Instructions
for

Advanced
Zone Pressure Diagnostics

Program "ZPDa"

April 2004 (v. 1.0)

INTRODUCTION

This advanced zone pressure diagnostics software is based on *An Investigation into Zone Pressure Diagnostic Protocols for Low Income Weatherization Crews*, December 2001, prepared by the Center for Energy and Environment for the Energy Center of Wisconsin, Scott Pigg, project manager. The Executive Summary of this report states:

> Zone pressure diagnostics (ZPDs) have become an established tool for low-income weatherization programs in diagnosing indirect air leakage paths in houses. Other programs, such as the American Lung Association's Health House, use ZPDs to establish performance specifications. Despite widespread use, there are substantial differences in the way field personnel decide when to use ZPDs, which of the three methods to use, and how to make the best measurements. A project team comprised of staff from the Center for Energy and Environment, Michael Blasnik & Associates, and the Energy Conservatory developed and tested protocols for ZPDs used by weatherization crews and developed methods for determining the accuracy of ZPDs.
>
> ZPDs are used to identify and measure series leaks or leaks that pass through several zones of the house. For example, air leaking through the attic roof must first move from the living space into the attic through the attic floor. ZPDs measure the pressure difference between the living space and the bordering zone (the attic) and the bordering zone and the outdoors. The techniques rely on the principle that the ratio of the pressure difference across the interior and exterior boundaries of a series leak is a direct function of their leakage area.

The results of the *An Investigation into Zone Pressure Diagnostic Protocols for Low Income Weatherization Crews* included many improvements to both the methodology used to collect ZPD measurements and the calculation procedures used to estimate the magnitude of air leakage from selected zones. To learn more about these new and advanced ZPD methods, we recommend that you download, use, and study the instructions for The Energy Conservatory's ZPD Calculation Utility (ZPDCU). This free Windows software is available at http://www.energyconservatory.com/products/products8.htm. The ZipTest Pro² version, ZPDa, is based on this Windows version.

If you are to use these techniques and this program properly, you should have a good working knowledge of basic zone pressure diagnostic testing. These are some of the important improvements of this advanced zone pressure diagnostics methods over the basic method:

- You no longer must reach a pressure difference from the house to the outdoors of 50 Pascals. The advanced method allows you to use lower house pressures, although for the sake of accuracy, use a house pressure as close to 50 Pascals as possible.
- When you select "Door" as the opening type for this advanced method (similar to using the "door" method of the older basic ZPD), you are no longer required to have a zero pressure drop across the pressure boundary within which the door is located.

Here is a practical example (thanks to Collin Olson) demonstrating the advantages above: Let's say that you use Ring A on you Minneapolis Blower Door, Model 3 to measure the CFM_{50} and an attic-to-outdoor pressure of –4 Pascals.

You decide to crack open the attic hatch until you get a good pressure shift. So now with the hatch open, the attic-to-outdoor pressure is –16. However, there is no way you can measure the square inches of attic opening, the darn thing is too irregular. If you select "Door" as the opening type in this ZipTest Pro² ZPDa program, you will not be asked to enter a square inch area, so the irregular opening problem vanishes.

Now you crank up your blower door to get a CFM_{50} reading with this hole open, but you find that with the blower door Ring A (it is best to stick with the same Ring you used for the no-opening blower

door test, but you don't have to), you can only reach a house pressure of –35 Pascals. This is not a problem with the advanced method; continue your test for your final results. You can also repeat this test with the hatch completely removed.

Companion ZPDa Forms

Two forms are included at the end of this chapter to assist you when you are doing a ZPDa analysis. The first form on page 81 is an aid for an analysis of one zone. The second form on page 82 is helpful for an analysis of from two to four zones. **We strongly recommend that you use these forms. They will also provide documentation of your testing.**

ACKNOWLEDGEMENTS

For those who were part of the work that culminated in *An Investigation into Zone Pressure Diagnostic Protocols for Low Income Weatherization Crews*, December 2001, we thank the following members of the project monitoring committee for their valuable feedback and considerable patience:

- Martha B. Benewicz, Wisconsin Division of Energy
- Mark Bergmeier, State of Iowa Weatherization Program
- Anthony Cox, New River Center for Energy Research and Training
- Gary Gorlen, Wisconsin Division of Energy
- Suzanne Harmelink, Wisconsin Energy Conservation Corporation
- Tim J. Lenahan, Ohio Office of Energy Efficiency
- Scott Pigg, Energy Center of Wisconsin
- Bob Stoffs, Madison Gas & Electric
- Roger Williams, Minnesota Department of Economic Security

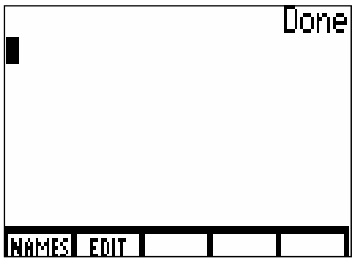
The authors of the project document would also like to thank the members of six weatherization crews for their dedication to a testing process that was often frustrating and required them to go well beyond their normal responsibilities:

- Craig Thorne, Operation Threshold
- Jim Perry and Don Forney, NEICAC
- Shawn Brown and Robert Holtz, AEOA Duluth
- Don Carlisle, Mike Cuff and Robin Viger, AEOA Virginia
- Bob Pfeiffer, Steve Smith, and Kerry Kazenske, Coulee CAP
- Tom Kalina, Robert Parkhurst, and Adrian Scott, West CAP

The research work was supported through funding provided by the Energy Center of Wisconsin, Chicago Weatherization Region state programs, Madison Gas & Electric, United States Department of Energy, State of Minnesota, State of Wisconsin, State of Iowa, State of Ohio, and the State of Indiana.

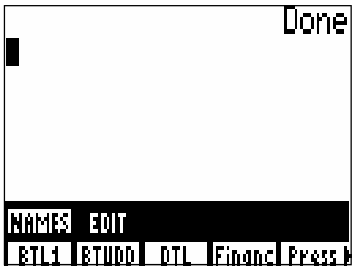
Finally, for the development of this software program for the Texas Instruments TI-86 calculator, thank you to Collin Olson for his help with the program design and writing of the mathematical program code. Thank you to those working on the research project who made certain the calculations for advanced pressure diagnostics would run on the TI-86 calculator.

