

ZipTest Pro³

Building & Energy Diagnostics Software

I-P edition

Version

1.0

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Building & Energy Diagnostics Software

I-P edition

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1.0

Specifications and Instructions, I-P edition, April 2010

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WxWare Diagnostics is a division of

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Charlie Holly, Ph.D. (mathematics) was the primary programmer for the ZipTest Pro^{3™} software. Charlie's devotion, creativity, systematic approach, and relaxed attitude made the project successful and the process a pleasure. His combination of mathematical expertise programming knowledge, understanding of building science theory and practice, and pleasant manner made him the perfect person for the work. Thank you, Charlie, for all your great ideas and expert programming.

Finally, thank you to many loyal users of previous ZipTest software versions. Scores of good ideas for improvements have been voiced by many. Some features that you liked have been expanded; some features that you never used have been discontinued from this version. Please keep your suggestions coming; we will do our best to respond.

I-P Edition

For this first release of ZipTest Pro^{3™} it is only available in I-P (Inch-Pound) units, not in S-I (International System of Units), often referred to as the metric system. If there are requests for an S-I version of ZipTest Pro^{3™}, we will consider releasing an S-I version in the future.

For those of you who would prefer S-I units, it might help to familiarize yourself with the units conversion features of the TI-89 Titanium. Please see “Converting from One Unit to Another” on page 117 for more information about this topic.

Table of Contents



ZipTest Pro³ home screen

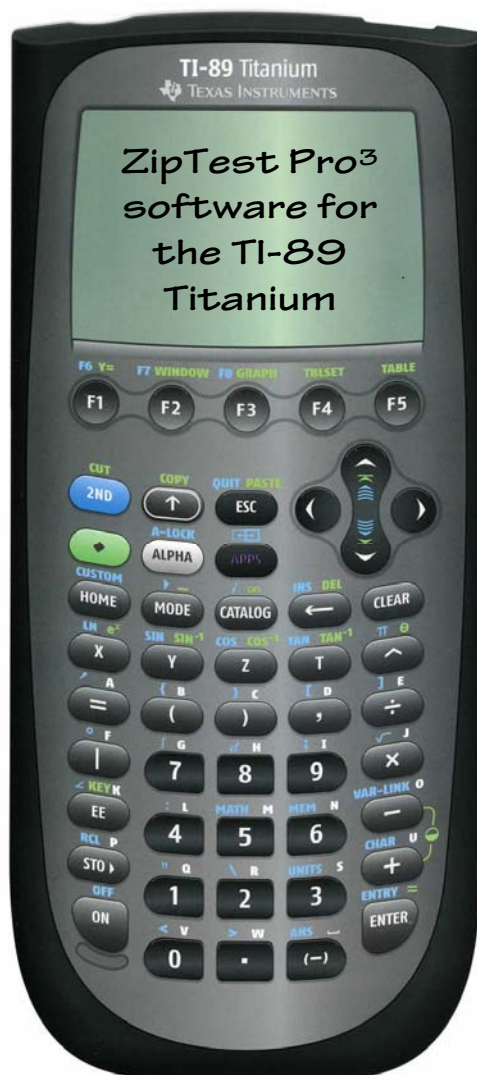
Software License Agreement and Limited Warranty.....	i
Acknowledgements.....	ii
I-P Edition.....	iii
Table of Contents	v
<i>Introduction.....</i>	<i>1</i>
What's New?	3
Logical organization of features.....	4
Dropdown menus	4
Dialogue boxes	4
Session choice: "NEW SESSION" or "CONTINUE SESSION"	5
Math calculations on-the-fly	6
Automatic call-up feature.....	6
Reports	7
Easy-to-set default values	7
Printing a Screen Image or Adding an Image to a Report.....	7
ASHRAE 62.2-2007 Alternative Compliance for Existing Houses.....	8
Before Loading the Software into the TI-89 Titanium	8
Texas Instruments Memory, Applications, and Loading ZipTest Pro ³	8
<i>Loading the Software</i>	<i>11</i>
Finding Your Calculator ID number	11
Receiving the Software by E-mail.....	13
Using TI Connect to Load ZipTest Pro³ into Your TI-89	13
<i>F1-Programs.....</i>	<i>19</i>
1:Energy Index	21
2:Ventilation	27
1:ASHRAE 62.2	28
2:BTLA (Building Tightness Limit advanced)	34

3:BTL (Building Tightness Limit)	38
3:WCEG (Weatherization Cost-Effective Guidelines)	42
4:ZPD (Zone Pressure Diagnostics).....	47
1:Hole Method	48
2:Door Method.....	49
<i>Tools – F2</i>.....	51
1:Blower Door	52
1:Minn BD3 (Minneapolis Blower Door™, Model 3).....	52
2:Adj CFM50 (Temperature adjusted CFM ₅₀)	53
2:Fuel.....	54
1:\$/Therm (Cost per therm of fuel).....	54
2:Cost to Units (Fuel units from fuel cost).....	56
3:DHW Fuel (Domestic hot water fuel units)	57
3:Duct Blaster	59
4:New Const 62.2 (New construction ASHRAE 62.2).....	60
5:Heat Index	62
6:Refrig SIR (Refrigerator Savings-to-Investment Ratio)	63
7:62.2 Alt Comp (ASHRAE 62.2 alternate compliance method).....	64
8:LBL# (Lawrence Berkeley Laboratory number).....	68
9:ZTP# (ZipTest Pro number).....	69
<i>Nuggets – F3</i>	71
Introduction.....	71
1:Air press/leak	72
1:Depress Tight Lim (Depressurization Tightness Limit or DTL)	72
2:ACH natural (Air Change per Hour at natural conditions)	75
3:ACH at 50 Pascals (Air Change per Hour at 50 Pascals).....	76
4:Air equation (Building leakage air flow rate)	76
5:Spec leak ratio (Specific leakage ratio).....	77
6:Stack pressure	77

7:Heating \$ air leak (Annual heating cost of air leakage).....	78
8:Heating CEG (Heating Cost Effective Guideline for air sealing)	79
9:Air leak heat loss.....	80
A:Cooling \$ air leak (Annual cooling cost of air leakage).....	80
B:Cooling CEG (Cooling Cost Effective Guideline for air sealing).....	81
C:Effective leakage.....	81
D:Equivalent leakage	82
2:Heating/Cooling	82
1:\$/therm of fuel	82
2:Annual heating	83
3:Eff improve saving (Savings from heating system efficiency improvements)	84
4:SIR system replace (Savings-to-Investment Ratio for replacing a heating system).....	84
5:Sensible/total (Cooling sensible-to-total load ratio).....	85
6:Total capacity (Cooling total capacity).....	85
3:Heat transfer	86
1:Surface transfer (Surface heat transfer).....	86
2:R-value infrared (Calculated R-value from infrared camera)	86
4:Geometry	87
1:Area of triangle	87
2:Area of circle	87
3:Circum of circle (Circumference of circle).....	87
4:Duct round to rect (Round duct to rectangular)	87
5:Pythagorean	88
5:Carbon monoxide.....	88
1:CO air-free (Carbon Monoxide air-free from CO as-measured).....	88
6:Ventilation	89
1:Fan run-time.....	89
2:Vent heat energy (Annual cost of space heating for ventilation)	90
3:Vent elec energy (Annual cost of electricity for ventilation)	90
7:Psychrometrics.....	91
1:Dew point.....	91
8:Thermal comfort.....	92
1:Wind chill v2001	92
9:Finance.....	92

1:Loan payments	92
2:SIR (Savings-to-Investment Ratio)	93
A:Air speed	93
1:Air speed, fpm.....	93
2:Air speed, mph	94
B:Miscellaneous.....	94
1:Body Mass Index	94
Reports.....	95
Reports-F4	95
1:View.....	95
2:Save	95
3:Load	97
Defaults and Quitting.....	99
F5-Defaults.....	99
1:Edit.....	99
2:View.....	100
3:Reset	101
4:Software Key	101
Quit – F7	101
Appendices.....	103
ZipTest Pro² compared to ZipTest Pro³.....	103
Weather Factors for North America (W in units of ACH)	108
LBL Climate Zone Map	111
Heating Degree Day Correction Factors.....	111
Air Density Correction Factors.....	113
TI-89 Cable Functionality and Support.....	113
Ordering Information.....	114
Support and Updates	115

Software Training	115
Some Important Details.....	115
Deleting Files from the ZipTest Pro ³ software package	115
Battery Management	115
Automatic Power Down (APD)	116
Contrast Adjustment	116
Adding Programs to Your TI-89 Titanium	117
Converting from One Unit to Another	117
<i>Glossary</i>	<i>119</i>
<i>Index</i>	<i>123</i>



Chapter

Intro

Introduction

First, a little history. Back in late 1994 Neil Moyer had the idea of writing building diagnostics software for a programmable calculator. Neil wrote zone pressure diagnostics programs and a few blower door routines for the TI-85 calculator. After Neil introduced me to his easy-to-carry-around software at a training session, he and I worked together to launch the expanded software package, ZipTest, for the Texas Instruments TI-85 in 1995. ZipTest Pro was released in 1999 for the TI-86 when Texas Instruments withdrew the TI-85 from the market. ZipTest Pro², an expanded version of the 1999 release, was released for the TI-86 in 2004.

For almost fifteen years, ZipTest building diagnostics software and its improved descendants have been used by hundreds of energy auditors and analysts in the field for calculating values needed for building diagnostic work. A number of state weatherization programs have included the ZipTest Pro² software as a required tool for their energy auditors and analysts.

As a result of Texas Instruments withdrawing the TI-86 from the market, the ZipTest Pro³™ software package was written for the more powerful TI-89. The TI-89 graphics calculator is a powerful, durable and inexpensive calculator/computer. Again, we have improved on the software to make it easier to use, more powerful, and more useful.

Comment

The actual TI-89 Titanium screen is 25 percent larger than the screen capture diagrams in this instruction manual, making the real screen easier to read than these screen diagrams.



ZipTest Pro³ home screen



To insure the most effective and accurate use of the TI-89 and the ZipTest Pro^{3™} software, please read the TI-89 instruction book and this ZipTest Pro^{3™} software manual.

TI-89 Pre-Titanium Models

ZipTest Pro^{3™} will not run on TI-89 models that pre-date the Titanium.

Navigating the ZipTest Pro^{3™} Features

There is an interesting characteristic about new software, whether it is written for a powerful computer or a much simpler graphing calculator such as the TI-89 Titanium; it is fun to take the software for a “drive” right out of the box. We know this is what you are going to do even though you have this detailed instruction book in front of you. And why not; we would do the same thing. We hope you have as much fun playing with and using the ZipTest Pro^{3™} software package as we had putting it together. So go ahead and take it for a drive; this is actually a very good way to learn about the features. You will find it is simple yet powerful; detailed yet durable. Once you have the software loaded into your TI-89 Titanium and you notice the main menu tabs at the top of the ZipTest Pro^{3™} home screen, you are ready to go. Notice the copy of the home screen to the left.

The main menu tabs at the top of the ZipTest Pro^{3™} home screen make it easy to navigate the features of the software package. On the screen at the left, the dropdown menu shows after pressing [F1]. In order to move to a different main menu tab, use the cursor keys or press the appropriate function key ([F1] through [F7]). Note that to activate the “F7- Quit” tab with a function key, you must first press [2nd] (light blue) and then the [F2] key; [F7] is the second function of the [F2] key. The features of all the main menu tabs are explained in detail in this manual.

There are a few things that you should NOT do when using ZipTest Pro^{3™}:

1. Do not reset the calculator, the “Flash ROM”, or “All Memory”. This will delete the software or part of it. However, if you do delete the ZipTest Pro^{3™} package

by mistake, you can always load it again.

2. Do not delete any of the programs that are part of the software package.

Some things you should know early on are:

1. Fill in all fill boxes with values for programs and tools. A sample of the ZPD (Zone Pressure Diagnostics) hole-method input dialogue box is shown at the left. The fill boxes are the long rectangles into which you type values.
2. **For Nuggets, leave the fill box blank for the variable for which you want a solution.**
3. When entering a value in a fill box, there are a number of things worth knowing:
 - a. You can determine which line or fill box the cursor is on in an input dialogue box by looking for the blinking horizontal cursor line.
 - b. You can move up and down in an input dialogue box by using the up and down cursor keys. Do not use the [ENTER] key to move down.
 - c. If you enter an erroneous number in a fill box, you can press [CLEAR] to delete all characters in the fill box, you can backspace and delete one character at a time by pressing [←], or you can simply type over the erroneous entry if it is highlighted.
 - d. If you want to enter a negative number, use the [(-)] key before the negative number, not the [-] key. Notice the subtle difference between these two keys. The [-] key is intended for the operation of subtraction; the [(-)] key denotes a negative number.

The image shows a software input dialog box titled "ZPD - HOLE METHOD 1/1". It contains six input fields, each with a label and a value: "Build/Zone ΔP1: 35.0", "Zone/Out ΔP1: 15.0", "Hole Location: Build/Zone", "Hole Size: 130", "Build/Zone ΔP2: 28.0", and "Zone/Out ΔP2: 22.0". Below the fields are two buttons: "Enter=OK" and "ESC=CANCEL". At the very bottom, a line of text reads "TYPE + [ENTER]=OK AND [ESC]=CANCEL".

What's New?

For those of you who were familiar with the previous versions of the ZipTest Pro software, you will find some major improvements to this version. There are two basic reasons for this. First, we have learned over the last fifteen years what works and what doesn't work for you. We have done our best to improve the features that work and eliminate features that were not used. Second, the TI-89 Titanium is a much more powerful device than the TI-86 was, allowing us to use dialogue boxes, dropdown menus, index tabs, and more. The most significant new features are explained below.

Logical organization of features

All the ZipTest Pro³™ features – programs, tools, nuggets, reports, and defaults – are organized in a logical manner so that you can get to each of them easily. The main menu tabs, dropdown menus, and dialogue boxes with sequence numbers will help you get where you want to go.



Dropdown menus

Dropdown menus are familiar to all of us using computers. The TI-89 has dropdown menu capabilities that were used for the ZipTest Pro³™ software package whenever it made sense to do so. Notice the dropdown menu to the left. The “F3 – Nuggets” main menu tab is highlighted and the first Nugget dropdown menu item “1:Air press/leak” (this is an abbreviation for air pressure and leakage) is highlighted. The “→” indicates there is a subordinate menu you can view by pressing [ENTER] (if you press the right cursor key, you are taken to the “F4 – Reports” dropdown menu).

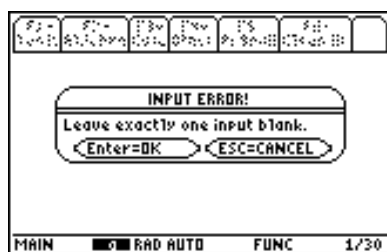
Also notice the “↓” just to the right of the item number “8”. This indicates there are more dropdown menu items after “8↓Thermal comfort”. Scroll downward to these additional items by pressing the down cursor key. You can also press the [♦] key (lime green) and the down cursor key to scroll larger segments of the defaults list, or the [2nd] (light blue) and then the down cursor key to scroll to the end of the list. These key actions also allow you to scroll up.

Dialogue boxes

Within the ZipTest Pro³™ software package, dialogue boxes come in different sizes, depending on the amount of information you need to enter in the particular box. The input dialogue box at the left is the first of two for the ENERGY INDEX program. With programs and tools the numbers to the right of the input dialogue box title indicate which of the dialogue boxes you are viewing and the number of input dialogue boxes in the sequence. Using the screen to the left as our example, there we are viewing the second of two dialogue boxes, that is “2/2”. This code is used throughout the ZipTest Pro³™ software package.



Sample Input Dialogue Box



Sample Message Dialogue Box



Additionally, there are message dialogue boxes which usually only allow two options. A sample is at the left.

Session choice: “NEW SESSION” or “CONTINUE SESSION”

When you exit the ZipTest Pro³™ software by pressing [F7], you are taken to the TI-89 “HOME” screen. To return to the ZipTest Pro³™ software, you must press the [♦] key (lime green) and then the [3] key. **This combination of key presses always loads the software package into the TI-89 working memory.** Unless it is the first time you have loaded the software in the working memory after loading the software into the calculator, you will be given the choice of “1:NEW SESSION” and “2:CONTINUE SESSION” (see screen at left).

If you select 2:CONTINUE SESSION:

1. The values of variables you entered during your previous session are saved. A few examples include gallons of oil, square feet of living space, and volume of living space. If you entered 2000 square feet of living space in your previous work session and you select “2:CONTINUE SESSION”, 2000 square feet will automatically appear in any fill box asking for living space square feet.
2. All “factory” default values that you over-wrote in any fill box will be remain rather than reverting back to the default value shown in “F5-Defaults”.
3. Any reports you have saved will remain accessible from the “F4-Reports, 3:Load” menu.

On the other hand, if you select 1:NEW SESSION:

1. The values of variables you entered during your previous session will be deleted.

2. All “factory” default values that you over-wrote in any fill box will be revert back to the default value shown in “F5-Defaults”.
3. All reports you have saved for later viewing will be deleted and will no longer be accessible from the “F4-Reports, 3:Load” menu.

Regardless of whether you select “1:NEW SESSION” or “2:CONTINUE SESSION:

1. “Factory” default values are not altered.

TIP

There is no need to exit the Program, Tool, or Nugget to perform math calculations.

Math calculations on-the-fly

If you want to perform a math calculation on-the-fly, merely include the calculation in a fill box of the dialogue. For example, in the screen to the left the “Flr Space Sq Ft:” is calculated by typing in “1000*2” (1000 square feet times two floors). There is no need to type anything else; when the answers are calculated this mathematical operation will be carried out. For on-the-fly calculations the following mathematical operators can be used: [+] (addition); [-] (subtraction); [÷] (division); [x] (multiplication); [^] (exponential); and [√] (square root). You can also use more than one type of operator in a fill box at the same time.

Automatic call-up feature

In some cases, if you intentionally leave a fill box blank, you will get a helpful message reminding you that a related ZipTest Pro³™ routine can assist you. For example, with the Energy Index program, if you don’t enter a value for “Therms per year +:” and press [ENTER] (see the sample screen to the left), you will see the lower sample screen to the left. This is a reminder of the “\$ to Units Tool” that can help you calculate the annual number of fuel units from the annual fuel dollars. The “+” mark at the end of the line “Therms per year +:” in the input dialogue box indicates there is a helpful feature in the ZipTest Pro³™ software package, in this case the “\$ to Units Tool”. If you select the tool, you will automatically be taken to it for the calculation. When the calculation is finished, you will be returned to the program, the fill box automatically filled in with the calculated value.

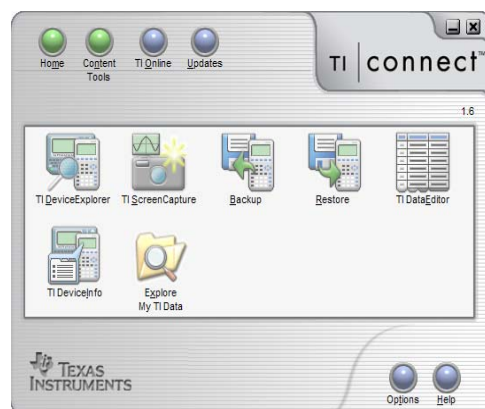
Reports

You can save the results – input values and answers – for up to eight program or tool calculations. Saving reports allows you to view reports back at your office or share them with your crew, subcontractors, colleagues, or supervisor. See Chapter 5 for more information.

Easy-to-set default values

ZipTest Pro³™ allows you to easily set, save, view, and reset many default values needed to operate this building & energy diagnostics software package effectively. The default value categories include:

1. Fuel prices (seven fuels).
2. Seasonal efficiencies (seven fuels).
3. Weather data, including heating degree days, climate zone, and weather factor.
4. Other data includes stories above grade, payback term, fuel type, LBL exposure, labor cost per hour, and material cost per hour for air sealing.

