



Blower Door Testing Basics and Beyond



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The Energy Conservatory***



Agenda

- RESNET Chapter 8
- TECTITE Inputs
- Dealing with Wind
- Pressure Matching and “Nulling” Methods to measure exhaust fan flows
- Baselines and ZPD
- Testing with Multiple-Fans



Revised RESNET Test

- Revised RESNET BD Test (Chapter 8)
 - Effective 1/3/12
 - Three building enclosure test options, including a simple one-point test.
 - Has added a way to determine when the test results are adversely affected by wind.
 - Specifies when and how to adjust flows for temperature and elevation.
 - Possible to do a test without software (but software makes it much easier).
 - CFM50 adjusted for level of accuracy



Three RESNET Test Options

- One-point test
- Multi-point test
- Repeated single-point test
- Tests may be de-pressurization or pressurization



Performing a One-Point Test

- Without Software
 - Gather data and use temperature charts & elevation formula
- With Software
 - Manual data entry
 - Gather data for manual entry into TECTITE 4.0 software or iTEC RESNET iOS (Apple) app
 - Automated test
 - Use TECTITE 4.0 software for an automated test



Performing a One-Point Test

- No Software – gather data
 - Record five 10 second average (minimum) baseline readings to determine the level of accuracy
 - Perform Blower Door test using the Baseline and CFM50 functions.
 - Adjust for temperature using charts (not required if delta T less than 30F)
 - Adjust for elevation using a formula (not required if altitude less than 5,000 ft)
 - TEC Quick Guide: Collecting Data for a Manual RESNET One-Point Airtightness Test includes a data collection form



Performing a One-Point Test

- Determine level of accuracy using Baseline readings
 - Determine Baseline range
 - Difference between highest and lowest reading
 - Less than 5 Pa range = Standard Level of Accuracy
 - Between 5 Pa and 10 Pa = Reduced level of Accuracy
 - Greater than 10 Pa = 1 point-test can not be performed



Performing a One-Point Test

- Taking Baseline w / longer time period
 - Longer time period should result in narrower range
 - If you lengthen the baseline time period, you must also lengthen the test time period
- Perform the Blower Door test

One-Point Manual Test

- RESNET Quick Guide and Form



RESNET One-Point Airtightness Test Form

Technician: _____ Date: _____

Building Address: _____

Building Address: _____

Section A

<p>Pre-Test Baseline Pressure Readings (include sign of reading)</p> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<p>Time Averaging Period (seconds)</p> <input type="text"/>
--	--

<p>Largest Baseline Reading <input type="text"/></p> <p><i>minus</i></p> <p>Smallest Baseline Reading <input type="text"/></p> <p>Baseline Range <input type="text"/></p>	<p>Check the appropriate accuracy level below, based on the size of the Baseline Range.</p> <p><input type="checkbox"/> Standard Accuracy Test (Baseline Range less than 5.0 Pa)</p> <p><input type="checkbox"/> Reduced Level of Accuracy Test (Baseline Range between 5.0 and 10.0 Pa)</p> <p><input type="checkbox"/> Invalid Test (Baseline Range greater than 10.0 Pa)</p>
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Section B

<p>If Using TEC Software: (PR/FL Mode) <input type="checkbox"/></p>	<p>Nominal Building Pressure (Pa) <input type="text"/></p>	<p>Nominal Fan Flow (CFM) <input type="text"/></p>	<p>Fan Configuration <input type="text"/></p>
<p>If Not Using Software: (PR/FL@50 Mode) <input type="checkbox"/></p>	<p>Induced Building Pressure (Pa) <input type="text"/></p>	<p>Nominal CFM50 <input type="text"/></p>	<p>Fan Configuration <input type="text"/></p>

Section C

Indoor Temp (F): Outdoor Temp (F): Site Elevation (ft)

<p>Blower Door Fan</p> <ul style="list-style-type: none"> Model: _____ Serial Number: _____ 	<p>Digital Gauge</p> <ul style="list-style-type: none"> Model: _____ Serial Number: _____
--	--

One-Point Manual Test

- Enter results from a RESNET One-Point Test into TECTITE 4.0 or iTEC RESNET – both generate reports



TECTITETM 4.0
Building Airtightness Testing


Version 4.0.11.0
Registered to:
Paul Morin
TEC



The **ENERGY CONSERVATORY**
DIAGNOSTIC TOOLS TO MEASURE BUILDING PERFORMANCE

phone (612) 827-1117 fax (612) 827-1051
email: info@energyconservatory.com
internet: www.energyconservatory.com

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Projects Example Help

Test Data - Manual Test

Pressurization	Depressurization
Indoor Temp (F):	69.4
Outdoor Temp (F):	22.8
Site Altitude (Ft):	456.0
Time Averaging Period (s):	10.0

Test Date: 3/9/12

Baseline Readings

Average Baseline (Pa):	-0.8
Baseline Range (Pa):	5.5

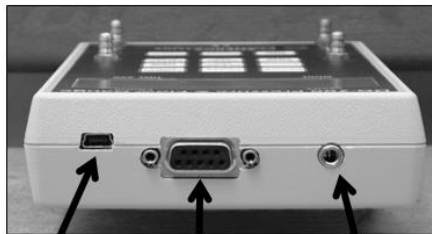
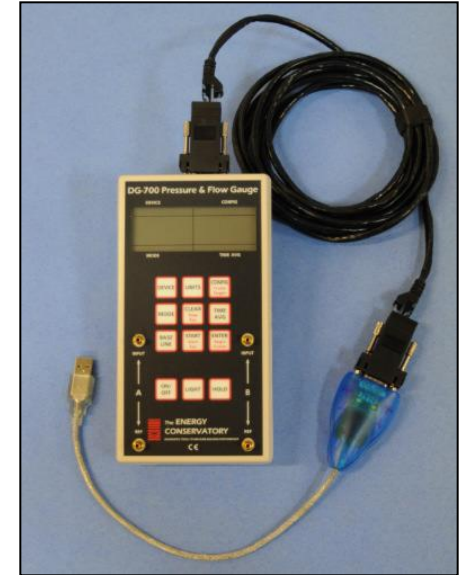
Test Readings