ZPDa-1



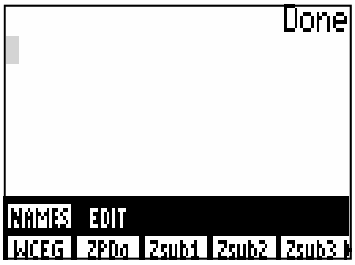
- Turn the TI-86 on by pressing the **ON** key.
- Then press the **PRGM** (Programs) key. You will see the screen at the left on your calculator.
- Now press F1 for **NAMES.**
- **Note: It is best never to press F2 for EDIT.**

ZPDa-2



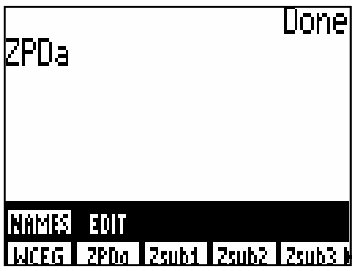
- Notice the sub-menu on the bottom of the display screen. The program we are looking for — ZPDa — is not on this first sub-menu set. Press the **MORE** key to move to the second sub-menu set.

ZPDa-3



- Notice that the "ZPDa" program is on this second sub-menu set above the **F2** key.
- Notice the names above the **F3**, **F4,** and **F5** keys. These "Zsubx" are not really programs but subroutines for the "ZPDa" program. There are eight of these subroutines — if you press the **MORE** key, the third sub-menu will show five more — that you should not call up because you will get an error message.
- Press the **F2** key only once to start the "ZPDa" program.

ZPDa-4

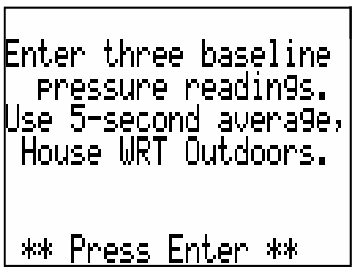


- You will now see "ZPDa" at the top left of the calculator display. Make sure that the only "ZPDa" is at the top left. When you press **ENTER** it instructs the calculator to look for and run the "ZPDa" program, so make sure there are no extraneous numbers or letters listed on this line on the display.
- Press **ENTER**.

ZPDa-5

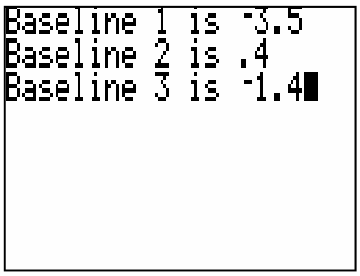
- This is the home screen for the Advanced Zone Pressure Diagnostics program.
- Select **F1**, "ZPD", to start the program routine.
- Select **F4**, "ACKLG", (acknowledgements) to see who wrote the program.
- Select **F5**, "QUIT", to quit the program. Always exit the program by selecting **F5** from this menu; this resets the decimal place is thereby set to "floating".
- Press **F1** to start the "ZPD" routine.

ZPDa-6



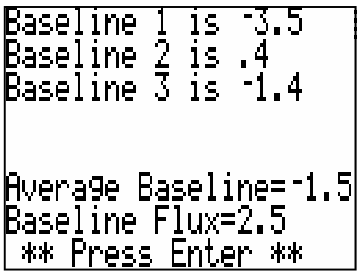
- This display is informational only; it alerts you about what is coming up next so that you can prepare. These three baseline pressures are taken in a manner similar to a baseline pressure preceding a blower door test — house closed up, blower door fan plugged, and no openings made.
- These baseline pressures are used to determine the degree of measurement error from wind during the advanced zone pressure diagnostics testing.
- Press **ENTER** to go to the next display.

ZPDa-7



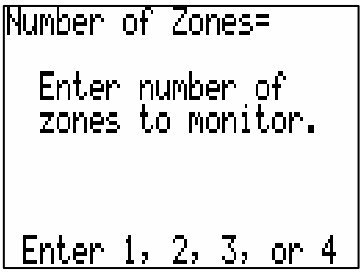
- For this example, at the left we have entered the 5-second baseline pressures of –3.5, 0.4, and –1.4 (Important: When you enter a negative number, you must use the key to the left of the **ENTER** key, not the subtraction operation key).
- This is a good time to mention the ZPDa test companion forms at the end of this chapter. The first of the two forms is for testing one zone only and the second form is for testing two through four zones. **Make as may photocopies of this ZPDa form as you wish.** Enter these example baseline pressures and other information on a copy of the second of these forms to help you keep things straight. This will also provide a record of each test.

ZPDa-8



- After entering the three baseline pressures, in Pascals, press the **ENTER** key.
- You will see the display at the left on your TI-86 screen.
- Notice that the "Average Baseline=-1.5" and the "Baseline Flux=2.5".
- Enter these two calculated values on the ZPDa form. Note that all calculated values on the ZPDa forms have names that are in *italics*.
- Press **ENTER**.

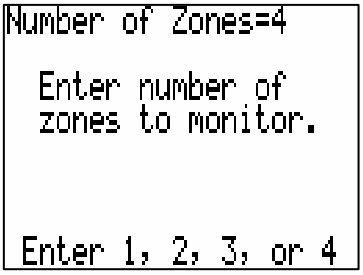
ZPDa-9



- Here you must enter the number of zones you wish to test. In the this software you may enter one through four zones, each designated by the numbers 1 to 4. Use the ZPDa form to name the zone numbers.
- Let's assume for this example that we are testing four zones:

1 = attic
2 = garage
3 = crawl space
4 = basement

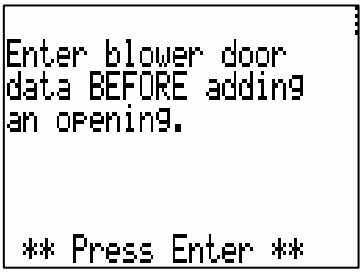
ZPDa-10



- Press the "4" key to designate the number of zones you want to include in this test. You cannot change this unless you start the program over, so make sure you enter the right number.
- **Note: We recommend that you fill out as much of the ZPDa form before you start entering your data into the ZPDa program. This will help you plan you test and ensure that you gather all the house data necessary.**
- After you have pressed the "4" key, press **ENTER** to move to the next screen.