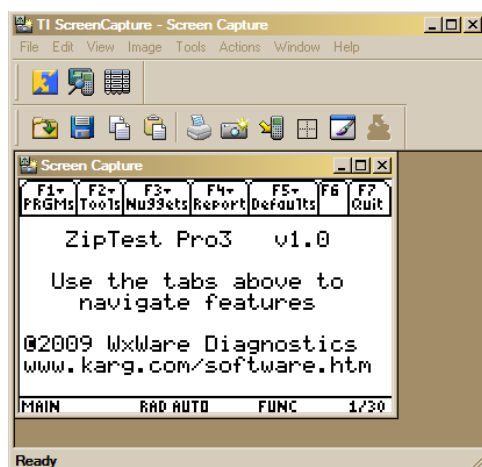


TI Connect main screen

Printing a Screen Image or Adding an Image to a Report

Printing is easier than ever with the TI-89 Titanium and the TI Connect software that was included in your TI-89 calculator package. A copy of the TI Connect main screen is shown at the left.

Select the “TI ScreenCapture” feature. In the “TI ScreenCapture – Screen Capture” example at the top of the next page, you can see an example of the ZipTest Pro³ home screen. For the screen capture feature, under the “View” dropdown menu, set the “Default Screen Size” to 200% or 300%; the printed screen image is larger as you increase this default screen size.



When you have the screen on your TI-89 that you want to print or add to a report, press the camera icon on the screen capture feature. The screen capture at the left of the ZipTest Pro³ home screen has the default screen size set at 200%.

To print this screen, merely press the printer icon on the screen capture feature.

To copy the captured screen image to a report, press control + C on your computer, or press “Copy” in the dropdown “Edit” menu, or press the copy icon in the screen capture feature tool bar (two icons to the left of the printer icon). Now paste the image of the captured screen into your report.

ASHRAE 62.2-2007 Alternative Compliance for Existing Houses

In 2009 ASHRAE added a significant alternative compliance path for existing dwellings. This alternative path is grounded in the understanding that it is often difficult and expensive in existing homes to meet the ventilation requirements of 62.2-2007 for a 50 CFM exhaust fan in each bathroom and a 100 CFM exhaust fan in a kitchen. We added a tool to make this alternative path calculation easy for you; this tool is integrated into the “F1-PRGMs, 2:Ventilation, 1:ASHRAE 62.2” program and you can also use it as a stand-alone tool, “F2-Tools, 7:62.2 Alt Comp”. Please refer to page 64 for more information.

Before Loading the Software into the TI-89 Titanium

Texas Instruments Memory, Applications, and Loading ZipTest Pro³

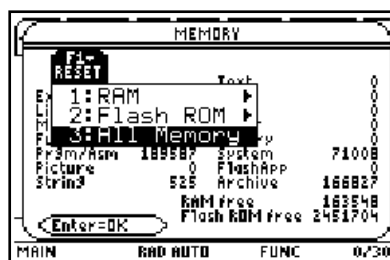
Before loading the software into your TI-89 Titanium, it is important to think about the available calculator memory. As of July 2009, a new TI-89 Titanium calculator shipped with sixteen preloaded applications (APPS) from Texas Instruments. Many other applications are available at the TI website. Of course, the TI-89 Titanium has a limited amount of memory.



TI-89 Titanium HOME screen



MEMORY screen of new TI-89
(June 2009), ZipTest Pro³
software not loaded



MEMORY screen of new TI-89
(June 2009), ZipTest Pro³
software not loaded

We recommend you delete these applications before you load the ZipTest Pro³ package to ensure you have enough memory to properly run the building & energy diagnostics software package. This can easily be done by resetting your TI-89 before you load ZipTest Pro³. To perform a reset, first go to the TI-89 home screen by pressing [HOME] (perhaps you are already there). From the home screen, press [2nd] and then [MEM] (this is the second function of the [6] key); you will then see the “MEMORY” screen, similar to the one at the left.

While viewing the MEMORY screen, press [F1] and then select “3:All Memory” to reset the memory of your calculator.

If you are interested in any of the applications that were loaded in your TI-89 Titanium when you purchased it or you want to use any other applications or software for the calculator, we recommend you purchase a second TI-89 for running these applications or software. It is best if you dedicate a TI-89 calculator to the ZipTest Pro³ software package.

In the screenshot of the memory screen at the left, the items are defined as follows:

“Expr” = an abbreviation for expression. An expression consists of numbers, variables, operators, functions, and their arguments that evaluate to a single answer.

“List” = a set of real or complex elements.

“Matrix” = a two-dimensional array arranged in rows and columns.

“Function” = a function returns a value, examples are +, -, x, and log.

“Prgm/Asm” = includes programs written for the TI-89 Titanium as well as any assembly-language programs you have loaded.

“Picture” = a graph or picture display.

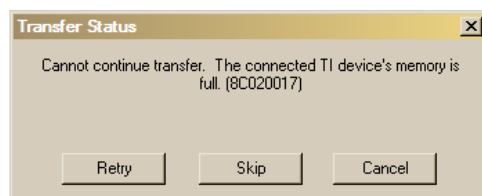
“String” = a sequence of characters enclosed in “quotes”.

“Text” = text strings set off in “quotes”.

“GDB” = graph databases



MEMORY screen after reset of all TI-89 Titanium memory



TI Connect software indicating TI-89 memory is full when loading ZipTest Pro³ software

“Other” = [at the time of this writing (July 2009) we cannot find an explanation for “other”].

“History” = size of history pairs saved in the Home screen’s history area.

“System” = operating system

“FlashApp” = size of Flash applications.

“Archive” = a protected place in the memory of the TI-89 Titanium where data, programs or other variables can be stored. Archiving data frees up RAM.

“RAM free” = free space in RAM.

“Flash ROM free” = free space in Flash ROM.

When you load the ZipTest Pro³ software with TI Connect, if there is not enough memory, a transfer status dialogue box like the one at the left will pop up.

If by mistake you delete any of the programs that are part of the ZipTest Pro³ software package, merely reload the entire software package from your computer with the use of the TI Connect software. See “Using TI Connect to Load ZipTest Pro³ into Your TI-89” on page 13.

Before you start loading your new software into your calculator, it will be helpful to become familiar with the keyboard. We suggest this because you must enter the software key you received when you purchased the ZipTest Pro³ software package into the calculator when you load the software. This software key will include numbers and letters. The numbers are easy to enter, but entering letters can be frustrating. A few of the letters (alpha characters) have their own primary keys. These include [X], [Y], [Z], and [T]. All the other letters require that you press the white colored [ALPHA] key first. Practice this a bit before trying to enter the software key. By the way, the software key letters that you will have to enter may be either upper or lower case; it makes no difference. Just make sure you enter the right letter.

Chapter

1

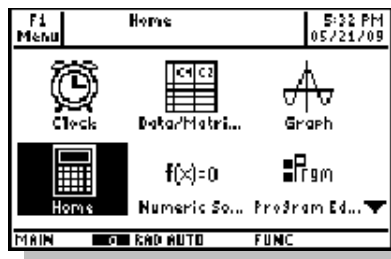
Loading the Software

The ZipTest Pro³ software package must first be downloaded from the website or received by e-mail and then, with the help of TI Connect software that is shipped with the TI-89 Titanium calculator package, must be loaded into your TI-89 Titanium calculator. Instructions for these procedures follow.

Finding Your Calculator ID number

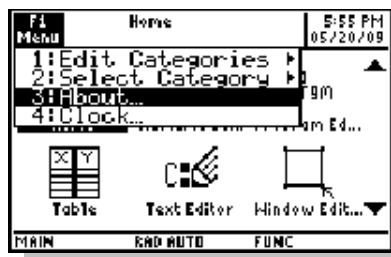
Before you download the ZipTest Pro³ software package from the website or order it from us by e-mail, you must have your TI-89 Titanium calculator ID# at hand for the purchase process. Of course, this means you must have your TI-89 Titanium before you purchase the software package; **you cannot order the software without a TI-89 calculator and its unique ID#**. The calculator ID# is put on your calculator's digital chip at the time of manufacture by Texas Instruments.

We use your TI-89 calculator ID# and the serial number embossed on the back of your calculator to generate your unique software key. This is generated at the website where you purchased the software package or we generate it for you if you order the ZipTest Pro³ software by e-mail. When loading the ZipTest Pro³ software, you will be asked to enter this 11-character software key.



There are a number of ways you can find your calculator's device ID number, either with the use of the TI Connect utility software shipped with your calculator or without this PC- or Mac-based software by merely navigating to the proper place in the TI-89 Titanium's operating system.

First, the easiest way to find your calculator device ID number: Start by turning on your calculator. If your calculator is not showing the APPS screen already, push the [APPS] key. The APPS screen is shown at the left. Notice "F1 Menu" in the top left hand corner of the screen.

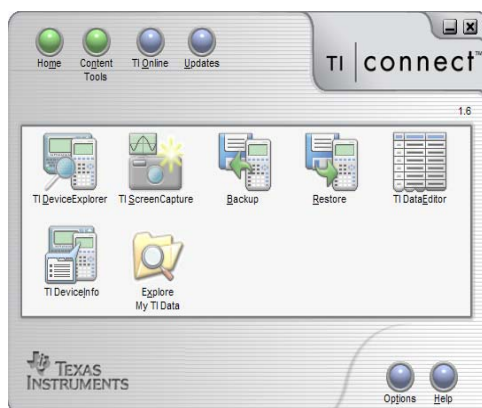


Press the [F1] key. The menu that is on the left will appear. Either scroll down to "3:About" with the scroll keys and then press [ENTER] or press [3].

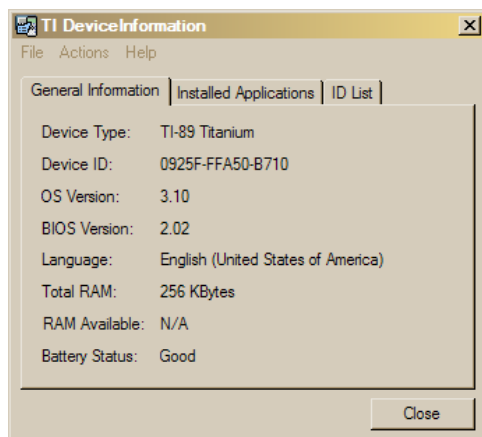


An informational screen similar to the one at the left will then appear. Notice the ID# is the largest item on the screen. For this sample calculator, the device ID number is 0925F FFA50 B710. Please note that the "0" characters in this ID are the number zero, not the letter "O". The small dot in the center of the circle that forms the "0" indicates it is the number zero. If it were the letter "O" there would be no dot inside the circle.

It is also possible to obtain the device ID number from the TI Connect software that you must install on your computer to load the ZipTest Pro³ software into your TI-89. With TI Connect loaded on your computer, connect the TI-89 with the proper cable and ensure that it is communicating properly with the computer. **(Please see the comments regarding cable functionality and support on page 113.)**



TI Connect main screen



TIP

If you need to update your TI-89 OS Version, use the TI Connect software - "Updates" - to get the latest operating system version from Texas Instruments online.

From the main screen of the TI Connect software, find and click on the "TI DeviceInfo" icon.

TI Connect will begin communication with your connected TI-89. Once the cable and port have been selected, the informational screen at the left will appear with the device ID number of your connected calculator clearly displayed. For this sample calculator the device ID number is 0925F FFA50 B710. This is an example of the device ID you need when you purchase the ZipTest Pro³ software package at the website or by e-mail. **(Please do not use the device ID in this paragraph; it will not work for you.)**

Please note: The "OS Version" and the "BIOS Version" must match or be greater than those listed on the screen at the left; that is 3.10 and 2.02 respectively. Otherwise the ZipTest Pro³ software will not load properly. Use the TI Connect software for updates.

Receiving the Software by E-mail

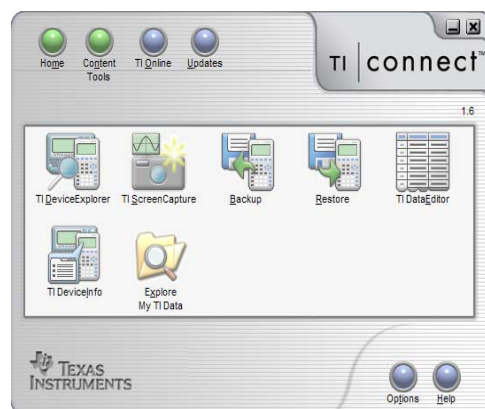
If you received the ZipTest Pro³ software package by e-mail, the instructions for loading will be provided in the e-mail message. These instructions are very similar to those in the next section, so if you lose your e-mail instructions, you can follow the instructions below.

Using TI Connect to Load ZipTest Pro³ into Your TI-89

Once you have downloaded the ZipTest Pro³ software package from the website or received it by e-mail, you must load the software into your TI-89 Titanium calculator. In

order to load your new ZipTest Pro³ software package into your TI-89 Titanium, follow the steps below. **Please make sure you have read “Before loading the software into the TI-89 Titanium” on page 8 before proceeding with the loading process.**

1. First load TI Connect, a Texas Instruments utility program for transferring files to the TI-89 Titanium, screen capturing, organizing files, updating the calculator operating system from the TI website, and other tasks.

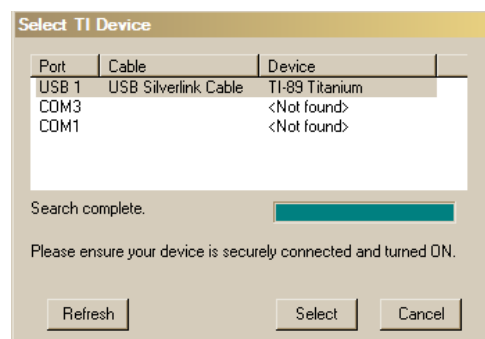


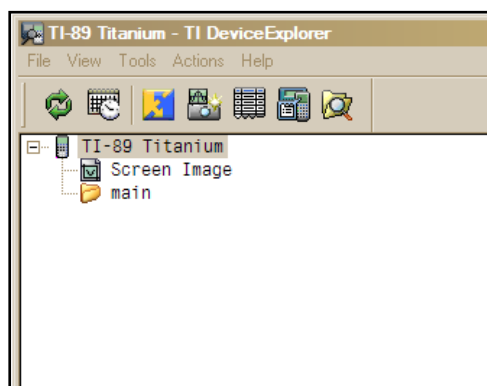
TI Connect main screen

After the TI Connect software is loaded on your computer and running properly, follow the steps below to load the ZipTest Pro³ file into your TI-89 Titanium.

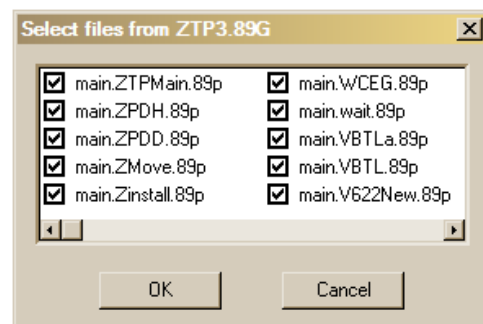
As a step of loading, **you must have available your unique software key** you received when you purchased your ZipTest Pro³ software package from a website or by e-mail.

2. Open TI Connect to the main screen that appears at the left.
3. Make sure a working cable is connected from a USB port on your computer to the TI-89 Titanium. **Please see the comments regarding cable functionality and support on page 113.** Make sure the calculator is turned on.
4. Click on “TI DeviceExplorer”. The screen at the left will automatically appear, “Select TI Device”. TI Connect is attempting to identify the cable and port being used. After the search is complete, select the proper choice. The sample screen at the left shows the use of the Silverlink USB Cable. Now the TI DeviceExplorer screen will appear on your computer monitor.

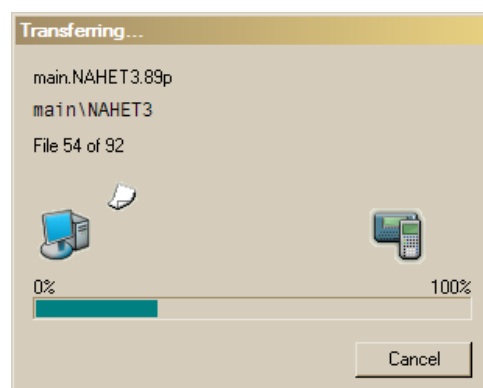




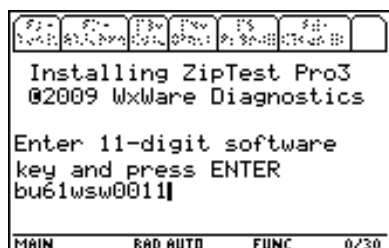
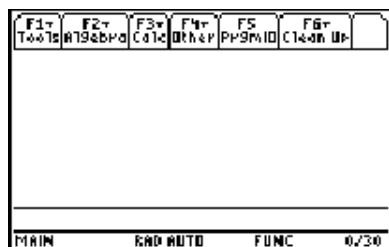
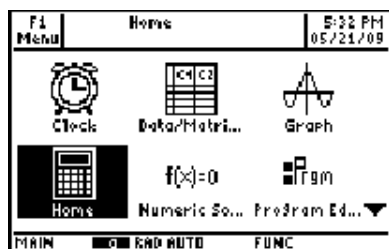
5. Either drag or copy the ZipTest Pro³ group file you downloaded from the website or received by e-mail to your computer to either the “TI-89 Titanium” or the “Main” folder on TI DeviceExplorer.



6. After the files are read by TI Connect, the screen at the left will appear giving you the choice of which files to load into your TI-89 Titanium. Since all the files are already selected, just press “OK” on the TI Connect dialogue box. **It is very important that all these files be selected and loaded into your TI-89.**



7. When you click on “OK”, the dialogue box at the left will appear indicating that the ZipTest Pro³ files are being transferred to your TI-89, one at a time. **Please make sure you have read “Before Loading the Software into the TI-89 Titanium” on page 8 before proceeding with the loading process.** After this process is complete, you will notice that there is a “+” sign to the left of “main” in the “TI DeviceExplorer” file structure. If you click on this “+” the files just loaded into your calculator will appear.



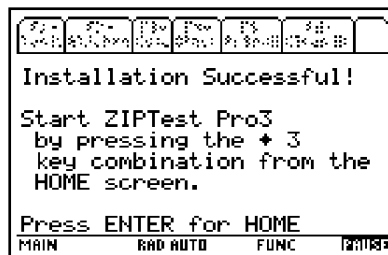
8. Now that the ZipTest Pro³ files are loaded, you must go to the "HOME" screen of the calculator. The screen shot to the left shows the APPS screen, which is probably showing on your calculator now. Notice that the "HOME" icon is highlighted and "Home" appears at the top of the display, indicating that "Home" is selected. Pressing [ENTER] will take you to the "HOME" screen. Another way of getting to the "HOME" screen is by pressing [HOME].
9. At the left is a screen shot of the TI-89 "HOME" screen. From this screen press the [♦] (lime green color) key and then [1]. This key sequence is only used for the initial loading of the ZipTest Pro³ software.
10. Next you will see the screen at the left instructing you to enter your unique software key.
11. Carefully enter your eleven (11) character software key and check it for accuracy before you press [ENTER]. **Your new software will not operate unless you enter the software key correctly.** This software key will include numbers and letters. The numbers are easy to enter, but letter entry can be frustrating. A few of the letters (alpha characters) have their own primary keys. These include [X], [Y], [Z], and [T]. All the other letters require that you press the white colored [ALPHA] key first. By the way, **the software key letters that you enter may be either upper or lower case, it makes no difference.** We recommend entering letters as lower case because it is easier, just make sure you enter the right letter. Be careful with the slight differences between the upper case letter "I", the number "1" (one), and the lower case "l" (the letter L).
12. The screen shot at the left shows a sample software key. Do not enter this sample software key; it will cause your software to malfunction.



If you enter the wrong software key, you will receive an error message (see screen at left) instructing you try again by pressing [ENTER] or aborting the installation by pressing [ESC].



13. After entering the software key the software will be configured, compiled, and archived. The screen will indicate the progression of this process (it will take four to five minutes to complete). The screen shot to the left shows the screen during this process. Notice the highlighted **"BUSY"** in the lower right of the screen. This means the calculator is working and cannot be disturbed.