Nominal Building Press. (Pa):	-48.5
Nominal Fan Flow (CFM):	1,132



Automated Testing

- Connection options



USB
Communication
Port

Serial
Communication
Port

Fan Control
Output Jack





Automated Testing

- Run an automated RESNET Test

TECTITETM 4.0
Building Airtightness Testing

Version 4.0.11.0

Registered to:
Paul Morin
TEC

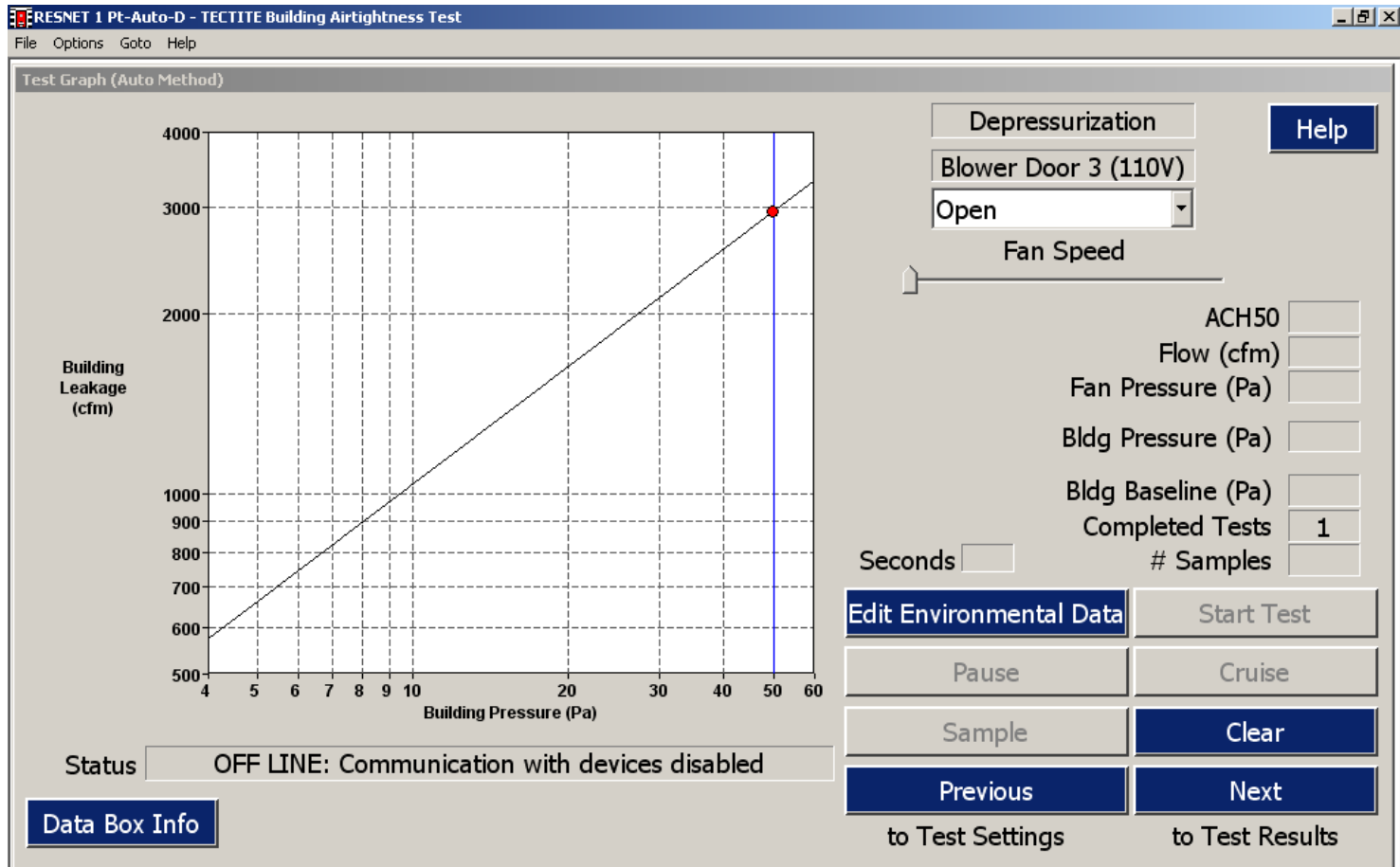
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One-Point Automated Test