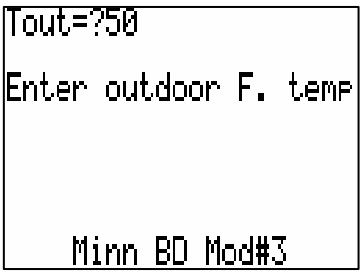
This is very important!

ZPDa-11



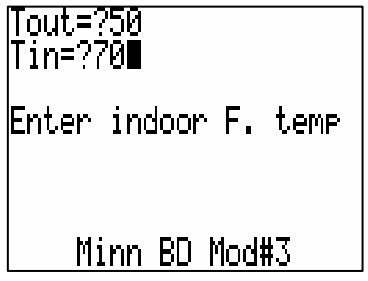
- This screen informs you that it is time to enter your whole house blower door test data. This is the blower door test BEFORE you add any openings for the zone pressure diagnostics testing (later in the program you will have to enter house blower door data with an opening made in one of the zones).
- Press **ENTER** to start the blower door data entry.

ZPDa-12



- For this example, enter an outdoor temperature — "Tout" — of 50 degrees.
- The program will automatically adjust your blower door readings for outdoor/indoor temperature differences. Notice there are simple instructions on the display. We include these whenever possible.
- By the way, this program works only with the Minneapolis Blower Door, Model 3 manufactured by The Energy Conservatory (notice the abbreviation for this blower door at the bottom of the display).

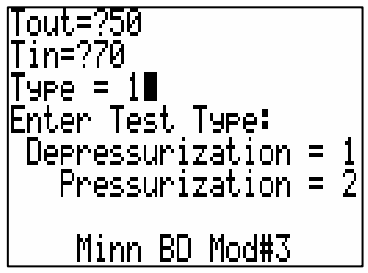
ZPDa-13



- Now enter the indoor temperature — "Tin" — of 70 degrees.
- Notice the short instruction on the display.
- **Note: It is a very good idea to look at the values you have entered before you press ENTER, because after you press ENTER you cannot go back and change your entry. If you notice that you have made an entry mistake after pressing ENTER, you must press the 2nd key, then QUIT (the second function of EXIT), and then ENTER. This takes you back to the beginning of the program and you must start over.**

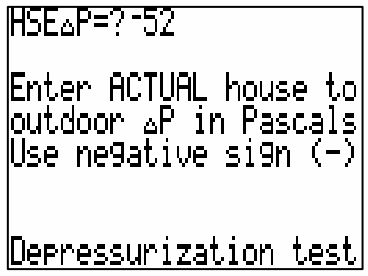
This is very important!

ZPDa-14



- Press **ENTER**.
- Because we are temperature adjusting the blower door readings, it is necessary to ask whether the blower door test is depressurizing or pressurizing the house. Normally we depressurize, as we are assuming in this example.
- **Note: If you make an entry mistake and notice it before pressing enter, move the cursor over the erroneous entry and re-type the correct one.**
- Press **1** for depressurization and then press the **ENTER** key.

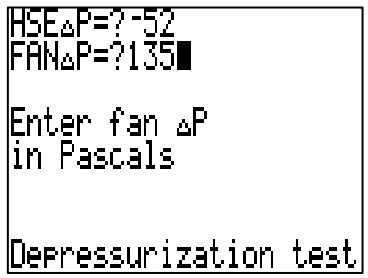
ZPDa-15



- Now you must enter the pressure difference, the house with reference to the outdoors, created by the blower door. Please notice the instruction on the screen. Because we are performing a depressurization blower door test for this example, we MUST put a negative sign in front of the pressure difference of 52 Pascals. Notice at the bottom of the display we are reminded that we are doing a depressurization test requiring a negative sign. **Note: The negative sign is just to the left of the ENTER key on the TI-86 calculator.** [continued on next panel]

This is very important!

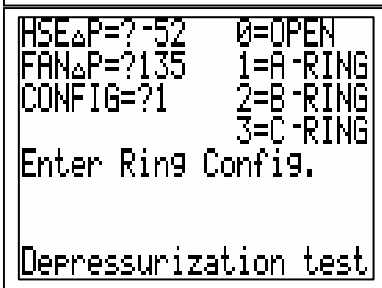
ZPDa-16



The "HSE∆P" (house pressure) should ideally be from 45 to 55 Pascals for the whole house test and the pressure readings taken in each of the zones we are testing (see panel ZPDa-23 to 26). If you cannot reach at least 45 Pascals, take these readings at the highest achievable pressure.

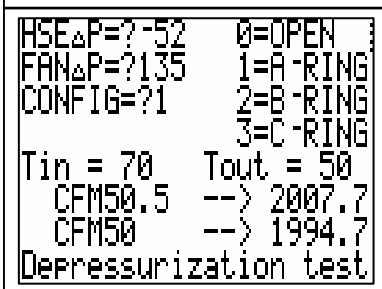
- Now enter the blower door fan pressure difference — "FAN∆P" — without a negative sign, in units of Pascals.
- Press **ENTER**.

ZPDa-17



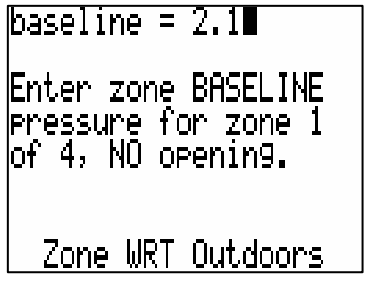
- Enter the blower door fan configuration — "CONFIG". There is a menu of the choices on the upper right corner of the display.
- Enter **1** for our example and then go to the next screen by pressing the **ENTER** key.
- Remember to write all this data on your ZPDa form as you proceed through the testing.

ZPDa-18



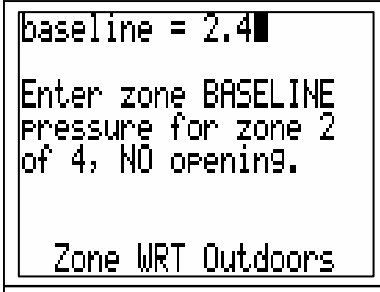
- This next display shows the blower door data you entered and the results of the blower door test, temperature adjusted and baseline adjusted. Notice that the "HSE∆P" (house pressure) in panel ZPDa-17 was entered as "-52". Well, the average house baseline for the test of –1.5 (see panel ZPDa-8) was subtracted from –52 Pascals to yield a net house ∆P of –50.5. This is why we have "CFM50.5 —> 2007.7" and an adjusted "CFM50 —> 1994.7". Both of these CFM values are adjusted for temperature differences between outdoors and indoor.