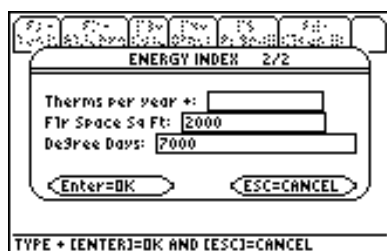


14. After the configuring, compiling, and archiving process is complete, your new building diagnostics software can be used. Notice the instructions on the calculator screen. Press [ENTER] to go to the TI-89 HOME screen. After moving to the HOME screen, press [♦] (lime green color) and then the [3] key. **You will use this key combination often to load the ZipTest Pro³ software package into the working area of the calculator memory.**



15. You are now ready to start using your new software. Congratulations! Notice the tabs at the top of the screen to help you navigate to F1 - PRGMS, F2 - Tools, F3 - Nuggets, F4 - Report, F5 - Defaults, and F7 - Quit.

Chapter 2



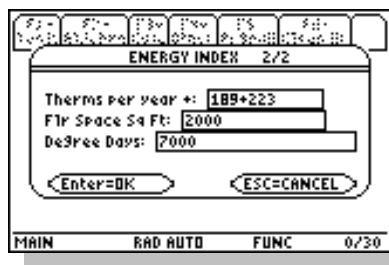
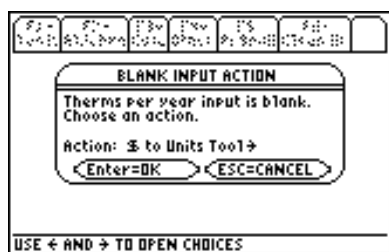
F1-Programs

All the programs in this chapter can be found in the “F1-Programs” menu tab. Please see the screen at the left. The chapter subheadings in this manual appear exactly as they do in the ZipTest Pro³ software, for example “1:Energy Index”.

Each program is described in this manual starting with an explanation of the Program Input Variables followed by an explanation of the Program Outputs (answers). Sample screens with values in the input variable fill boxes are included for each of the programs in the left margin.

To properly work with each program, include values in all fill boxes of the input dialogue boxes. When all the inputs are filled in as you wish, press [ENTER] once or twice for the calculation and answers (program outputs). If you forget to put a value in a fill box, you will get an error message when you press [ENTER], such as the one to the left.

In some cases, if you intentionally leave a fill box blank, you will get a helpful message reminding you that a related ZipTest Pro³ routine can assist you. This **automatic call up feature** can save you a lot of time. For example, with the Energy Index program, if you don't enter a value for “Therms per year +:” and press [ENTER] (see the sample screen to the left).



This is a reminder that the “\$ to Units Tool” can help you calculate the annual number of fuel units from the annual fuel dollars. The “+” mark at the end of the line “Therms per year +:” in the input dialogue box indicates there is a helpful feature in the ZipTest Pro³ software package, in this case the “\$ to Units Tool”.

Notice on the line “Action: \$ to Units Tool →”. If you press the [▶] (right cursor) key, you are given a choice of “1:\$ to Units Tool” or “2:Back”. If you select the tool, you are taken to the tool. When you use this tool to calculate the units of fuel from dollars of fuel, the answer is automatically inserted in the “ENERGY INDEX 2/2” dialogue in the “Therms per year+:” fill box. If you select “2:Back”, you are taken back to the input dialogue box “ENERGY INDEX 2/2” where the fill box “Therms per year+:” remains blank.

Another very helpful feature of the ZipTest Pro³ software package is **math calculations on-the-fly**. This unique feature works with any input dialogue box within the package; programs, tools, and Nuggets. Assume you want to use the Energy Index program for a customer using #2 Oil. The customer has not totaled the amount of oil they have used for the year, but they have all the oil delivery coupons ready for you. You can just enter each coupon’s fuel amount in gallons in the “Gal per year +:” fill box, pressing the [+] key between each. The example screen to the left shows only two entries, but you can enter as many as you wish. Then when you press [ENTER] to calculate your answers, the sum of the gallons from the oil coupons will be totaled and used in the calculation of your Energy Index value. As a reminder, on-the-fly calculations work with any mathematical operators, including [+] (addition); [-] (subtraction); [÷] (division); [x] (multiplication); [^] (exponential); and [√] (square root). You can also use more than one type of operator in a fill box at the same time.

You can back up and/or exit a feature by pressing the [ESC] key.

1:Energy Index

Program Input Variables

1. Fuel Type = one of seven choices. From the “F5 – Defaults” menu you can select the default fuel type.
2. [Units] per year = the amount of space heating fuel used annually. The units that appear on this line depend on the fuel type selected. For natural gas it is “Therms”, for oil it is “Gals”, for wood it is “Cords”, etc.
3. Flr Space Sq Ft = the square feet of conditioned floor space.
4. Degree Days = degree days per year. This is usually Heating Degree Days (base 65 F°), but the program can be used for cooling degree days, also.

Program Outputs

1. Energy Index = the energy index for the dwelling based on the input value of the fuel used. The efficiency of the heating system is not an input in this program. Of course if the heating system efficiency were higher, the fuel used per year would be lower.

Introduction

The Energy Index program can be used to rate or compare the annual dwelling fuel use in units of Btu/ft², HDD (British thermal units/square foot of living area, heating degree day) in any heating-climate zone. The lower the Energy Index value, the more efficient the building. Other names for this value include Home Heating Index and Energy Intensity. Energy Index values from 10 to 15 Btu/ft², HDD might have average amounts of insulation, air leakage, and heating system efficiency. Homes with values higher than these can definitely use some weatherization. We have seen some older homes in the Northeast with values as high as 30! Big savings are possible in these homes. Very well insulated, well air sealed with high efficiency heating systems might have Energy Index values of 2 or lower. This is a reasonable and responsible target for new homes. Of course, existing homes are another issue. We think a good target is 4 to 6.

The fuels included in the program are:

1. Electricity at 3412 Btu input per kWh.
2. Natural gas at 100,000 Btu input per therm.
3. Propane (LPG) at 91,500 Btu input per gallon.
4. #2 oil at 138,690 Btu input per gallon.
5. #1 oil at 134,000 Btu input per gallon.
6. K-1 kerosene at 126,000 Btu input per gallon.
7. Wood at 21,000,000 Btu input per cord.

The Btu/ft², HDD values are intended for space heating fuel use only. If a space-heating system also produces domestic hot water, the hot water fuel usage must be subtracted from the total fuel use before Btu/ft², HDD is calculated. See the instructions below for a method for calculation of domestic hot water fuel usage.

With experience, you will develop an idea of Btu/ft², DD number ranges for efficient, average, and inefficient buildings. Use these numbers for the initial appraisal of the work the building will require. Keep a record of the Btu/ft², HDD values so that you can develop good, average and poor ranges for your area. The numbers generally will not be influenced by fuel type.

The Btu/ft², HDD values can also serve to find unusual problems. For example, if a building is heated with an oil-fired boiler, is tighter than average, and has better than average insulation levels, we would expect a low Btu/ft², HDD value. However, if the value is high, it could indicate a number of problems such as 1) a very inefficient oil-fired boiler, 2) a buried oil tank that is leaking into the ground, or 3) occupants keeping windows or doors open during the heating season, etc.

Note: If a building has more than one space heating fuel, calculate the Btu/ft², HDD for each fuel and add the values together to get the total Btu/Ft², DD for the building.

Domestic Hot Water Use Calculation

The calculated value for Btu/Ft², HDD should include only fuel used for space heating. Fuel used for domestic water heating, lights, cooking, air-conditioning, etc. must be subtracted from any fuel-use figures before the Btu/ft², HDD calculation is done with the Energy Index program.

If a building has a combination space heating/domestic water heating system (tankless coil, indirect-fired hot water with storage, etc.) the space heating usage is found by subtracting the domestic hot water usage from the annual fuel quantity. This baseload usage (household baseload is energy used for everything but space conditioning) can be estimated by examining non-heating season bills, calculating the monthly baseload usage, and then subtracting this twelve-month baseload usage from the total fuel consumption. The result is the fuel quantity for space heating.

If you don't have a complete history of fuel usage for the calculation of baseload usage, the following method can be used to estimate domestic hot water usage. This process is greatly simplified by using the appropriate Tool in the ZipTest Pro³ software package. Please refer to the instructions for the use of "F2 - Tools, 2:Fuel, 3:DHW Fuel" on page 57.

$$Q = \frac{\text{gal/yr} \times F^{\circ} \text{ Temp Rise} \times 8.34 \text{ lbs/gal} \times 1 \text{ Btu/lb, } F^{\circ}}{\text{Eff} \times C} \quad (2.1)$$

where:

- Q = energy per year for domestic hot water, in appropriate fuel units.
- gal/yr = estimated gallons of hot water used in one year.
- $F^{\circ} \text{ Temp Rise}$ = the entering water temperature subtracted from the output water temperature of the water heating appliance, F° .
- 8.34 lbs/gal = the weight of water per gallon.
- $1 \text{ Btu/lb, } F^{\circ}$ = the specific heat of water.
- Eff = seasonal efficiency of water heating appliance, as a decimal. This is usually referred to as the "energy factor".

- C = conversion factor for energy source of water heating appliance,
 - a. 3412 for electricity,
 - b. 100,000 for natural gas,
 - c. 91,500 for propane (LPG) gas,
 - d. 138,690 for #2 oil,
 - e. 134,000 for #1 oil,
 - f. 126,000 for K-1 kerosene, and
 - g. 21,000,000 for firewood, dry hardwood.

Hot water use per day in North America averages about 62 gallons per household; two adults in a household use from 30 to 60 gallons per day. A household with two adults and two children might have an average daily use as high as 90 gallons per day. Households with very young children often use more than average, elderly people often use less than average. To get the figure for gal/yr, estimate the gallons per day and multiply it by the number of days the family is at home during the year (usually 365).

For “F° Temp Rise” you must subtract the water heater output temperature from the input temperature. The output temperature of the water from the water heating appliance, you can take the time to measure this temperature with a thermometer, or you can estimate it. For residential buildings it is usually between 120 F° and 140 F°. For the input temperature of water to the water heating appliance, subtract the latitude from 90 for an estimate of this water temperature (usually 40 F° to 50 F°).

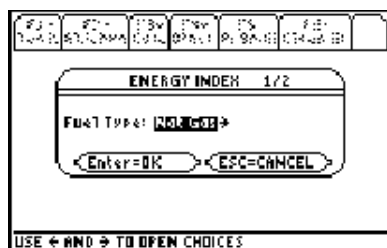
The efficiency of the water heating appliance is difficult to estimate for there are only a few field studies that have examined combination unit efficiencies. One study found that efficiencies of indirect-fired storage systems (boiler for space heating and domestic water heating with a separate storage tank for domestic hot water) were 51% to 79% during the heating season and 47% to 58% during the non-space heating months. The greater the use of domestic hot water, the higher the efficiency. The efficiencies for tankless coil systems (no storage) are usually lower than indirect-fired storage systems.

Using the Energy Index Program

To use the Energy Index program you need to know the therms per year of fuel used. A therm is merely 100,000 Btus of thermal energy. If you know the cost of the fuel use, but not the annual therms used, use “F2 – Tools, 2:Fuel, 2:Cost to Units” to determine the annual therms for the Energy Index program. See page 55 for an explanation.

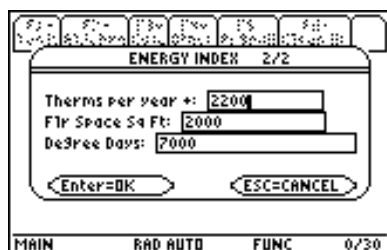


The Energy Index program, “F1 – PRGMs, 1:Energy Index”, is simple to use. The screen to the left shows the program selection from the dropdown “F1 – PRGMs” menu. Scroll to the program you want to use and then press [ENTER], or simply press the program number – 1 through 4 – to save keystrokes.



The first of two input dialogue boxes for the Energy Index program is to the left. With programs and tools the numbers to the right of the dialogue box title (in this case “ENERGY INDEX”) indicate which of the input dialogue boxes you are viewing and the number of dialogue boxes in the sequence. Using the screen to the left as our example, there we are viewing the first of two input dialogue boxes, that is “1/2”. This code is used throughout the ZipTest Pro³ software package.

For this first dialogue box you must select the fuel type used in the house. In the dialogue screen to the left natural gas is selected. If this is the fuel you want, simply press [ENTER]. For other fuel choices, simply push the right cursor key and then select the fuel. The default fuel for this dialogue box can be set from the “F5 – Defaults” menu (this is explained on page 99).



After you have selected the appropriate fuel and pressed [ENTER], the second input dialogue box will appear, similar to the one at the left. Notice the “2/2” to the right of the dialogue title, indicating this is the second of two dialogue boxes.

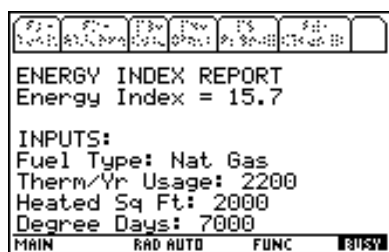
1. Fill in the “Therms per year +:” for space heating fuel. The “+” here is an indication there is another feature in the ZipTest Pro³ software package that

is helpful to your analysis. In this case “F2 – Tools, 2:Fuel, 2:Cost to Units” converts annual dollar cost of fuel to units of fuel. The value you enter here should not include fuel for heating hot water, operating a gas dryer, a gas range or any other baseload appliance.

2. Enter the “Flr Space Sq Ft:” (Floor Space in square feet) of the heated area. There is always a question about a basement that is not occupied but contains the heating system. Should this basement be included in the floor space value or not? In most cases, it would not be included. Use your best judgment here.

Note this convenient feature that we included in the ZipTest Pro³ software: If you want to perform a calculation on-the-fly, merely include the calculation in the fill box of the dialogue. For example, in the screen to the left the “Flr Space Sq Ft:” is calculated by typing in “1000[x]2” (1000 square feet times two floors). There is no need to type anything else; when the answers are calculated this mathematical operation will be carried out. For on-the-fly calculations the following mathematical operators can be used: [+] (addition); [-] (subtraction); [÷] (division); [x] (multiplication); [^] (exponential); and [√] (square route). You can also use more than one operator in a fill box.

3. Fill in the “Degree Day:” value. In most cases, this will be annual heating degree days, but this program can be used for calculating an energy index for space cooling. If this program is used for cooling, this Degree Day value should be annual cooling degree days. Annual heating and cooling degree days can be found at various places in the Internet.



4. After you have entered all the values in the “2/2” input dialogue box, press [ENTER] and wait for your answers to be calculated. Be patient, the TI-89 Titanium is not a high-powered PC; it takes a bit of time to think. The screen at the left shows the results.

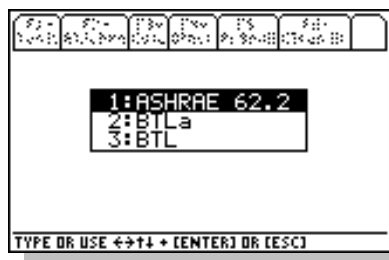
Notice that on the ENERGY INDEX REPORT the “Energy Index” is 15.7 Btu/ft², HDD.

For all reports generated by the ZipTest Pro³ software, the results of the calculations, the outputs or answers, appear at the top of the REPORT screen as on the screen to the left. The INPUTS are always below the results.

After viewing the report for the Energy Index program, press [ESC] to return to the ZipTest Pro³ home screen.

2: Ventilation

This section includes three programs; “ASHRAE 62.2”, “BTLa”, and “BTL”.



ASHRAE 62.2 is based on the current residential standard *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings* (Standard 62.2-2007). This most recent ASHRAE standard for residential ventilation — the first that is exclusively for residential buildings — renders the previous two methods (BTL and BTLa) obsolete. However, we decided to keep them as a part of the ZipTest Pro³ software package because some analysts and weatherization programs continue to use these older methods. **Analysts in the field should attempt to convert to the use of “ASHRAE 62.2”, based on the most recent ASHRAE Standard 62.2-2007.**

The BTLa (Building Tightness Limit advanced) method of calculation requires more input information than the BTL method and is considered more accurate because it is based on more reliable methods (ASHRAE 119 and 136). Because the BTLa and BTL methods are based on ASHRAE 62-1989, they have been obsolete since the release of

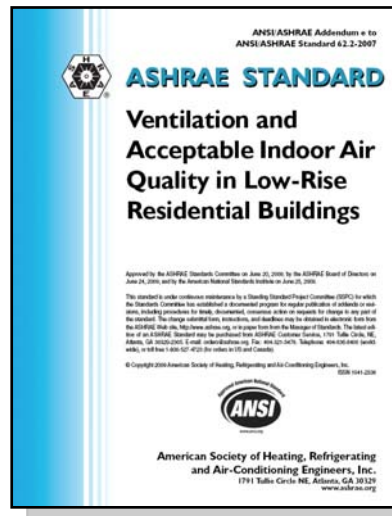
ASHRAE 62.2 in 2003.

Each of these methods calculates the required whole building ventilation rate for compliance with the ventilation standard on which the method is based; ASHRAE 62-1989 for “BTL” and “BTLa” and ASHRAE 62.2-2007 (with existing-house alternative compliance path) for “ASHRAE 62.2”.

1:ASHRAE 62.2

Program Input Variables

1. ZTP# = ZipTest Pro number. Please refer to “9:ZTP#” on page 69 for a detailed explanation. The program determines the ZTP# for you after you enter:
 - a. Building Ht = the height of the conditioned part of the building. This height should include the above-grade part of a basement if the basement is within the thermal envelope. Do not include an attic if it is not within the thermal envelope. This value is divided by an 8 foot ceiling height to find the number of stories.
 - b. Flow Exponent = the slope of the leakage curve of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the actual flow exponent for the building in question.
 - c. Living Sq Footage = the square feet of the occupied floor space. Basements that are not lived in but are considered to be within the thermal boundary of the house are usually not counted as occupied floor space.
 - d. Living Volume = this volume should correspond to the living area square footage.
2. Weather Factor = the weather factor for the local from the tables starting on page 108 that is closest to the actual house you are analyzing (from Table 1, ASHRAE 136-1993, *A Method of Determining Air Change Rates in Detached*



ZTP# TOOL 1/1	
Buildin3 Ht:	20.0
Flow Exponent:	.65
Living Sq Footage:	2000
Living Volume:	16000
Weather Factor:	.91
<input type="button" value="Enter=OK"/> <input type="button" value="ESC=CANCEL"/>	
TYPE + ENTER=OK AND [ESC]=CANCEL	

ZTP# = 16.42

Switching back to
ASHRAE 62.2 Program

MAIN RAD AUTO FUNC

ASHRAE 62.2 PROGRAM 1/1

CFM50: 1000

Occ: 4.0

Use Alt Comp Tool? 1:Yes 2:No

Enter=OK ESC=CANCEL

TYPE OR USE <+> + [ENTER] OR [ESC]

Dwellings, reproduced in these instructions).

3. Measured CFM50 = the measured leakage from a standard blower door test. This is usually the post-weatherization blower door value because this is the one that helps determine the final whole building ventilation rate.
4. # Occ = the number of occupants living in the house. If you are not sure, count the number of bedrooms and add 1 (this assumes two people for the master bedroom).
5. Use Alt Comp Tool? = the alternative compliance path tool for existing dwellings. You may select "Yes" or "No". If you select "Yes", the "Alt Comp Tool" is automatically called up, you must enter the following data, after which you are returned to the "ASHRAE 62.2 program report screen."
 - a. Bath(s) Affected? = your choice of "Yes" or "No". A bathroom (bath) is defined as a room that has a bathtub, shower, spa or similar source of moisture. According to ASHRAE 62.2-2007, each bathroom shall have an exhaust fan of 50 CFM. If you have measured the flow of a bathroom exhaust fan to be 50 CFM or greater, then it is not affected and should not be included as one of your bathrooms. If you are not sure whether a bathroom is affected or not, select "Yes" and the tool will decide for you. If you answer "Yes", then:
 - i. # Baths Affected = your choice of 1 through 5. A bathroom (bath) is defined as a room that has a bathtub, shower, spa or similar source of moisture. **If you are intending to install the whole building ventilation fan in a bathroom, do not count it.** For each bath that is affected, you are asked:
 - 1) Local CFM = the measured flow rate of an exhaust fan in this bathroom.
 - 2) Has Window = your choice of "Yes" or "No". Note that this question refers to openable windows only. If a bathroom has a window, but it does not open, answer this question "No".
 - b. Kitchen Affected? = your choice of Yes or No. A kitchen is defined as any room containing cooking appliances. **If you are intending to install the whole building ventilation fan in the kitchen, then answer "No".**
 - i. Local CFM = the measured flow rate of an exhaust fan in the kitchen.