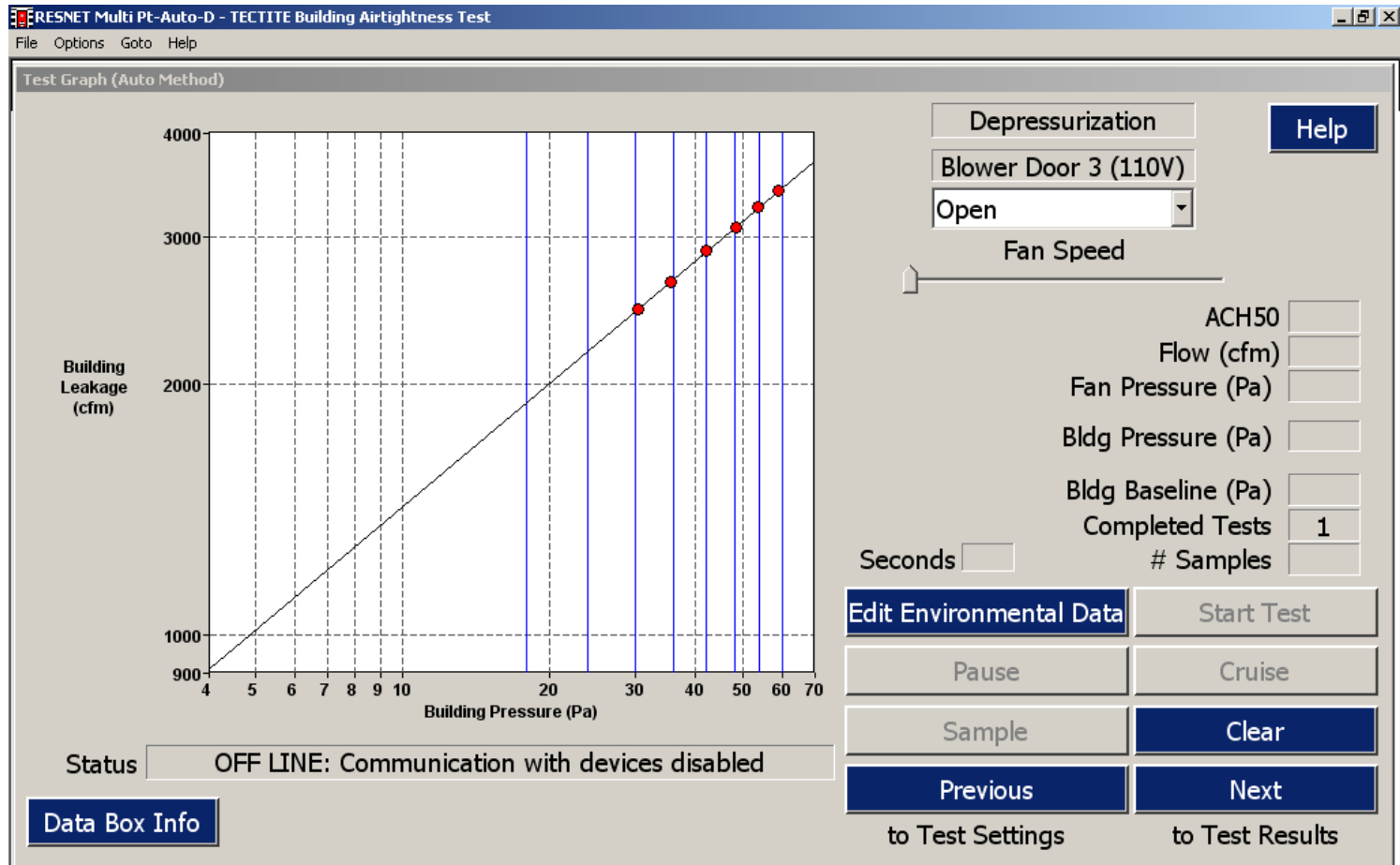
- Automated RESNET One-Point Test





Multi-Point Automated Test

- Automated RESNET Multi-Point Test





Repeated Single-Point Automated Test

- Automated RESNET Repeated Single-Point Test

Indoor Temperature (°F)	Outdoor Temperature (°F)	Altitude (ft)
90.0	0.0	100.0

Data Points

Baseline Pressure (Pa)	Nominal Building Pressure (Pa)	Baseline Adjusted Building Pressure (Pa)	Fan Pressure (Pa)	Nominal Flow (cfm)	Adjusted CFM50	Fan Configuration
0.1	-50.3	-50.4	50.2	3424	2955	Open
-0.4	-49.2	-48.8	49.2	3392	2990	Open
-0.5	-49.8	-49.3	49.6	3405	2981	Open
-0.2	-51.1	-50.9	51.3	3460	2966	Open
-0.5	-50.8	-50.3	50.7	3439	2971	Open

Time Averaging Period: 10

Deviations from Standard RESNET Repeated Single-Point Test - Test Parameters

None



Standard vs Reduced Accuracy

- Standard Accuracy Test
 - One-Point Test (Baseline Range < 5 Pa)
 - Multi-Point and Repeated Single-Point (Calculated uncertainty $< 10\%$)
- Reduced Accuracy Test
 - One-Point Test (Baseline Range $5 - 10$ Pa)
 - Multi-Point and Repeated Single-Point (Calculated uncertainty $> 10\%$)
 - Must adjust CFM50 for extra uncertainty - add approx 10 percent CFM50 penalty for HERS rating or testing to determine if building meets an airtightness threshold (such as IECC 2012)



TECTITE Results – Basic

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Test Results

[Help](#)

Airflow at 50 Pascals 2962 CFM50 8.88 ACH50	Estimated Annual Infiltration 113.1 CFM 0.34 ACH 22.6 CFM per person
Leakage Area 162.9 in ² LBL ELA @ 4 Pa	Estimated Design Infiltration Winter: 138.0 CFM 0.41 ACH Summer: 141.1 CFM 0.42 ACH
Building Leakage Curve Flow Coefficient (C) = 232.9 Exponent (n) = 0.650 (Assumed)	Estimated Cost of Air Leakage \$ 15 per year heating \$ 132 per year cooling
Accuracy Level Standard Level of Accuracy Test	Mechanical Ventilation Guideline Recommended Whole Bldg 69.7 CFM Base 62.5 CFM Supplemental 38.8 CFM Infiltration <31.6 CFM>

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to Test Graph to Deviations from Std



TECTITE Inputs – Building Info

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Building Test Info

Test Date

Technician

Customer Information

Customer Name

Name Line 2

Address

Address Line 2

City

State/Province

Zip/Postal Code

Phone

Fax

Email

Website

Project Number [Help](#)

Building Information

Building

Building Address

Address Line 2

City

State/Province

Zip/Postal Code

Year of Construction

Volume ft³ Height ft

Floor Area ft² # Bedrooms

Surface Area ft² # Occupants

[Clear](#)

[Next](#)
to Environmental Info



TECTITE Inputs – Environmental Info

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Environmental Info

Location Climate Characteristics

Heating Degree Days (F)	<input type="text" value="591"/>	Cooling Degree Days (F)	<input type="text" value="2149"/>
Energy Climate Factor	<input type="text" value="23"/>	Vent Weather Factor	<input type="text" value="0.75"/>
Design Winter Temp. Differential	<input type="text" value="30"/>	Design Summer Temp. Differential	<input type="text" value="18"/>
Design Winter Wind Speed (mph)	<input type="text" value="6.2"/>	Design Summer Wind Speed (mph)	<input type="text" value="8.6"/>

Heating

Natural Gas Electric Resistance Heat Pump HSPF
 Propane Wood Heat Pump COP
 Oil Coal

Heating Fuel Costs: \$ per ccf
Heating Percent

Wind Shield

Heavy Light
 Shielded Exposed
 Moderate

Cooling

Electric Cost for Cooling: \$ per kwh
SEER Rating of Cooling

to Building Info to Mechanical



TECTITE Results – Environmental Info

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Test Results

Help

Airflow at 50 Pascals 2962 CFM50 8.88 ACH50	Estimated Annual Infiltration 113.1 CFM 0.34 ACH 22.6 CFM per person
Leakage Area 162.9 in ² LBL ELA @ 4 Pa	Estimated Design Infiltration Winter: 138.0 CFM 0.41 ACH Summer: 141.1 CFM 0.42 ACH
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to Test Graph to Deviations from Std

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.