ZPDa-19



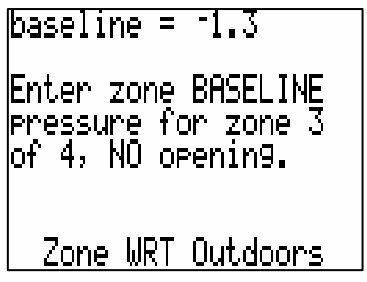
- Now you must enter the baseline pressures, in Pascals, for each of the four zones in this example. **Notice that these baseline pressure are taken from the zone WRT (with reference to) the outdoors, no openings have yet been created for the zone pressure diagnostics testing, the blower door is off, and the blower door fan is closed.**
- Notice the instruction on the display indicates that this baseline pressure is for "zone 1 of4". This should help you enter the right values for each zone.
- Press **ENTER** to move to the next screen.

ZPDa-20



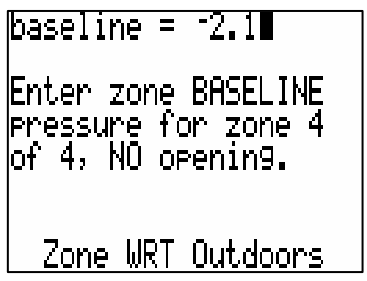
- The next baseline pressure should now be entered. Enter the number shown at the left.
- Notice that the instruction now states "zone 2 of 4". As we named the four zones for this ZPDa test, zone 2 is the garage (see panel ZPDa-9).
- Press **ENTER** to move to the next screen and enter the next baseline pressure.

ZPDa-21



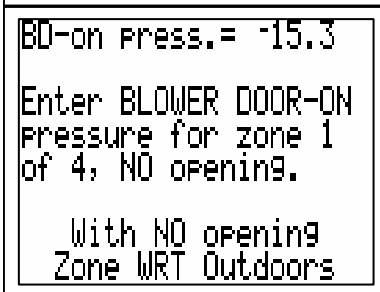
- For "zone 3 of 4" enter "-1.3". As we mentioned earlier, the negative key for the negative sign before this number is just to the left of the **ENTER** key on the TI-86 keyboard.
- Press **ENTER** to move to the next screen.

ZPDa-22



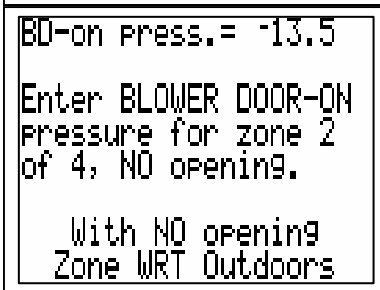
- For the final baseline entry, "zone 4 of 4", enter "-2.1", again using the negative sign key just to the left of the **ENTER** key.
- If we had decided to work on just three zones for this zone pressure diagnostics test and entered "Number of Zones" as 3 (see panels ZPDa-9 and 10), rather than four, only three screens would have come up for baseline readings. The "Number of Zones" we enter determines the number of times we are asked for "baseline" and "BD-on press." before and after we add a temporary test opening. Press **ENTER**.

ZPDa-23



- Notice that now we must enter "BD-on press" readings, in Pascals, while the blower door is running, **but there is no opening made yet for the analysis.**
- Again, the instruction on the display states this is the entry for "zone 1 of 4" to assist you in entering the proper values.
- Enter "-15.3".
- Press **ENTER** to move to the next screen.

ZPDa-24



- Enter "-15.3" for "zone 2 of 4".
- Press **ENTER**.

ZPDa-25

```
BD-on press.= -2.1

Enter BLOWER DOOR-ON
pressure for zone 3
of 4, NO opening.

   With NO opening
  Zone WRT Outdoors
```

- Enter "-2.1 for "zone 3 of 4".
- Of course, in order to gather this pressure data you must have a pressure hose in each of the zones and another hose connected to the outdoors. It is a very good idea to use different color hoses for each of the zones so that you can keep things straight. And don't forget to enter all your data on the ZPDa form for each analysis.
- Press **ENTER.**

ZPDa-26

```
BD-on press.= -46

Enter BLOWER DOOR-ON
pressure for zone 4
of 4, NO opening.

   With NO opening
  Zone WRT Outdoors
```

- Enter "-46 for "zone 4 of 4". Earlier we designated zone 4 as the basement in this example analysis (see panel ZPDa-9). This high value from the "Zone WRT Outdoors" indicates that the basement walls are a **relatively** tight pressure barrier compared with the pressure barrier between the main house and the basement (the basement ceiling).
- Press **ENTER.**

ZPDa-27

```
    BaseLn BD-On  Diff
Hse -1.5   -52.0 -50.5
Zn1 2.1    -15.3 -17.4
Zn2 2.4    -13.5 -15.9
Zn3 -1.3   -2.1   -.8
Zn4 -2.1   -46.0 -43.9

Data With No Opening
```

- Now we see the tabular results of all of our work up to this point! On the far left of the table are the row designations for the house ("Hse"), zone 1 ("Zn1"), zone 2 ("Zn2"), etc.
- The column "BaseLn" lists the entered baseline pressures (the one for the house is the average of the three baseline pressures entered for the house — see panel ZPDa-8).
- The next column "BD-On" lists the blower door-on pressures for each zone.

[continued on next panel]

ZPDa-28

[Intentionally left blank]

- Finally, the last column "Diff" lists the actual zone pressures, the "BaseLn" values subtracted from the "BD-On" values. These net pressure values are used for the program calculations.
- Notice at the bottom of the display there is a reminder that no openings have been created yet.
- Press **ENTER.**

ZPDa-29

```
CFM50=1995     Hole
             Location
Zn H/Z Z/O H/Z   Z/O
1  32  18  Best  OK
2  33  17  Best  OK
3  49  1   Best  No
4  4   46  No    Best
Min pressure shift=10
```

- This table shows the zones — 1 through 4 for this example, the house-to-zone pressures ("H/Z"), the zone-to-outdoors pressures ("Z/O"), and the best place for the location for a temporary opening for the analysis. These suggested opening location guidelines are for your convenience. This example display includes a three possibilities under "Hole Location"; Best, OK, or No.
- "Best" indicates that adding an opening here, say house-to-zone for zone 1, will produce the best zone leakage estimates and allows for the largest possible change in zone pressure.

