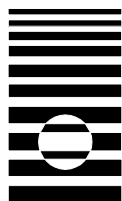


***Zone Pressure Diagnostics (ZPD)
Calculation Utility***

Software User's Guide



**The ENERGY
CONSERVATORY**

DIAGNOSTIC TOOLS TO MEASURE BUILDING PERFORMANCE

Zone Pressure Diagnostics (ZPD) Calculation Utility

Software User's Guide

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Chapter 1 Introduction to the ZPD Calculation Utility

Overview

Zone pressure diagnostics (ZPD) are widely used by weatherization professionals to prioritize airsealing efforts in houses by estimating the amount of air leakage from attached zones (e.g. attics, crawlspaces, garages and basements). ZPD techniques typically combine Blower Door airtightness test results with zone pressure measurements made both before and after an opening or hole has been added to one surface of the zone being tested. In 2000, the Energy Center of Wisconsin commissioned a study of ZPD techniques and procedures in order to improve the accuracy and reliability of zone leakage estimates.

The results of that study, published in 2002, include numerous improvements to both the methodology used to collect ZPD measurements and the calculation procedures used to estimate the magnitude of air leakage from tested zones. See [Appendix B](#) for a discussion of the key ZPD study findings and how the study recommendations are implemented in this calculator.

The Energy Conservatory's ZPD Calculation Utility is a simple software program which can be used to quickly perform ZPD calculations using many of the improvements recommended in the Energy Center's study. The ZPD calculation utility is comprised of 7 Steps (or screens) which are used to input test information and display test results.

- Step 1:** Input test ID, test settings and the names of zones to be monitored.
- Step 2:** Input baseline house pressure readings. These readings are used to estimate the level of measurement error from wind conditions during the test.
- Step 3:** Conduct a Blower Door test prior to any opening being added to a zone. Input baseline zone pressure measurements, zone pressure measurements with the Blower Door running (no opening added), and Blower Door test results (i.e. house pressure and fan flow).
- Step 4:** View zone test guidelines generated by the ZPD program. Guidelines include suggested opening location (house to zone, or zone to outside) for each monitored zone, and the minimum shift in zone pressure needed (from adding an opening or hole) to provide reliable leakage estimates.
- Step 5:** Select a primary zone to be tested (i.e. the zone where the opening will be added). Add the opening and repeat the Blower Door test. Input the type and size of opening added to the tested zone. Input baseline zone pressure measurements, zone pressure measurements with the Blower Door running (opening added), and Blower Door test results.
- Step 6:** View zone leakage estimates calculated by the ZPD program. The test results include an estimate of the leakage area (in square inches) between the house and the zone tested, the leakage area between the zone tested and outside, and an estimate of the house air leakage through the tested zone (in CFM50). All 3 estimates are presented as a range (**min** to **max**) based on a 63% confidence interval (i.e. the real answer will be between the **min** and **max** 63% of the time).
- Step 7:** View information for any other zones monitored during the ZPD test. This screen also provides an indication as to whether each of the monitored zones has a physical connection (i.e. leakage path) with the primary zone tested.

The ZPD Calculation Utility assumes that the Blower Door test results and zone pressure measurements are being collected using either an Energy Conservatory digital pressure gauge (manual test), or as part of an automated Blower Door test using an APT system with 3 or more pressure channels. Suggested tubing connections to the digital pressure gauge and APT system are shown in [Appendix A](#).

ZPD test records are stored using a database structure. Each database file created may contain an unlimited number of separate test records, with each test record having a 12 character *Test ID* field used to identify the record. A simple test report can be printed for any test record from an open database file.

[Installing the ZPD Calculation Utility](#)