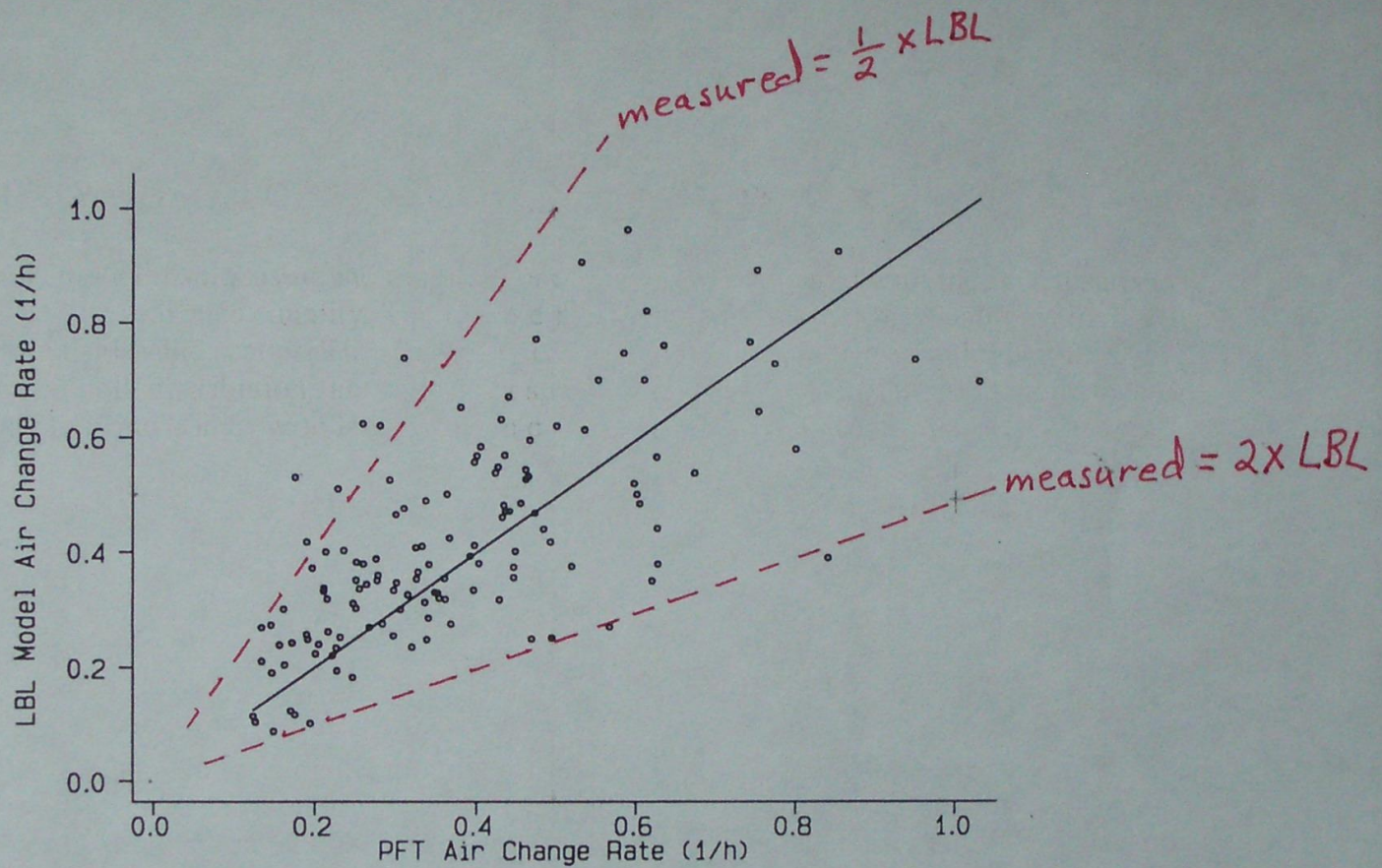


Figure 11.1. Comparison of PFT and LBL model results

LBL hourly predictions used National Weather Service data for the duration of the PFT test. The line indicates equality.



TECTITE Inputs – Mechanical Ventil.

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Mechanical Ventilation

Calculate Mechanical Ventilation Guideline and include in Test Results [Help](#)

New House

Existing House

Existing Exhaust Fan Flow (CFM)

	Kitchen:	<input type="text" value="20"/>	<input checked="" type="checkbox"/> Operable Window
# Bathrooms	Bathroom	<input type="text" value="15"/>	<input checked="" type="checkbox"/> Operable Window
<input type="text" value="3"/>	Bathroom	<input type="text" value="0"/>	<input checked="" type="checkbox"/>
	Bathroom	<input type="text" value="0"/>	<input type="checkbox"/>
	Bathroom	<input type="text"/>	<input type="checkbox"/>
	Bathroom	<input type="text"/>	<input type="checkbox"/>
	Bathroom	<input type="text"/>	<input type="checkbox"/>
	Bathroom	<input type="text"/>	<input type="checkbox"/>

[Clear](#)

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to Environmental Info to Comments



TECTITE Results – Mechanical Ventil.

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Test Results

Help

Airflow at 50 Pascals 2962 CFM50 8.88 ACH50	Estimated Annual Infiltration 113.1 CFM 0.34 ACH 22.6 CFM per person
Leakage Area 162.9 in2 LBL ELA @ 4 Pa	Estimated Design Infiltration Winter: 138.0 CFM 0.41 ACH Summer: 141.1 CFM 0.42 ACH
Building Leakage Curve Flow Coefficient (C) = 232.9 Exponent (n) = 0.650 (Assumed)	Estimated Cost of Air Leakage \$ 15 per year heating \$ 132 per year cooling
Accuracy Level Standard Level of Accuracy Test	Mechanical Ventilation Guideline Recommended Whole Bldg 69.7 CFM Base 62.5 CFM Supplemental 38.8 CFM Infiltration <31.6 CFM>

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to Test Graph to Deviations from Std



TECTITE Inputs – Comments

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Comments

Help

Clear

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to Mechanical Ventilation

Next
to Test Settings



TECTITE Inputs – Test Settings

RESNET 1 Pt-Auto-D - TECTITE Building Airtightness Test

File Options Goto Help

Test Settings

[Help](#)

Test Pressures

Default
 CUSTOM

[Edit Custom Pressures](#)

Zonal Pressures

Active

[Settings](#)

Method

Manual
 Auto
 Semi-Auto

Test Mode

Pressurize
 Depressurize

Auto Test Parameters

Time Averaging Period (sec)

Fan Adjust Rate

Target Tolerance (Pa)

Building High Pressure Limit (Pa)

Fan Start (%)

[Restore Factory Settings](#)

Test Standard

Set as Defaults for New Tests

[Previous](#) [Next](#)

to Comments to Test Graph



TECTITE - Report



BUILDING LEAKAGE TEST

Joe's Garage
We Can Fix It
5566 99th Ave.
#22

Spokane, WA 55555

Phone: 666-666-6666 Fax: 666-666-6667

Email: jim@spudco.com Website: www.spudco.com

Date of Test: 1/31/2012

Test File: RESNET 1 Pt-Auto-D

Customer: Bill King
a.k.a. Killer
3333 34th Ave.
#22
Wheaton, IL 60187
Phone: 666-666-6666
Fax: 777-777-7777
Email: bking@testo.com
Website: www.bking.com

Technician: Jim Smith
Project Number: 443334

Building Address: King Apartments
6667 Peach Ave.
Highway 35
Atlanta, GA 5555

Test Results

- Airflow at 50 Pascals: 2962 CFM50
(50 Pa = 0.2 w.c.) 8.88 ACH50
- Leakage Area: 162.9 in2 LBL ELA @ 4 Pa
- Building Leakage Curve: Flow Coefficient (C) = 232.9
Exponent (n) = 0.650 (Assumed)
- Test Settings: Test Standard: RESNET One-Point Test
Test Mode: Depressurization
- Accuracy Level: Standard Level of Accuracy Test

