Pressure Testing Buildings:
or three physics majors step out

Summer Camp 2012

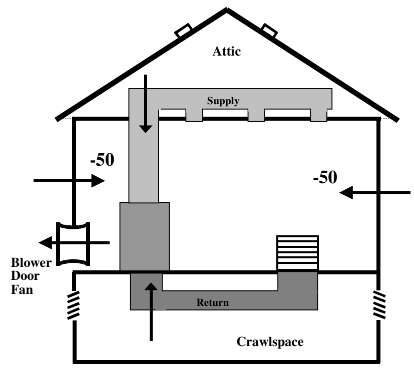
Westford, MA

Objectives

- To have some fun and maybe learn something from the attendees and are otherwise;
- on a need to know basis

Fan Pressurization Airtightness Test

- Blower Door fan is used to blow air out of (or into) the building.
- If fan causes all leaks to leak in the same direction, mass flow through the fan equals mass flow through the leaks.
- Flow through the fan needed to induce a 50 Pa pressure change is one measure of the building airtightness (CFM50).



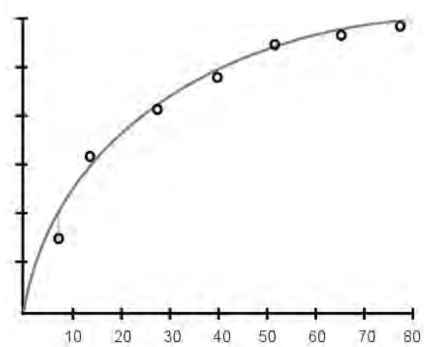
Characterizing the Air Leakage

Regression analysis on
Transformed Nonlinear Function:
$Q_{cfm} = C^*(\Delta P_{pascals})^n$

Where C = flow coefficient
n = flow exponent ($0.5 \leq n \leq 1.0$)

Special case of the sharp-edge orifice
$Q_{cfm} = 1.06^*A_{in^2}{}^*(\Delta P_{pascals})^{0.5}$

Special case of laminar flow element or thin cracks
$Q = C^*\Delta P$

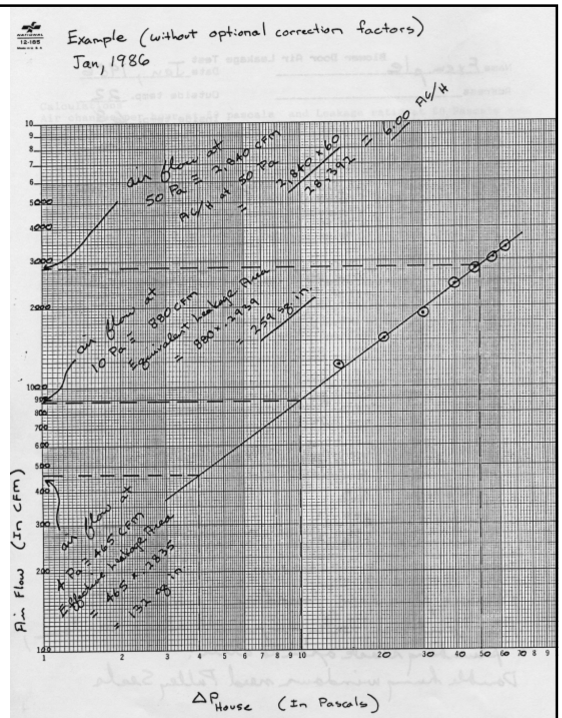


This is a simplification. Air density and viscosity also affect flow and the leakage curve really isn't a power law.

In the old days we graphed data on log-log paper and did a regression by eyeballing a straight line thru the points. Tedious, largely a waste of time, but part of the show to impress clients. (And required by standards.) It does provide some averaging to improve noisy data on windy days.

C, n, and flows at various pressures are then determined from the line.

Notice that extrapolating to 4 or 1 Pascal has problems.



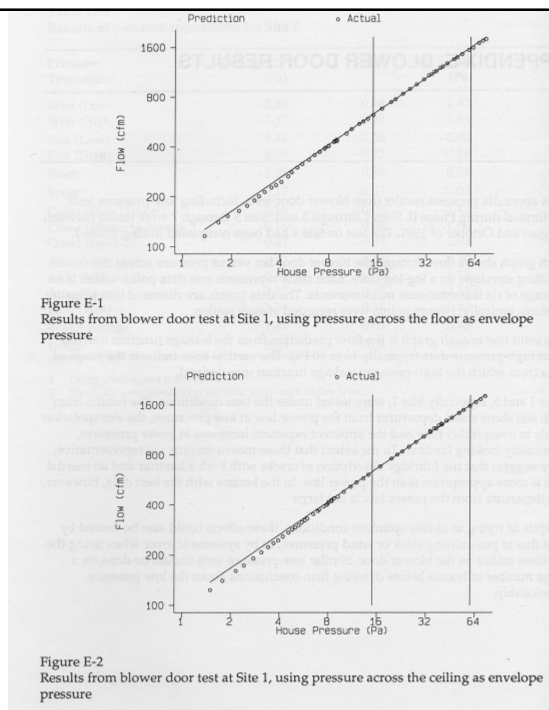
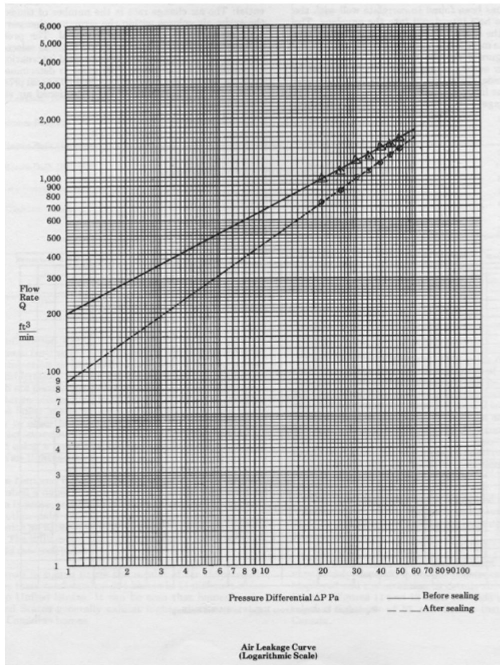


Figure E-1
Results from blower door test at Site 1, using pressure across the floor as envelope pressure

Figure E-2
Results from blower door test at Site 1, using pressure across the ceiling as envelope pressure

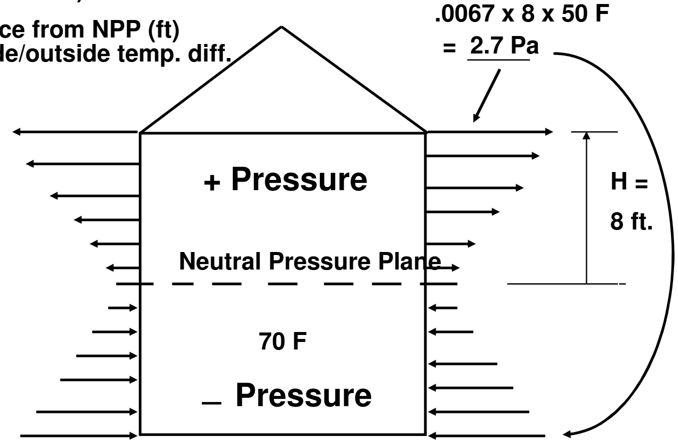


STACK EFFECT

At sea level:
Stack Pressure (Pa) = (0.0067 x H x △ T)

H = distance from NPP (ft)
△ T = inside/outside temp. diff.

At Top and Bottom:
Stack Pressure = .0067 x 8 x 50 F = 2.7 Pa



Pascal's Principle

- When a fan is turned on to pressurize or depressurize a single zone, the pressure difference between inside and outside changes by <u>exactly</u> the same amount everywhere.

Why Test?

- To determine leakage parameters to use in infiltration modeling
  - Accurate measurement at lower pressures is desirable
- To check for compliance with an airtightness specification or regulation
  - Repeatability is important. Different people on different days with different weather and using different equipment. Measuring at higher pressures helps repeatibility.
- To find leaks
  - Zonal diagnostics to measure leakage between spaces (attics, crawlspaces, garages, neighboring apartments
  - Theatrical fog
  - Infrared
  - Hot wire anemometer
- To evaluate retrofit effectiveness

11 COMPARISON OF PFT AND LBL RESULTS

The LBL model results using the modified parameters are compared with the PFT results in Fig. 11.1. The line indicates equality. The two methods track one another reasonably well although there is considerable scatter. The variability of infiltration rates increases at higher levels of infiltration and both distributions are skewed positive. Large negative deviations from the one-one line may indicate homes with large occupancy effects.

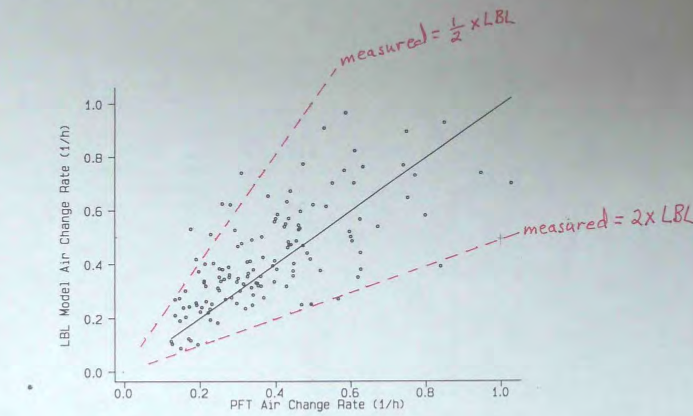


Figure 11.1. Comparison of PFT and LBL model results
LBL hourly predictions used National Weather Service data for the duration of the PFT test. The line indicates equality.

Palmiter + Brown, Ecotope, 1989

Codes and Standards

2012 IECC (Residential)

All homes must be tested for airtightness and meet the following levels:

Climate zones 1-2	5 ACH50
Climate Zones 3-8	3 ACH50

Questions: Is a standard test procedure specified?
Is volume well defined?

Passive House

- 0.6 ACH50

UK Commercial Standard

- 10 m3/hr/m2 @50 Pa (approximately 0.71 CFM75/ft2)
- Best practice for air conditioned buildings 2 m3/hr/m2 @50

Energy Star Version 3 (Performance Path)

Goes into effect for houses getting final inspection after 1/1/2012

All houses must be tested by a rater using a RESNET approved test standard and meet the following levels:

Climate Zones 1-2	6 ACH50
Climate Zones 3-4	5 ACH50
Climate Zones 5-7	4 ACH50
Climate Zone 8	3 ACH50

Army Corps of Engineers

- U.S. ARMY CORPS OF ENGINEERS AIR LEAKAGE TEST PROTOCOL FOR MEASURING AIR LEAKAGE IN BUILDINGS **http://www.wbdg.org/pdfs/usace_airleakagetestprotocol.pdf**
- Requires:
  - Continuous air barrier systems design, installation, pressure testing, identify air leakage sites, remediation if needed
  - Air leakage rate normalized to surface area of enclosure ≤ 0.25 cfm/ft2 enclosure at 75 pascals

Washington State Energy Code Commercial and Multifamily

Air barrier is defined and key areas that must be sealed are specified.