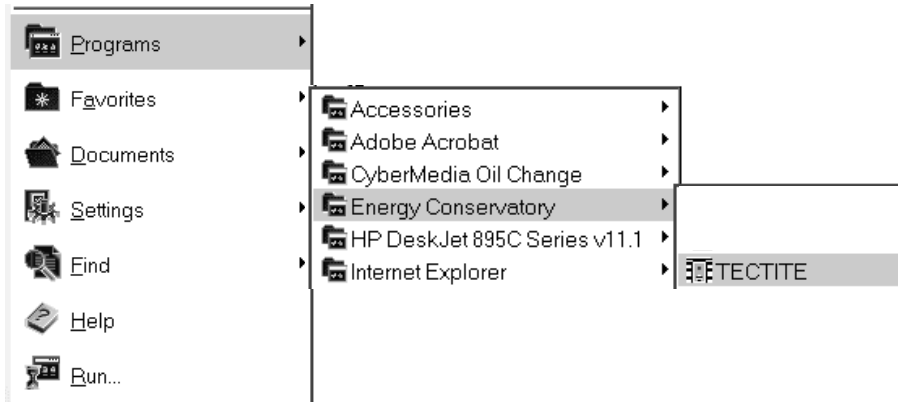
The ZPD Calculation Utility is available from The Energy Conservatory website at www.energyconservatory.com/products/products8.htm. To install the program, first download the program file to any folder on your computer. Double click on the downloaded file to begin installation. The program will self-extract and prompt you through the installation process.

Chapter 2 Starting the ZPD Calculation Utility

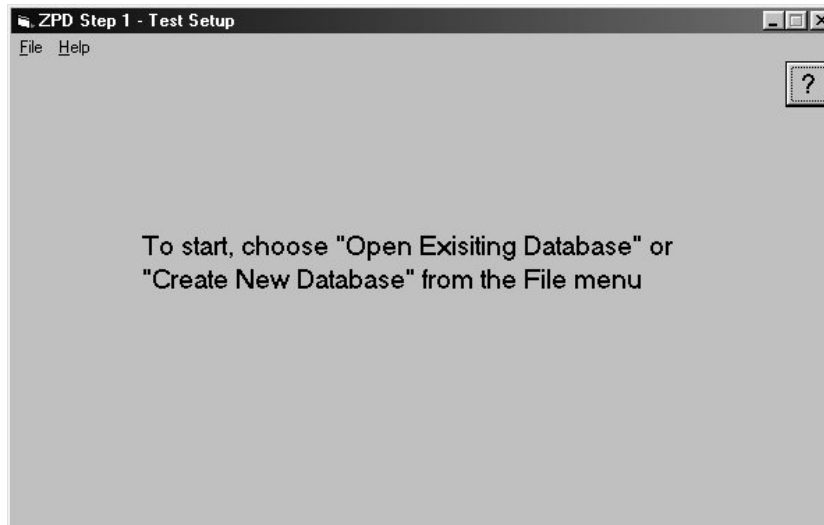
Starting the ZPD Calculation Utility

The ZPD Calculation Utility program should have been installed using the procedures outlined in *Chapter 1*.

To start the program, click on **Start...Programs...Energy Conservatory...ZPDCU**.



The opening ZPD utility screen will now appear, with the Main Menu containing **File** and **Help** located in the upper left hand corner. The message “To start, choose “Open Existing Database” or “Create New Database” from the File menu.” also appears on the opening screen.



Selecting a Database File

From the Opening Screen, click on the main **File** menu item to either open an existing database file or to create a new database file. **Note:** ZPD test files are stored using a database structure. Each database file created may contain an unlimited number of separate test records, with each test record having a 12 character **Test ID** field used to identify the test.

From the File menu, the following options are available.



- ⇒ **Open Existing Database** lets you recall a previously saved database file containing ZPD test records. After selecting the database file to open, the first test record from the file is loaded into the program and the **Step 1** screen appears. Existing test records may be viewed, edited and printed. Test records may also be added or deleted from the database file.
- ⇒ **Create New Database** is selected to begin entering ZPD test records into a newly created database file. After entering the database file name, the **Step 1** screen appears.

Chapter 3 Overview of the ZPD Step Screens

Help Buttons

Each of the seven ZPD Step screens has its own **Help** button (? located in the upper right hand corner) which opens a **Help** window providing useful information on each screen. Be sure to use the **Help** feature the first time you use the ZPD Utility, and refer to the **Help** buttons whenever you have a question on program operation. To close a **Help** window, click on **OK**.

ZPD Step 1: Test Setup

The **Step 1: Test Setup** screen is used to enter a test ID, test settings and the names of all zones to be monitored. The **Test ID** field must be filled out for each test record. The **Test ID** field is used as the unique identifier for the various test records stored in the database file.

On the **Step 1** screen you must choose the test mode for the Blower Door test (pressurization or depressurization), as well as the data source for your Blower Door test results and zone pressure measurements. For the data source, choose either a **Digital Gauge**, or a **TECTITE Report** generated as part of an automated Blower Door test using an APT system with 3 or more pressure channels.