Infiltration Estimates

- Estimated Average Annual Infiltration Rate: 113.1 CFM
0.34 ACH
22.6 CFM per person
- Estimated Design Infiltration Rate: Winter: 138.0 CFM Summer: 141.1 CFM
0.41 ACH 0.42 ACH

Cost Estimates

1. Estimated Cost of Air Leakage Reduction: \$ 45,000.00



Dealing with Wind

- Blower Door Testing
 - Location of the enclosure reference
 - Shielding of the tubing
 - Baseline function of the DG-700
 - Multiple 10 second averages
 - Baseline and @50
 - Long term averages
 - Accuracy of the test





COMPACT
CARS ONLY
BECAUSE OF
LOADING DOCK
ENTRANCE

LAGER VEHICLES
AT YOUR OWN RISK











5

DST

PARKING





Dealing with Wind

- Worst Case Depressurization
 - What is your depressurization limit?
 - Multiple 10 second averages
 - Baseline and worst case
 - What is the range of your numbers
 - On / off with fans
 - Accuracy?
 - When is it too windy?



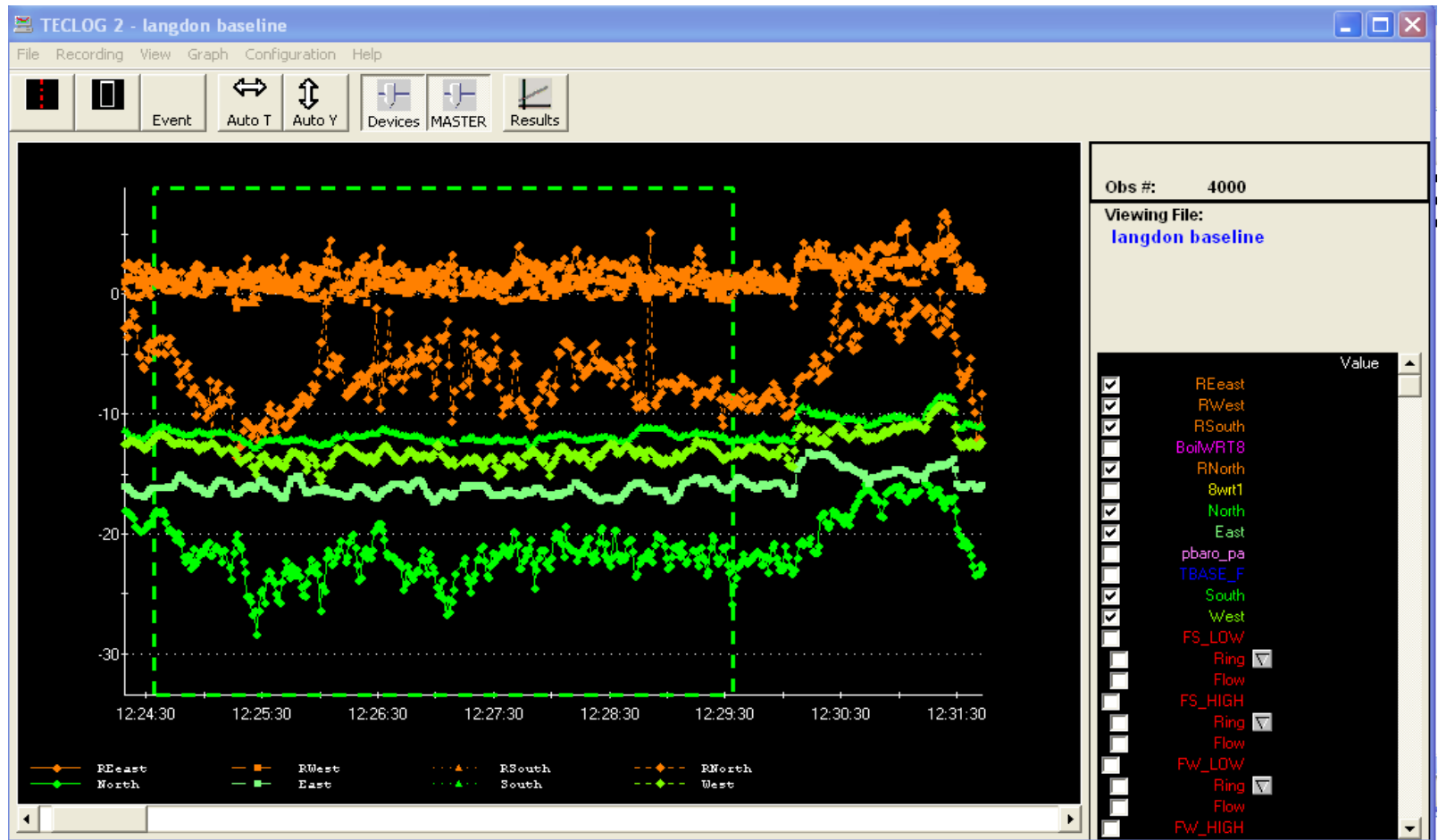
CO2

WH Vent



Dealing with Wind

- Baseline period
 - 11 story building – 4 sides, roof and ground level





Pressure Matching Method (Nulling)

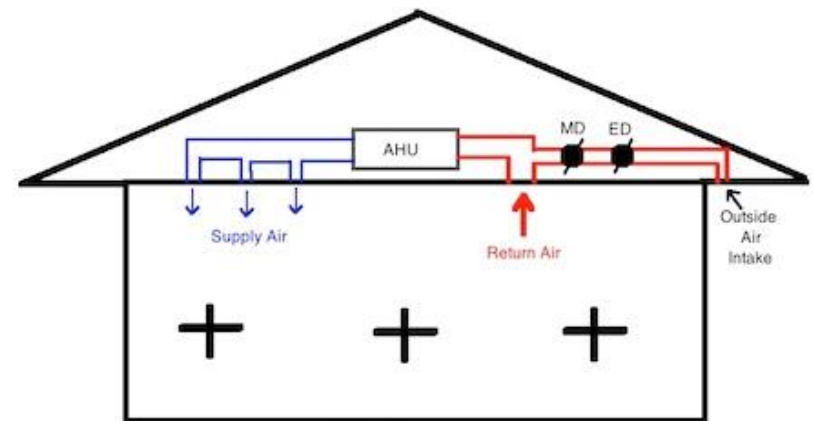
- Measuring flow of large kitchen fans:
 - Set up blower to pressurize the home
 - Cap blower & enter baseline into DG-700
 - Install ring C on blower door (50-300 CFM)
 - With fan on, Set DG-700 to cruise 0 (not -0)