Target airtightness is .40 cfm75/ft^2

All buildings must be tested for compliance

May pressurize, depressurize, or both using ASTM E779 or approved similar test

Passing the test not required for Certificate of Occupancy

Washington State Energy Code Residential

All new houses must be tested and have an SLA (Specific Leakage Area) < .0003

SLA = ELA(at 4Pa)/Conditioned Floor Area

Where ELA and CFA are both in square inches

A simple one point CFM50 test is explained on their web site but it neglects to measure and subtract the baseline pressure.

Washington State Energy Code Residential - continued

You now must convert the flow rate (CFM50) to SLA. Use the following formula:

SLA = (CFM50 X .055) / (CFA X 144)

Where: SLA = Specific Leakage Area

CFM50 X .055 = Blower door fan flow rate at 50 pascal pressure difference, converted to a conversion factor (SLA reference pressure)

CFA x 144 = Conditioned floor area of the housing unit, converted to square inches

Washington State Energy Code Residential - continued

According to the web site, an SLA of .0003 is exactly equivalent to .786 cfm50/CFA where CFA is in square feet.

Test Standards

- ASTM E779-10 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
- ASTM E1827-Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
- ISO 9972 Thermal performance of buildings- Determination of air permeability of buildings – Fan pressurization method (EN 13829)
- ATTMA Technical Standard L2. Measuring the Air Permeability of Building Envelopes (Non-Dwellings)
- CGSB-149.10-M86 Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method
- CAN/CGSB-149.15-96, Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems

RESNET Test Standard
(Draft out for public review soon)

- Allows pressurization, depressurization, or both
- Allows multi point, single point, or multiple single point tests
- Single point CFM50 test allowed if baseline meets a stability requirement
- Most detailed description of how to prepare the building for test

Multifamily Compartmentalization

- LEED Multifamily ETS PR 2012
  - 0.23 cfm 50/ft2 unit enclosure (all six sides)
  - Blower door test must be performed
  - A sampling protocol may be used
- EnergyStar for Highrise
  - 0.3 cfm 50/ft2 unit enclosure
  - Blower door test must be conducted (E779-10 or E1827)
  - Sampling protocol spelled out in standard may be used
  - Requires preliminary and final testing

Finding air leaks

- Air leakage between house and attached garage
- Trace airflow patterns (e.g. from printshop to office area)
- Series pressure drops
- Chemical smoke
- Infrared imaging
- Theatrical fog (roll film)

Airtightness Units (Mesmerizing Metrics)

- Airflow at a test pressure:
  - CFM at 50 pascals (CFM50)
  - L/s or m3/hr at 50 pascals
- Leakage Area
  - ELA (4 pa)
  - EqLA (10 pa)
- Airflow at a test pressure normalized (divided) by enclosure area
  - CFM at 75 pascals per square foot of enclosure (5 or 6 sides of the box)
  - m^3/hr or L/s at 75 pascals per square meter of enclosure

Metrics continued

- Airflow at a test pressure normalized by volume
  ACH50 = CFM50*60/Volume
- Leakage Area normalized by an area
  SLA = ELA (4 Pa)/Conditioned Floor Area (both in same units)
- Normalize to useable floorspace? (Collin)

And on and on

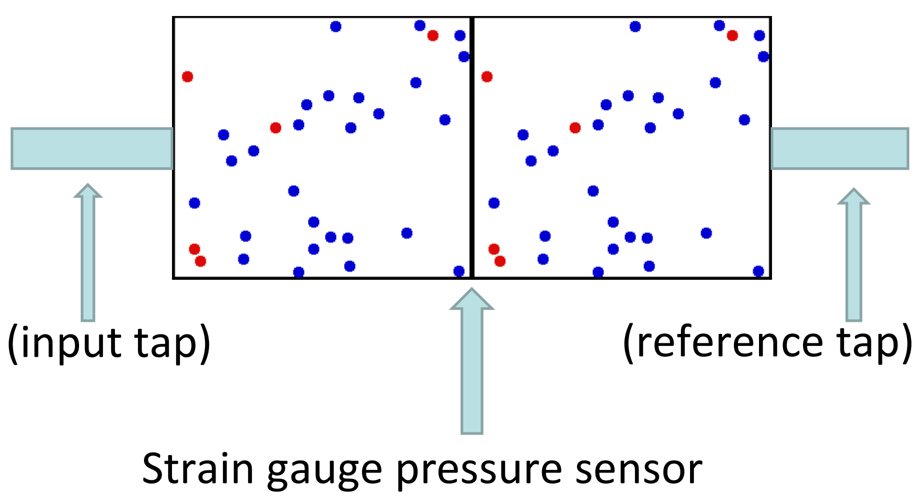
Pitfalls

What could possibly go wrong?

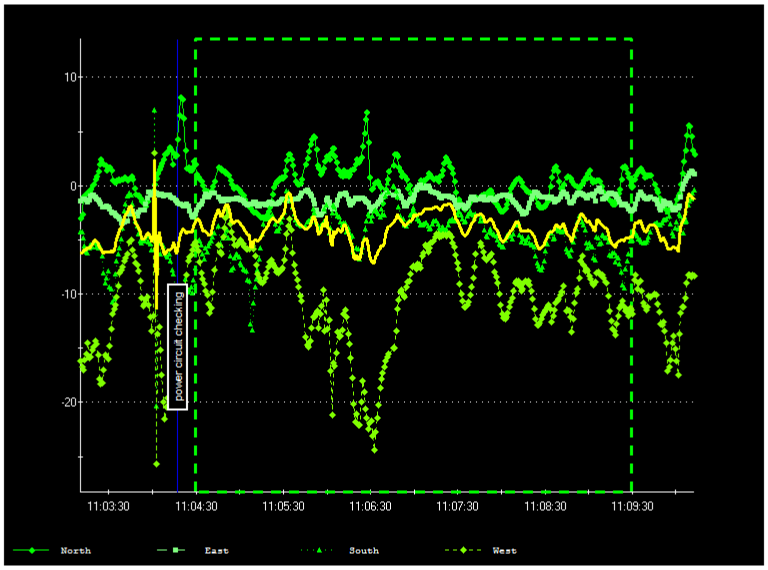
Pitfalls

- Calculating surface area
- Building setup
  - Mechanical systems
  - Enclosure
  - Things blow open
  - People in the building
- Wind and stack effects
- Single zone condition?
- Fan location (not the same as calibration)
- Wind effect on fans
- Tubing issues
  - Stack effect
  - Expansion of air in tubing
  - Leakage

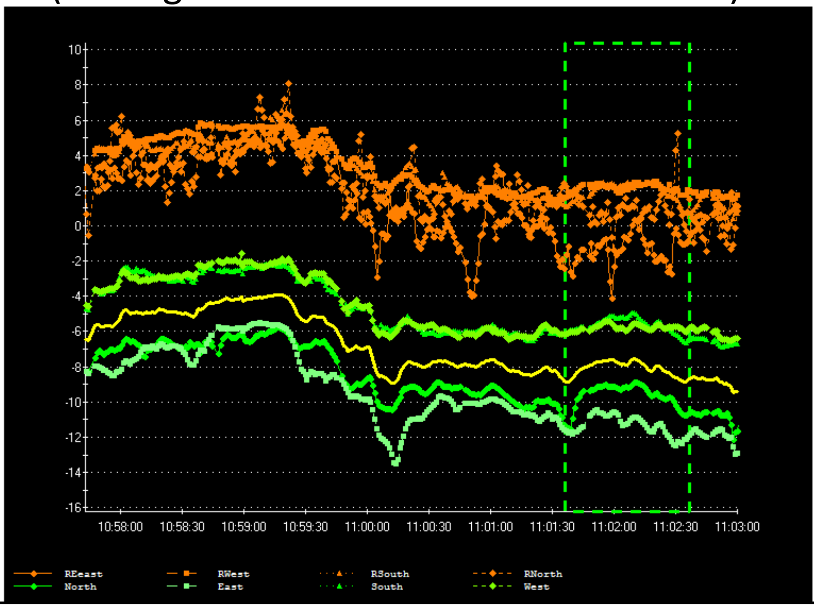
Here is what we actually measure



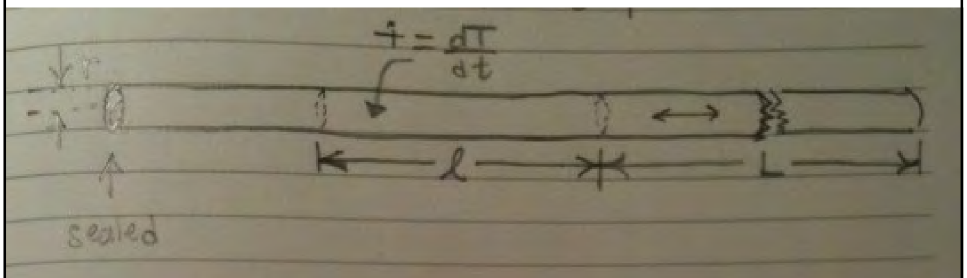
Wind Pressures on Building – Fans Off (Average of Four Sides shown in Yellow)



Stack Pressures on Building – Fans Off (Average of Four Sides shown in Yellow)



Thermal expansion of air in tubing: Theoretical Model



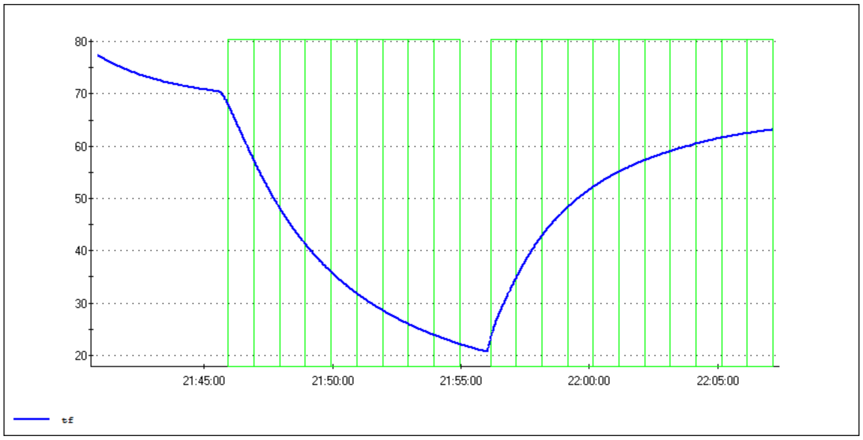
$$\Delta p = \frac{8 \mu l L \dot{T}}{r^2}$$

What about thermal expansion in tubing?