- ii. Has Window = your choice of yes or no. Note that this question refers to openable windows only. If a kitchen has a window, but it does not open, answer this question “No”.

Program Outputs

1. EqLA = the equivalent leakage area of the thermal/pressure boundary of the house. This number generally is very close to 10 percent of the entered CFM₅₀ value.
2. Est Nat CFM = the average leakage over the heating season in Cubic Feet per Minute of outdoor air.
3. Est Nat CFM/Occ = the average leakage over the heating season in Cubic Feet per Minute of outdoor air per reported occupant.
4. Est Nat ACH = the average leakage over the heating season expressed as Air Changes per Hour.
5. CFM Min = the Cubic Feet per Minute *minimum* of outdoor air for compliance with ASHRAE 62.2-2007.
6. Alt Comp Supplement = the alternate compliance path supplement for existing dwellings. This amount is added to the whole building ventilation value, “Mech Vent CFM 100%”, to compensate for the lacking local exhaust ventilation in bathrooms and the kitchen. Note: This answer (output) only shows if you have chosen to use the “Alt Comp Tool”.
7. Inf Credit = the infiltration credit calculated according to ASHRAE 62.2-2007 using the guidelines of ASHRAE 119 and 136. This credit can be applied to existing homes; not new homes. The infiltration credit allowance for air leakage equals ½ of the excess air leakage above 2 CFM per 100 square feet of living area. This credit is subtracted from the whole building ventilation result determined by equation 2.2, shown below.
8. Mech Vent CFM 100% = the continuously operating mechanical ventilation required for compliance with ASHRAE 62.2-2007. This value assumes the fan runs 100 percent of the time when the windows of the house are closed. Notice there is a “★” just to the right of “Mech Vent CFM 100%”. This indicates that there is a tool or Nugget that might be helpful to you. In this case it is the “Fan run-time” Nugget (see page 89 for details). As mentioned above, **the “Mech**

Comment

The Alternative Compliance Path Supplement (No. 6) is added to the CFM Minimum (No. 5) before the Infiltration Credit (No. 7) is subtracted to get the final value for the Mechanical Ventilation CFM 100% (No. 8).

TIP

If you wish to operate the whole building ventilation less than 100 percent of the time, use the ventilation run-time calculator found in F3-Nuggets, 6:Ventilation, 1:Fan run-time (refer to page 89).

TIP

When sizing whole building ventilation for an existing dwelling, you must often install this ventilation **before** knowing the final tightness level of the building. We suggest you use the "1:ASHRAE 62.2" procedure, but add the infiltration credit back into the calculated whole building ventilation CFM, install the ventilation accordingly, and then adjust the CFM downward to suit the post-weatherization tightness level.

To explain, using the results for the example starting on the next page with an "Inf Credit" = 10 and "Mech Vent CFM 100%" = 57: 67 CFM is the total for the whole building ventilation (10 CFM + 57 CFM), no matter how tight it is. Install a fan during weatherization that will provide at least 67 CFM. After completing weatherization and the post-weatherization CFM₅₀, enter this value in the program again and adjust your whole building fan speed to the calculated/required rate.

Vent CFM 100%" includes the addition of the "Alt Comp Supplement" and the subtraction of the "Inf Credit".

This procedure is based on the ventilation standard for residential buildings published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, Standard 62.2-2007. The objective of this procedure is the determination of the mechanical or intermittent ventilation requirements for low-rise residential (three stories or less) buildings. Standard 62.2 is a "continuous maintenance" standard, meaning that changes are always being considered by the ASHRAE 62.2 committee. A new version is released every three years.

The basic requirement for this method is the whole building ventilation, expressed by this equation:

$$Q_{fan\ flow} = 0.01A_{floor} + 7.5(N_{bedrooms} + 1) \quad (2.2)$$

Where:

- $Q_{fan\ flow}$ = fan flow rate, CFM.
- A_{floor} = occupiable floor area in square feet.
- $N_{bedrooms}$ = number of bedrooms plus one or actual number of occupants, whichever is larger.

$Q_{fan\ flow}$ is the required whole building ventilation required by the ASHRAE 62.2 standard. This ventilation may operate continuously or intermittently. For example, if the whole building ventilation is calculated to be 40 CFM, it must operate at a measured and verified 40 CFM if it runs continuously. If it is operated for 20 minutes of each hour (20 minutes on; 40 minutes off), or 1/3 of the time, the flow rate must be tripled to 120 CFM. The fan run-time Nugget, "F3-Nuggets, 6:Ventilation, 1:Fan run-time", is helpful for calculating either run-time or what the CFM of the fan must be.

As part of the ASHRAE 62.2 standard, an infiltration (air leakage) credit is allowed for existing dwellings if the estimated natural infiltration is more than two times the floor

area/100, or:

$$\text{Infiltration Credit}_{\text{CFM}} = 0.5 \left(\text{Natural Air Leakage}_{\text{CFM}} - \frac{2A_{\text{floor}}}{100} \right) \quad (2.3)$$

This infiltration credit is subtracted from the $Q_{\text{fan flow}}$ value for the whole building ventilation, allowing for a lower whole building ventilation CFM. The infiltration credit CFM is included in the ASHRAE 62.2 program report.

Additionally, this procedure includes the alternative compliance path for existing dwellings, approved by the ASHRAE 62.2 committee in 2009. If you chose to use the “Alt Comp Tool”, this calculated CFM is added to and included in the reported “Mech Vent CFM 100%”. **We strongly recommend you carefully read the section on the alternative compliance tool on page 64 before using it as part of this ASHRAE 62.2 program.**

ASHRAE 62.2 example

When you start the ASHRAE 62.2 program, the ZPT# tool is quickly and automatically called up. Fill in the dialogue box for this tool (see the explanation on page 69) and then press [ENTER] to return to the ASHRAE 62.2 program. The sample screen at the left shows the “ZTP# TOOL” dialogue box with the example values in the fill boxes.

After you are switched back to the ASHRAE 62.2 program, you will see a dialogue box similar to the one at the left. Fill in the “CFM50” value. This is usually the post-weatherization test value because the whole building ventilation rate is partially based on the final leakage rate. Next, fill in the number of occupants next to “# Occ”. This is usually the number of bedrooms, plus one. If you are aware that there are more occupants than this, enter the known number.

Finally, this is where you decide whether you are going to use the alternative compliance path for existing homes or not. Chose “Yes” or “No” just after “Use Alt Comp Tool?” **Please see the detailed discussion of the “62.2 Alt Comp” tool on page 64.** This is an important detail, so please spend some time learning about this alternative

62.2 ALT COMP TOOL 1/1+

Bath(s) Affected? 1/33→
Kitchen Affected? Yes→

Enter=OK ESC=CANCEL

USE ← AND → TO OPEN CHOICES

62.2 ALT COMP TOOL 2/4+

Baths Affected 1→

Enter=OK ESC=CANCEL

USE ← AND → TO OPEN CHOICES

62.2 ALT COMP TOOL 3/4

Bathroom #1:

Local CFM: 0
Has Window? Yes→

Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

62.2 ALT COMP TOOL 4/4

Kitchen

Local CFM: 40
Has Window? Yes→

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

compliance path procedure so that you fully understand its use. Let's select "Yes" and move on with our example.

When you select this tool, you are switched to the "62.2 Alt Comp" tool. Here you select if bathroom and/or the kitchen is affected. See the example screen at the left. Let's assume that one bathroom is affected (you have a choice of from one to five bathrooms) and the kitchen is affected. By the way, a bath(room) only qualifies if it contains a tub, shower, spa, or similar moisture producing source. Press [ENTER] to move on.

Next you are asked how many baths are affected. Let's select one. You are not asked the number of kitchens because you are given the choice of only one kitchen. Please see the screen to the left for the example dialogue box.

We will assume this bath has no exhaust fan, so "Local CFM" is equal to zero. We will also assume that it has an openable window, so we answer "Has Window?" with a "Yes". By the way, a window only counts if it opens, so if there is a window, but it does not open, answer "No".

The next dialogue box of the "62.2 Alt Comp" tool is for entering the same data about the kitchen. Let's assume the kitchen has a 40 CFM range hood and an openable window. Enter this data and press [ENTER].



The whole building ventilation rate is now calculated along with many other useful pieces of information. The sample “ASHRAE 62.2 PROGRAM REPORT” screen is displayed to the left. Notice at the bottom of the visible data is the “Alt Comp Supplement = 18” and “Inf Credit = 10”. Also notice the “>” at the bottom left of the screen, indicating that there is more data to view if you scroll downward.

If you scroll down one screen (not one line, but one screen), you will see the screen at the left. On the line under “ASHRAE 62.2 PROGRAM REPORT” you see “Mech Vent CFM 100%★ = 57”. This is the whole building ventilation required if it operates 100 percent of the time. The “Alt Comp Supplement” of 18 and the “Inf Credit” of 10 are each included in this value. Here is how it works: The “Mech Vent CFM 100%”, not including the “Inf Credit” of 10, would be 67 CFM, rather than 57 CFM. The “Mech Vent CFM 100%”, not including the “Alt Comp Supplement” of 18, would be 39, rather than 57.

As a reminder, the “★” just to the right of “Mech Vent CFM 100%” indicates that there is a tool or Nugget that might be helpful to you. In this case it is the “Fan run-time” Nugget. If you wish to operate the whole building fan intermittently, this Nugget will calculate the required CFM for you. Please see page 89 for an explanation and example.

After viewing the report for the ASHRAE 62.2 program, press [ESC] or [ENTER] to return to the ZipTest Pro³ home screen.

2:BTLa (Building Tightness Limit advanced)

Program Input Variables

1. ZTP# = ZipTest Pro number. Please refer to “9:ZTP#” on page 69 for a detailed explanation. The program determines the ZTP# for you after you enter:
 - a. Building Ht = the height of the conditioned part of the building. This height should include the above-grade part of a basement if the basement is within the thermal envelope. Do not include an attic if it is not within the thermal envelope.

- b. Flow Exponent = the slope of the leakage curve of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the flow exponent for the building in question. Use this known flow exponent.
 - c. Living Sq Footage = the square feet of the occupied floor space. Basements that are not lived in but are considered to be within the thermal boundary of the house are usually not counted as occupied floor space.
 - d. Living Volume = this volume should correspond to the living area square footage.
 - e. Weather Factor = the weather factor for the local from the tables starting on page 108 that is closest to the actual house you are analyzing.
- 2. Measured CFM50 = the measured leakage from a standard blower door test.
 - 3. # Occ = the number of occupants living in the house. If you are not sure, count the number of bedrooms and add 1 (this assumes two people for the master bedroom).

Program Outputs

- 1. EqLA = the equivalent leakage area of the thermal/pressure boundary of the house. This number generally is very close to 10 percent of the entered CFM₅₀ value.
- 2. Est Nat CFM = the average leakage over the heating season in Cubic Feet per Minute of outdoor air.
- 3. Est Nat CFM/Occ = the average leakage over the heating season in Cubic Feet per Minute of outdoor air per reported occupant.
- 4. Est Nat ACH = The average leakage over the heating season expressed as Air Changes per Hour.
- 5. CFM Min = the Cubic Feet per Minute of outdoor air for compliance with ASHRAE 62-1989.

6. Mech Vent CFM = the continuously operating mechanical ventilation required for compliance with ASHRAE 62-1989. This ventilation flow rate is based on what is often called the “0.5 rule” from “Interaction of Mechanical Systems and Natural Infiltration by L. Palmiter and T. Bond, 1991, Ecotope, Inc.
7. CFM50 BTL_a = Building Tightness Limit expressed in units of CFM₅₀. This is the threshold value for compliance with ASHRAE 62-1989; if the house is tighter than this value, continuously operating ventilation is needed for compliance. If the house is looser than this value, mechanical ventilation is not required for compliance.

The calculation of many of the output values takes into account the guidelines set by ASHRAE 62-1989 – the dwelling envelope must provide either 0.35 air changes per hour (ACH) **and** 15 cubic feet per minute (CFM) per person. **This method is not intended for use in commercial applications.**

If a dwelling is tighter than the ASHRAE 62-1989 guidelines, the program calculates the ventilation necessary (“Mech Vent CFM”) to bring the dwelling into compliance with the ASHRAE 62-1989 guidelines.

Please note, this method is based on an obsolete section of ASHRAE Standard 62-1989 that has been replaced by another ASHRAE Standard, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, Standard 62.2-2007.

BTL_a Example

When you open the “2:Ventilation, 2:BTL_a” program, you are automatically sent to the ZTP# tool. The opening screen is similar to the one at the left.



ZTP# TOOL 1/1

Building Ht: 10

Flow Exponent: .65

Living Sq Footage: 1000

Living Volume: 10000

Weather Factor: .91

Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

At the ZTP# tool you must fill in any blank fill boxes and make sure the ones that are already filled in contain the values you want. In the example at the left, the values filled in are default values that can be set in the "F5-Default, 1:Edit" menu.

ZTP# TOOL 1/1

Building Ht: 10

Flow Exponent: .65

Living Sq Footage: 1000

Living Volume: 10000

Weather Factor: .91

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

Fill in all the values in the dialogue box. If you wish, try the example at the left.

BTLA PROGRAM 1/1

CFM50: 1200

Occ: 4

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

After filling in all the values in the ZTP# tool, press [ENTER]; you will then be returned to the BTLA program. Fill in the two required values and press [ENTER] once or twice to see the answers.

BTLA PROGRAM REPORT

EqlA = 124

Est Nat CFM = 74

Est Nat CFM/Occ = 19

Est Nat ACH = .45

CFM Min = 60

Mech Vent CFM = 0

CFM50 BTLA = 971

MAIN RAD AUTO FUNC 0/30

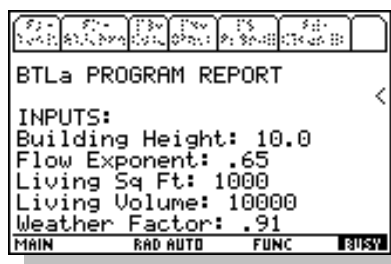
The "BTLA PROGRAM REPORT" sample to the left shows the answers that are explained above. This sample house does not require ventilation because the "Est Nat CFM/Occ" = 19, which is more than the threshold of 15, and the "Est Nat ACH" = .45, which is more than the threshold of 0.35.

For all reports generated by the ZipTest Pro³ software, the results of the calculations, the outputs, appear at the top of the REPORT screen as on the screen to the left. The INPUTS are always listed below the results.

The INPUTS show all the choices you made and the values you entered for the program,

tool, or nugget. Notice the ">" at the bottom right of the screen. This indicates there is more information to be seen by scrolling down.

1. You can scroll down one line at a time by pressing the down scroll key.
2. You can scroll down one screen at a time by pressing [◆] (lime green in color) and then the down scroll key.
3. You can scroll to the **end** of the report by pressing the [2nd] key (light blue) and then the down scroll key.



The screen to the left has been scrolled to the end of the report. Notice the "<" near top right of the screen. This indicates there is more information to be seen by scrolling up. Scroll up by using various combinations of the up scroll key.

After viewing the report for the BTLa program, press [ESC] to return to the ZipTest Pro³ home screen.

TIP

For a thorough explanation of the BTL method, see "Building Tightness Guidelines: When is a House Too Tight", George Tsongas, *Home Energy*, March/April 1993, pages 18 - 24.

3:BTL (Building Tightness Limit)

Program Input Variables

1. LBL# = Lawrence Berkeley Laboratory number. This number is the relationship between the leakiness of the house at 50 Pascals (during a standard blower door test) and the average natural leakage over the heating season. For example, if the LBL# is 20 and the CFM50 is 3000, the average natural leakage over the heating season is approximately $3000 \div 20 = 150$ CFM. The program determines the LBL# for you after you enter:
 - a. The appropriate climate zone in North America, 1, 2, 3, or 4 from the accompanying map.
 - b. The exposed height of the building. The choices are 1, 1.5, 2, 2.5 or 3 stories. Cape Cod and raised-ranch style houses are usually considered to be 1.5 stories.
 - c. The exposure of the building. The choices are 1:Well Shielded, 2:Normal, and 3:Exposed. The greater the exposure, the lower the CFM50 BTL.

2. Measured CFM50 = the measured leakage from a standards blower door test.
3. # Occ (> 5) = the number of occupants living in the house. If you are not sure, count the number of bedrooms and add 1 (this assumes two people for the master bedroom). The value you enter must be equal to or greater than 5. If you enter fewer than 5 for the number occupants, you will receive an error message.
4. Living Sq Ft = the square feet of the occupied floor space. Basements that are not lived in but are considered to be within the thermal boundary of the house are usually not counted as occupied floor space.
5. Avg Ceiling Ht = the average ceiling height of the occupied floor space. If the ceiling heights are different on a first and second floor, just average the two and enter that value.

Program Outputs

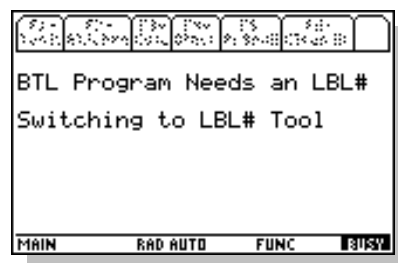
1. Est Nat CFM = the average leakage over the heating season in Cubic Feet per Minute of outdoor air.
2. Est Nat CFM/Occ = the average leakage over the heating season in Cubic Feet per Minute of outdoor air per reported occupant.
3. Est Nat ACH = the average leakage over the heating season expressed as Air Changes per Hour.
4. CFM Min = the Cubic Feet per Minute of outdoor air for compliance with ASHRAE 62-1989.
5. Mech Vent CFM = the continuously operating mechanical ventilation required for compliance with ASHRAE 62-1989. This ventilation amount is based on the "Measured CFM50" value you entered. If you tighten the building, causing the "Measured CFM50" value to decrease, the "Mech Vent CFM" will increase. This ventilation flow rate is based on what is often called the "0.5 rule" from "Interaction of Mechanical Systems and Natural Infiltration" by L. Palmiter and T. Bond, 1991, Ecotope, Inc.
6. CFM50 BTL = Building Tightness Limit expressed in units of CFM50. This is the threshold value for compliance with ASHRAE 62-1989; if the house is tighter than this value, continuously operating ventilation is needed for compliance. If the house is looser than this value, ventilation is not required.

The objective of this calculation procedure is the determination of a minimum CFM₅₀ threshold value for compliance with ASHRAE 62-1989. Awareness of this value allows building energy analysts and weatherization workers to add mechanical ventilation if the building is made tighter than the threshold BTL value.

Building Tightness Limits (BTL) was developed to give weatherization crews a minimum tightness value for air-leakage and insulation work. The “BTL” method used for this software is that which appeared in *Home Energy* magazine in the March/ April, 1993 issue. This article – *Building Tightness Guidelines: When is a House Too Tight?* – was written by George Tsongas, Professor of Mechanical Engineering at Portland State University in Oregon. It is strongly recommended that you read this article before using the BTL procedure. Mr. Tsongas’ work was built on the research of others, including Max Sherman at Lawrence Berkeley Laboratory, and Gary Nelson at The Energy Conservatory.

The values calculated by this program are based on ASHRAE Standard 62-1989, *Ventilation for Acceptable Indoor Air Quality*. This standard states that outdoor air requirements for residential living areas shall be “0.35 air changes per hour but not less than 15 cfm per person.” **These procedures are not appropriate for commercial buildings.**

Please note, this method is based on ASHRAE Standard 62-1989 that has been replaced by another ASHRAE Standard, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, Standard 62.2-2007.



BTL Example

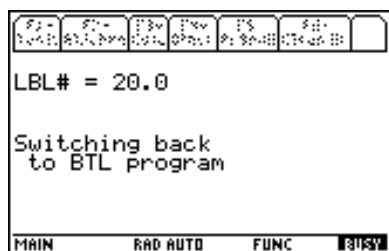
When you open the “2:Ventilation, 1:BTL” program, you are automatically sent to the LBL# tool. The opening screen is similar to the one at the left.