Pressure Matching Method (Nulling)

- Measuring flow + pressure systems:
 - Set up blower to depressurize the home
 - Enter baseline into DG-700
 - Install ring C on blower door (80-300 CFM)
 - Set DG-700 to cruise -0 (not 0)



Positive Pressure
Mechanical Ventilation System

Photo from EnergyVanguard.com



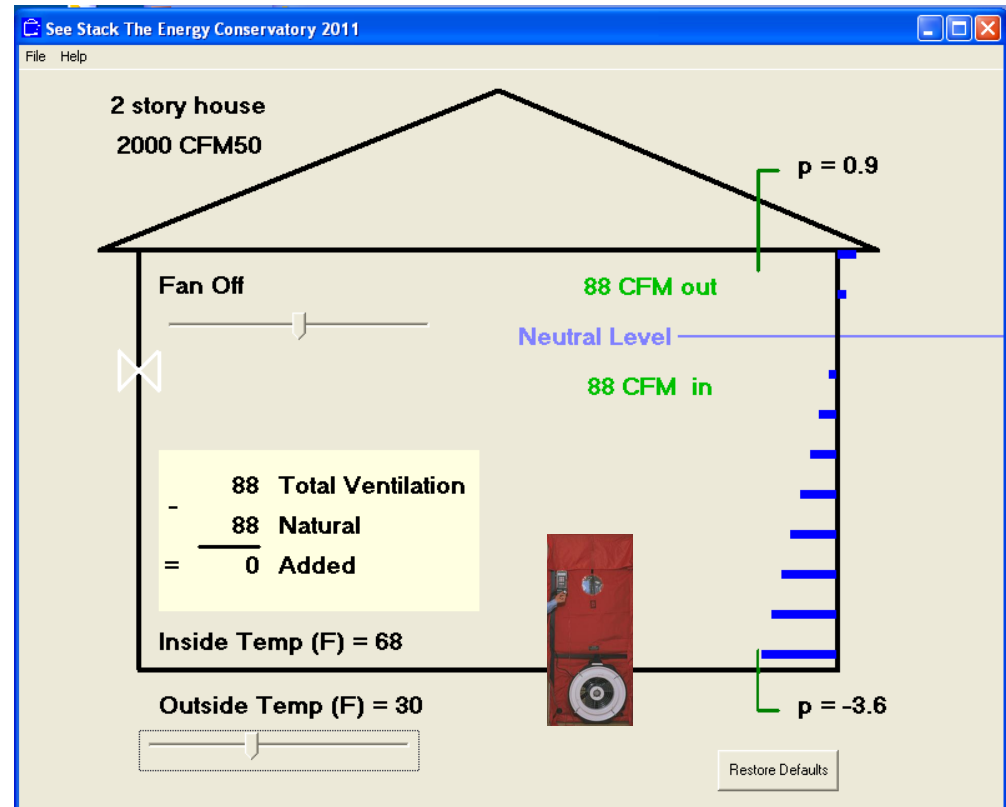
Nulling Example

- A big, leaky enclosure and wind limit precision
- 2500 ft², 8 ft high, 3 ACH50 = 1000 CFM50
 - CFM(1) = 79
 - CFM(.1) = 18
- .6 ACH50 = 200 CFM50
 - CFM(1) = 16
 - CFM(.1) = 4



Baselines and ZPD

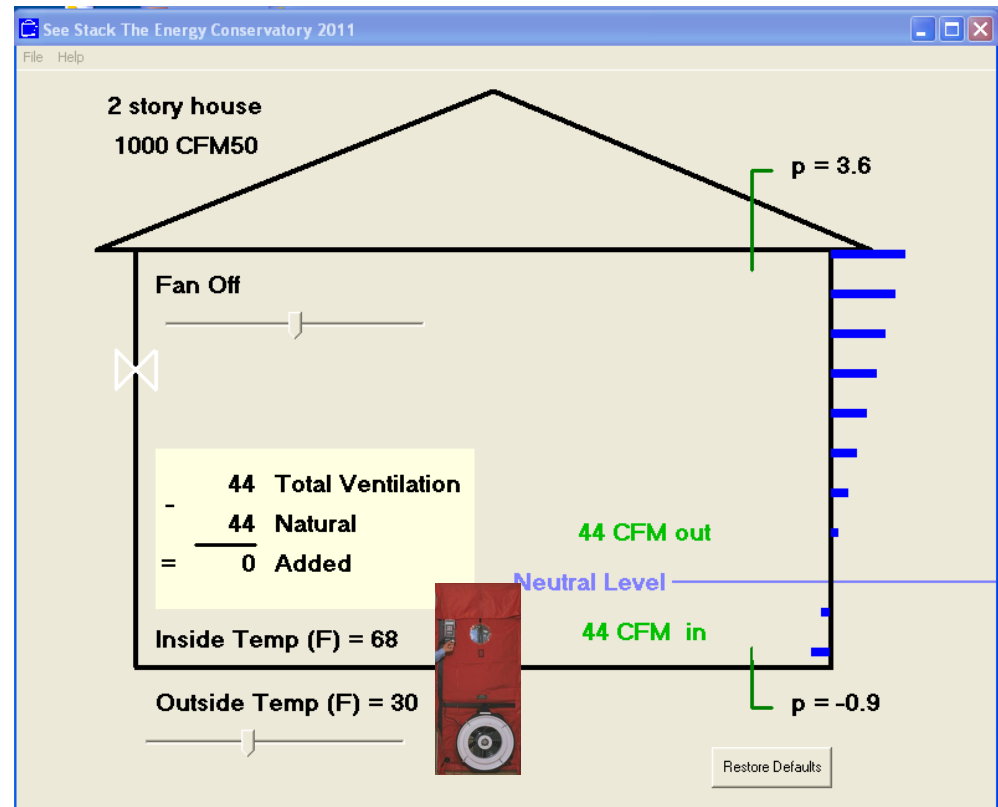
- Importance of measuring baseline attic ΔP
 - Lots of attic air leaks – 2000 CFM50
 - High NPP
 - 30° outside
 - 2 story
 - Baseline:
 - -3.6 at BD
 - + 0.9 at attic





Baselines and ZPD

- Importance of measuring baseline attic ΔP
 - Sealed attic bypasses – 1000 CFM50
 - Low NPP
 - 30° outside
 - 2 story
 - Baseline:
 - -0.9 at BD
 - + 3.6 at attic





Testing with Multiple Fans

- Multi fan testing – 2 or 3 fan systems





Two Fan Single-Point Protocol

- Primary gauge and Secondary gauge
- Enter baseline and turn primary fan all of the way up
- Determine which flow ring – start secondary fan before removing ring
- Bring to 50 Pa and add flows together.