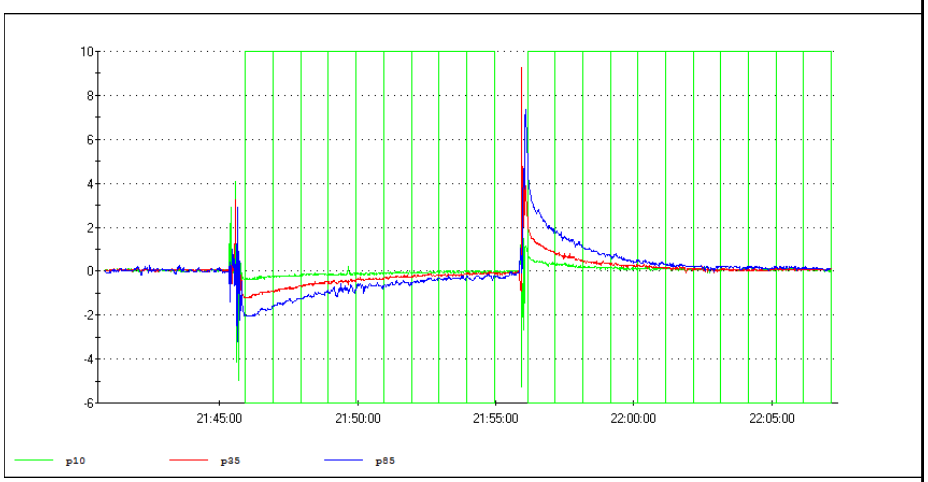
3 Tubes

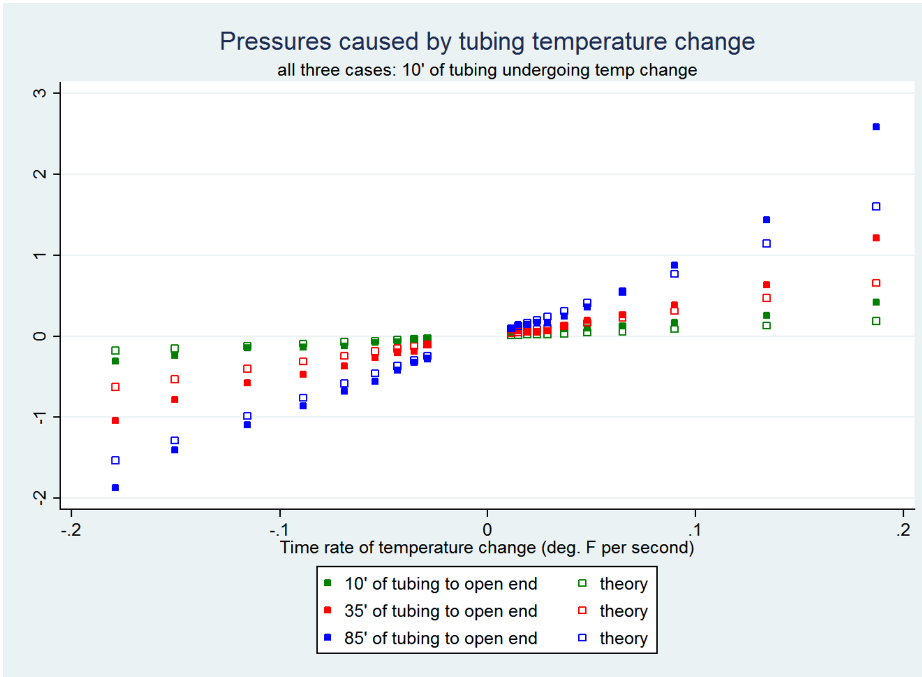
- Each have 10’ length of tubing in freezer
- Remaining portion outside (10’, 35’, 85’)
- Open end of tap next to reference port
- Calculate theoretical pressure change

Temperature change in tubing



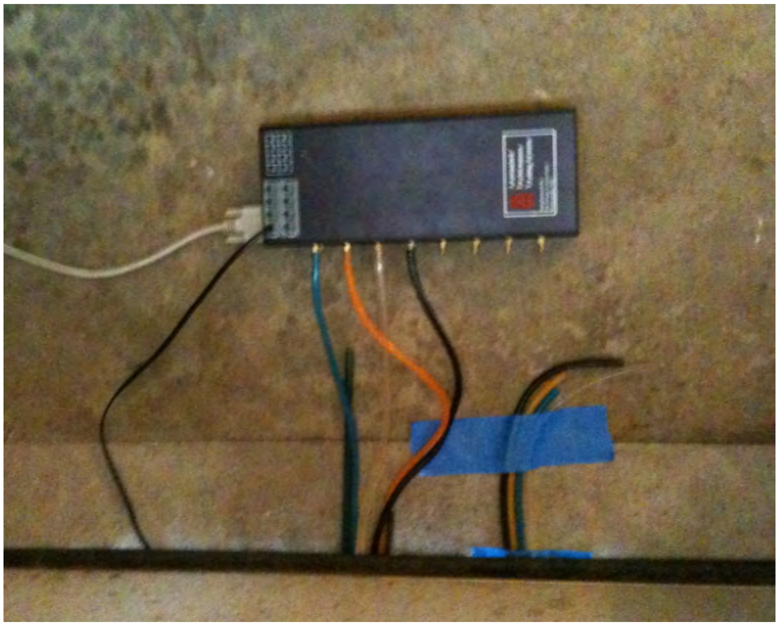
Measured pressures



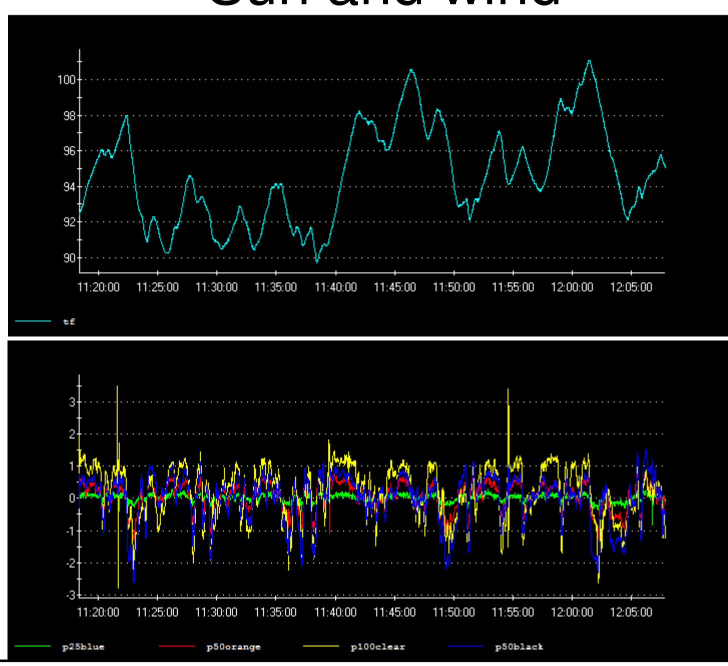


Experiment #2: Sun and Wind

- Pressure measurement equipment in the garage
- Tubing runs to outside, into the sun, back into the garage
- Actual pressure difference between end of tube and reference port is 0 Pa
- Clouds passing over and bright sun (June 22, 2010)



Sun and wind


100
98
96
94
92
90
11:20:00
11:25:00
11:30:00
11:35:00
11:40:00
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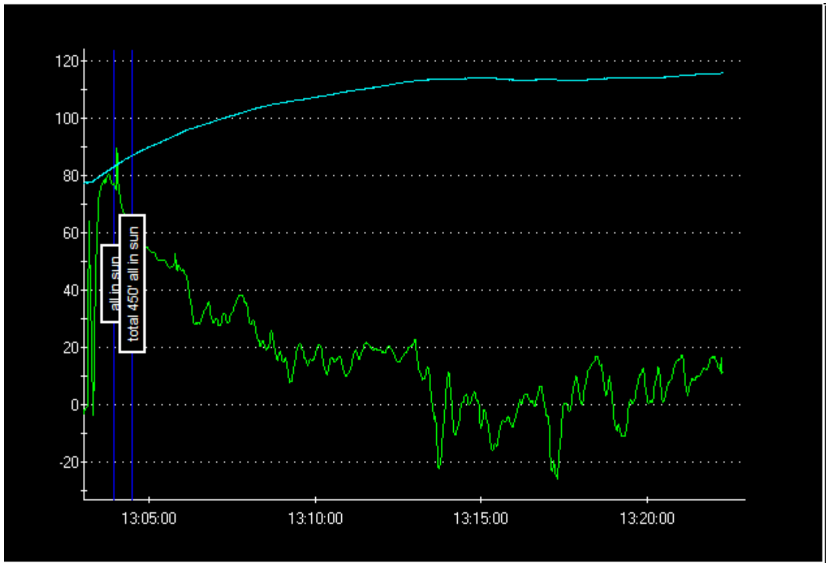
11:50:00
11:55:00
12:00:00
12:05:00
tf
3
2
1
0
-1
-2
-3
11:20:00
11:25:00
11:30:00
11:35:00
11:40:00
11:45:00
11:50:00
11:55:00
12:00:00
12:05:00
p25blue
p50orange
p100clear
p50black

Long tubing (450’) in sun



Conclusions

- Sun and wind can cause pressure errors which appear to be direct wind
  - Some (not stack) disappear with shorter tubing
- Really long tubes can cause really bad problems, according to model and data
- Clear tubing less susceptible (All else equal)
- Stick with guidance of tubing < 100’

Nobody knows the trouble I've seen

- Tubes get stepped on
- Tubes get sucked into fans
- Wind causes fans to windmill
- Controllers in the "just on" position
  - Or just beyond
- At the last minute we're told we can't blow air into the building

Nobody knows…

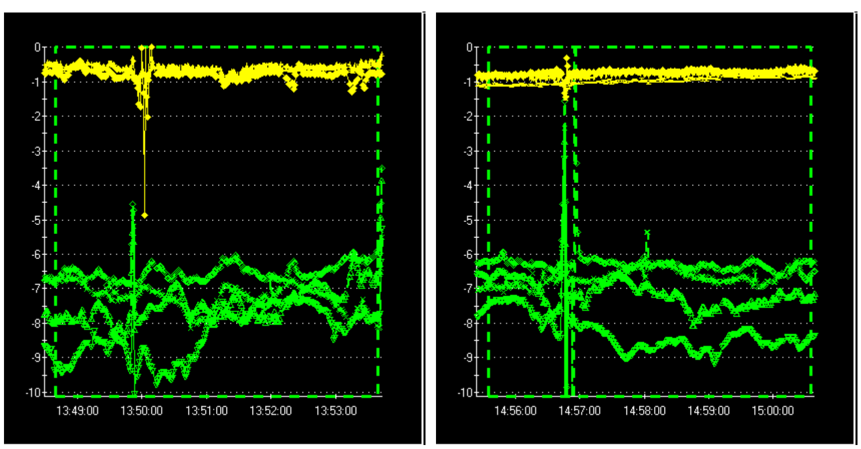
- "helpers" opening doors during pressurization tests
- Test witnesses who just want to talk
- "helpers" closing doors during pressurization tests
- "helpers" installing booby trapped frames
- Hard to hear

Advice for large building testing

- Keep teams small
- Clearly define the chain of command and responsibilities
- Seriously consider setting specs based on depressurization only
- Have line-of-sight to fans but not too close
- Get to know the mechanical system designer or on-site staff
- Pre-test planning meeting: go through the sequence of testing