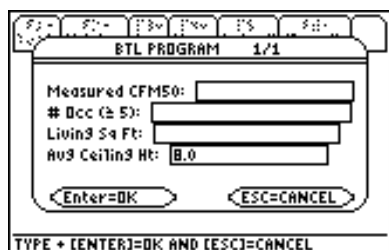
At the LBL# tool you must select “Climate Zone”, “Exposure”, and “Stories Above Grade”. Notice the right-pointing arrows at the end of each of these lines on the screen at the left. With the cursor on any of these lines, press the right cursor key to see the dropdown menu for each.



The screen at the left shows the dropdown menu for the “Climate Zone” line. To select your climate zone, either highlight the proper zone and press [ENTER] or press the appropriate number for your climate zone (in the example at the left, press [2] for climate zone 2). Note that you can set a default value for each of these lines in the “F5-Default, 1:Edit” menu. The default value you set will show up as the default value in each of these three lines.



After you have selected the three items for the LBL# tool, press [ENTER]. You will then be returned to the BTL program.



The BTL Program dialogue box is now ready for your input. Notice in the title for the box after “BTL Program” is “1/1”. This “1/1” means this is the first of one dialogue box. You don’t see the LBL# listed on this screen, but is being used in the calculation (for this example it is equal to 20).

Notice the values entered in the fill boxes in the example to the left. Remember that the number of occupants must be equal to five or more.

Press [ENTER] once or twice. The calculation will be performed for you. During this time in the lower left corner of the screen you will see “**BUSY**”. The screen at the left shows the “BTL PROGRAM REPORT” screen with the answers (output values). The values you are probably most interested in are the “Mech Vent CFM” and the “CFM50 BTL”. This example house requires 60 CFM of continuously operating ventilation and the CFM50 BTL is 1800. The 60 CFM of ventilation is required because the house is tighter – 1200 CFM₅₀ – than the CFM50 BTL of 1800. If you scroll down on the report screen you will see your input values.

After viewing the report for the BTL program, press [ESC] to return to the ZipTest Pro³ home screen.

3:WCEG (Weatherization Cost-Effective Guidelines)

Program Input Variables

1. LBL# = Lawrence Berkeley Laboratory number. This number is the relationship between the leakiness of the house at 50 Pascals (during a standard blower door test) and the average natural leakage over the heating season. For example, if the LBL# is 20 and the CFM₅₀ is 3000, the average natural leakage over the heating season is approximately $3000 \div 20 = 150$ CFM. The program determines the LBL# for you after you enter:
 - a. The appropriate climate zone in North America, 1, 2, 3, or 4 from the

- accompanying map.
- b. The exposed height of the building. The choices are 1, 1.5, 2, 2.5, or 3 stories. Cape Cod and raised-ranch style houses are usually considered to be 1.5 stories.
- c. The exposure of the building. The choices are 1:Well Shielded, 2:Normal, or 3:Exposed. The greater the exposure, the lower the CFM₅₀ BTL.
- 2. HDD = Heating Degree Days, base 65 degrees.
- 3. Payback Years = a reasonable payback, in years, for air sealing activities. Seven to ten years is standard.
- 4. Fuel Type = the fuel type selected, one of seven types, including:
 - a. Electricity at 3412 Btu input per kWh.
 - b. Natural gas at 100,000 Btu input per therm.
 - c. Propane (LPG) at 91,500 Btu input per gallon.
 - d. #2 oil at 138,690 Btu input per gallon.
 - e. #1 oil at 134,000 Btu input per gallon.
 - f. K-1 kerosene at 126,000 Btu input per gallon.
 - g. Wood at 21,000,000 Btu input per cord.
- 5. \$ per [unit] = the cost per unit of fuel. The unit is dependent on the fuel selected. For example, oil is in units of gallons, natural gas is in units of therms, etc.
- 6. % Heating Eff = the seasonal efficiency of the heating system, entered as a percentage.
- 7. Mat Cost / Wrk Hr = the average materials cost one worker will expend, on average, during one hour of air sealing activities. This is a difficult number to estimate, but an average number is required for the program to work properly.
- 8. Lab Cost / Wkr Hr = the total average labor cost per worker hour. If you want to include benefits, etc., this is where you should add these costs to the hourly labor cost.

Program Input Variables for Cost-Effective Guideline (CEG) test

1. CFM50 Reduction = the CFM₅₀ reduction accomplished by the crew (not each worker, but the entire crew).

2. # Workers = the number of workers on the air sealing crew.
3. # Minutes = the number of minutes, not hours, the crew worked to accomplish the most recent CFM₅₀ reduction entered. For example, if a crew of two worked for 45 minutes, enter "45".

Program Outputs

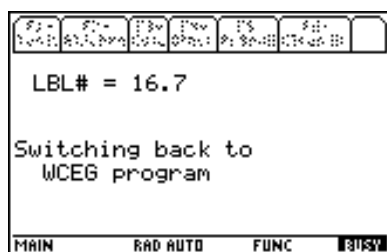
1. CEG = Cost-Effective Guideline for air sealing. For example, if this guideline is calculated to be \$120, this means that as long as it costs less than \$120 per 100 CFM₅₀ of air leakage reduction, it is cost effective. When the 100 CFM₅₀ reduction costs more than \$120, it is not cost effective, so air sealing work should stop.
2. CFM₅₀ Guideline per worker hr = the worker guideline per hour. For example, if this value is 30 CFM₅₀, the air sealing activities should continue as long as a worker can reduce CFM₅₀ by more than 30 each hour (this is sealing approximately three square inches of leakage each hour). This value corresponds with the CEG value.
3. \$/100CFM₅₀ = the actual cost for the last air sealing session in dollars per 100 CFM₅₀.
4. CFM₅₀/WKHR = the actual CFM₅₀ reduction for the last air sealing session in CFM₅₀ per worker hour.
5. "CONTINUE AIR SEALING" or "STOP AIR SEALING".

This program was written for the Wisconsin low-income weatherization program in 1999 and later adapted for all areas of the United States. It is useful for blower-door directed air sealing to reduce energy loss and client discomfort due to air leakage during the heating season.



Weatherization Cost-Effective Guideline example

When you start the WCEG program you are transferred to the LBL# Tool to generate an LBL number. This number represents the relationship between the CFM₅₀ of the house and the average CFM over the heating season. The sample screen at the left shows the LBL Tool that begins the WCEG program routine.



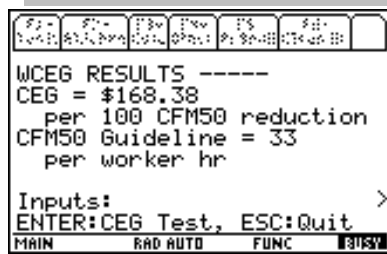
After the LBL number is calculated, you are transferred back to the WCEG program. Please see the sample screen to the left.



Enter values in the two fill boxes of the first input screen of the WCEG PROGRAM. Press [ENTER] once or twice to move to the second input screen.



Now enter values in the other fill boxes if they aren't already filled in with the values you want. Press [ENTER] once or twice to move on.



Although this screen looks like the final report screen of the other programs and tools in the ZipTest Pro³ package, this is not the final report screen for the WCEG program. The CEG of \$168.38 has been calculated as the Cost-Effective Guideline (CEG) for the example at the left. This value indicates that air sealing activities should continue as long as a 100 CFM₅₀ reduction can be achieved for less than \$168.38. Additionally, the CFM₅₀ Guideline of per worker hour has been calculated. This indicates that air sealing should continue as long as each worker can achieve at least a CFM₅₀ reduction each hour of 36. These cost-effective guideline threshold values for this example of \$168.38 per 100 CFM₅₀

reduction and 36 CFM₅₀ reduction per worker hour are based on your appropriate default values and the values you entered in the two input dialogue boxes.

Notice at the bottom of this screen you are given the choice to press [ENTER] to do a CEG test or you can press [ESC] to quit. Let's do a test. Even if you scroll down to see the inputs, this line will remain at the bottom of the screen.

Assume two workers working for 67 minutes reduced the CFM₅₀ of the dwelling by 300. These values are entered in the sample input dialogue box at the left. It is probably clear by now that a blower door must be set up during air sealing activities to use this WCEG program. Of course, even if you don't use this program, it is a very good idea to use a blower door during air sealing. Now press [ENTER] to see if this air sealing work was cost effective.

Notice at the top of the screen you are instructed to continue air sealing. The “\$/100CFM₅₀” value is significantly lower than the \$168.38 cost-effective guideline per 100 CFM₅₀ and the “CFM₅₀/WKHR” (CFM₅₀ per worker hour) of 134 is significantly more than the guideline of 36.

An underlying assumption of this program process is that the most cost-effective air sealing will be completed first and as air sealing continues the air sealing activities will become less cost effective. Although there are exceptions to this assumption, it is most often the way air sealing proceeds.

Continue air sealing and taking blower door readings occasionally. Enter the data into the calculator to determine whether to continue or stop air sealing. Just put the calculator aside until you need to do another re-test. The TI-89 will automatically shut off in about two minutes. When you are ready for a re-test simply press the [ON] key to start where you left off.

Let's assume you continue air sealing, completing three air sealing sessions before the

example at the left (80 CFM₅₀ reduction by 2 workers in 83 minutes). The effectiveness of the air sealing activities will usually diminish as air sealing continues.

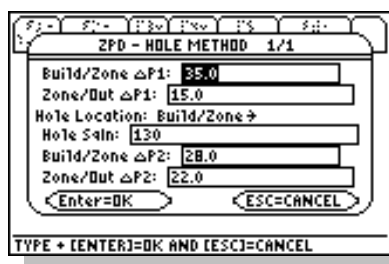
Notice that after you enter values and press [ENTER] to do another cost-effective test, the results from the previous cost-effective test are displayed on the screen until the new values are calculated. Please wait for the new values to show on the screen. We hope this delay won't confuse you.

After pressing [ENTER] once or twice for this example, the screen sample at the left will appear. Notice that the instruction of "STOP AIR SEALING!" is at the top of the screen. Also notice that "\$/100CFM₅₀" value is higher than the \$168.38 cost-effective guideline per 100 CFM₅₀ and the "CFM₅₀/WKHR" (CFM₅₀ per worker hour) of 29 is lower than the guideline of 36. Air sealing is no longer cost effective unless you discover new leaks that will be inexpensive to seal. Although given the instruction to stop air sealing, you are still given the options to re-test by pressing [ENTER] or to quit by pressing [ESC].

4:ZPD (Zone Pressure Diagnostics)

Zone Pressure Diagnostics (ZPD) is an extremely powerful diagnostics tool that can be used for:

1. Determining the leakage to an attic before and after air sealing.
2. Finding the connection between an attached garage and a living area.
3. Estimating the amount of leakage through the walls, doors, and windows by determining the whole-house CFM₅₀ and subtracting from it 1) the total path leakage through the top of the structure (attic floor/roof and gable-ends) and 2) the total path leakage through the bottom of the structure (first-story floor/basement walls). This is sometimes called disaggregating the air leakage.
4. Determining if spaces are connected to the outdoors. An example of a space that might be connected to the outdoors is as attached porch roof/ceiling structure.
5. Helping to appraise indoor air quality issues. For example, determining how well is a crawl space with bad air connected to the living space.
6. Ensuring that the pressure boundary (primary air barrier) is in line with the



thermal boundary (insulation).

7. Assisting quality assurance (QA) activities by allowing QA staff to determine the square inches of leakage from a house to another zone separated by a pressure boundary.

Two ZPD routines are included in the ZipTest Pro³ software package; the add-a-hole (Hole Method) and the open-a-door (Door Method).

1:Hole Method

Program Input Variables

1. Build/Zone $\Delta P1$ = the building-to-zone pressure difference before a temporary hole is created, in Pascals. During this measurement, the house should be depressurized or pressurized to 50 Pascals difference between the inside and outside. Enter as a positive number.
2. Zone/Out $\Delta P1$ = the zone-to-outdoor pressure difference before a temporary hole is created, in Pascals. This should be the Build/Zone $\Delta P1$ subtracted from 50 (the house pressure is at 50 Pascals), plus or minus 2 Pascals. Enter as a positive number.
3. Hole Location = the location of the temporary hole. Select from the two choices of "Build/Zone" (building-to-zone) or "Zone/Out" (zone-to-outdoors). It is best to create the hole in the tightest of the two pressure boundaries.
4. Hole S_{qin} = the square inches of the temporary hole. **Note: Opening the temporary hole will reduce the house pressure to less than 50 Pascals. Make sure you increase the house pressure back up to 50 Pascals by increasing the blower door fan speed.**
5. Build/Zone $\Delta P2$ = the building-to-zone pressure difference with a temporary hole open, in Pascals. Enter as a positive number.
6. Zone/Out $\Delta P2$ = the zone-to-outdoor pressure difference with a temporary hole open, in Pascals. This should be the Build/Zone $\Delta P2$ subtracted from 50 (the house pressure is at 50 Pascals), plus or minus 2 Pascals. Enter as a positive number.

```

ZPD HOLE METHOD REPORT
CFM50 Flow:
Build/Zone: 2205
Zone/Out: 3824
Total Path: 1749

INPUTS:
Build/Zone ΔP1: 35.0
MAIN    RAD AUTO    FUNC    [RIGHT]

```

Program Outputs

1. Build/Zone CFM50 Flow = the CFM₅₀ flow through the building-to-zone pressure boundary before the temporary hole was opened. If this CFM₅₀ flow rate is divided by 10, the answer yields an approximation of the square inches of holes in the building-to-zone pressure boundary.
2. Zone/Out CFM50 Flow = the CFM₅₀ flow through the zone-to-outdoor pressure boundary before the temporary hole was opened. If this CFM₅₀ flow rate is divided by 10, the answer yields an approximation of the square inches of holes in the zone-to-outdoor pressure boundary.
3. Total Path CFM50 Flow = the CFM₅₀ flow simultaneously through the building-to-zone and zone-to-outdoor pressure boundaries before the temporary hole was opened. Do **not** divide this CFM₅₀ flow rate by 10 for the square inches of holes. The Total Path CFM50 Flow is always less than the Build/Zone CFM50 Flow or the Zone/Out CFM50 Flow. This is because the Total Path CFM50 Flow includes the resistance to air flow through both of these other pressure boundaries.

If you are not able to create a building pressure of negative or positive 50 Pascals with a blower door with the temporary hole open, you cannot depend on the results of this method. This method works best when the pressure drop resulting from the creation of the temporary hole is 15 to 25 Pascals or more.

2:Door Method

Program Input Variables

1. Closed CFM50 = the initial building CFM₅₀ before the door is opened. This is a value you know if you have done a blower door test on the building.
2. Build/Zone ΔP = the building-to-zone pressure difference before the door is opened, in Pascals. During this measurement, the house should be depressurized or pressurized to 50 Pascals difference between the inside and outside. Enter as a positive number.
3. Zone/Out ΔP = the zone-to-outdoor pressure difference before the door is opened, in Pascals. This should be the Build/Zone ΔP1 subtracted from 50 (the

```

BASIC ZPD - DOOR METHOD 1/1
Closed CFM50: 2250
Building/Zone ΔP: 32.0
Zone/Outdoors ΔP: 18.0
Door Location: Build/Zone
Open CFM50: 3000
Enter=OK    ESC=CANCEL

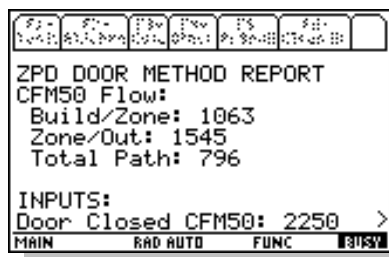
TYPE + [ENTER]=OK AND [ESC]=CANCEL

```

house pressure is at 50 Pascals), plus or minus 2 Pascals. Enter as a positive number.

4. Door Location = the location of the door that is opened. Select from the two choices of "Build/Zone" (building-to-zone) or "Zone/Out" (zone-to-outdoors). It is best to create the hole in the tightest of the pressure boundaries.
5. Open CFM₅₀ = the building CFM₅₀ with the door is opened. Note: It is very important that the building-to-outdoor pressure be brought back up to 50 Pascals after the door is opened before recording this CFM₅₀ value. The pressure across the pressure boundary in which you open the door should be less than one Pascal, otherwise the method will lose significant accuracy.

Program Outputs



```

ZPD DOOR METHOD REPORT
CFM50 Flow:
Build/Zone: 1063
Zone/Out: 1545
Total Path: 796

INPUTS:
Door Closed CFM50: 2250 >
MAIN      RAD AUTO  FUNC      8152
  
```

1. Build/Zone CFM₅₀ Flow = the CFM₅₀ flow through the building-to-zone pressure boundary before the temporary hole was opened. If this CFM₅₀ flow rate is divided by 10, the answer yields an approximation of the square inches of holes in the building-to-zone pressure boundary.
2. Zone/Out CFM₅₀ Flow = the CFM₅₀ flow through the zone-to-outdoor pressure boundary before the temporary hole was opened. If this CFM₅₀ flow rate is divided by 10, the answer yields an approximation of the square inches of holes in the zone-to-outdoor pressure boundary.
3. Total Path CFM₅₀ Flow = the CFM₅₀ flow simultaneously through the building-to-zone and zone-to-outdoor pressure boundaries before the temporary hole was opened. **Do not divide this CFM₅₀ flow rate by 10 for the square inches of holes.** The Total Path CFM₅₀ Flow is always less than the Build/Zone CFM₅₀ Flow or the Zone/Out CFM₅₀ Flow. This is because the Total Path CFM₅₀ Flow includes the resistance to air flow through both of these other pressure boundaries.

If you are not able to create a building pressure of negative or positive 50 Pascals with a blower door with the door open, you cannot depend on the results of this method.

Chapter 3

Tools – F2

Tools fall between the complexity of programs, such as WCEG, and the simplicity of Nuggets, such as ACH natural. This is not to say that all programs are complex and all Nuggets are simple, but it gives you a general idea about how we classified the ZipTest Pro³ mathematical routines.



All the tools in this chapter can be found in the “F2-Tools” menu tab. Please see the screen at the left. The subheadings in this chapter appear exactly as they do in the ZipTest Pro³ software, for example “2:Fuel, 3 DHW Fuel”. Notice the “↓” just to the right of the item number “8”. This indicates there are more dropdown menu items after “8↓LBL”. Scroll downward to these additional items by pressing the down cursor key. You will discover that there is only one more item, “9:ZTP#”.



Each tool is described starting with an explanation of each of the tool Input Variables followed by an explanation of each of the Tool Outputs. Sample screens with values in the input variable fill boxes are included for each of the tools in the left margin.

To properly work with each tool, include values in **all** fill boxes of the input dialogue boxes. When all the inputs are filled in as you wish, press [ENTER] once or twice for the calculation and answers (tool outputs). If you forget to put a value in a fill box, you will get an error message when you press [ENTER], such as the one to the left.



Minneapolis Blower Door™
Model 3

1:Blower Door

For this version of ZipTest Pro³, only the Minneapolis Blower Door™, Model 3, is included. In the future we will consider including tools for other blower door brands.

The two tools under this heading include “1:Minn BD3” for calculating the CFM₅₀ (temperature adjusted) for the Minneapolis Blower Door, Model 3, and “2:Adj CFM50” for temperature adjusting a given blower door CFM₅₀ (this tool will work for any blower door brand).

1:Minn BD3 (Minneapolis Blower Door™, Model 3)

Input Variables

1. Test Type = choice of either depressurization (default) or pressurization test.
2. Building Press = the building pressure difference between the indoors and outdoors created by the blower door, for a depressurization or pressurization test, in units of Pascals. Always enter a positive number in this fill box.
3. Fan Press = the blower door fan pressure reached during the blower door test in units of Pascals. This should be 25 Pascals or greater for the sake of accuracy.
4. Ring Config = the ring configuration for the blower during the blower door test. The ring choices are 1:Open, 2:A-Ring, 3:B-Ring, and 4:C-Ring.
5. Inside Temp = the temperature indoors during the blower door test, F^o.
6. Outside Temp = the temperature outdoors during the blower door test, F^o.

Tool Outputs

1. CFM at test pressure = the measured CFM at test pressure. For example, if the test pressure was 45 Pascals, the CFM₄₅ is calculated. This value is a temperature adjusted value.
2. CFM50 = the measured CFM₅₀ of the building. This is a temperature adjusted value.