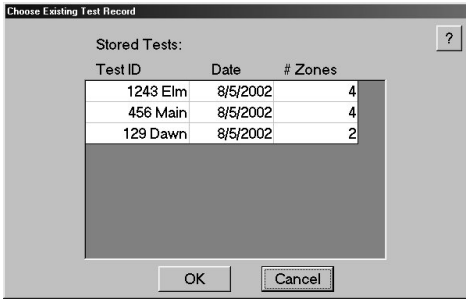
Zones to be monitored are selected by checking the box next to the zone name. A total of 4 zones may be selected, and the zone name may be edited.

You can click on individual fields to enter information, or use the **Tab** key to quickly move between fields. Information entered into each field of the test record is immediately stored in the database file. When you are finished filling out the **Step 1** screen, click on **Next** to move to the **Step 2** screen.

❑ *Selecting a Test Record Within a Database File:*



When an existing database file is opened, the first test record from the file is loaded into the program and automatically appears on the ZPD screens. To view other test records stored in the currently open database file, click on “Choose Existing Test” from the main **File** menu. **Note:** The number of test records stored in the open database file is shown on the bottom left hand side of **Step 1** screen.



After clicking on “Choose Existing Test”, a window appears which lists all the test records stored in the currently open database file. To view any record, simply highlight the **Test ID** field desired and click on **OK**.

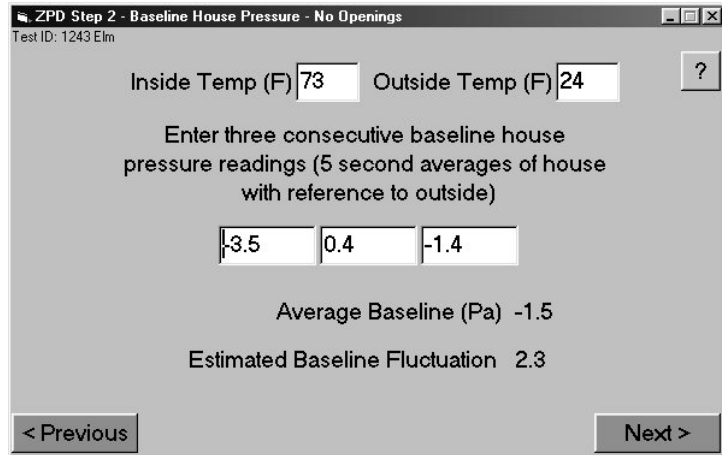
In addition, you can browse through the stored test records in the open database file by clicking on the up and down arrow keys (left hand side) on the **Step 1** screen. The number shown next to the arrows is the database record number for the currently displayed test record.

ZPD Step 2: Baseline House Pressure – No Openings

The **Step 2: Baseline House Pressure – No Openings** screen is used to enter baseline house pressure readings **prior** to an opening being added to a zone. The baseline house pressure readings are used to estimate the level of measurement error from wind conditions during the ZPD test. The **Step 2** screen will appear differently depending on which Data Source was chosen on the **Step 1** screen.

❑ *Step 2 Screen – Digital Gauge Data Source (manual test):*

If you chose Digital Gauge as your data source, enter the inside and outside temperatures prior to beginning the ZPD test. Now collect and enter 3 consecutive baseline house pressure readings (in Pascals – with reference to outside) using the 5 second time-averaging mode on the digital gauge. Be sure to enter the proper sign (+ or -) of the baseline house pressure reading. After entering the baseline readings, the average baseline pressure and estimated baseline fluctuation will be calculated and displayed on the screen.



□ *Step 2 Screen – Tectite Report (Auto) Data Source:*

If you chose TECTITE Report (Auto) as your data source, enter the house baseline standard deviation from the **ZPD Input Table** found at the end of the TECTITE Zone Data Report (available with TECTITE Version 2.5 or higher).

Click on **Next** to move to the **Step 3** screen.

ZPD Step 3: Test Readings – No Openings

The **Step 3: Test Readings – No Openings** screen is used to enter ZPD test readings **prior** to an opening being added to a zone. The **Step 3** screen will appear differently depending on which Data Source was chosen on the **Step 1** screen. **Note:** All pressure measurements are to be taken with reference to outside.