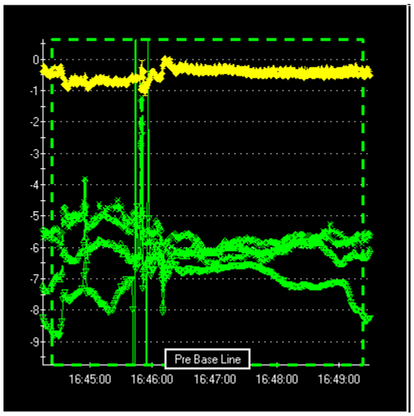
Interior Pressures - Depressurizing

Pre test baseline   Post test baseline

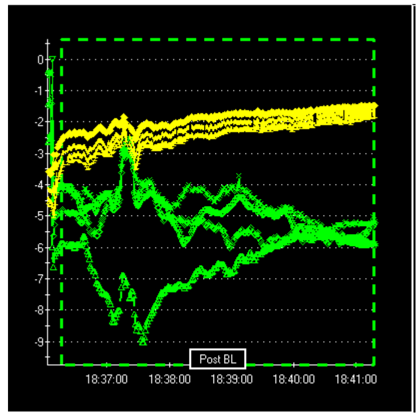


Interior Pressures - Pressurizing

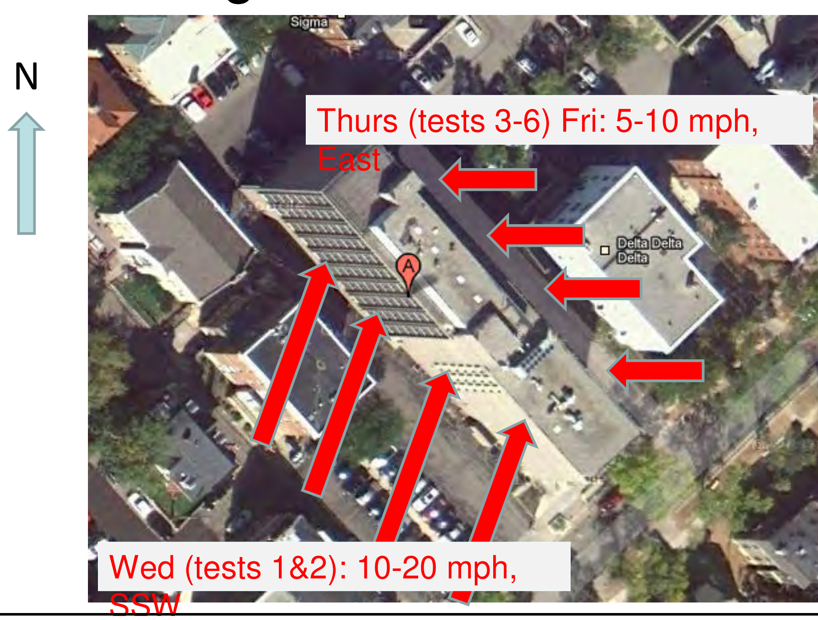
Pre test baseline

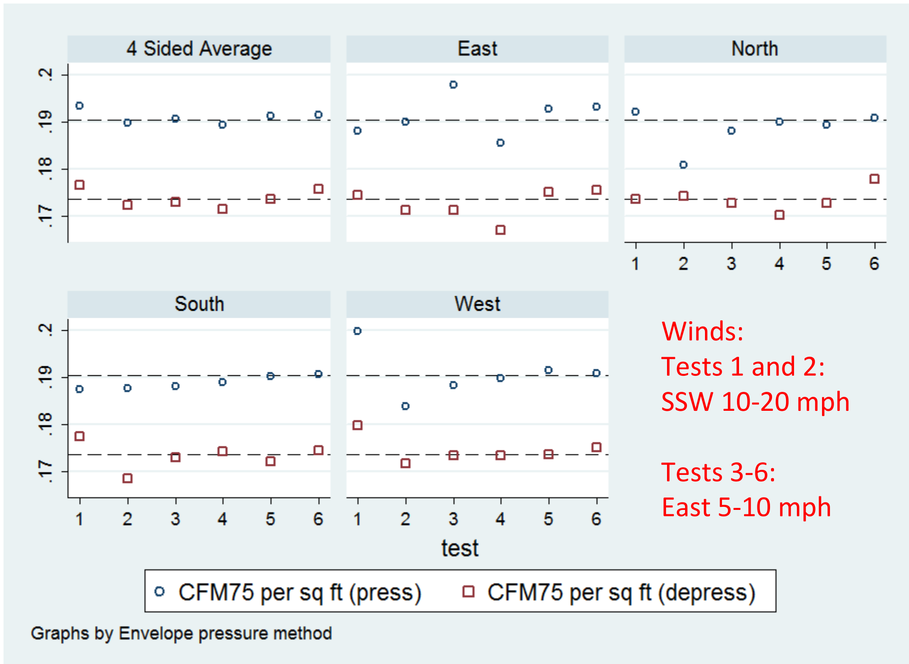


Post test baseline



Building Orientation and Winds




4 Sided Average
East
North
South
West
.17
.18
.19
.2
1
2
3
4
5
6
test
Winds:
Tests 1 and 2:
SSW 10-20 mph
Tests 3-6:
East 5-10 mph
CFM75 per sq ft (press)
CFM75 per sq ft (depress)
Graphs by Envelope pressure method

History

History

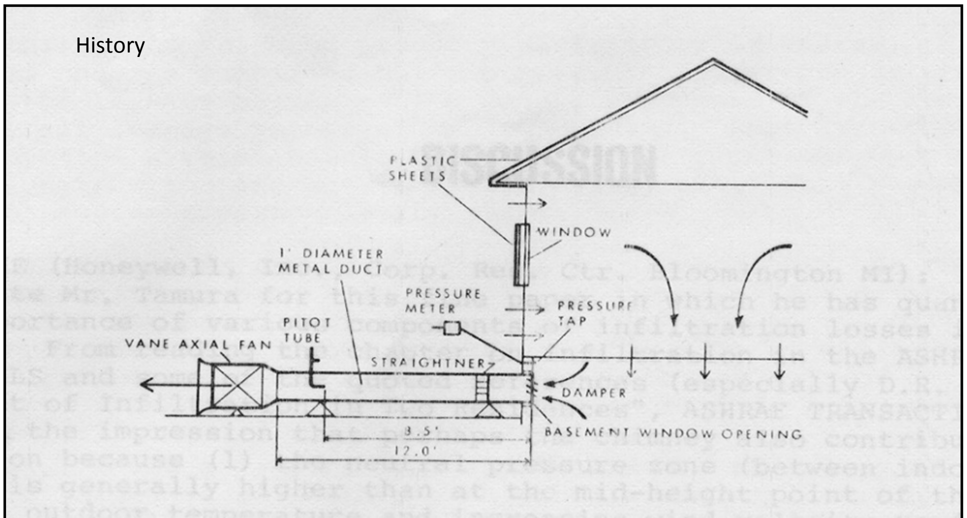
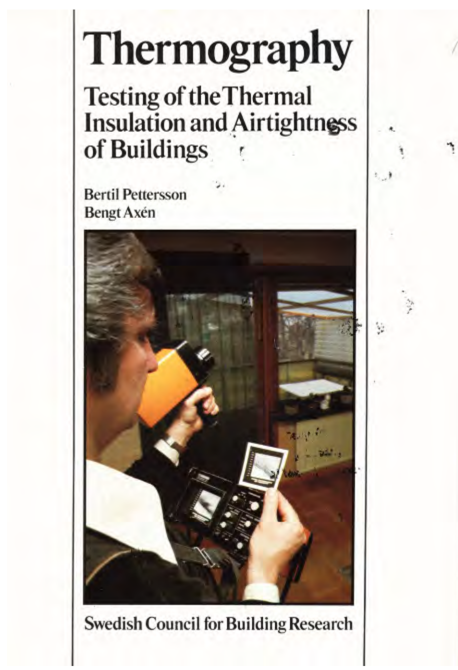


Fig. 1 Test arrangement

Tamura, NRC 1968



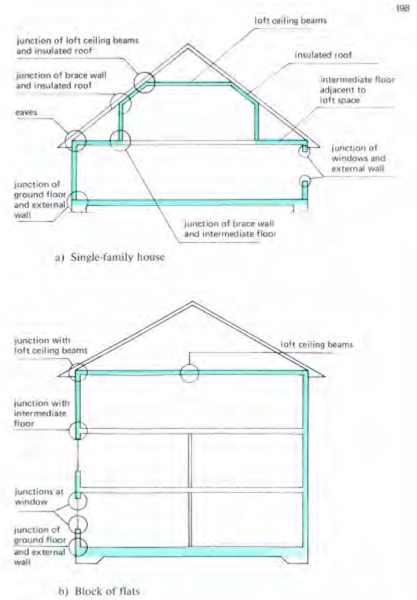
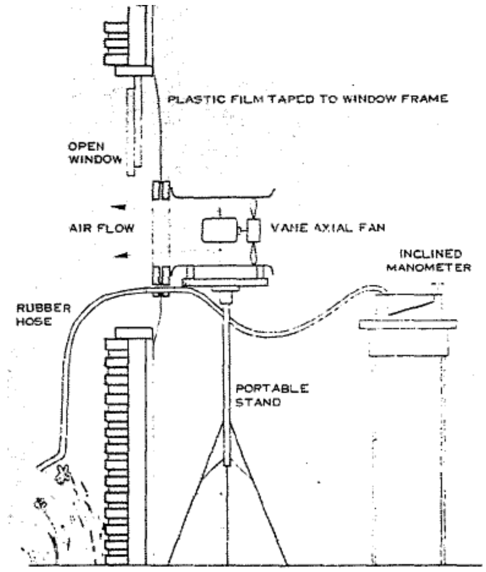


Fig. 123. Single-family house and block of flats with constructional elements sensitive from the thermal insulation and airtightness standpoint marked.

Table 2.1 Maximum air change rate (ach) at 50 Pa for residential buildings according to SBN 1980 and maximum air leakage rate (m3/m2,h) according to Nybyggnadsregler BFS 1988.