This tool will adjust your blower door reading for temperature differences and give you an answer for your test pressure, for example CFM₄₅, and at CFM₅₀. For the example screen at the left, notice that the inside and outside temperatures are the same, so no

MINN BD3 TOOL 1/1

Test Type: Depressurized →

Building Press: 45.0

Fan Press: 90

Ring Config: Open →

Inside Temp: 65

Outside Temp: 65

Enter=OK ESC=CANCEL

USE ← AND → TO OPEN CHOICES

MINN BD3 TOOL REPORT

CFM45.0= 4537

CFM50= 4858

Inputs:

Test Type: Depressurized

Building Press: 45.0

Fan Press: 90

MAIN RAD AUTO FUNC EXIT

temperature adjustment is done during the calculation. If it were colder outside than inside, the final CFM₅₀ value would be less. Remember, the blower door is accurately estimating the air leaking into the house by measuring the air going out of the house at the flow ring of the blower (assuming a depressurization test). When the air leaking into the house is a different temperature (density) than the air flowing through the blower, an adjustment must be made to account for the differing air densities flowing into the house and through the fan. If it is colder outside than inside, the CFM₅₀ will be adjusted to a smaller value. Experiment with this tool.

For those of you using the Energy Conservatory DG-700 digital manometer with your blower door; most of us set the DG-700 to give a readout of the flow at 50 Pascals of pressure, so we never see what the right-hand readout that the gauge is “seeing” directly – the fan pressure. If you set the DG-700 to show readouts of house pressure (on the left-hand readout) and fan pressure on the right-hand readout, you can enter these two pressures into this “Minn BD3” tool to get the CFM₅₀ value. It is unlikely you would use this tool for this purpose because it is easier to use the DG-700 to get the CFM₅₀ value. However, if temperature-adjusted values are important to you, use the Minn BD3 tool; the DG-700 does not automatically perform temperature adjustment.

2:Adj CFM50 (Temperature adjusted CFM₅₀)

Input Variables

1. Test Type = your choice of either depressurization (default) or pressurization test.
2. Building Press = the building pressure difference between the indoors and outdoors created by the blower door, for a depressurization or pressurization test, in units of Pascals. Always enter a positive number in this fill box.
3. CFM = the measured CFM for the corresponding building pressure difference above. For example, if 45 Pascals was the building pressure during the test that you want to adjust for temperature, enter in this fill box the CFM₄₅ that was calculated during the test.
4. Inside Temp = the temperature indoors during the blower door test, F_O.
5. Outside Temp = the temperature outdoors during the blower door test, F_O.

ADJ CFM50 TOOL 1/1

Test Type: Depressurized →

Building Press: 50

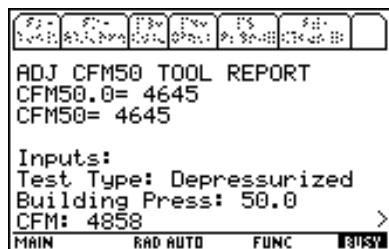
CFM: 4858

Inside Temp: 65

Outside Temp: 20

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30



Tool Outputs

1. CFM at test pressure = the measured CFM at test pressure. For example, if the test pressure was 45 Pascals, the CFM₄₅ is calculated. This value is a temperature adjusted value.
2. CFM50 = the measured CFM₅₀ of the building. This is a temperature adjusted value.

If you have a blower door CFM₅₀ value already and you want to adjust it for temperature differences inside and out, this tool is just what you need. The author of this manual lives in Maine where the winters can be very cold. If I am comparing a blower door test that was done when it was 65 degrees outside (4858 CFM₅₀) with my blower door test done when it is 20 degrees outside, this tool is very helpful. You can see for the example at the left, the original test of 4858 CFM₅₀, retested at a lower temperature, has the equivalent of a 4645 CFM₅₀.



2:Fuel

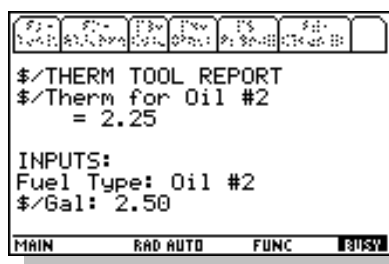
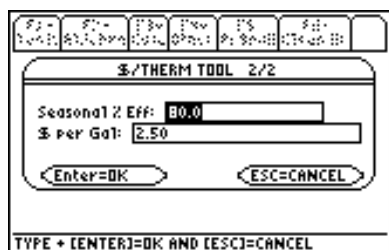
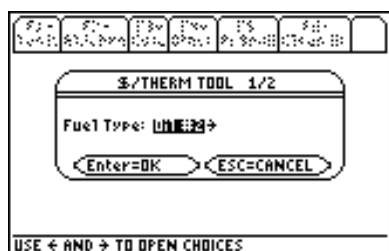
This tool category includes three items related to fuel costs and amounts (please see the menu at the left).

The first, "1:\$/Therm", allows you easily convert a particular fuel at a given cost per unit to the cost per therm. A therm is merely 100,000 British thermal units (Btus). The second tool in this category, "2:Cost to Units", converts the annual cost of a particular fuel to the corresponding units of that fuel. Finally, "3:DHW Fuel", calculates an estimate of the amount of fuel used in one year for heating domestic hot water.

1:\$/Therm (Cost per therm of fuel)

Input Variables

1. Fuel Type = one of seven choices. From the "F5 - Defaults" menu you can select the default fuel type. The fuels included are:
 - o Electricity at 3412 Btu input per kWh.



- a. Natural gas at 100,000 Btu input per therm.
 - b. Propane (LPG) at 91,500 Btu input per gallon.
 - c. #2 oil at 138,690 Btu input per gallon.
 - d. #1 oil at 134,000 Btu input per gallon.
 - e. K-1 kerosene at 126,000 Btu input per gallon.
 - f. Wood at 21,000,000 Btu input per cord.
2. Seasonal % Eff = the seasonal efficiency of the heating system. Enter as a percentage.
 3. \$ per [unit of fuel] = the cost per unit of the fuel selected. The units listed in the dialogue box correspond to the selected fuel, for example, if you select natural gas, "\$ per therm" is listed.

Tool Outputs

1. \$/Therm for [fuel] = the calculated cost per 100,000 Btu of the selected fuel. One therm is equal to 100,000 Btus.

If you want to compare the cost of a number of fuels to a common unit to find their relative costs, this tool is a great help. The example at the left shows the first input dialogue box of two for finding the cost per therm of #2 heating oil.

The second dialogue box shows the seasonal efficiency of the oil heating system and the cost per gallon of oil. After pressing [ENTER] once or twice, the answer screen will appear.

You can see the cost per therm was calculated to be \$2.25. As mentioned above, you can calculate the cost per therm for any of the seven fuels listed.

A Nugget very similar to this tool is described later in these instructions. This Nugget may be found at "F3-Nuggets, 2:Heating, 1:\$/therm of fuel" (see page 82). When you use the Nugget version, you must enter Btus, but you can solve for any of the variables.

2:Cost to Units (Fuel units from fuel cost)

Input Variables

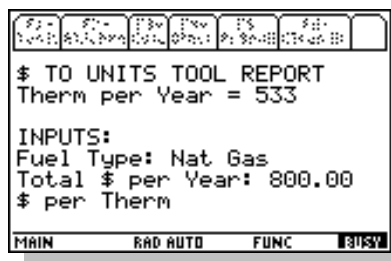
1. Fuel Type = one of seven choices. From the "F5 - Defaults" menu you can select the default fuel type. The fuels included are:
 - a. Electricity at 3412 Btu input per kWh.
 - b. Natural gas at 100,000 Btu input per therm.
 - c. Propane (LPG) at 91,500 Btu input per gallon.
 - d. #2 oil at 138,690 Btu input per gallon.
 - e. #1 oil at 134,000 Btu input per gallon.
 - f. K-1 kerosene at 126,000 Btu input per gallon.
 - g. Wood at 21,000,000 Btu input per cord.
2. Annual Fuel Cost = the cost of fuel for one season or year.
3. \$ per [unit of fuel] = the cost per unit of the fuel selected. The units listed in the dialogue box correspond to the selected fuel, for example, if you select natural gas, "\$ per therm" is listed.

Tool Outputs

1. [Units] per Year = the calculated number of fuel units used based on the total cost per year for the particular fuel and the cost per unit of that fuel.

This tool will convert the cost of heating with a fuel to the corresponding fuel quantity. This tool is called up automatically by the Energy Index program if you leave the "Therms per year +:" fill box blank.

You may select any one of the seven fuels to convert from dollars to units. In the sample screen at the left, natural gas is selected.



With the annual fuel cost of \$800 and the cost of gas being \$1.50 per therm, the number of therms per year of natural gas used is 533.

Please Note

“Energy Factor” is the only efficiency value in the entire ZipTest Pro³ software package that is entered as a decimal. This is because it is the convention in the industry to list water heater energy factors as decimals.

3:DHW Fuel (Domestic hot water fuel units)

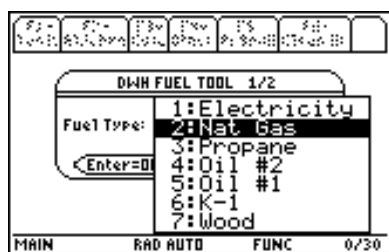
Input Variables

1. Fuel Type = one of seven choices. From the “F5 – Defaults” menu you can select the default fuel type. The fuels included are:
 - a. Electricity at 3412 Btu input per kWh.
 - b. Natural gas at 100,000 Btu input per therm.
 - c. Propane (LPG) at 91,500 Btu input per gallon.
 - d. #2 oil at 138,690 Btu input per gallon.
 - e. #1 oil at 134,000 Btu input per gallon.
 - f. K-1 kerosene at 126,000 Btu input per gallon.
 - g. Wood at 21,000,000 Btu input per cord.
2. DWH Gal/Yr = The Domestic Hot Water used in one year in units of gallons. Please refer to Domestic Hot Water Use Calculation discussion starting on page 23.
3. Temp Rise = the entering water temperature subtracted from the output water temperature of the water heating appliance, F^o.
4. Energy Factor = seasonal efficiency of water heating appliance, **as a decimal**.

Tool Outputs

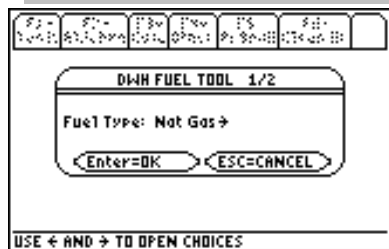
1. Annual DHW Fuel = the total number of fuel units, based on fuel type selected, for annual hot water heating.

This tool estimates the annual fuel use for domestic hot water use. Please refer to Domestic Hot Water Use Calculation discussion starting on page 23. The tool allows you

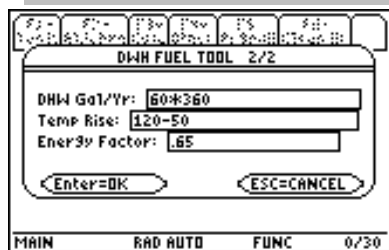


to use the same seven fuels that are available for other tools and programs (please see sample screen at left).

After selecting the fuel from the first of two input dialogue boxes, press [ENTER] to move to the next dialogue box.

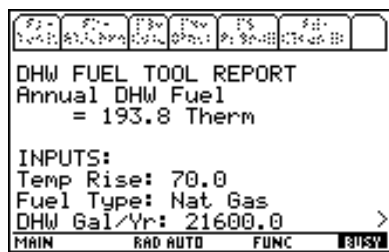


Gallons of hot water use per day in North America averages about 62 gallons per household; two adults in a household use from 30 to 60 gallons of hot water per day. A household with two adults and two children might have an average daily use as high as 90 gallons per day. Households with very young children often use more than average, elderly people often use less than average.



To get the figure for “DHW Gal/Yr”, estimate the gallons per day and multiply it by the number of days the family is a home during the year (usually 365). In the example screen to the left, the math-on-the-fly feature has been used to determine the gallons per year. The “DHW Gal/Yr” fill box has “60*360” (enter 60[x]360), meaning 60 gallons per day times 360 days per year. Additionally, the entry for “Temp Rise” is “120-50” (enter 120[-]50), meaning 120 F° output water temperature minus 50 F° input water temperature. This math-on-the-fly feature can save you time.

For the water output temperature from the water heating appliance, you can take the time to measure this temperature with a thermometer, or you can estimate it. For residential buildings it is usually between 120 F° and 140 F°. For the water input temperature to the water heating appliance, subtract the local latitude from 90 for an estimate of this water temperature (usually 40 F° to 50 F°).



Press [ENTER] once or twice to find the answer. This screen indicates there are more inputs if you scroll down.



Duct Blaster™ duct blower

3:Duct Blaster

Input Variables

1. Serial # = the serial number of the particular Duct Blaster™ you are using. Because of a change in the manufacturing of Duct Blaster™ fans in March 1995, the characteristics of the fans changed. In order to calculate the flow accurately, you must enter whether the fan serial number is from 0 to 591 or 592 or higher.
2. Duct Press = the duct pressure at which the test is done. This is usually 25 Pascals, 50 Pascals or the actual operating pressure of the duct system. If you are not able to reach 25 Pascals, enter the pressure that was reached. The calculation tool will calculate the CFM₂₅ from the input data you provide. The calculation assumes a flow exponent of 0.65.
3. Fan Press = the Duct Blaster™ fan pressure.
4. Configuration = the ring configuration of the Duct Blaster™ fan during the test. The choices are "1:Open", "2:Ring 1", "3:Ring 2", and "4:Ring 3".

Tool Outputs

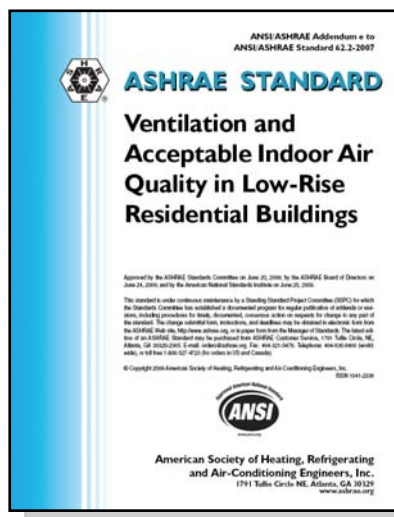
1. CFM [actual duct pressure] = the CFM leakage of the actual duct pressure during the test. If the actual duct pressure was 22 Pascals, this would be the CFM₂₂ duct leakage reading.
2. CFM₂₅ = the CFM₂₅ duct leakage result, even though the actual duct pressure during the test was less than 25 Pascals or 50 Pascals.
3. CFM₅₀ = the CFM₅₀ duct leakage result even though the actual duct pressure during the test was less than 25 Pascals or 25 Pascals.
4. Leakage = the approximate leakage area of the tested ductwork in square inches.

This tool is set up only for the duct blower manufactured by the Energy Conservatory called the Duct Blaster™. The primary use of the device is for determining the leakiness of ductwork, although it also has other uses.

Notice you must select the Duct Blaster™ serial number. This is because the Energy Conservatory used a different manufacturer before March 1995, resulting in a different fan design.

A duct blower leakage test is usually performed at 25 Pascals of pressure because this pressure is similar to the duct pressure when the air handler is operating. In the example at the left, it is assumed that the pressure of 25 Pascals was not reached, but only 23 Pascals. Fill in the fan pressure and don't forget to select the appropriate ring configuration.

Notice in the sample "DUCT BLASTER TOOL REPORT" the "CFM23", "CFM25", and "CFM50" are reported. Also note that an approximation of the duct leakage is reported, in square inches.



4: New Const 62.2 (New construction ASHRAE 62.2)

Input Variables

1. Living Sq Ft = the square footage of the building floor area.
2. # Occupants = the number of occupants living in the house, usually determined by the number of bedrooms, plus one. For example, if there are three bedrooms, the house, the number of occupants is four. This assumes that two people reside in the master bedroom. When higher occupant densities are known, they may be used.

Tool Outputs

1. Mech Vent CFM 100% = the whole building mechanical ventilation assuming it operates 100 percent of the time. In the example screen below and to the left, notice the asterisk just after "Mech Vent CFM 100%". The asterisk indicates

there is a Nugget that can help with your ventilation design. With “F3-Nugget, 6:Ventilation, 1:Fan run-time” you can easily calculate the required CFM flow of the whole house fan if you wish to run it less than 100 percent of the time.

NEW CONST 62.2 TOOL 1/1

Living Sq Ft: 2000

Occupants: 4

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

NEW CONST 62.2 TOOL REPORT

Mech Vent CFM 100%* = 50

INPUTS:

Living Sq Ft: 2000

Occupants: 4.0

MAIN RAD AUTO FUNC 3/30

This tool is based on ASHRAE Standard 62.2-2007, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*. Please refer to this publication for important details about this ventilation standard. **Note that this tool is to be used for new construction only; if you want to design ventilation for occupied dwellings, please use the program “F1-PRGMs, 2:Ventilation, 1:ASHRAE 62.2” on page 28.** If you purchase this ASHRAE standard at www.ashrae.org you will find that Table 4.1a can be used for new construction instead of this tool.

In the example shown at the left, the “Living Sq Ft” represents the area of the dwelling that is lived in. If the basement is not lived in, it should not be included in this square foot value.

The top screenshot shows the 'HEAT INDEX TOOL 1/1' interface. It has two input fields: 'Air Temp:' with the value '90' and '% Relative Humidity:' with the value '85'. Below the fields are buttons for 'Enter=OK' and 'ESC=CANCEL'. The bottom status bar shows 'MAIN RAD AUTO FUNC 0/30'.

The bottom screenshot shows the 'HEAT INDEX TOOL REPORT'. It displays 'Heat Index = 117.5' and 'INPUTS: Temp: 90.0, % Relative Humidity: 85.0'. The bottom status bar shows 'MAIN RAD AUTO FUNC 3/30'.

5:Heat Index

Input Variables

1. Air Temp = the outdoor air temperature, F^o.
2. % Relative Humidity = the outdoor relative humidity at the assumed outdoor air temperature.

Tool Outputs

1. Heat Index = the apparent temperature or heat index used by weather reporters during hot and humid weather. This index includes the combined affect of heat and humidity on the human body.

The index combines the effects of high temperature and relative humidity to yield a value that portrays the temperature perceived by a typical person. Notice in the example to the left that an air temperature of 90 F^o and a relative humidity of 85 percent results in a perceived temperature of 117.5 F^o.

The heat index values assume a person is in the shade. Direct sunlight can increase the heat index by as much as 15 F^o. The equation results assume a 5 knot wind.

<i>Possible Heat Disorders for People in High Risk Groups</i>		
Category	Heat Index, F ^o	Disorder
Extreme Danger	130 and higher	Heat stroke or sunstroke likely
Danger	105 - 129	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	90 - 105	Sunstroke, muscle cramps, and/or heat exhaustion with prolonged exposure and/or physical activity.
Caution	80 - 90	Fatigue possible with prolonged exposure and/or physical activity.
Source: National Weather Service		

6:Refrig SIR (Refrigerator Savings-to-Investment Ratio)

Input Variables

1. Old Ref kWh/yr = the measured or estimated annual electrical usage of the old refrigerator, kWh/yr. This value should not be adjusted for any temperature differences. This value is the metered usage or the estimated usage from the manufacturer or the AHAM directory of refrigerators. If the refrigerator is metered, the metering time should be at least two hours.
2. Avg Ambient Temp = the average annual ambient temperature to which the existing refrigerator is exposed. This is an estimate of the average temperature, F° , around the refrigerator during a year.
3. Current Ambient Temp = the current ambient temperature at the time the existing refrigerator is metered, F° . If you want to negate the impact of temperatures during metering, enter 70 F° for both "Avg Ambient Temp" and "Current Ambient Temp".
4. New Ref kWh/yr = the estimated kWh/yr consumption of the replacement refrigerator.
5. \$/kWh = the cost of the delivered electricity per kWh, cents.
6. Replacement cost = the cost of replacing the old refrigerator. This price should include the new refrigerator cost, any delivery charge, and any disposal charge for the old refrigerator.
7. Discounted Life = the estimated life of the new refrigerator (usually 15 years) discounted appropriately to account for inflation of energy cost, general inflation, the cost of money, etc. Discount values (UPV or uniform present value) are usually published every April by the National Institute of Standards and Technology (NIST). Please see *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis - April 2009*, NIST. This document is available on the Internet.