[continued on next panel]

ZPDa-30

[Intentionally left blank]

- "OK" indicates opening a hole in this pressure boundary will give reliable zone leakage estimates, but the estimates will not be as certain as the "Best" designation.
- "No" indicates that reliable estimates of zone leakage cannot be achieved by opening a temporary hole in these pressure boundaries because the boundary is too leaky to allow the minimum pressure change ("Min pressure shift").

[continued on next panel]

ZPDa-31

```
CFM50=1995    Hole
              Location
Zn H/Z Z/O H/Z   Z/O
1  32  18  Best  OK
2  33  17  Best  OK
3  49  1   Best  No
4  4   46  No    Best
Min pressure shift=10
```

- **Note: This is the same display as panel ZPDa-29.**
- You may select any of the four zones to analyze; this table instructs you when to make the temporary opening for the most reliable test results.
- Notice that the CFM_{50} value of the whole house blower door test (no openings) is at the top left on this display as a reminder.
- Also notice that at the bottom of the screen is an important value, the "Min pressure shift=10". When you create a temporary opening for your zone pressure diagnostics testing, the shift across [continued on next panel]

ZPDa-32

[Intentionally left blank]

the pressure boundary through which you create the opening must be at least 10 Pascals (for this example) to achieve reliable results. The minimum pressure shift is four times the estimated baseline fluctuation (see "Baseline Flux" in panel ZPDa-8).

- Don't forget to record the minimum pressure shift on the ZPDa form. You will notice that there is no entry area on the ZPDa forms for Best, OK, and No. With experience, you will be able to quickly examine the data already recorded on the form to determine the best pressure boundary for an opening.
- Press **ENTER**.

ZPDa-33

```
Zone #=1

Of 4 zones, which do
you want to analyze?



Min pressure shift=10
```

- Now you must decide which zone (of a total of four for this example) you want to analyze by adding an opening. For this example we will analyze zone 1.
- Notice the instruction on the display. Also, as a reminder, the minimum pressure shift is displayed at the bottom of the screen. This value should have already been recorded on your ZPDa form.
- On the next two or three screens you will enter information about the temporary opening you are making.
- Press **ENTER**.

ZPDa-34

```
Zone #=1
Location=1      1=H/Z
                2=Z/O

Where will you make
the temporary openinG

Min pressure shift=10
```

- Select the location for the temporary opening. Guidance for this is displayed for this example on panel ZPDa-31; the best pressure boundary for the opening is between the house and the zone (H/Z).
- Notice the minimum pressure shift, in Pascals, is displayed at the bottom of the screen as a reminder. This means that when you make the opening, you should drop the pressure across this pressure boundary by at least 10 Pascals for reasonable accuracy.
- Press **ENTER**.

ZPDa-35

```
Zone #=1
Location=1  1=Orifice
Hole Type=2 2=Hatch
            3=Partial
            4=Door
            5=Rough

  Select Hole Type
```

- You must enter the opening type here. Please see **The Five Types of Temporary Openings** on page 80 at the end of this chapter for an explanation of the hole types and uses.
- Unless you enter "4" for "Door", you will next be asked for the opening size. On the ZPDa forms these opening types are merely designated as "OHPDR" so that you can easily circle the hole type you use.
- Enter "2" for "Hatch" and then press **ENTER**.

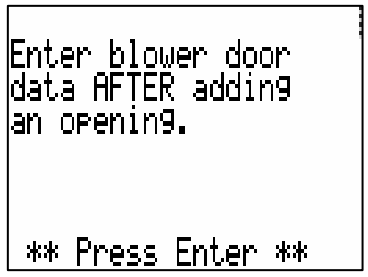
ZPDa-36

```
Hole Size=120


Enter hole size in
free square inches.
```

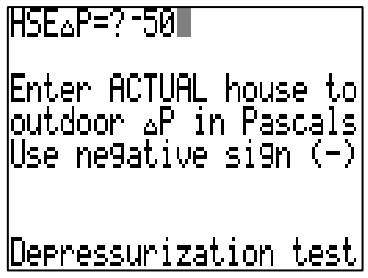
- Enter the hole size in square inches. If the hole is covered by a louver or a screen, do your best to determine and enter the *free* square inches of opening. The more accurate your measurement, the less uncertain your results will be.
- Remember, you must drop the pressure difference across the pressure boundary in which you make the opening by at least the minimum pressure shift (for this example, 10 Pascals). Make the hole larger if you need to increase the pressure shift.
- Enter "120" and then press **ENTER**.

ZPDa-37



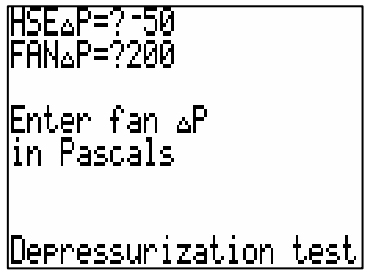
- Now it is time to enter the blower door information with the temporary hole open.
- Press **ENTER**.

ZPDa-38



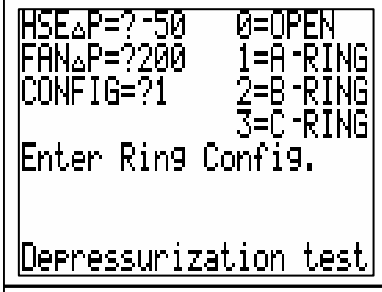
- Notice that you are not asked to enter the outdoor, indoor, or test type again as you were for the first blower door test. This data is held in the memory of the TI-86 for this second hole-open blower door test.
- The "HSEDP" (house pressure) should ideally be from 45 to 55 Pascals for the whole house test and the pressure readings taken in each of the zones we are testing (see panel ZPDa-42 to 49). If you cannot reach at least 45 Pascals, take these readings at the highest achievable pressure.
- Enter "-50" for this example. Don't forget to enter the negative sign for the house pressure when performing a depressurization test. Press **ENTER**.