Type of building	SBN 80	BFS 1988
	ach	m^3/m^2,h
Detached and terraced, single-family houses	3.0	3.0
Other residential buildings of not more than two storeys	2.0	3.0
Residential buildings of 3 or more storeys	1.0	3.0

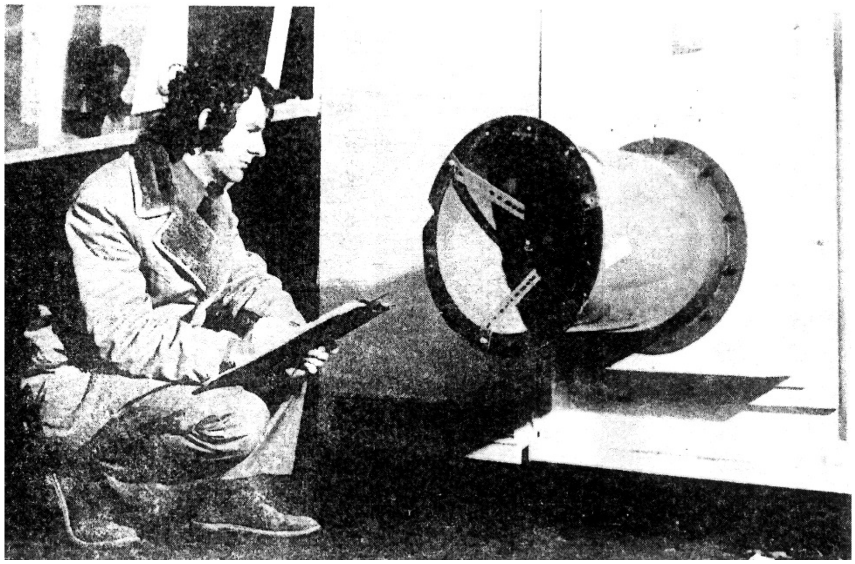
These ACH50 values were unchanged from the 1975 code which was adopted in 1977



Sol Stricker, Ontario Hydro, 1974

In connection with a study of heat losses from electrically heated houses, a novel method of measuring the air leakage area of houses was developed. Field measurements indicate that doors and windows account for only a fraction of the total air leakage. A survey is described where some correlations were found between the leakage area and indoor environmental conditions such as relative humidity, air-particulate levels and heating-energy consumption. Leakage areas that give rise to acceptable indoor conditions are given.

Stricker, Ontario Hydro 1974, Defined Equivalent Leakage Area



McIntyre, BRE 1975

SUMMARY

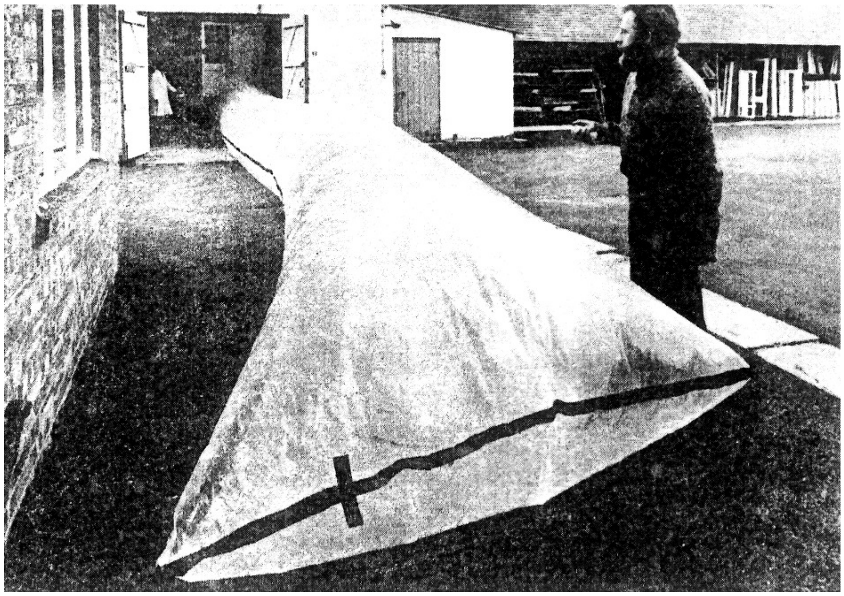
The possibility of reduced energy consumption through the control of excess air infiltration indicated a need to know about the air leakage characteristics of building envelopes generally.

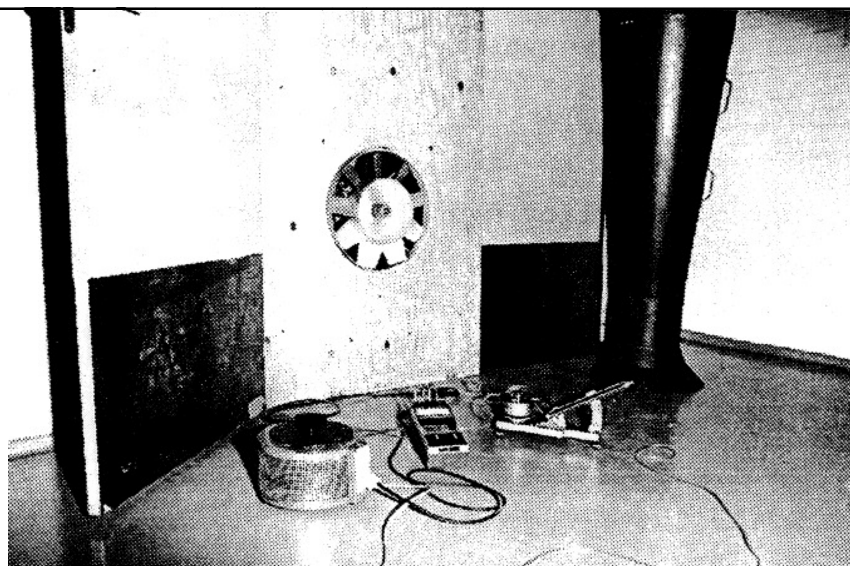
A portable air leakage apparatus capable of measuring the air infiltration of whole dwellings directly on site has been developed and is described.

The apparatus is a potential analytical tool for studying the effect of various individual leakage sources and for comparing one dwelling with another. Results for two houses are given.

The test method could form the basis of a performance acceptance test for new dwellings with a view to saving energy through air leakage control.

McIntyre, BRE 1975





Collet, 1976 Byggeteknik Teknologisk Institut, Denmark

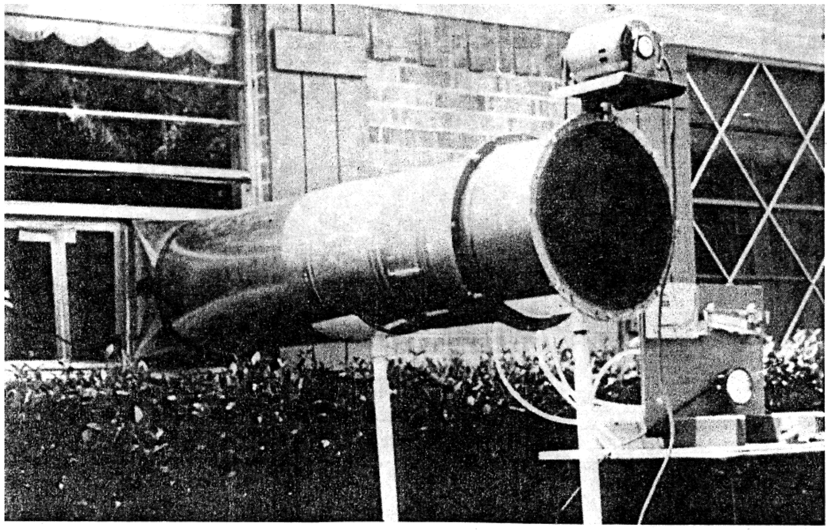
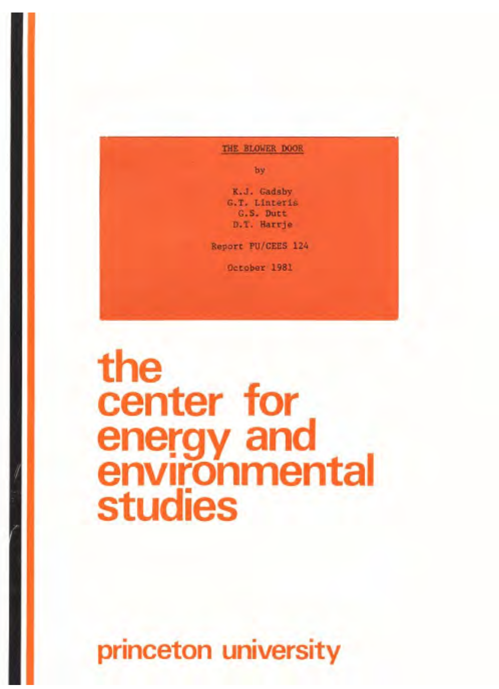


Fig. 1

Caffey, Texas Power & Light 1979 “Super Sucker



THE BLOWER DOOR

by

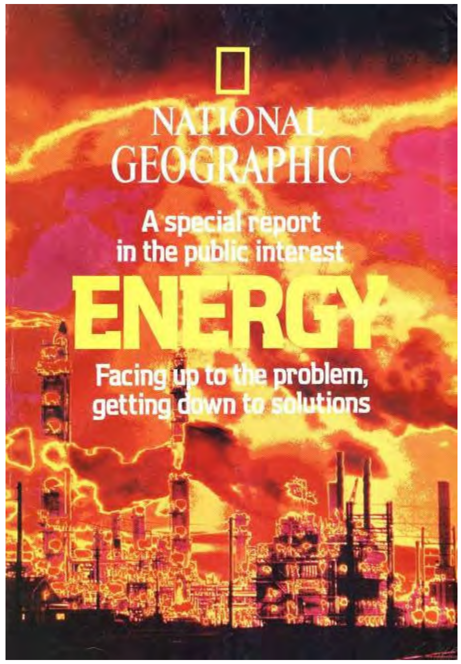
K.J. Gadsby
G.T. Linteris
G.S. Dutt
D.T. Harrje

Report PU/CEES 124

October 1981

the
center for
energy and
environmental
studies

princeton university



A VISIT FROM HOUSE DOCTORS

If some energy researchers from Princeton University have their way, an army of tens of thousands of "house doctors" will be calling on millions of American homes a year. This army would visit every household by the mid-1990s.

They would prescribe the standard cures for leaky homes—caulking, weather stripping, more insulation, and storm windows. They would tune up furnaces or prescribe new ones. More important, they would use special instruments to locate a whole category of air leaks no one knew about until recently and seal them on the spot.

In the mid-1970s a Princeton team realized that no one really understood how a house performs thermally. With federal funding, the team began putting instruments in well-insulated New Jersey homes and found that, despite insulation, the houses were losing three to five times more heat through the roof than expected.