□ *Step 3 Screen – Digital Gauge Data Source (manual test):*

When first entering the **Step 3** screen, the baseline house pressure field will already be filled in using the data entered in **Step 2**. All other fields in the **Step 3** screen will need to be entered manually. Enter the baseline zone pressure measurements, the zone pressure measurements with the Blower Door running (no opening added), and the Blower Door test results (i.e. house pressure and fan flow). The baseline zone pressure readings should be taken with the Blower Door fan closed off. The house and zone pressure readings taken with the Blower Door fan running (**BD On**) should ideally be taken with the house pressure somewhere between 45 and 55 Pascals (with reference to outside). If the house is too leaky to generate 45 to 55 Pascals of house pressure, take the readings at the highest achievable house pressure.

	Baseline	BD on	Change
House	1.5	-51.4	-49.9
attic	2.1	-15.3	-17.4
garage	2.4	-13.5	-15.9
crawl	-1.3	-2.1	-0.8
bsmt	-2.1	-46	-43.9

BD Flow (CFM) Ring

❑ *Step 3 Screen – TECTITE Report (Auto) Data Source:*

Enter the zone pressure measurements with the Blower Door running (no opening added), and the Blower Door test measurements. Use the **ZPD Input Table** found at the end of the TECTITE Zone Data Report for the zone pressure and Blower Door measurements to be entered. All baseline values are pre-set to zero and the house pressure value is pre-set to 50 when using a TECTITE Report as the data source.

Pressures wrt outside (Pa)			
	Baseline	BD on	Change
House	0	-50	-50
attic	0	-15.3	-15.3
garage	0	-13.5	-13.5
crawl	0	-2.1	-2.1
bsmt	0	-46	-46

BD Flow (CFM) 2235 Ring A

Click on **Next** to move to the **Step 4** screen.

ZPD Step 4: Zone Guidelines

The **Step 4: Zone Guidelines** screen displays zone test guidelines generated by the ZPD program based on the test data from **Steps 2** and **3**. For each monitored zone, a **Suggested Opening Location** (house to zone, or zone to outside) is provided, as well as a **Ratio** value which provides information on the location of the primary air barrier for the zone.

House CFM50 = 2133

Minimum shift in zone pressure needed = 9 Pa

Zone	Ratio *	Suggested Opening Location	
		house/zone	zone/out
attic	0.35	BEST	OK
garage	0.32	BEST	OK
crawl	0.02	BEST	NO
bsmt	0.88	NO	BEST

*Ratio is from 0 to 1 where 0 = out and 1 = in

❑ *Minimum Shift in Zone Pressure Needed:*

This is an estimate of the smallest change in zone pressure (from adding an opening or hole) needed to provide reliable zone leakage estimates. **Note:** The estimated minimum pressure shift needed is calculated to be 4 times the **estimated baseline fluctuation** (or baseline standard deviation) from **Step 2**.

❑ *Suggested Opening Location:*

- BEST:** Adding an opening to this side of the zone should produce the best zone leakage estimates. Opening locations labeled **BEST** will allow for the largest possible change in zone pressure.
- OK:** Adding an opening to this side of the zone will likely provide reliable zone leakage estimates, however, the uncertainty in the leakage estimates will tend to be higher than if the location labeled **BEST** is used. Always use the **BEST** location if possible.
- NO:** Adding an opening to this side of the zone will not produce reliable zone leakage estimates because the minimum change in zone pressure needed will not be achieved.

❑ *Ratio:*

The **Ratio** value provides information on the location of the primary air barrier for the monitored zone. If the **Ratio** value is between 0.0 and 0.5, the zone is better connected to the outside than it is to the inside of the house (i.e. the primary air barrier for that zone is between the house and the zone). If the **Ratio** value is between 0.5 and 1.0, the zone is better connected to the inside of the house than it is to the outside (i.e. the primary air barrier for that zone is between the zone and outside) .

Click on **Next** to move to the **Step 5** screen.

ZPD Step 5: Test Readings - Opening Added

The **Step 5: Test Readings – Opening Added** screen is used to enter ZPD test readings **after** an opening has been added to a zone. The **Step 5** screen will appear differently depending on which Data Source was chosen on the **Step 1** screen. **Note:** All pressure measurements are to be taken with reference to outside.

