***Second Annual Symposium on Improving Building Energy Efficiency in Hot and Humid Climates.*** September 24-26, College Station, Texas. Contact Dr. William Murphy, Coordinator, Building Energy Symposium, Department of Mechanical Engineering, Texas A&M University, College Station, TX 77843.

## CANADA

***Indoor Air Quality in Cold Climates: Hazards and Abatement Measures.*** April 29-May 1, Ottawa, Ontario. Contact Air Pollution Control Association, Box 2861, Pittsburgh, PA 15230; (412) 621-1090.

***Intersol 85 — Congress of the International Solar Energy Society.*** June 23-29, Montreal, Quebec. Contact Intersol 85, Suite 410, P.O. Box 1427, Desjardins Postal Station, Montreal Quebec H5B 1H3 Canada.

## INTERNATIONAL

***Sixth European Photovoltaic Solar Energy Conference.*** April 15-19, Kensington Town Hall, London England. Contact Dr. W. Palz, Commission of the European Communities, DG X11, Rue de la Roi, 200, B-1049 Brussells, Belgium, (322) 235-69-22.

***Solar U.S.A. Tour.*** June 16-23, California, Texas, Colorado, Minnesota, Michigan, and Montreal. Contact Jordan Educational Travel Services, Cedar Springs, MI 49319; (616) 696-1180.

***First International Energy Conservation and Technology '85.*** June 10-15, Shanghai, China. Contact Roddy Shashoua, China Energy Conservation '85, International Trade and Exhibitions Ltd., 553-579 Harrow Road, London, W10, England, (01) 968-4567.

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