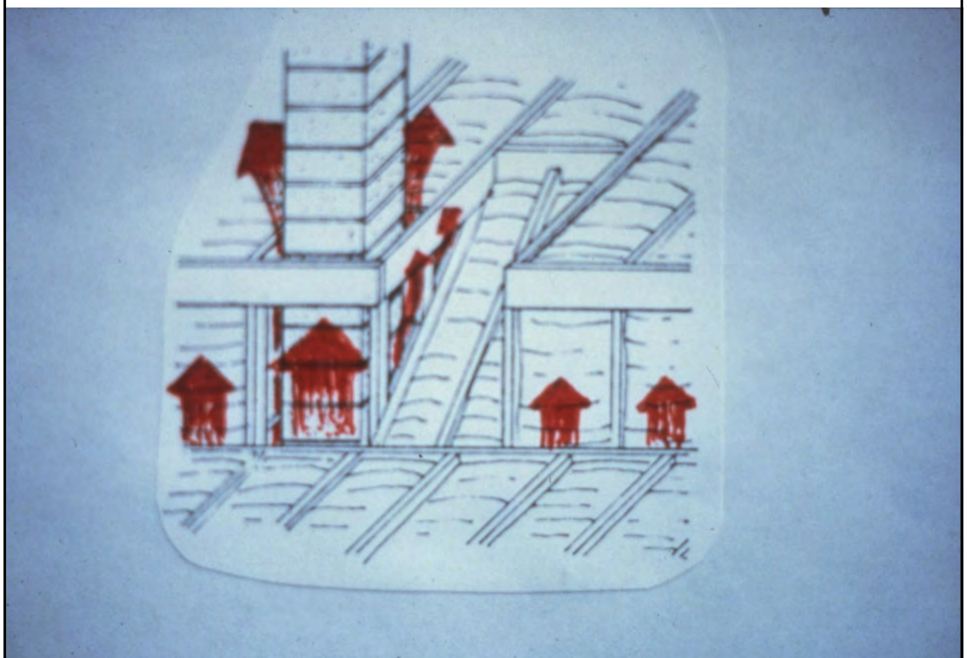
Demonstrating their techniques (**above**)*, the team sets up a large fan, called a blower door, to create a 20-mile-an-hour draft in this home. While Gautam Dutt monitors instruments to calculate the overall leakage of air from the house, his associate Kenneth Gadsby, at right, scans ceilings and walls with an infrared heat detector.*

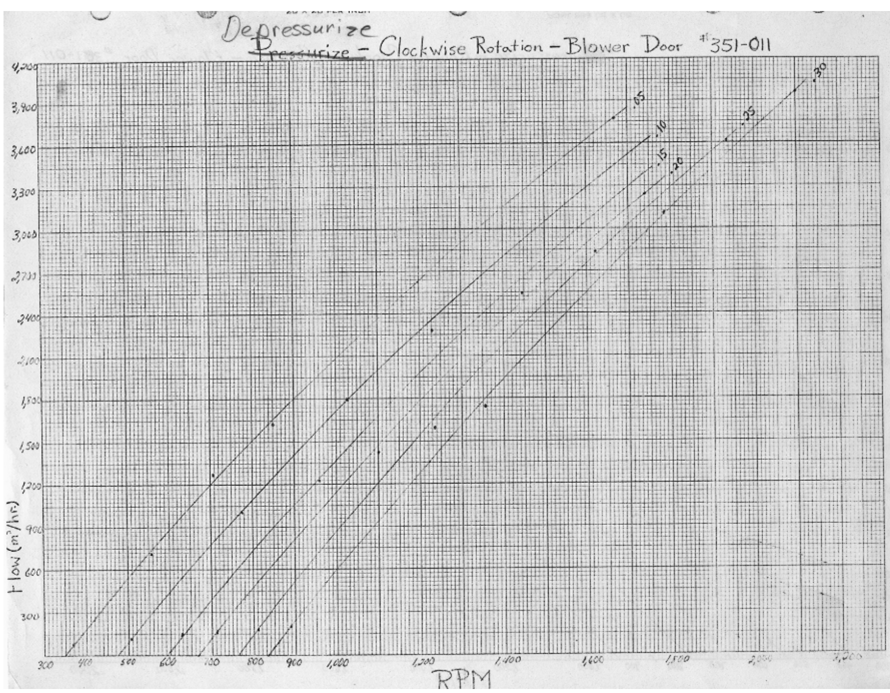
Cold spots appear dark in the scanner, indicating that heat is being lost through some invisible bypass.

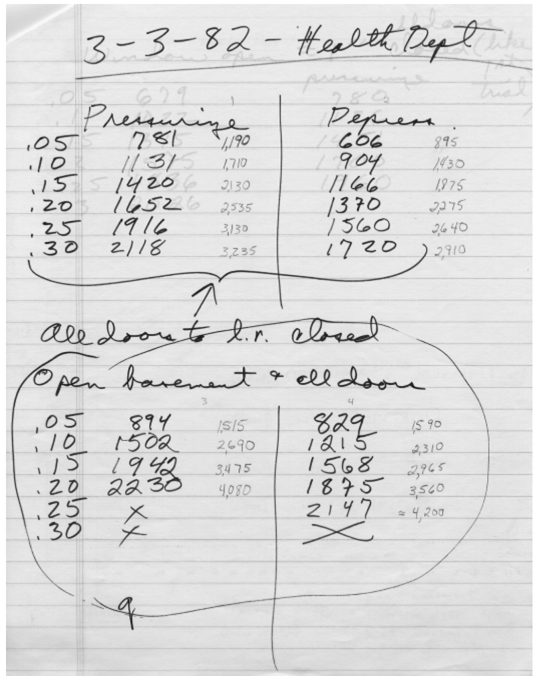
The house doctors locate other leaks with a "smoke pencil" (**below**)*. A smoky tracer streams into an electrical socket, another source of unexpected heat leaks in most homes. Inexpensive foam gaskets can be used to seal these outlets.*

Nearly every house, the team discovered, had many paths through which surprising amounts of heat bypass the attic insulation. These might be as obvious as a hole in the attic floor or a missing insulation batt. Many bypasses, however, are obscure. Hollow interior walls or openings where the plumbing vents and electrical wires pass the attic floor can be breezeways for heat to the outside.

A one-square-foot opening around a




Depressurize
Pressurize – Clockwise Rotation – Blower Door #351-011
Flow (m³/hr)
RPM
.05
.10
.15
.20
.25
.30
4,200
3,900
3,600
3,300
900
600
300
300
400
500
600
700
800
900
1,000
1,200
1,400
1,600



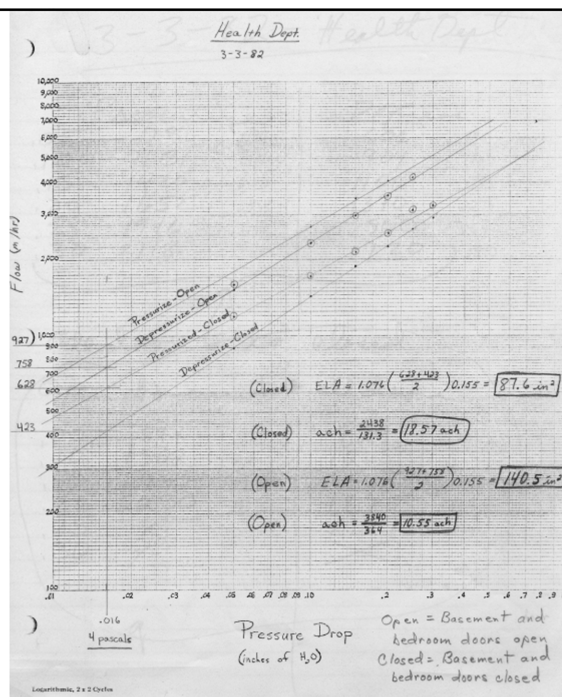
3-3-82 - Health Dept

	Pressurize		Depress.	
.05	781	1,190	606	895
.10	1131	1,710	904	1430
.15	1420	2130	1166	1875
.20	1652	2,535	1370	2275
.25	1916	3,130	1560	2640
.30	2118	3,235	1720	2,910

All doors to l.r. closed

Open basement & all doors

.05	894	1515	829	1590
.10	1502	2690	1215	2310
.15	1942	3475	1568	2965
.20	2230	4080	1875	3560
.25	X		2147	≈ 4,200
.30	X		X	



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BUILDING RESEARCH NOTE

AN EXHAUST FAN APPARATUS FOR ASSESSING THE AIR LEAKAGE CHARACTERISTICS OF HOUSES

by

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National Research Council Canada Conseil national de recherches Canada

NO 156

THE INFILTROMETER & THE ENER•SEAL PROGRAM

There is presently a sufficient body of evidence which indicates that uncontrolled air leakage is generally the main component of the space heating and cooling costs of most residential dwellings. It follows then, a comprehensive sealing program should be considered as the first step in virtually every residential energy conservation program. Accessibility to air leakage points into attic spaces is one reason why sealing should be a first priority. It is also apparent that size selection of heating and cooling systems should always be performed after all cost-effective energy conserving measures have been undertaken. Because a comprehensive sealing program often has the shortest payback period compared to most other retrofit measures, it is an essential first step towards energy conservation.

An experienced, professional contractor can, in most cases, locate and effectively seal the majority of common air leakage points in a home without de-pressurization equipment. We cannot overstress however, the importance of quantifying the relative tightness of the house in response to the health and safety concerns that can result from a tighter environment. Understanding the dynamic "air system" in a house is as important as understanding the academics of air sealing and air tightness measurement.

The Infiltrometer* is a de-pressurization device that has been designed to perform three important functions. They are:

(1) to permit easy identification of air leakage points;
(2) to automatically generate the air leakage data of each house on site, and;
(3) to provide verification of the success and relative importance of a sealing program.

The Infiltrometer is a portable assembly that can easily and quickly be installed in a doorway by one person. It is essentially a "package" consisting of the following components:

— an adjustable aluminum frame designed to accommodate different-sized door openings. (This frame is quickly clamped to the door jamb);
— a three-piece fibreglass "panel" which is clamped against the aluminum frame. At least one, and sometimes up to three of the panels contains a fan/motor assembly which exhausts air from the structure, thereby creating a negative pressure;
— a calibrated fibreglass nozzle to measure the air flow rates for each fan motor;
— a fibreglass control box which houses all of the electronic recording equipment and electrical conductors.

The Infiltrometer

The Ener-Seal* program is designed to cost-effectively reduce the uncontrolled air change rate of a structure. In quantitative terms, this means that a substantial reduction in the equivalent leakage area of a home should be achievable by a two-man crew within one day. The Ener-Seal program generally includes the following:

— weatherstripping of exterior doors;
— weatherstripping of windows;
— application of gaskets to all switches and receptacles on interior and exterior walls;
— interior caulking around all window and door casings;
— caulking of all exterior and interior baseboards where air leakage has been identified;
— weatherstripping of kneewall doors and attic access hatches;
— sealing around ceiling penetrations such as ductwork, plumbing stacks, and chimneys;

*Trademarks of Ener-Corp Management Limited

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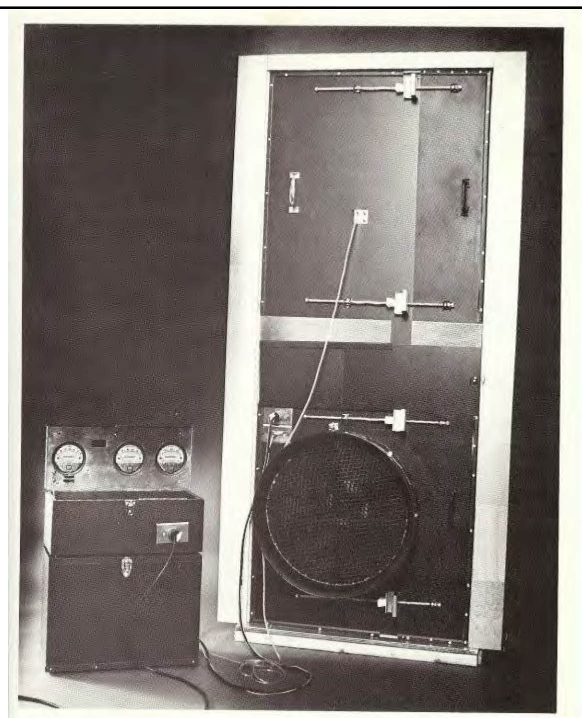
COMPUTERIZED
AUDITING
REPORTING AND
EVALUATION SYSTEM



History of Big Building Testing

- Shaw, Sander Tamura NRC 1973
- Persily, 1987?
- Both using HVAC system
- Anyone know of something earlier?