ZPDa-39



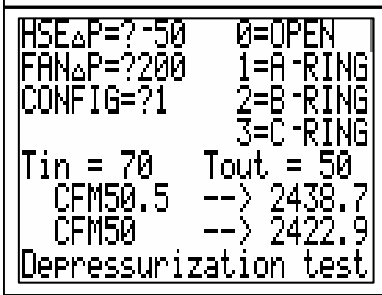
- Enter the fan pressure of "200" Pascals for this example.
- Press **ENTER**.

ZPDa-40



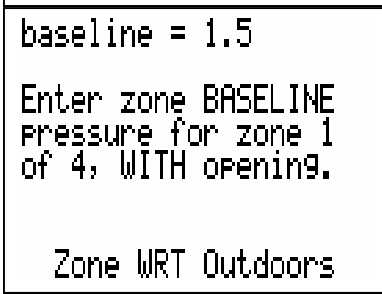
- Enter the fan configuration of 1. You should try to use the same blower door fan ring on this hole-open blower door test as you did on the first one. Use the same ring as long as you can reach a house pressure difference of at least 35 Pascals. This will result in a narrower range of minimum and maximum zone leakage results. **However, if you must change rings for the blower door test with a hole opened, do so; you will only suffer some decrease in accuracy.**
- Press **ENTER**.

ZPDa-41



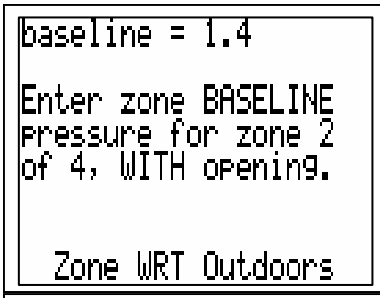
- Here is all the data you entered and the results for the second blower door test. Notice that the temperature values you entered for the first blower door test are listed here. We are assuming that the temperatures have not changed for the second of two blower door tests.
- As a result of adding a temporary opening in the attic floor by removing a hatch, the house CFM_{50} value increased from 1995 to 2423.

ZPDa-42



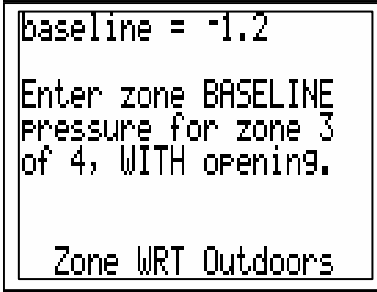
- Now the baseline values must be entered for the zones. The blower door must be off and the blower closed, however, the hole should be open to the size already entered in the calculator and recorded on the ZPDa form.
- Enter the zone with reference to outdoors baseline pressure difference for zone 1 of 4. For this example this is 1.5 Pascals.
- Press **ENTER**.

ZPDa-43



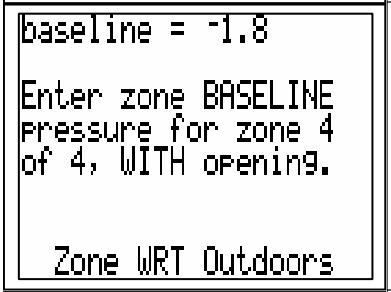
- Enter the zone with reference to outdoors baseline pressure difference for zone 2 of 4. For this example this is 1.4 Pascals.
- Press **ENTER**.

ZPDa-44



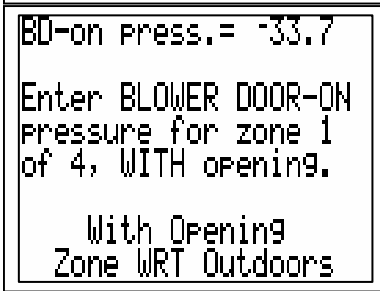
- Enter the zone with reference to outdoors baseline pressure difference for zone 3 of 4. For this example this is -1.2 Pascals.
- Press **ENTER**.

ZPDa-45



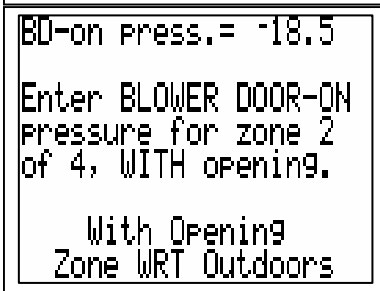
- Enter the zone with reference to outdoors baseline pressure difference for zone 4 of 4. For this example this is -1.8 Pascals.
- Press **ENTER**.

ZPDa-46



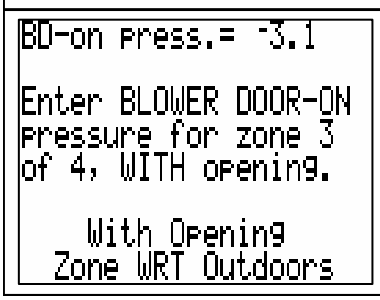
- Now enter the zone pressures with the blower door operating and the hole of a specified size (or a door of a non-specified size) open.
- Enter the zone with reference to outdoors pressure difference for zone 1 of 4. For this example this is –33.7 Pascals.
- Because this is a depressurization test, all for of these example zone pressures will be negative.
- Press **ENTER**.

ZPDa-47



- Enter the zone with reference to outdoors pressure difference for zone 2 of 4. For this example this is –18.5 Pascals.
- Press **ENTER**.

ZPDa-48



- Enter the zone with reference to outdoors pressure difference for zone 3 of 4. For this example this is –3.1 Pascals.
- Press **ENTER**.

ZPDa-49

```
BD-on press.= -47.2

Enter BLOWER DOOR-ON
pressure for zone 4
of 4, WITH opening.

    With Opening
  Zone WRT Outdoors
```

- Enter the zone with reference to outdoors pressure difference for zone 4 of 4. For this example this is –47.2 Pascals.
- Press **ENTER** to move on to the tabulated results of the baseline and zone pressures.

ZPDa-50

```
    BaseLn BD-On  Diff
Hse -1.5   -50.0 -48.5
Zn1 1.5    -33.7 -35.2
Zn2 1.4    -18.5 -19.9
Zn3 -1.2   -3.1  -1.9
Zn4 -1.8   -47.2 -45.4

  Data With Opening
```

- Here are the results for the baseline and zone pressure differences, and the net zone pressures ("Diff") for each of the four zones in this example and the house. Notice, as indicated at the bottom of the display, these are the pressures with the opening, in this case between the house and the attic (zone 1).
- Press **ENTER**.