Equipment and Software Options

- Software options:
 - Manual data entry
 - New version of TECTITE
 - TECTITE Express
 - Automated testing
 - TECLOG2



Equipment and Software Options

- TECTITE Express
 - Test to CGSB, EN13829, E779-10
 - Simplified report
 - No savings info
 - No infiltration information



Equipment and Software Options

- TECLOG2
 - Will control up to 24 fans with one slide bar
 - Will average multiple outdoor references
 - Can monitor interior pressures during test
 - Set channel to measure
 - Flow, BD or DB
 - Envelope pressure of pressure
 - Can be used for long term pressure monitoring

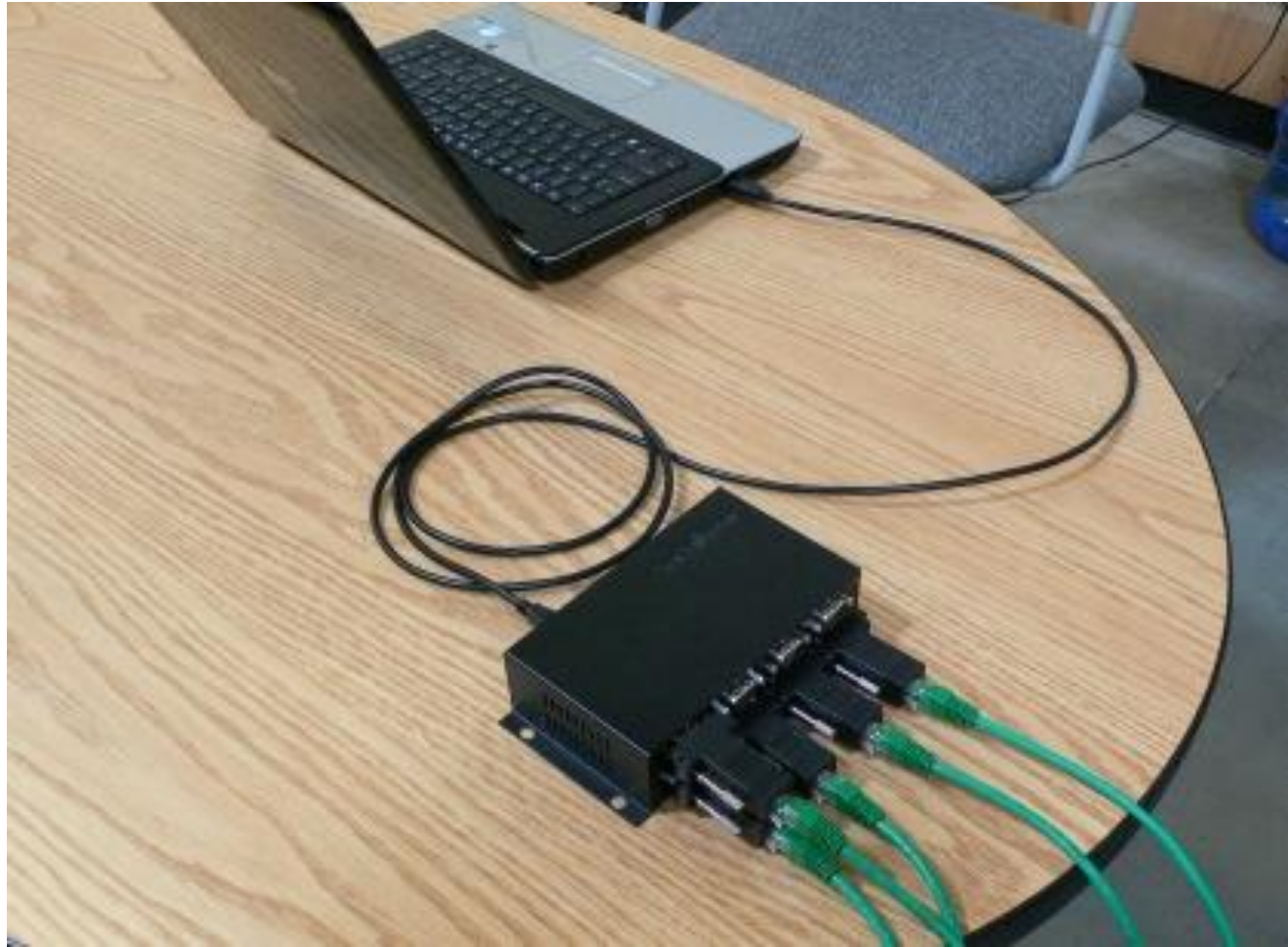


Multi-Fan Testing





Data Acquisition Hardware





At the Other End...

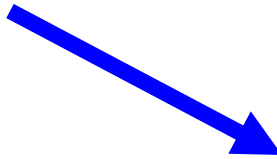




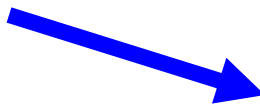
Two Gauges and Three Fans

Gauge 1

A: Envelope Press.
B: Bottom Fan

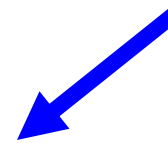


3 Controllers



Gauge 2

A: Middle Fan
B: Top Fan



- No open taps on gauges
- Combine two CAT5 cables into one
- Fans plugged into separate circuits