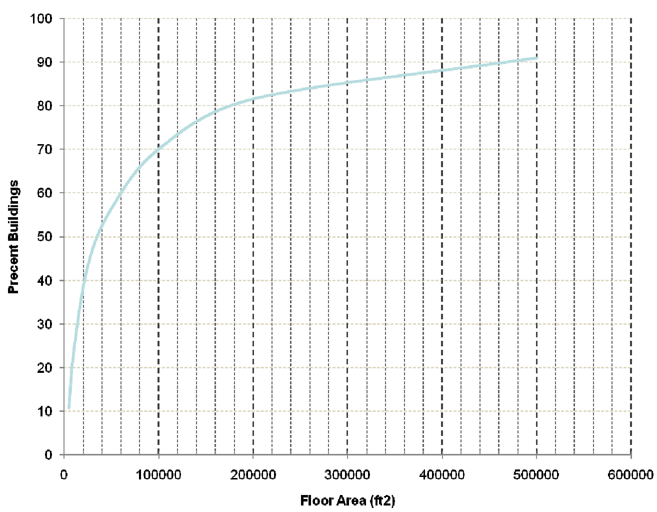
Recent History of Testing Big Buildings or multi-zone guarded tests

- Multiple fan doors, building HVAC; walking with notebook, manometer, flowhood, pitot tube; spreadsheet analysis of data
- Multiple fan doors, APT data logger/TECLOG, miles of tubing, spreadsheet analysis
- Multiple fan doors; CAT5 cable/multiple micromanometers/short tubing runs;TECLOG2 data logging/analysis

Different buildings?

- Single family, duplexes, row houses, three stories and taller
- Offices, schools, public buildings
- Special cases:
  - Pools and spas
  - Industrial
  - Isolation wards and clean rooms
  - Museums, archives, artifacts, musical instruments

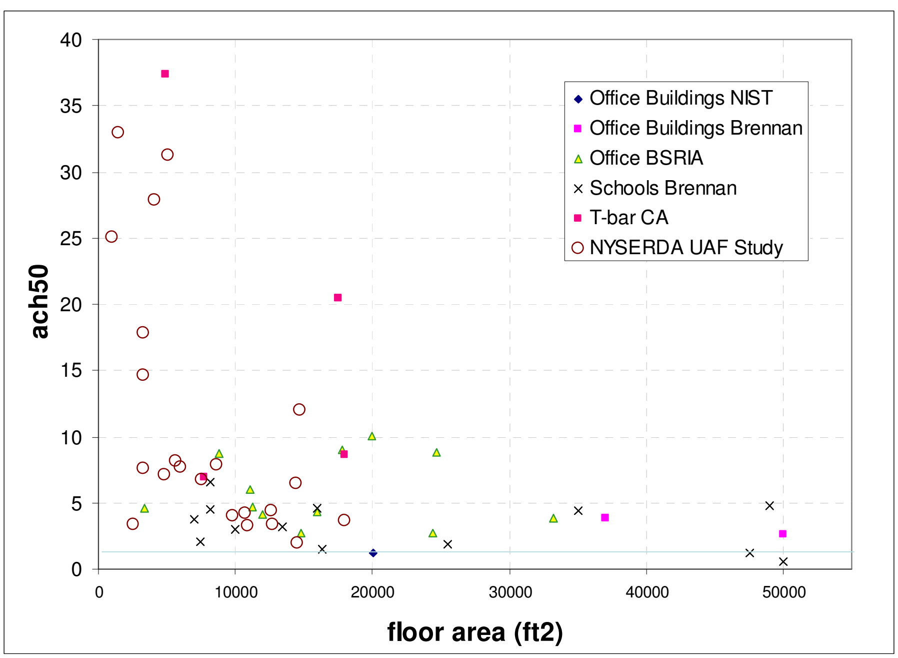
What's a big building?

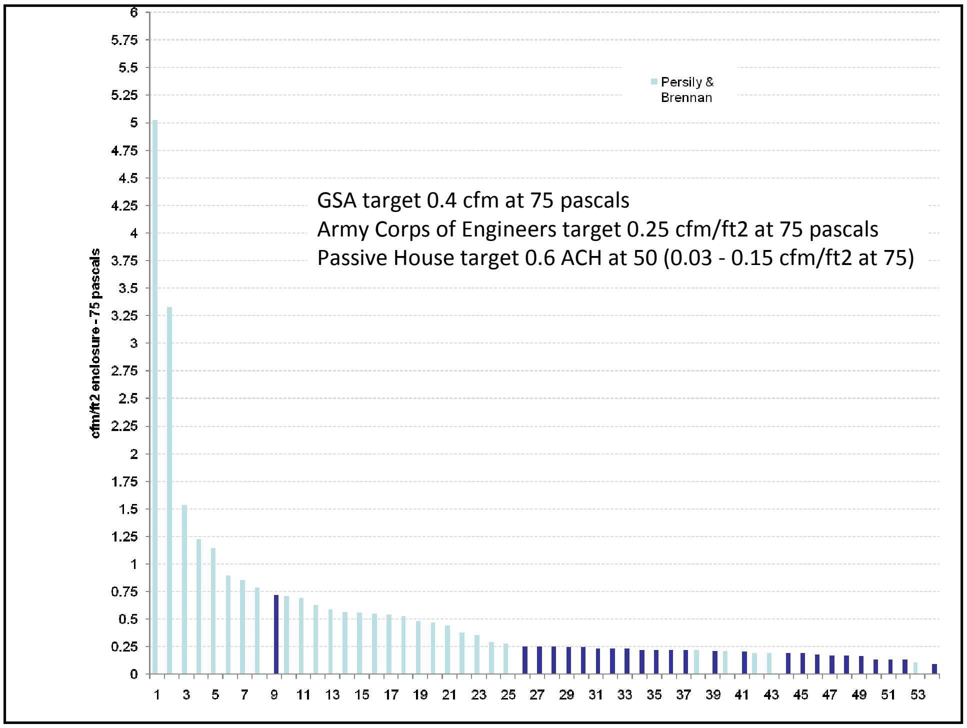


From the 1995 Commercial Buildings Energy Consumption Survey

How are "big" buildings different than single family?

- More complex HVAC systems
- More barriers to single zone condition:
  - Bottle necks
  - Barriers that cause
  - Really big holes
- Bigger stack and wind issues
- More security and safety issues
- More scheduling issues
- More walking and climbing




cfm/ft2 enclosure - 75 pascals
Persily & Brennan
GSA target 0.4 cfm at 75 pascals
Army Corps of Engineers target 0.25 cfm/ft2 at 75 pascals
Passive House target 0.6 ACH at 50 (0.03 - 0.15 cfm/ft2 at 75)


ASHRAE 1478 Measuring Air-tightness of
Mid- and High-Rise Non-residential Buildings

ASHRAE 1478-TRP
Measuring Air-Tightness of Mid- and High-Rise Non-Residential Buildings

Fan pressure test buildings:

- – Built since 2000
- – Based on ASTM E779; Normalize results to above grade envelope area
- – Climate Zones 2 – 7 of the EICC Climate Zone Map
- – Analyze the measured data with respect to design and construction variables (e.g. envelope materials)
- – Identify major air leakage sites

Weirdest Blower Door Test?

- Tightest building?
- Leakiest?

Making Them Airtight

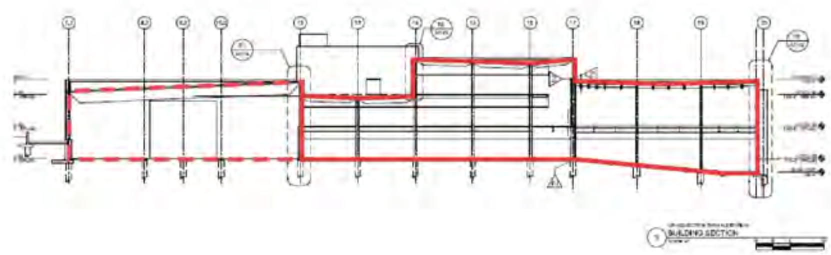
- Identify a target air tightness level
- Design to make them airtight
- Training, inspection, and quality assurance programs
- Conduct intermediate and final pressure testing
- Fix it and retest as needed

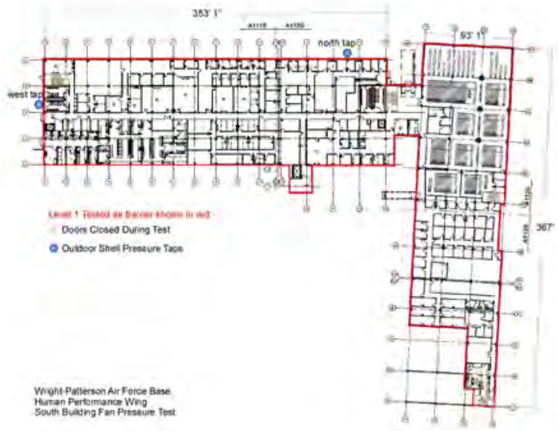
Design

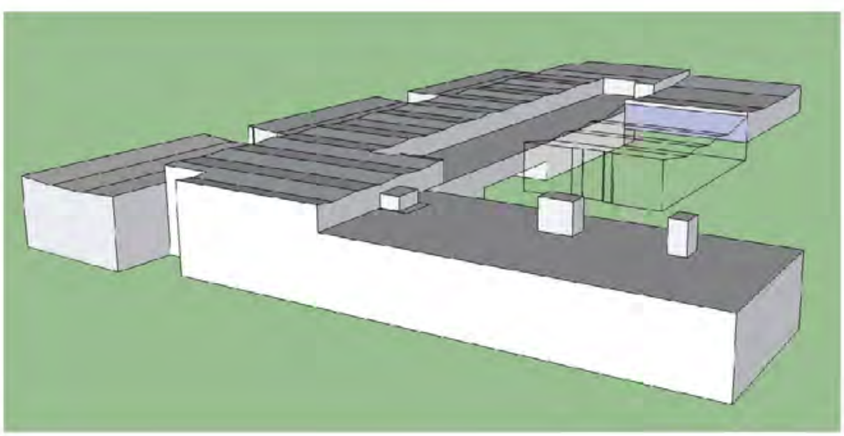
- Identifying air barrier locations
- Making it easy/making it hard
- Air barrier materials and systems
- Provide details and specifications illustrating air barrier continuity at joints and penetrations
- Specify inspections, qualifications, QA and intermediate and final testing
- Air Barrier Association of America (ABAA)
  - Manufacturers
  - Contractors
  - QAP
- Assess section for condensation and drying potential, given climate and internal loads.