❑ *Step 5 Screen – Digital Gauge Data Source (manual test):*

First enter information about the opening that has been added including the location of the opening and the opening type. Now enter the baseline house and zone pressure measurements, the zone pressure measurements with the Blower Door running (opening added), and the Blower Door test results (i.e. house pressure and fan flow). The baseline pressure readings should be taken with the Blower Door fan closed off. The house and zone pressure readings taken with the Blower Door fan running (**BD On**) should ideally be taken with the house pressure somewhere between 45 and 55 Pascals (with reference to outside). If the house is too leaky to generate 45 to 55 Pascals of house pressure, take the readings at the highest achievable house pressure.

Note: If you were using one of the Blower Door flow rings during **Step 3: Test Readings – No Openings**, you should continue to use that same flow ring during **Step 5** as long as you can reach a house pressure of at least 35 Pascals. This will result in a more narrow range of minimum and maximum zone leakage results (shown in **Step 6** below), than if you choose to change the flow ring configuration.

Opening from **attic** to **house** **hatch** **200** Sq. In. ?

	Baseline	BD on	Change
House	-0.6	-50.5	-49.9
attic	1.5	-33.7	-35.2
garage	1.4	-18.5	-19.9
crawl	-1.2	-3.1	-1.9
bsmt	-1.8	-47.2	-45.4

BD Flow (CFM) **3075** Ring **open**

< Previous All Pressures wrt Outside Next >

□ *Step 5 Screen – TECTITE Report (Auto) Data Source:*

First enter information about the opening that has been added including the location of the opening and the opening type. Now enter the zone pressure measurements with the Blower Door running (opening added), and the Blower Door test measurements. Use the **ZPD Input Table** found at the end of the TECTITE Zone Data Report for the zone pressure and Blower Door measurements to be entered. All baseline values are pre-set to zero and the house pressure value is pre-set to 50 when using a TECTITE Report as the data source.

Opening from **attic** to **house** **hatch** **120** Sq. In. ?

	Baseline	BD on	Change
House	0	-50	-50
attic	0	-33.7	-33.7
garage	0	-18.5	-18.5
crawl	0	-3.1	-3.1
bsmt	0	-47.2	-47.2

BD Flow (CFM) **3075** Ring **open**

< Previous All Pressures wrt Outside Next >

□ *Entering Opening Information:*

When entering information about the added opening (the top part of the Step 5 screens), first enter the location of the opening (e.g. **attic to house**, or **attic to outside**). You will then need to select an opening type and enter an opening area in square inches. There are 5 opening types to choose from:

orifice: an orifice is defined as a carefully measured opening cut into a thin, flat material such as cardboard, sheetmetal or plywood. Other requirements of an orifice are:

- The smallest dimension of the opening should not be less than 10 times the thickness of the orifice material.(e.g. for ½” cardboard, the smallest opening dimension should not be less than 5”).
- The hole cut into the orifice should not be bigger than ½ the outside dimension of the orifice material (e.g. for a 2’ by 3’ wide piece of plywood, the orifice hole should not have dimensions bigger than 1’ by 1.5”).
- There should be no obstructions to airflow on either side of the opening, within 2 times the largest dimension of the orifice opening (e.g. for a 10” by 8” opening, no obstructions within 20”).

hatch: a hatch is defined as a fully opened rectangular access hatch or small door with an easily measurable opening area.

partial opening: a partial opening is defined as a partially opened access hatch or small door. The partial opening makes the opening area more difficult to measure.

rough opening: a rough opening is defined as a hatch or door with an irregular opening which makes it very difficult to accurately measure the opening area (e.g. a partially opened hatch with fiberglass insulation attached to the back of the hatch door).

door: select this option when using a completely open full sized door as your opening. When selecting this option, you will not be asked to enter an opening size, and the opening area will not be used in the leakage estimate calculation.

The choice of opening type will affect the uncertainty in the zone leakage estimates. **Orifice** openings provide the least uncertainty, with **hatch**, **partial opening** and **rough opening** increasingly adding uncertainty to the estimate. The choice of **door** completely eliminates the use of an opening area in the leakage estimate.

Click on **Next** to move to the **Step 6** screen.

[ZPD Step 6: Zone Leakage Results](#)

The **Step 6: Zone Leakage Results** screen is used to display the pressure measurements (adjusted to 50 Pa) and leakage estimates for the tested zone (i.e. the zone where the hole was added).