ZPDa-51

```
Calculating Results..




Progress -------
```

- As you can see from this display, the humble TI-86 is working very hard to calculate the results of your zone pressure analysis. The work-in-progress graphic at the bottom of the display indicates the heavy work being accomplished. Be patient. **You do not have to press ENTER here; when the calculations are complete, the results will be displayed.**

ZPDa-52

```
  Results for Zone 1
--------------------
      CFM50    CFM50
      -----    -----
 H/Z 444   to 972
 Z/O 747   to 1404
Path 349   to 726
```

- Here are the results we have be working for! This screen shows the house-to-zone ("H/Z") CFM_{50} range, the zone-to-outdoors ("Z/O") CFM_{50} range, and the total path ("Path") CFM_{50} range. **If you divide the house-to-zone and the zone-to-outdoors CFM_{50} values by 10, you get an approximate range of leakage area in square inches.**
- Notice the reminder at the top of the display that these are the results for zone 1, in this example this is the attic.
- The total path range values will always be less [continued on next panel]

ZPDa-53

[Intentionally left blank]

than the house-to-zone or zone-to-outdoors range values. This is because the total path includes the impact of **both** the pressure boundaries. This is a very powerful analysis and has many advantages over the basic zone pressure diagnostics procedure (see the ZPD sub-program in the PRESS section of the ZipTest Pro² software package).

- Press **ENTER**.

ZPDa-54

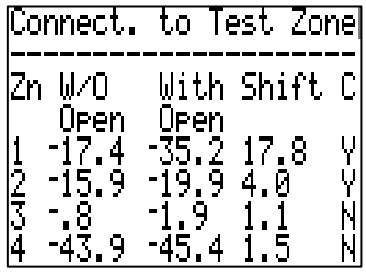
```
Connect. to Test Zone
---------------------
Zn W/O   With Shift C
   Open  Open
1 -17.4 -35.2 17.8  Y
2 -15.9 -19.9 4.0   Y
3 -.8   -1.9  1.1   N
4 -43.9 -45.4 1.5   N
```

- This is a powerful feature of advanced zone pressure diagnostics, the connection of zones. The title of this table is "Connection to Test Zone".
- The column headings, for left to right are:

Zone ("Zn")
Zone pressure **without** opening made ("W/O Open")
Zone pressure **with** opening ("With Open")
The pressure shift in the zone as a result of the hole being opened ("Shift")

[continued on next panel]

ZPDa-55



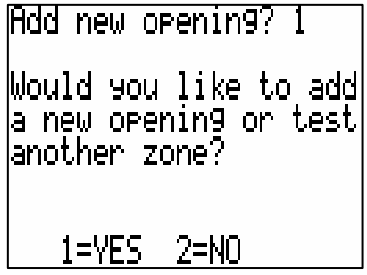
[continued from panel ZPDa-54] (This is the same screen as in panel ZPDa-54.) Connection to the tested zone — in this case, zone 1 — or not ("C"). If a connection between the tested zone and another zone is indicated, a "Y" for YES is displayed. If no connection was found, an "N" for NO is displayed. Notice that there is a "Y" for YES for zone 1. This is indicating that zone 1 — the tested zone — is connected to itself. No surprise! Notice that a connection between zone 2 and zone 1 — the tested zone — had been detected. This is powerful information. [continued on next panel]

ZPDa-56

[Intentionally left blank]

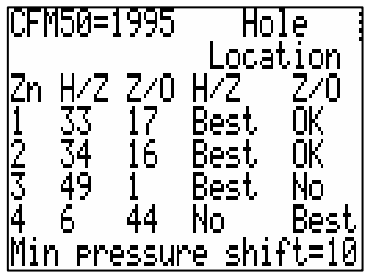
- If you select only one zone for your analysis (go back and look at panel ZPDa-10), the "Connect. To Test Zone" screen will not appear. Because of the one-zone analysis, there is no point in displaying a screen that will show you what you already know; the zone you tested is connected to itself.
- If you select two, three, or four zones to analyze, this Connect. To Test Zone" screen will only show that number of zones.
- Press **ENTER.**

ZPDa-57



- The program step above in panel ZPDa– 55, the connection display, is the last step of the program. You may end your testing of this house here by pressing "2" to return to the home screen of the ZPDa program — see panel ZPDa-58 — or you may test another zone or try a new opening size or type in the zone you just tested.
- If you press "1" for "YES", the program will take you back to the screen displayed in ZPDa-panel 58, showing the results of the blower door test with no opening made, the baseline and zone pressures, [continued on next panel]

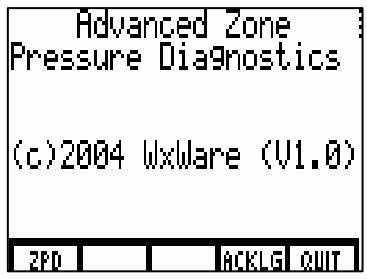
ZPDa-58



and the minimum pressure shift. If you have used one of the ZPDa forms during your analysis, it will be much easier to start again at this point and test another zone.

- The screen to the left is a reminder of the initial analysis setup. Proceed from here to test one, two, or three more zones based on your initial readings.

ZPDa-59



- If you select "2" for "NO" at the screen displayed in panel ZPDa-57, you will be taken back to the home screen for the ZPDa program displayed at the left. The initial data entered for the house you were analyzing will be lost.

ZPDa-60

[Intentionally left blank]

The Five Types of Temporary Openings*

When entering information about the temporary added openings, you will then need to select an opening type and enter an opening area in square inches (Note: As an exception here, you are not asked to enter the area if your opening selection is "Door"). Of the five opening types, the percent bias or the level of uncertainty increases from "orifice" to "rough opening". This means that if you use an "orifice" type opening there will be less uncertainty in your results than if you use a "hatch". The results from using a "hatch" type opening will be less uncertain than using a "rough opening". A level of bias or uncertainty does not apply to a "door" type opening for there is no need to determine the size of a door opening.

If you select the opening type that most closely represents the one you are actually using, the accuracy of your analysis will increase. There are five opening types to choose from.

Orifice

An orifice is defined as a carefully measured opening cut into a thin, flat material such as cardboard, sheet metal, or thin plywood. When you select "orifice", you will then be asked for opening size.