Tool Outputs

1. SIR = Savings-to-Investment ratio for replacing the refrigerator with the designated new one. If the SIR is less than one, the refrigerator should not be replaced. The higher the SIR value, the better the rationale for replacement.

Refrig SIR Tool 1/2

Old Ref kWh/yr: 1600
 Avg Ambient Temp: 68
 Current Ambient Temp: 75
 New Ref kWh/yr: 500

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

Refrig SIR Tool 2/2

\$ / kWh: .14
 Replacement Cost: 600
 Discounted Life: 11.5

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

REFRIG SIR TOOL REPORT
 SIR = 2.3

INPUTS:
 Old Ref kWh/yr: 1600
 Avg Ambient Temp: 68.0
 Current Ambient Temp: 75.0
 New Ref kWh/yr: 500

MAIN RAD AUTO FUNC 0/30

This tool calculates the Savings-to-Investment Ratio (SIR) for replacing a refrigerator. Of course, if the SIR is less than one, the refrigerator in question should not be replaced.

The screen to the left shows the first of two input dialogue boxes for this tool. Notice that the “Current Ambient Temp” is higher than the “Ave Ambient Temp”. This will increase the metered reading because the metered refrigerator will have to work harder to keep the food cool. The mathematics on which the tool is based will automatically adjust for this.

Notice in the second dialogue box of the sample screen that the “Discounted Life” is 11.5 years. This is the discounted value of the typical 15-year expected life of a refrigerator. This discounted value was found in *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis* - April 2009, National Institute of Standards and Technology.

The results of an SIR of 2.3 show that replacing this refrigerator is a wise investment.

7:62.2 Alt Comp (ASHRAE 62.2 alternate compliance method)

Introduction

This tool addresses the alternative compliance option of ASHRAE Standard 62.2-2007 for local exhaust requirements in **existing buildings only**.¹ Requirements that are relatively easy to satisfy in new construction, such as the installation of a 100 CFM exhaust range hood in a kitchen and a 50 CFM exhaust fan in each bathroom, may be very difficult or

¹ *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, ASHRAE Standard 62.2-2007. This tool refers to “Normative Appendix C – Existing Buildings” of ASHRAE 62.2-2007 (this appendix became part of this Standard in 2009).

extremely expensive to install during renovations of an existing dwelling. This alternate compliance method is intended to allow more flexibility for compliance with these requirements of the Standard.

ASHRAE Standard 62.2-2007 requires local exhaust fans to remove moisture and cooking odors at the source; a 100 CFM exhaust range hood in a kitchen and a 50 CFM exhaust fan in each bathroom (a bathroom is defined as a room having a tub, shower, spa, or other similar source of moisture). In addition to following requirements for whole building ventilation, it is best practice to adhere to these local ventilation requirements. When it is difficult or expensive to install local ventilation in an existing house, it is permissible to use this alternate compliance option to satisfy the Standard, as long as the authority having jurisdiction decides under what circumstances the provisions of the alternate option may be used.

The alternate method allows less than 50 CFM or no exhaust ventilation in each bathroom and less than 100 CFM or no exhaust ventilation in kitchens, but the whole building ventilation rate must be increased to compensate for the local exhaust that is lacking. You are asked if a bathroom or the kitchen has a window because operable windows are given a local ventilation credit of 20 CFM.

It is likely you will never use this tool as a stand-alone calculation procedure, but you might. It is more likely that you will see this tool as an automatic call-up feature for the ASHRAE 62.2 program (please refer to page 28) where you are asked if you want to use this tool to determine the whole building ventilation CFM rate. If you answer affirmatively, this tool will activate, calculate the ventilation supplement, and then return you to the ASHRAE 62.2 program.

Input Variables

1. Bath(s) Affected? = your choice of “Yes” or “No”. A bathroom (bath) is defined as a room that has a bathtub, shower, spa or similar source of moisture. According to ASHRAE 62.2-2007, each bathroom shall have an exhaust fan of 50 CFM. If you have measured the flow of a bathroom exhaust fan to be 50

CFM or greater, then it is not affected and should not be included as one of your bathrooms. If you answer "Yes", then:

- a. # Baths Affected = your choice of 1 through 5. A bathroom (bath) is defined as a room that has a bathtub, shower, spa or similar source of moisture. **If you are intending to install the whole building ventilation fan in a bathroom, do not count it.** For each bath that is affected, you are asked:
 - i. Local CFM = the measured flow rate of an exhaust fan in this bathroom.
 - ii. Has Window = your choice of yes or no. Note that this question refers to openable windows only. If a bathroom has a window, but it does not open, answer this question "No".
2. Kitchen Affected? = your choice of "Yes" or "No". A kitchen is defined as any room containing cooking appliances. **If you are intending to install the whole building ventilation fan in the kitchen, then answer "No".**
 - a. Local CFM = the measured flow rate of an exhaust fan in the kitchen.
 - b. Has Window = your choice of yes or no. Note that this question refers to openable windows only. If a kitchen has a window, but it does not open, answer this question "No".

Tool Outputs

1. Alt Comp Supplement = the Alternative Compliance Supplement, which is the amount of flow, in CFM, that must be added to the whole building ventilation to compensate for the lack of local ventilation in the bathrooms and the kitchen.



An example of this tool starts with the screen at the left. You must first decide if bath(s) are affected. There are a number of reasons a bathroom would not be affected, in other words, would not be included in this procedure:

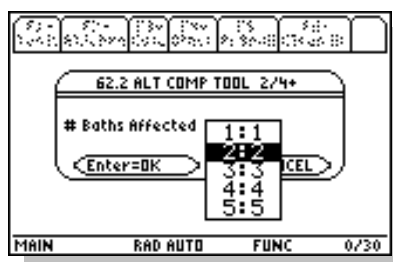
1. The bathroom does NOT have a tub, shower, spa, or similar source of moisture.
2. The bathroom complies with the primary compliance path of ASHRAE 62.2 meeting the local exhaust fan requirement of 50 CFM on-demand fan or a 20 CFM continuously operating fan.
3. The whole building ventilation fan will be located in this bathroom.

If there is a bathroom(s) that is affected, select “Yes”. If there are none affected, select “No”.

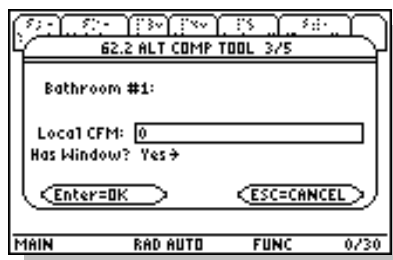
For this same dialogue box you must make a similar decision about the kitchen; is it affected or not? There are also reasons a kitchen might not be affected:

1. The kitchen satisfies the primary compliance path of ASHRAE 62.2, meeting the local exhaust fan requirement of 100 CFM on-demand fan or a 5 ACH (based on the kitchen volume) continuously operating fan.
2. The whole building ventilation fan will be located in the kitchen.

If you answer “Yes” to “Bath(s) Affected?”, you must choose the number of bathrooms affected. A dropdown menu allows you to select from one to five bathrooms. Let’s select two. Please note: you don’t have to select the number of kitchens because it is assumed there is only one.



For “Bathroom #1” we will assume no local exhaust fan and an openable window (if there is only a fixed window, it would not count as a window; to count as a window it must open). The sample screen at the left shows these entries.



Now we will assume that “Bathroom #2” has a 30 CFM fan (we measured the fan flow, of course) and no openable window.



For the kitchen we will assume a 40 CFM range hood and an openable window. For this procedure, it makes no difference if there is one openable window, or five openable windows. Now press [ENTER] to view the results.

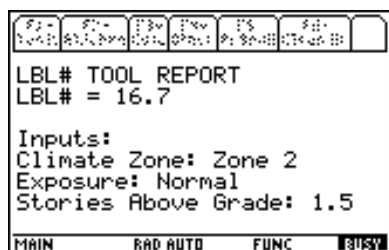
The “62.2 ALT COMP TOOL REPORT” is shown at the left. Notice that the “Alt Comp Supplement = 23”. This means that the whole building ventilation rate should be increased by 23 CFM in order to compensate for the deficiency of local exhaust ventilation in the two affected bathrooms and the kitchen of this example. If the whole building ventilation rate is increased by this amount, it will comply with the ASHRAE 62.2 alternate compliance path for existing dwellings.

It is likely that you will see this tool most when you use the “ASHRAE 62.2” program because it is an automatic call-up feature. You can use this tool by itself when you are strategizing about whether to comply with the normal requirements of the 62.2 Standard or use the alternate compliance path that this tool deals with.

8:LBL# (Lawrence Berkeley Laboratory number)

Input Variables

1. Climate Zone = your selection of “1:Zone 1”, “2:Zone 2”, “3:Zone 3”, or “4:Zone 4” from the climate zone map on page 111.
2. Exposure = your selection of “1:Well Shielded”, “2:Normal”, or “3:Exposed”. These terms have to do with the degree to which the house is exposed to wind. If the house is located in a dense suburb or in a thick forest, it is well shielded. If it is on the top of a hill with very little around it to protect it from the wind, it is exposed. If it is somewhere between these two descriptions, it is normal.
3. Stories Above Grade = your choice of the number of stories above grade line, including 1, 1.5, 2, 2.5, or 3. A raised ranch or a Cape Code style house is usually considered 1.5 stories. A ranch style house is usually one story.



Tool Outputs

1. LBL# = Lawrence Berkeley Laboratory number. This value shows the estimated relationship between CFM₅₀ and CFM on average over a heating season. For example, if the CFM₅₀ is 3000 and the LBL# is 16.7, as in the example at the left, the average CFM during the heating season is 3000/16.7 or 180.

The LBL# tool is called up automatically for the BTL program (F1-PRGMs, 2:Ventilation, 3:BTL) and for the WCEG program (F1-PRGMs, 3:WCEG).

9:ZTP# (ZipTest Pro number)

Input Variables

1. Building Ht = the height of the conditioned part of the building. This height should include the above-grade part of a basement if the basement is within the thermal envelope. Do not include an attic if it is not within the thermal envelope. This value is divided by an 8 foot ceiling height to find the number of stories.
2. Flow Exponent = the slope of the leakage curve of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the actual flow exponent for the building in question.
3. Living Sq Footage = the square feet of the occupied floor space. Basements that are not lived in but are considered to be within the thermal boundary of the house are usually not counted as occupied floor space.
4. Living Volume = this volume should correspond to the living area square footage, however, do not include below-grade volume.
5. Weather Factor = the weather factor for the local from the tables starting on page 108 that is closest to the actual house you are analyzing.

ZTP# TOOL 1/1

Building Ht: 20
 Flow Exponent: .65
 Living Sq Footage: 2000
 Living Volume: 16000
 Weather Factor: .91

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

ZTP# TOOL REPORT
 ZTP# = 16.4

INPUTS:
 Building Height: 20.0
 Flow Exponent: .65
 Living Sq Ft: 2000
 Living Volume: 16000

MAIN RAD AUTO FUNC 0/30

Tool Outputs

1. ZPT# = ZipTest Pro number.

This is a calculation procedure and value are unique to this ZipTest Pro³ software package. The ZPT# is analogous to the LBL#, but it is based on ASHRAE Standard 136-1993, *A Method of Determining Air Change Rates in Detached Dwellings*. Although no field research has been done that we know of to compare the accuracy of the LBL# and the ZTP#, it is likely that the ZTP# is more accurate.

If the CFM₅₀ value is divided by the ZTP#, the CFM for the dwelling on average during the heating season is the result.

The ZTP# is called up automatically for the ASHRAE 62.2 program (F1-PRGMs, 2:Ventilation, 1:ASHRAE 62.2) and the BTLa program (F1-PRGMs, 2:Ventilation, 2:BTLA).

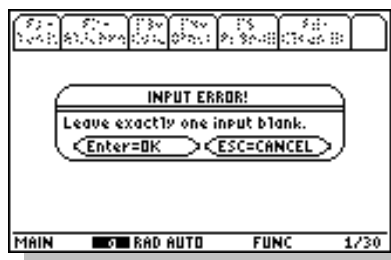
Chapter

4

Nuggets – F3

Please Note

For each of the Nugget input dialogue boxes, you must leave the fill box blank for the value you want to calculate.

**Introduction**

The thirty-seven equation Nugget in this section of ZipTest Pro³ package were selected for their relevance to building & energy diagnostics. Each of the equations is explained in this chapter.

The manner in which we programmed these equations allows you to solve for any of the variables of an equation, as long as values for all of the other variables are entered. No rewriting of the equation is necessary. You can do “what if” analysis, guess answers, and quickly find the correct one.

An extremely useful feature of the ZipTest Pro³ software is that variable values from programs, tools, and Nuggets are automatically saved to memory until the value is changed to a different value or a new session is started.

For each of the Nugget input dialogue boxes, you must leave the fill box blank for the value you want to calculate. If you forget to leave one blank and press [ENTER] you will receive the error message to the left.

**Please Note**

For each of the Nuggets described below, the variable that is **bold** after “Nugget Inputs/Outputs” is the one for which you are most likely to solve, making it the variable that best represents the use of that Nugget. However, you may solve for any of the variables in any Nugget.

After finishing your calculations with a particular Nugget, press [ESC] to return to the ZipTest Pro³ home screen with the navigation tabs at the top of the screen.

Using the Nuggets

To use the Nuggets enter values in all the fill boxes in a dialogue box **except** the one for which you want an answer, **this one must be left blank**. Then press [ENTER] twice for the solution. When the calculation is complete, our answer will now be in the fill box you left blank. If you want to solve for the same variable or another, simply delete ([DEL] or [CLEAR] key) the value in that fill box, making sure it is completely blank.

For each of the Nuggets described below, the variable that is **bold** under “Nugget Inputs/Outputs” is the one for which you are most likely to solve, making it the variable that best represents the use of that Nugget. However, you may solve for any of the variables in any Nugget.

Equation Selection

The Nuggets were collected and programmed by Rick Karg of WxWare Diagnostics, a division of R.J. Karg Associates, with the valuable help of Charlie Holly and Neil Moyer.

1:Air press/leak**1:Depress Tight Lim (Depressurization Tightness Limit or DTL)****Nugget Inputs/Outputs**

1. CFM = Cubic Feet per Minute for the total actual flow of exhaust appliances when they are all operating at the same time. The flow of these appliances should be measured if possible.
2. **CFM50 = the tested or assumed leakage rate of a house in units of Cubic Feet per Minute at the standard 50 Pascals difference between the inside and outside of the house.**
3. ΔP = the pressure difference between the indoors and outdoors of the building in units of negative Pascals (enter as a positive value).

4. Flow Exp = Flow Exponent (slope of the leakage curve) of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the flow exponent for the building in question. Use this known flow exponent.

This DTL (Depressurization Tightness Limits) Nugget allows you to solve for CFM₅₀, CFM or ΔP . The primary purpose of this Nugget is to allow you to determine if vented combustion appliances will vent properly from a house while all the appliances that exhaust air (bathroom and kitchen exhaust fans, clothes dryers, etc.) are operating.

Solving for CFM₅₀ is probably the most useful way to use this Nugget. To solve for CFM₅₀ you must leave the CFM₅₀ fill box blank and enter values for all the other variables. See the example at the left. Press [ENTER] to calculate CFM₅₀ depressurization tightness limit. For this example, assume the 400 CFM total for exhaust appliances is made up of a bathroom fan of 80 CFM, a kitchen fan of 120 CFM, and a vented clothes dryer of 200 CFM. Assume the ΔP of -2 Pascals (enter negative numbers as positive, without the negative sign) is your weatherization program's appliance depressurization limit for a conventionally vented gas water heater in the combustion appliance zone (CAZ). The standard flow exponent of 0.65 is entered.

When choosing the ΔP value to use, many energy auditing and weatherization programs select a $\Delta P = -5$ Pascals as the appliance depressurization limit for an oil- or gas-fired furnace or boiler. This is because common practice and testing has demonstrated that a negative pressure between indoors and outdoors of a greater negative magnitude than this will cause draft reversal. For example, if the combustion appliance zone (CAZ) contains a natural draft water heater, and your program's appliance depressurization limit for gas water heaters is -2 Pascals, this appliance is likely to suffer from draft reversal if the CAZ pressure is -4 Pascals with reference to the outdoors.

The tighter a weatherization crew makes a house (reduction of CFM_{50}), the greater the magnitude of the negative pressure created by a given total CFM of the exhaust appliances. Therefore, some weatherization programs use a depressurization tightness limit based on the vented appliances in the house to determine the limit to house tightening.

For the example problem, 3241 CFM_{50} is the calculated value. This means that if this house with a total of 400 CFM flow from exhaust appliances is tightened to 3241 CFM_{50} , a negative pressure of -2 Pascals will be created in the combustion appliance zone (if the flow exponent is 0.65).

A gas-fired range/oven or other unvented combustion appliance is not affected by negative pressures in a house because they are not vented – or coupled – to the outdoors, so the indoor-outdoor pressure difference is irrelevant for unvented combustion appliances.

With this Nugget you can also solve for CFM, the sum of the actual exhaust rate for all exhaust appliances operating simultaneously. To do this, you must enter values in all the fill boxes except the CFM box. This solution allows you to determine the maximum exhaust rate for a house with a given CFM_{50} . Again, you must select the appliance depressurization limit, ΔP , in units of Pascals. This is a helpful procedure if you are going to install any additional exhaust devices and wonder what total CFM exhaust rate will create a negative pressure of a higher magnitude than your threshold ΔP .

Finally, you can solve for ΔP in units of negative Pascals. If you know the sum of the actual CFM of exhaust appliances and the CFM_{50} of the house, you can determine the resulting negative ΔP in Pascals. This routine helps you determine if the combustion appliances are in danger of backdrafting when all the exhaust fans are operating simultaneously.

The value of the flow exponent can significantly influence the answers to the three solution paths. If you know the value for flow exponent, use it. The only way you can determine this value for a particular house is by performing a multi-point blower door

test. Be aware that as a house is tightened, the flow exponent value changes because the characteristics of the holes in the envelope are altered.

2:ACH natural (Air Change per Hour at natural conditions)

Nugget Inputs/Outputs

1. ACH Nat = the building air change rate per hour at natural pressure on average over the heating season. This average ACH can vary from the actual leakage by a factor of two or more over the heating season.
2. CFM50 = CFM₅₀ value from a standard blower door test.
3. LBL# = Lawrence Berkeley Laboratory correlation factor. Please refer to page 68 for a detailed explanation.
4. Vol = the volume of the building that is within the thermal envelope and above grade.

Air Changes per Hour (ACH) is sometimes used to compare the leakage of one house to another. Other values used for house leakage comparisons include ACH₅₀ and CFM₅₀. To determine the number of cubic feet of air leaking into a house in one hour on average during the heating season, multiply the house volume of air by the ACH value.

Because the ACH value is very dependent on the outdoor weather conditions, it can vary by a factor of two over the heating season. For example, as the outdoor temperature falls, the stack-effect air leakage in a house increases, thereby increasing the ACH. As the wind speed outdoors increases, the wind-driven air leakage increases, thereby increasing the ACH.

3:ACH at 50 Pascals (Air Change per Hour at 50 Pascals)

Nugget Inputs/Outputs

1. **ACH 50 = the building air change rate per hour at 50 Pascals of pressure difference between the indoors and outdoors of the building.**
2. CFM50 = CFM₅₀ value from a standard blower door test.
3. Vol = the volume of the building that is within the thermal envelope and above grade.

Air Changes per Hour at 50 Pascals of pressure difference between the inside and outside of a house (ACH₅₀) is less variable than ACH because it is calculated at a constant pressure difference. Because of this, it is a much better value than ACH for comparing the tightness of houses. Most analysts consider it more useful than CFM₅₀ for comparing house tightness rates because it adjusts for house volume.

4:Air equation (Building leakage air flow rate)

Nugget Inputs/Outputs

1. **Air Flow = the building leakage air flow rate.**
2. House Constant = the assumed air leakage flow at one Pascal of pressure difference.
3. ΔP = the pressure between the indoors and the outdoors of the building.
4. Flow Exponent = the slope of the leakage curve of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the flow exponent for the building in question. Use this known flow exponent.