Zone Tested = attic		
* Zone Shifted by -17.8 Pa, From -17.4 to -35.3		
	Leakage Range	
	min	max
house to attic leakage (sq. in.)	89	186
attic to outside leakage (sq. in.)	229	345
leakage through zone (CFM50)	739	1436

< Previous * Adjusted to a house pressure of 50 Next >

The leakage estimates displayed include:

- ⇒ Leakage area between the house and the tested zone (in square inches).
- ⇒ Leakage area between the tested zone and the outside (in square inches).
- ⇒ House air leakage through the tested zone (in CFM50).

All leakage estimates are presented as a range (from **minimum** to **maximum**) based on a 63% confidence interval. A 63% confidence interval means that the real answer will be between the **min** and **max** 63% of the time.

Click on **Next** to move to the **Step 7** screen.

ZPD Step 7: Additional Zones

The **Step 7: Additional Zones** screen is used to display information for any other zones monitored during the test. The screen displays the zone pressure measurements (adjusted to a house pressure of 50 Pa) made during the ZPD test, and provides an indication as to whether the ZPD program detected a physical connection (i.e. air leakage path) between any additional zones monitored and the primary zone tested. The ZPD program assumes a connection exists to the monitored zone if the change in monitored zone pressure (from adding an opening to the primary zone) is greater than the **estimated baseline fluctuation** (or baseline standard deviation) from **Step 2**.

Zone	No Openings	Opening Added	Shift	detected connection to zone tested?
garage	-15.9	-19.9	4	yes
crawl	-.8	-1.9	1.1	no
bsmt	-44	-45.5	1.5	no

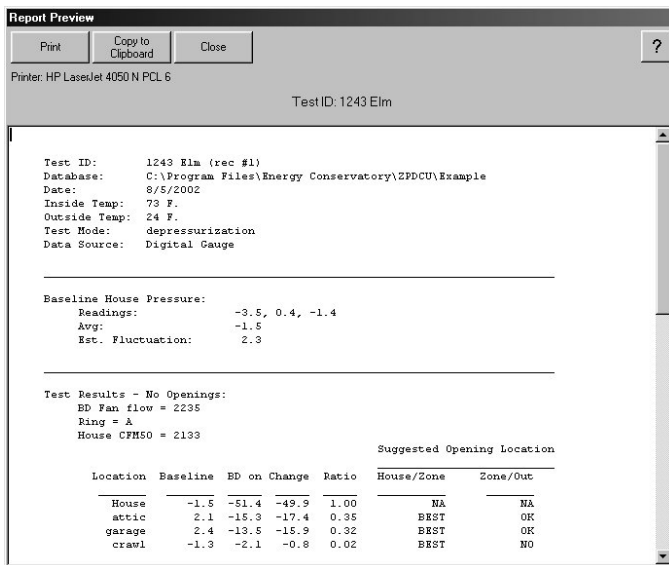
< Previous Pressures adjusted to house pressure of 50

Chapter 4 Printing Test Reports



A report for the currently open test record can be printed by accessing the main **File** menu and clicking on “Print”. **Note:** Report printing is only available for the currently open test record. Test records can be opened using the “Choose Existing Test” menu option.

After clicking on “Print”, a Report Preview screen opens displaying the results for the current test record. Two printing options are available from the Report Preview screen:



⇒ **Print** will allow you to print a test report to the printer which is currently selected in your Windows operating system. If you wish to print to a different printer, you will need to select that printer as your default Windows printer (using **Start....Settings.... Printers**) before choosing the “Print” option.

⇒ **Copy to Clipboard** will copy the contents of the Report Preview screen to the Windows clipboard. You can then paste the clipboard contents to any application of your choice using standard Windows paste commands.

When printing a report, the ZPD program attempts to use the *Courier* or *Courier New* fixed width font. If these fonts can not be found by the program, a message will appear alerting the user that the report will be printed using the printer’s default font. Use of a default (non-fixed width) font may cause alignment problems in the printed report.

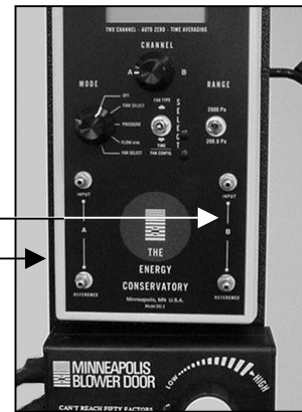
Click on “Close” to close the Report Preview screen.