Some analysts carry a number of orifices with them to use during ZPD testing. These pieces of cardboard, sheet metal, or thin wood paneling are then fit into attic hatches and other existing openings for creating openings of a known size.

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

Hatch

A hatch is defined as a fully opened rectangular access hatch or small door with an easily measurable opening area. A typical attic hatch is an example. When you select "hatch", you will then be asked for opening size.

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. This might be an attic hatch that is lifted up at one side to create an opening.

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, for example, 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.

Because the choice of a "door" type opening does not require the calculation or entry of the opening size, this entry eliminates the mathematical bias or uncertainty associated with the other opening types.

* Source: The Energy Conservatory's ZPD Calculation Utility (ZPDCU) Help section. This free Windows software is available at http://www.energyconservatory.com/products/products8.htm.

ZPDa Form for Single Test Zone

Advance Zone Pressure Diagnostics Testing for ZipTest Pro^2 Software

Initial Data Table			
Job #:	Job Name:	Analyst Name:	Date:
3 Baseline pressure readings: ( ) ( ) ( )		*Average Baseline:*	*Baseline flux:*
Blower Door Test Data with NO Opening			
Tout:	Tin:	Depressurization Test: ☐	Pressurization Test: ☐
House ΔP:	Blower ΔP:	Configuration: Open A B	*CFM$_{50}$:*

Zone Data with NO opening		Zone Pressure with NO opening Zone to Outdoors			Comments
	Zone Name	Baseline Pascals	Pressure Pascals	*Pressure Diff, Pa*	
	House				
1					
Minimum pressure shift when adding opening:					

Zone Pressure Testing Data Table 1 (data gathered from making an opening)								
ZPDa Test #:								
Blower Door Test Data with Opening								
House ΔP:	Blower ΔP:	Configuration: Open A B					*CFM$_{50}$:*	

Zone Data with Opening					Zone Pressures with Opening Zone to Outdoors			Comments
	Zone Name	Opening Location	Opening Type[1]	Opening Size, in^2	Baseline Pascals	Pressure Pascals	*Pressure Diff., Pa*	
	House							
1		H/Z Z/O	OHPDR					

H/Z CFM$_{50}$: to	*Z/O CFM$_{50}$: to*	*Total Path CFM$_{50}$: to*
H/Z in^2 leakage: to	*Z/O in^2 leakage: to*	

Zone Pressure Testing Data Table 2 (data gathered from making an opening)								
ZPDa Test #:								
Blower Door Test Data with Opening								
House ΔP:	Blower ΔP:	Configuration: Open A B					*CFM$_{50}$:*	

Zone Data with Opening					Zone Pressures with Opening Zone to Outdoors			Comments
	Zone Name	Opening Location	Opening Type[1]	Opening Size, in^2	Baseline Pascals	Pressure Pascals	*Pressure Diff., Pa*	
	House							
1		H/Z Z/O	OHPDR					

H/Z CFM$_{50}$: to	*Z/O CFM$_{50}$: to*	*Total Path CFM$_{50}$: to*
H/Z in^2 leakage: to	*Z/O in^2 leakage: to*	

[1] Opening types are O=Orifice, H=Hole, P=Partial, D=Door, and R=Rough. See software instructions for explanation.
Values with names in *italics* are calculated by the ZPDa program, a part of the ZipTest Pro^2 software package.

ZPDa Form for Two through Four Test Zones

Advance Zone Pressure Diagnostics Testing for ZipTest Pro^2 Software

Initial Data Table			
Job #:	Job Name:	Analyst Name:	Date:
3 Baseline pressure readings: ( ) ( ) ( )		*Average Baseline:*	*Baseline flux:*

Blower Door Test Data with NO Opening			
Tout:	Tin:	Depressurization Test: ☐	Pressurization Test: ☐
House ΔP:	Blower ΔP:	Configuration: Open A B	*CFM$_{50}$:*

Zone Data with NO opening		Zone Pressure with NO opening Zone to Outdoors			Comments
	Zone Name	Baseline Pascals	Pressure Pascals	*Pressure Diff, Pa*	
	House				
1					
2					
3					
4					
Minimum pressure shift when adding opening:					

Zone Pressure Testing Data Table 1 (data gathered from making an opening)								
ZPDa Test #:								
Blower Door Test Data with Opening								
House ΔP:	Blower ΔP:	Configuration: Open A B			*CFM$_{50}$:*			
Zone Data with Opening					**Zone Pressures with Opening** Zone to Outdoors			*Connected to tested zone? Yes or No*
Zone Name	Test Zone	Opening Location	Opening Type[1]	Opening Size, in^2	Baseline Pascals	Pressure Pascals	*Pressure Diff., Pa*	
House								
1	☐	H/Z Z/O	OHPDR					Y N
2	☐	H/Z Z/O	OHPDR					Y N
3	☐	H/Z Z/O	OHPDR					Y N
4	☐	H/Z Z/O	OHPDR					Y N
H/Z CFM$_{50}$: to		*Z/O CFM$_{50}$:* to			*Total Path CFM$_{50}$:* to			
H/Z in^2 leakage: to		*Z/O in^2 leakage:* to						

Zone Pressure Testing Data Table 2 (data gathered from making an opening)								
ZPDa Test #:								
Blower Door Test Data with Opening								
House ΔP:	Blower ΔP:	Configuration: Open A B			*CFM$_{50}$:*			
Zone Data with Opening					**Zone Pressures with Opening** Zone to Outdoors			*Connected to tested zone? Yes or No*
Zone Name	Test Zone	Opening Location	Opening Type[1]	Opening Size, in^2	Baseline Pascals	Pressure Pascals	*Pressure Diff., Pa*	
House								
1	☐	H/Z Z/O	OHPDR					Y N
2	☐	H/Z Z/O	OHPDR					Y N
3	☐	H/Z Z/O	OHPDR					Y N
4	☐	H/Z Z/O	OHPDR					Y N
H/Z CFM$_{50}$: to		*Z/O CFM$_{50}$:* to			*Total Path CFM$_{50}$:* to			
H/Z in^2 leakage: to		*Z/O in^2 leakage:* to						

[1] Opening types are O=Orifice, H=Hole, P=Partial, D=Door, and R=Rough. See software instructions for explanation.
Values with names in *italics* are calculated by the ZPDa program, a part of the ZipTest Pro^2 software package.