Fan Control Splitter



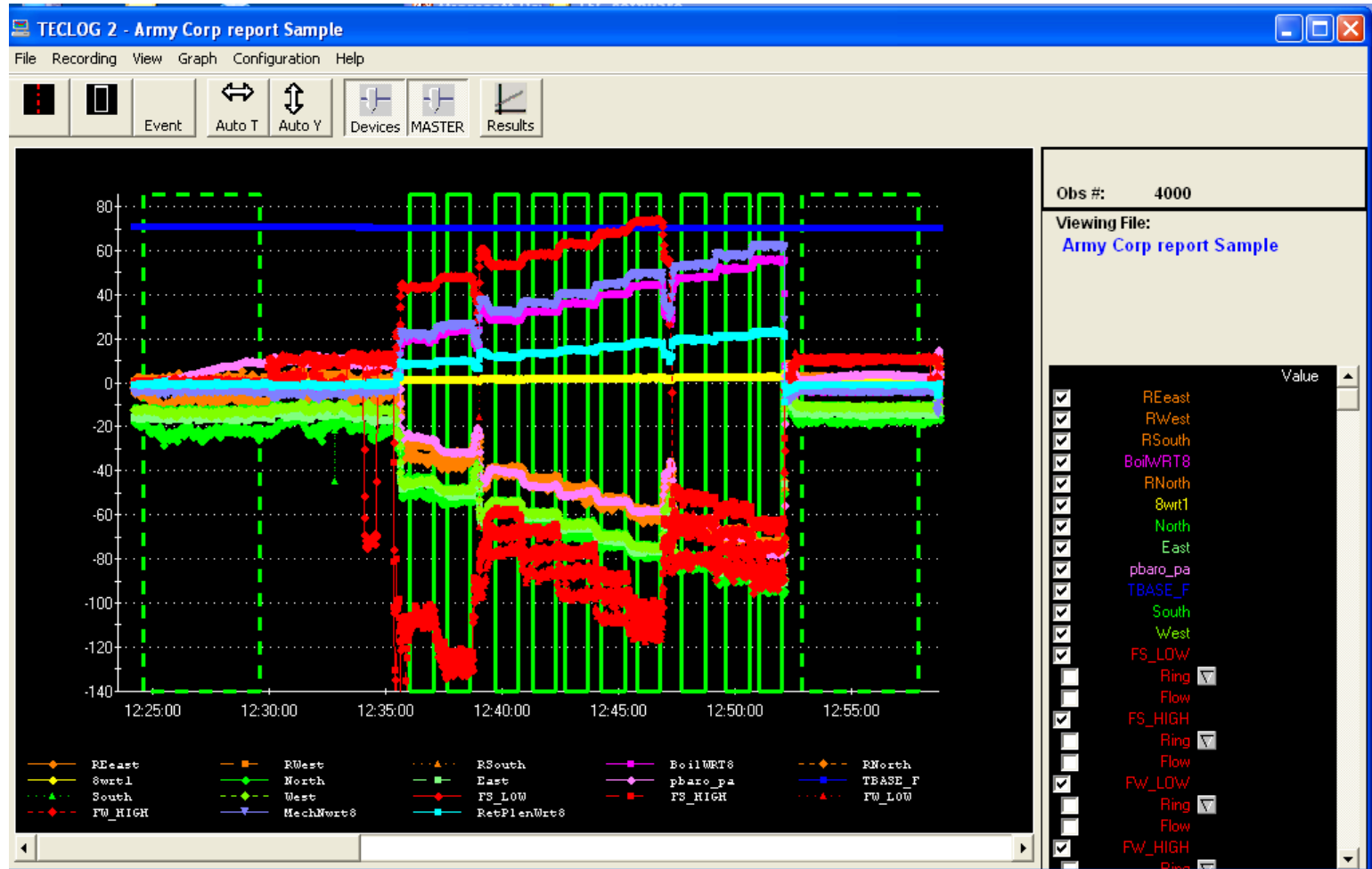
Master control slide bar controls all fans





Testing with Multiple Fans

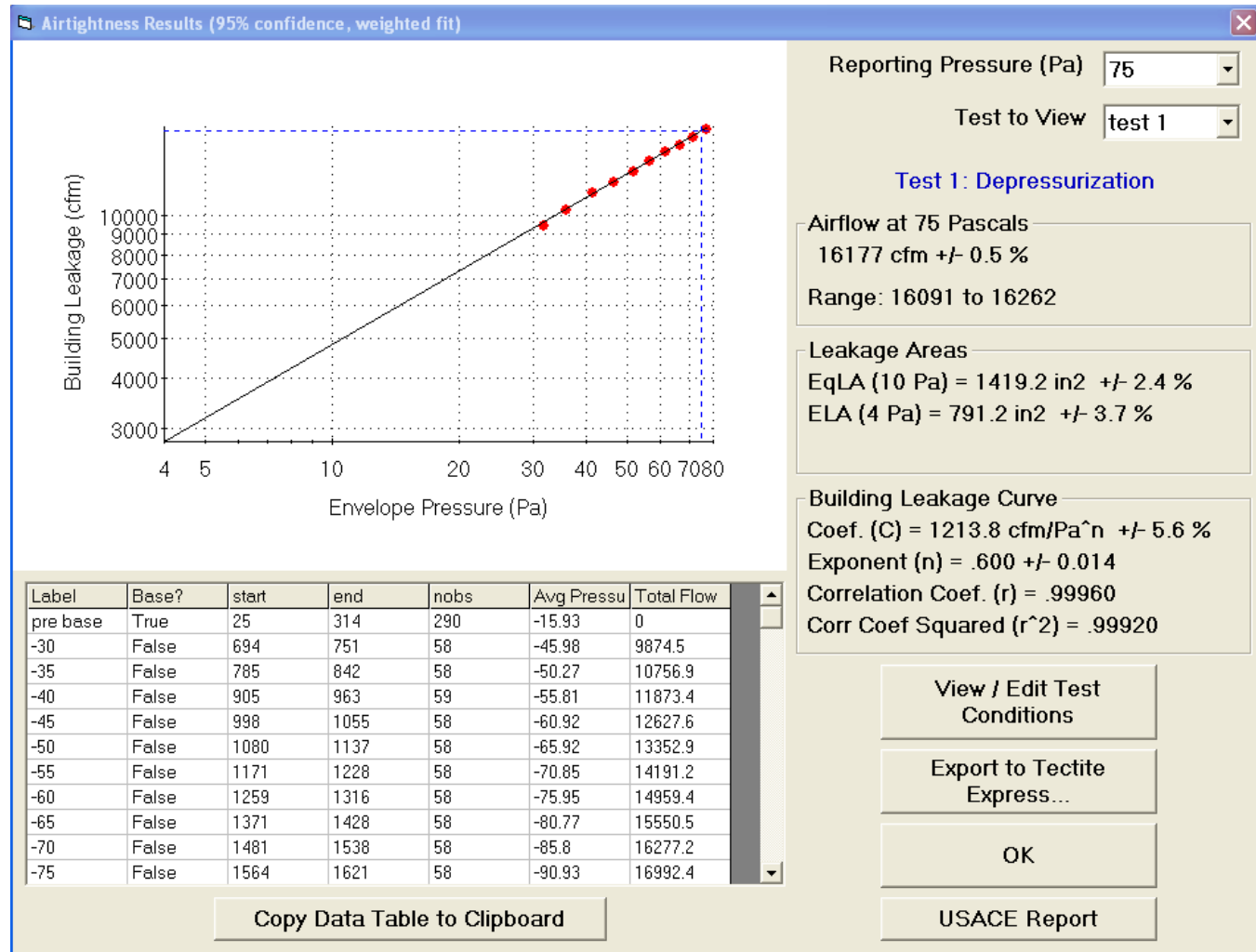
- TECLOG2 software





Testing with Multiple Fans

- TECLOG2 software





Blower Testing Basics and Beyond

Thank You!

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