Appendix A Recommended Tubing Connections

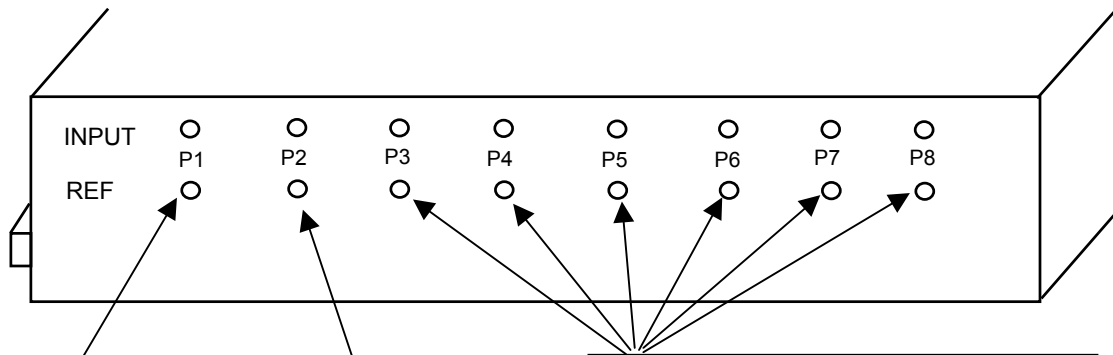
Tubing Connections for Digital Pressure Gauge

Channel B is used to measure flow from the Blower Door. Connect tubing from the Channel B Input tap to the Blower Door fan. The Channel B Reference tap should be connected to the space upstream of the fan.

Channel A is used to measure building and zone pressures with reference to outside. Connect tubing from the Channel A Reference tap to outside. The Channel A Input tap should be connected to the house, or to the zone being monitored.



Tubing Connections for APT System



Channel P1 is used to measure house pressure with reference to outside. Connect tubing from the Channel P1 Reference tap to outside. The Channel P1 Input tap should be connected to the house.

Channel P2 is used to measure flow from the Blower Door. Connect tubing from the Channel P2 Input tap to the Blower Door fan. The Channel P2 Reference tap should be connected to the space upstream of the fan.

Channels P3 – P8 are used to measure zone pressure with reference to outside. Connect tubing from the Channel P3 – P8 Reference taps to outside. If more than 1 zone is being monitored, run a single piece of tubing to the outside and use “T” connectors (along with short pieces of tubing) to connect the multiple reference pressure taps to the outside pressure tubing. The Channel P3 to P8 Input taps should be connected to the zones being monitored.

Appendix B ZPD Study Summary

Numerous refinements to and clarifications on ZPD testing have been incorporated in the ZPD Calculation Utility (ZPDCU) software as a result of the Energy Center of Wisconsin study.¹ Below is a brief summary of some of these findings and how they are implemented in the software. Italicized portions are direct quotes from the executive summary of the report. At the end of this section is a step by step description of how the calculations are performed.

- ❑ *Vent Method:* *Vent Method calculations proved to be a poor substitute for those of the Hole or Flow Methods.* Vent method calculations are not included in the ZPDCU software.
- ❑ *Flow Method:* The Flow Method is an updated version of “Open a Door”, or Blasnik Method 2. The equations for the Flow Method, presented in the report, do not require that the opening be made large enough to remove the entire pressure across it. This allows for Flow testing even with a small door or hatch. It also creates cases where both the Hole Method and the Flow Method can be utilized (see Hybrid Method) below. Also the Flow Method has been extended (compared to the existing Open a Door equations) to allow variable leakage exponents and house pressures other than 50.
- ❑ *Hole Method:* The Hole Method (Blasnik Method 1) remains largely unchanged. It has been extended to allow variable leakage exponents and house pressures other than 50. The types of holes typically added were studied to determine their actual flow characteristics and estimated uncertainties. This resulted in some changes and clarifications.

In the ZPDCU software, the user can choose from 5 different opening types to be added (orifice, hatch, partial, rough and door). Each opening type uses the following assumptions concerning bias errors and input opening area:

Opening Type	% Bias	Area Multiplier
Orifice	5	1.0
Hatch	10	1.2
Partial	25	1.2
Rough	50	1.2
Door	NA	NA

“% Bias” is the assumed bias uncertainty in the measured opening area and “Area Multiplier” is a multiplier automatically applied to the input opening area to account for typical air flow biases. If the opening type “Door” is selected then only the Flow method results are calculated.