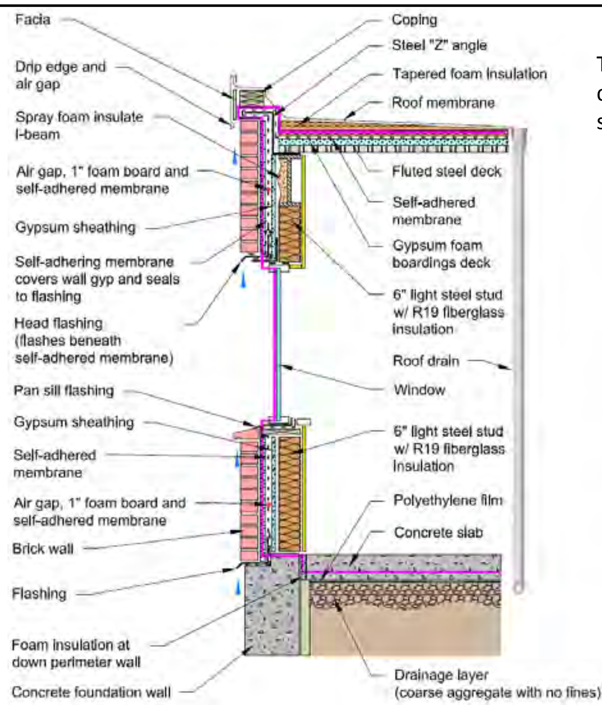
Air Barrier Association of America

- Understand the concept of Air Barrier Systems
- Design Air Barrier Systems
- Specify Air Barrier Systems in your Building Enclosure
- Locate Manufacturers and Distributors of Air Barrier Materials
- Locate Contractors who Install Air Barrier Assemblies and Systems
- Incorporate ABAA's Quality Assurance Program into your Project
- http://www.airbarrier.org/index_e.php

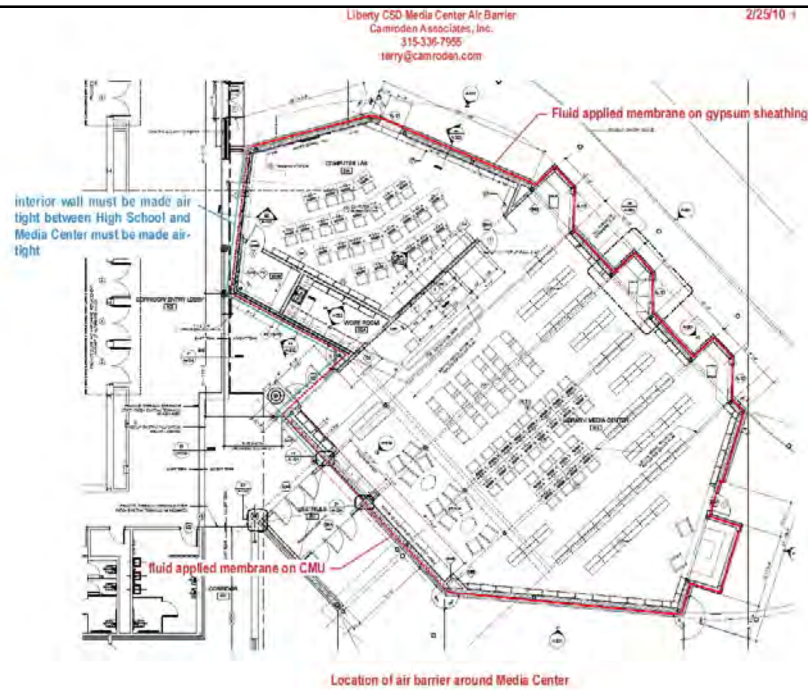


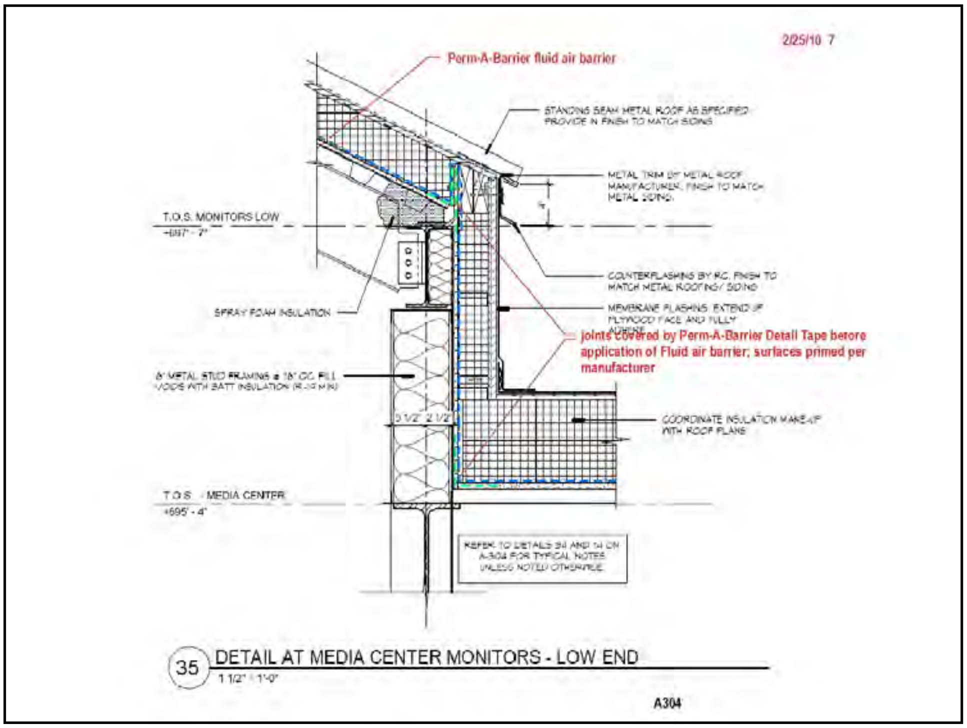

353' 1"
93' 1"
north tap
west tap
367'
Doors Closed During Test
Outdoor Shell Pressure Taps
Wright-Patterson Air Force Base
Human Performance Wing
South Building Fan Pressure Test

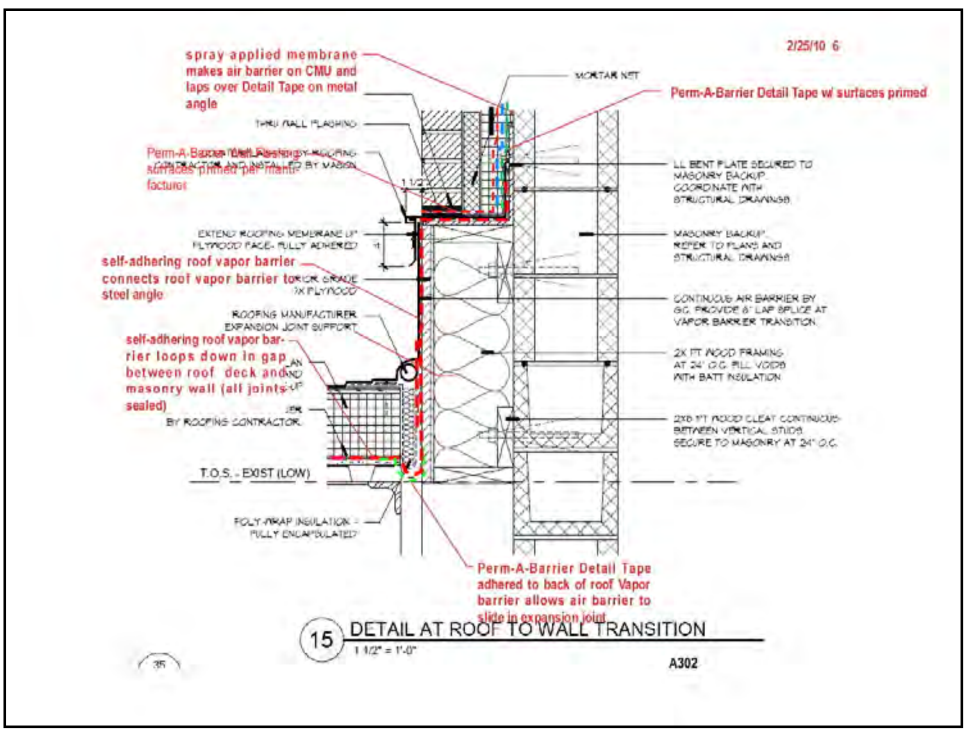




Tracing air barrier continuity through a section




2/25/10 7
Perm-A-Barrier fluid air barrier
STANDING SEAM METAL ROOF AS SPECIFIED
PROVIDE IN FINISH TO MATCH SIDING
METAL TRIM BY METAL ROOF
MANUFACTURER, FINISH TO MATCH
METAL SIDING
T.O.S. MONITORS LOW
COUNTERFLASHING BY RC, FINISH TO
MATCH METAL ROOFING/ SIDING
SPRAY FOAM INSULATION
MEMBRANE FLASHING, EXTEND UP
PLYWOOD FACE AND FULLY
joints covered by Perm-A-Barrier Detail Tape before application of Fluid air barrier; surfaces primed per manufacturer
COORDINATE INSULATION MAKE-UP
WITH ROOF PLANS
T.O.S. - MEDIA CENTER
+695' - 4"
REFER TO DETAILS 34 AND 14 ON
A-304 FOR TYPICAL NOTES
UNLESS NOTED OTHERWISE
35
DETAIL AT MEDIA CENTER MONITORS - LOW END
A304


2/25/10 6
spray applied membrane makes air barrier on CMU and laps over Detail Tape on metal angle
MORTAR NET
Perm-A-Barrier Detail Tape w/ surfaces primed
THRU WALL FLASHING
LL BENT PLATE SECURED TO
MASONRY BACKUP.
COORDINATE WITH
STRUCTURAL DRAWINGS
EXTEND ROOFING MEMBRANE UP
PLYWOOD FACE- FULLY ADHERED
MASONRY BACKUP.
REFER TO PLANS AND
STRUCTURAL DRAWINGS
self-adhering roof vapor barrier connects roof vapor barrier to steel angle
2X PLYWOOD
CONTINUOUS AIR BARRIER BY
GC. PROVIDE 6" LAP SPLICE AT
VAPOR BARRIER TRANSITION.
ROOFING MANUFACTURER
EXPANSION JOINT SUPPORT
self-adhering roof vapor barrier loops down in gap between roof deck and masonry wall (all joints sealed)
2X FT WOOD FRAMING
AT 24" O.C. FILL VOIDS
WITH BATT INSULATION
BY ROOFING CONTRACTOR.
2X6 FT WOOD CLEAT CONTINUOUS
BETWEEN VERTICAL STUDS
SECURE TO MASONRY AT 24" O.C.
T.O.S. - EXIST (LOW)
POLY-WRAP INSULATION -
FULLY ENCAPSULATED
Perm-A-Barrier Detail Tape adhered to back of roof Vapor barrier allows air barrier to slide in expansion joint
15
DETAIL AT ROOF TO WALL TRANSITION
1 1/2" = 1'-0"
A302