Comparison of Hole/Flow Methods:

The results from the Hole and Flow calculation methods generally agreed quite closely and had a correlation of 0.92. Statistical analysis indicated that the differences between the methods were consistent with expectations based on the error analysis. In the ZPDCU software both the Hole and the Flow methods are calculated whenever possible (see Hybrid Method below). If there is a discrepancy between the two methods, the user is warned.

¹ An Investigation into Zone Pressure Diagnostic Protocols for Low Income Weatherization Crews December, Energy Center of Wisconsin Report 208-1 and 208-2. December 2001.

Hybrid Method:

In cases where both the Flow Method and the Hole Method equations are valid, they can be used to generate a Hybrid Method result. In the ZPDCU software, the Hybrid Method result is generated as follows:

- ⇒ The uncertainties in both the Hole Method and the Flow Method are calculated using Taylor’s Series expansion.
- ⇒ Whichever result has the lower estimated uncertainty is used to generate the Hybrid Method results.
- ⇒ Hybrid Method results are reported as a Range (from min to max) within which the true answer is expected to lie 63% of the time.
- ⇒ If there is a discrepancy between the Hole and Flow Methods, this is reported to the user along with the separate results and uncertainties.
- ⇒ In cases where only one of the methods is applicable, the Hybrid Method is simply that individual result. For example, if the opening type added was “Door” then the Hole Method will be ignored and the Hybrid Method result is simply the result of the Flow Method calculation.

Necessity of Measuring Baselines:

Baseline measurements were found to be necessary in order to achieve acceptable accuracy even in relatively mild temperature conditions and no wind. Therefore, in the ZPDCU software, there are data input boxes available for the input of baseline pressures corresponding to ALL measured “**BD On**” pressures. The calculated uncertainties in the results assume that the user has entered baseline pressure readings any time they are a significant enough fraction (such as half) of the estimated baseline fluctuations to be of concern.

Details of Calculations on Step 6 – Test Results Screen

Listed below is a step-by-step description of the calculations made and results presented during the Test Results (**Step 6**).

- ⇒ Temperature-adjusted blower door flow values are calculated for use in the flow method. If either of the BD flow values has not been entered, then Flow Method results will not be calculated.
- ⇒ The house to zone pressures (before and after the opening are made) are calculated as the difference between the house to outside pressures and the zone to outside pressures.
- ⇒ Based on the opening type selected, the area uncertainty level is set and the value of the area is adjusted if appropriate.
- ⇒ Check that the blower door flow (adjusted to a house pressure of 50) increased when the opening was added. If a large decrease is found then a warning is generated.
- ⇒ Check that the location where the opening was made satisfied the following: It had a pressure across it of at least the minimum shift value before the opening was made, it shifted in pressure in the right direction when the opening was made and the shift was at least equal to the minimum shift.
- ⇒ Set up values for parameters to be used in the calculations and corresponding values for the Taylor Series error analysis.

□ *Taylor Series Calculations*

Parameter	Precision error	Bias error	Deriv size
Baseline adjusted house to outside pressure, no openings (Pa)	EBF	.1+.5%	.01
Baseline adjusted zone to outside pressure, no openings (Pa)	EBF	.1+.5%	.01
Temperature adjusted blower door flow, no openings (CFM)	0	0	.01
Measured area of added opening (Sq. Inches)	0	5%,10%,25%, 50%	.01
Baseline adjusted house to outside pressure, opening added (Pa)	EBF	.1+.5%	.01
Baseline adjusted zone to outside pressure, opening added (Pa)	EBF	.1+.5%	.01
Temperature adjusted blower door flow with opening added (CFM)	0	5+.5% or 5 + 1.5%	.01
Assumed house to zone flow exponent = .65	0	.02	.001
Assumed zone to outside flow exponent = .65	0	.02	.001
Assumed total house flow exponent = .65	0	.02	.001

Perform the Hole Method and Flow Method calculations as appropriate. Combine precision and bias uncertainties at the 63% confidence level by simply adding in quadrature to get the overall uncertainty estimate.

Present house to zone and zone to outside leakage results as a range, as discussed above.

Calculate the min and max total path limits based on the house to zone and zone to outside min and max results. For example: the min total path leakage is the series combination of the min house to zone leakage and the min zone to outside leakage.