SPEC LEAK RATIO NUGGET

Spec Leakage Ratio:

CFM50:

Abv Grd Surf Area:

Enter=OK ESC=CANCEL

MAIN RAD AUTO FUNC 0/30

SPEC LEAK RATIO NUGGET

Spec Leakage Ratio:

CFM50:

Abv Grd Surf Area:

Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

5:Spec leak ratio (Specific leakage ratio)

Nugget Inputs/Outputs

1. Spec Leakage Ratio = the specific leakage ratio (sometimes referred to as the Minneapolis leakage ratio), which is the CFM₅₀ value of the building divided by the above grade surface area of the same building.
2. CFM50 = CFM₅₀ value from a standard blower door test.
3. Abv Grd Surf Area = the above ground surface area of the thermal envelope of the building. Include above grade walls, windows, doors, attic floors, and other floors over unconditioned space.

The specific leakage ratio – CFM₅₀ of a building divided by the above grade surface area of the building – is a useful value for determining how leaky a house is.

For houses with specific leakage ratios greater than 1.0, usually cost-effective reductions in air leakage can be made. If the specific leakage ratio is less than 1.0, it is more difficult to achieve cost-effective reductions.

6:Stack pressure

Nugget Inputs/Outputs

1. ΔP at Given Ht = the building stack-effect pressure at a given height, in units of Pascals. This value should be the indoor pressure measured with reference to the outdoor pressure. Do not enter zero in this fill box.
2. Height above Neutral = the height in feet above the neutral plane. **If the observed height is below the neutral plane, enter this as a negative number by pressing the [(-)] key before the number.** The neutral plane is where the pressure in the building, from top to bottom, is zero. This is usually near the halfway-vertical height of the building, but many factors can change this, such as mechanical fans operating in the building. Do not enter zero in this fill box.
3. Outdoor Temp = the outdoor temperature in F°. If the outdoor temperature is below zero, use the [(-)] key before the below-zero number you enter.
4. ΔT = the difference between the temperature indoors and outdoors, F°. This value should be the indoor temperature minus the outdoor temperature. Do

not enter zero in this fill box.

This equation gives an estimate of the stack pressure in a building at a specific vertical location.

Notice in the example to the left, the “Height Above Neutral” is = -10 and the final “ ΔP at Given Ht” = -4.2 Pascals. If the “Height above Neutral” had been above the neutral plane, the resulting “ ΔP at Given Ht” would be a positive value.

For some fun, solve this Nugget for “Height Above Neutral” by leaving it blank, measuring the pressure with reference to the outdoors and entering this value in the “ ΔP at Given Ht” fill box. When you press the [ENTER] key, the “Height Above Neutral” answer will approximate the vertical distance of the neutral plane from where you measured the pressure with reference to the outdoors.

7: Heating \$ air leak (Annual heating cost of air leakage)

Nugget Inputs/Outputs

1. Heating \$/Yr = the annual heating costs of air leakage.
2. HDD = heating degree days, base 65 F°.
3. \$/Unit Fuel = the unit cost of heating fuel. For example, the cost per therm of natural gas or the cost per gallon of oil.
4. BTU/Unit Fuel = the input value of the corresponding heating fuel. The following values are suggested:
 - a. Electricity at 3412 Btu input per kWh.
 - b. Natural gas at 100,000 Btu input per therm.
 - c. Propane (LPG) at 91,500 Btu input per gallon.
 - d. #2 oil at 138,690 Btu input per gallon.
 - e. #1 oil at 134,000 Btu input per gallon.
 - f. K-1 kerosene at 126,000 Btu input per gallon.
 - g. Wood at 21,000,000 Btu input per cord.
5. CFM50 = CFM₅₀ value from a standard blower door test.
6. LBL# = Lawrence Berkeley Laboratory number. Please see page 68 for a

detailed explanation.

7. % Seasonal Eff = the estimated seasonal efficiency of the space heating system. Note: seasonal efficiency is always less than steady-state efficiency. Annual Fuel Utilization Efficiency (AFUE) is an estimate of seasonal efficiency. **Enter this value as a percentage.**

This Nugget estimates the annual heating cost of air leakage in a building. The example to the left is for natural gas at a unit cost of \$1.50 per therm. The total annual heat loss due to air leakage for the example is \$601.94

8:Heating CEG (Heating Cost Effective Guideline for air sealing)

Nugget Inputs/Outputs

1. CEG per 100 CFM50 = heating Cost-Effective Guideline per 100 CFM₅₀ reduction.
2. HDD = heating degree days, base 65 F°.
3. \$/Unit Fuel = the unit cost of heating fuel, for example, the cost of a gallon of fuel oil.
4. BTU/Unit Fuel = the input value of a unit of fuel, for example, the cost of a gallon of oil. The Btu per unit of fuel can be set as a default in the "F5 - Defaults" list. The fuel values suggested are:
 - a. Electricity at 3412 Btu input per kWh.
 - b. Natural gas at 100,000 Btu input per therm.
 - c. Propane (LPG) at 91,500 Btu input per gallon.
 - d. #2 oil at 138,690 Btu input per gallon.
 - e. #1 oil at 134,000 Btu input per gallon.
 - f. K-1 kerosene at 126,000 Btu input per gallon.
 - g. Wood at 21,000,000 Btu input per cord.
5. LBL# = Lawrence Berkeley Laboratory number. Please see page 68 for a detailed explanation.
6. % Seasonal Eff = the seasonal efficiency of the space heating system. Note that seasonal efficiency is always less than steady-state efficiency (that which is calculated with a combustion analyzer). Annual Fuel Utilization Efficiency

- (AFUE) is an estimate of seasonal efficiency. **Enter this value as a percentage.**
7. Payback Years = Reasonable payback period for weatherization measures, years.

The heating cost-effective guideline is the break-even point for air sealing in units of dollars per 100 CFM₅₀ reduction. The air sealing crew should continue to seal the building until the cost of an actual 100 CFM₅₀ reduction is equal to or more than the CEG per 100 CFM₅₀ value. See the Weatherization Cost Effective Guideline program on page 42 for a more thorough treatment of air sealing guidelines.

9: Air leak heat loss

Nugget Inputs/Outputs

1. BTU = the heat transferred (usually lost) in one year due to air leakage in Btu.
2. Volume = the volume of the building within the thermal envelope and above grade.
3. ACH = Air Changes per Hour. Please see Nugget "2: ACH natural" on page 75.
4. Degree Days = heating degree days, base 65 F°.

This Nugget estimates the heat loss in one year resulting from air leakage.

A: Cooling \$ air leak (Annual cooling cost of air leakage)

Nugget Inputs/Outputs

5. Cooling \$/Yr = annual cooling cost of air leakage.
6. CDD = cooling degree days, base 65 F°.
7. \$/kWh = kWh cost of electricity.
8. CFM₅₀ = CFM₅₀ from a blower door test.
9. LBL# = Lawrence Berkeley Laboratory number. Please see page 68 for a detailed explanation.
10. SEER = seasonal energy efficiency ratio for the cooling equipment.

This Nugget estimates the annual cooling cost of air leakage.

B: Cooling CEG (Cooling Cost Effective Guideline for air sealing)

Nugget Inputs/Outputs

1. **CEG per 100 CFM₅₀ = heating Cost-Effective Guideline per 100 CFM₅₀ reduction.**
2. CDD = cooling degree days, base 65 F°.
3. \$/kWh = kWh cost of electricity.
4. LBL# = Lawrence Berkeley Laboratory number. Please see page 68 for a detailed explanation.
5. SEER = seasonal energy efficiency ratio for the cooling equipment.
6. Payback Years = Reasonable payback period for weatherization measures, years.

The cooling cost-effective guideline is the break-even point for air sealing in units of dollars per 100 CFM₅₀ reduction. The air sealing crew should continue to seal the building until the cost of an actual 100 CFM₅₀ reduction is equal to or more than the CEG per 100 CFM₅₀ value.

C: Effective leakage

Nugget Inputs/Outputs

1. **ELA = Effective Leakage Area in square inches.**
2. CFM₅₀ = CFM house leakage at 50 Pascals of pressure difference.
3. Flow Exp = the slope of the leakage curve of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the flow exponent for the building in question. Use this known flow exponent.

D:Equivalent leakage

Nugget Inputs/Outputs

1. **EQLA = Equivalent Leakage Area in square inches. This is considered more accurate than the Effective Leakage Area, just above.**
2. CFM50 = CFM house leakage at 50 Pascals of pressure difference.
3. Flow Exp = the slope of the leakage curve of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the flow exponent for the building in question. Use this known flow exponent.

2:Heating/Cooling

1:\$/therm of fuel

Nugget Inputs/Outputs

1. **\$/Therm = the output cost per 100,000 Btu (therm) supplied to the conditioned volume of the house.**
2. \$/Fuel Unit = the unit cost of heating fuel, for example, the cost of a gallon of fuel oil.
3. BTU/Fuel Unit = the input value of a unit of fuel, for example, the cost of a gallon of oil. The Btu per unit of fuel can be set as a default in the "F5 - Defaults" list. The fuel values suggested are:
 - a. Electricity at 3412 Btu input per kWh.
 - b. Natural gas at 100,000 Btu input per therm.
 - c. Propane (LPG) at 91,500 Btu input per gallon.
 - d. #2 oil at 138,690 Btu input per gallon.
 - e. #1 oil at 134,000 Btu input per gallon.
 - f. K-1 kerosene at 126,000 Btu input per gallon.
 - g. Wood at 21,000,000 Btu input per cord.

4. % Seasonal Eff = the seasonal efficiency of the space heating system. Note that seasonal efficiency is always less than steady-state efficiency (that which is calculated with a combustion analyzer). Annual Fuel Utilization Efficiency (AFUE) is an estimate of seasonal efficiency. **Enter this value as a percentage.**

This Nugget can be used to find the comparative “\$/Fuel Unit” of different fuels. For example, if you just calculated the “\$/Therm” for #2 Oil is \$3.00 and you want to find the comparative “\$/Fuel Unit” for natural gas; simply leave the value of \$3.00 in the “\$/Therm” fill box, leave the “\$/Fuel Unit” fill box blank, enter 100,000 in the “BTU/Fuel Unit” fill box, enter the appropriate seasonal efficiency in the “% Seasonal Eff” fill box, and press [ENTER].

There is a similar tool in the software package, “F2-Tool, 2:Fuel, 1:\$/Therm”. When using this tool, you don’t have to enter the BTU/Fuel Unit. This tool is discussed on page 54.

2:Annual heating

Nugget Inputs/Outputs

1. **Fuel Qty = estimated annual fuel quantity.**
2. Design Heat Load = calculated Design Heat Load (DHL) in Btu/hr. Use an acceptable method of calculation, for example, *Residential Load Calculation – Manual J* by the Air Conditioning Contractors of America (ACCA).
3. HDD = heating degree days, base 65 F°.
4. HDD Corr Factor = empirical correction factor for HDD₆₅. Please refer to page 111 for a list of heating degree day correction factors. This value must be equal to or between 0.3 and 1.2.
5. BTU/Fuel Unit = the input value of a unit of fuel, for example, the cost of a gallon of oil. The Btu per unit of fuel can be set as a default in the “F5 – Defaults” list. The fuel values suggested are:
 - a. Electricity at 3412 Btu input per kWh.
 - b. Natural gas at 100,000 Btu input per therm.
 - c. Propane (LPG) at 91,500 Btu input per gallon.

Comment

See *Residential Load Calculation- Manual J*, by Air Conditioning Contractors of America (ACCA).

- d. #2 oil at 138,690 Btu input per gallon.
- e. #1 oil at 134,000 Btu input per gallon.
- f. K-1 kerosene at 126,000 Btu input per gallon.
- g. Wood at 21,000,000 Btu input per cord.
- 6. % Seasonal Eff = the seasonal efficiency of the space heating system. Note that seasonal efficiency is always less than steady-state efficiency (that which is calculated with a combustion analyzer). Annual Fuel Utilization Efficiency (AFUE) is an estimate of seasonal efficiency. **Enter this value as a percentage.**
- 7. Design ΔT = design temperature difference F° . This value should be the same design temperature difference used to calculate the Design Heat Load (DHL) of the building. The indoor design temperature is almost always $70 F^{\circ}$. The outdoor design temperature is dependent on the climate. Please refer to *Residential Load Calculation - Manual J* by the Air Conditioning Contractors of America (ACCA) for outdoor design temperatures.

3:Eff improve saving (Savings from heating system efficiency improvements)

Nugget Inputs/Outputs

- 1. **Savings = the fuel quantity or dollar savings from heating system efficiency improvements.**
- 2. Initial Amt = quantity or dollars of fuel consumed **before** efficiency improvements.
- 3. Initial % Eff = steady-state efficiency **before** efficiency improvements as a percentage.
- 4. % Eff Increase = steady-state efficiency increase as a result of improvements, as a percentage.
- 5. OSF = the off-cycle factor. For hot-air systems, 1.2 to 1.4; hot water systems, 1.4 to 1.6; and for steam systems, 1.6 to 1.8. This value must be from 1 to 2.

4:SIR system replace (Savings-to-Investment Ratio for replacing a heating system)

Nugget Inputs/Outputs

1. **SIR = the Savings-to-Investment Ratio, of the number of dollars saved for each dollar invested over the reasonable life of the heating replacement unit.**
2. Life = reasonable life of upgrade equipment or replacement heating system. May also use for this variable the Uniform Present Value (UPV) which represents a discounted life value.
3. OSF = the off-cycle factor. For hot-air systems, 1.2 to 1.4; hot water systems, 1.4 to 1.6; and for steam systems, 1.6 to 1.8. This value must be from 1 to 2.
4. Initial Fuel \$ = fuel cost before replacement or upgrade.
5. Upgrade Cost = total cost of replacing or upgrading the heating system.
6. Initial % Eff = steady-state efficiency before efficiency improvements as a percentage.
7. % Eff Increase = steady-state efficiency increase as a result of improvements, as a percentage.

5:Sensible/total (Cooling sensible-to-total load ratio)

Nugget Inputs/Outputs

1. **Sensible/Total = sensible cooling capacity to total cooling capacity ratio of air-to-air equipment.**
2. CFM = cubic feet per minute of air flowing across the cooling coil.
3. Entering Wet-bulb = entering wet-bulb temperature, F^o.
4. Entering Dry-bulb = entering dry-bulb temperature, F^o.
5. Outdoor Dry-bulb = outdoor dry-bulb temperature, F^o.

Comment

See *Residential Equipment Selection – Manual S*, by Air Conditioning Contractors of America (ACCA).

6:Total capacity (Cooling total capacity)

Nugget Inputs/Outputs

1. **Total Capacity = total capacity of air-to-air cooling equipment.**
2. KK = a constant. For generic cooling equipment, use 20780.
3. CFM = cubic feet per minute of air flowing across the cooling coil.
4. Entering Wet-bulb = entering wet-bulb temperature, F^o.
5. Outdoor Dry-bulb = outdoor dry-bulb temperature, F^o.

Comment

See *Residential Equipment Selection – Manual S*, by Air Conditioning Contractors of America (ACCA).

TIP

Don't forget, you can do math calculations on the fly with ZipTest Pro³. For example if you have a U-factor of 0.35, just enter "1[÷].35" in the "R-value" fill box. Your answer will be calculated and the returned result in the fill box will be "2.86" for the R-value.

3:Heat transfer**1:Surface transfer (Surface heat transfer)****Nugget Inputs/Outputs**

1. **BTUs = transmission (surface) heat transfer through a surface.**
2. Surface Area = heat transfer surface area in square feet.
3. Degree Days = heating or cooling degree days in F⁰.
4. R-value = the resistance to heat transfer in units of (Ft², F⁰, Hr)/Btu. The R-value is the inverse of the U-factor.

Use this equation to calculate the Btu annual savings resulting from an increase in R-value.

2:R-value infrared (Calculated R-value from infrared camera)**Nugget Inputs/Outputs**

1. **Wall R-value = calculated R-value of wall or other surface.**
2. Wall ΔT = Difference between the indoor surface temperature and the outdoor surface temperature in F⁰. **Enter as a positive number.**
3. Int Air - Int Wall = Interior air temperature minus the interior wall surface temperature, F⁰. Enter as a positive number.

This Nugget is useful for determining the R-value of a building assembly if you know the difference between the interior and exterior wall **surface** temperatures (an infrared camera or non-contact thermometer can be useful in determining these temperatures) and the interior (indoor) **air** temperature. Make sure you measure the indoor air temperature within a few feet of the wall in question.

4:Geometry

1:Area of triangle

Nugget Inputs/Outputs

1. Area = the area of that triangle.
2. Base = the base dimension of the triangle.
3. Height = the height of the triangle.

In the example at the left a gable end has a base dimension of 24 feet and a height of 12 feet, yielding an area of 144 square feet.

2:Area of circle

Nugget Inputs/Outputs

1. Area = the area of a circle.
2. Diameter = the diameter of the circle.

3:Circum of circle (Circumference of circle)

Nugget Inputs/Outputs

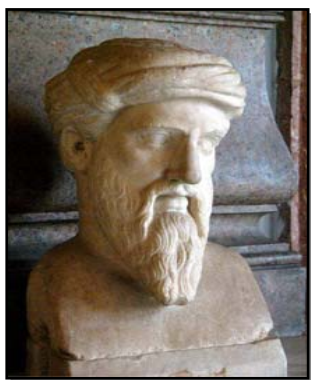
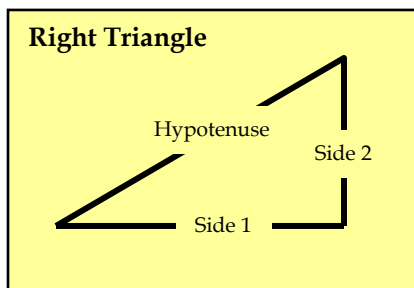
1. Circumference = the circumference of a circle.
2. Diameter = the diameter of the circle.

4:Duct round to rect (Round duct to rectangular)

Nugget Inputs/Outputs

1. Duct Diam = equivalent round duct diameter.
2. Side #1 = one rectangular dimension of the duct.
3. Side #2 = other rectangular dimension of the duct.

This Nugget is for converting round duct to rectangular dimensions or rectangular duct to round dimensions. For the example at the left, a rectangular duct with sides of 9 inches and 3 inches is the equivalent to a 5.5 inch diameter round duct. Remember, you



Pythagoras of
Samos

can also solve for one side of a duct if you enter the other side dimension and the round equivalent.

5:Pythagorean

Nugget Inputs/Outputs

1. **Hypotenuse = the hypotenuse of a right triangle. This is the side opposite the right angle of the triangle.** Please note: the hypotenuse **MUST** always be longer than either of the other sides.
2. Side 1 = side 1 of the right triangle, in units of length.
3. Side 2 = side 2 of the right triangle, in units of length.

This is probably the oldest equation in the ZipTest Pro^{3™} software package, dating back to the Greek named Pythagoras who was born between 580 and 572 BC and died between 500 and 490 BC. This equation can be used for finding a right angle, for example, if you are adding an addition to an existing house, you can ensure the new projecting walls are at exact right angles to the existing house with this equation. If you prefer to work with whole numbers, any multiple of the values 3, 4, and 5 will work in the equation.

5:Carbon monoxide

1:CO air-free (Carbon Monoxide air-free from CO as-measured)

Nugget Inputs/Outputs

1. **CO Air-free ppm = air-free carbon monoxide in units of parts per million (ppm). This is a calculated undiluted value.**
2. CO As-measured ppm = as-measured carbon monoxide in units of parts per million (ppm). This is a diluted sample.
3. % Oxygen = the percent of oxygen (O₂) in the flue gas sample. Enter this as a percentage, not as a decimal. For example, enter 9.5 percent as 9.5, not as 0.095.

Tip

For a typical heating system, the oxygen percentage in the flue gas of around 10, resulting in air-free CO or about twice the as-measured CO.

Use this Nugget for converting from as-measured carbon monoxide measurements to air-free measurements. Notice that the higher the oxygen percentage is in the combustion gas, the higher air-free carbon monoxide is for a given level of as-measured carbon monoxide.

6: Ventilation**1: Fan run-time****Nugget Inputs/Outputs**

1. Required CFM = the whole building ventilation required in a house for acceptable indoor air quality.
2. Fan CFM = the realistic air flow the fan is able to deliver in Cubic Feet per Minute.
3. **Min/Hr Fan On = the minutes per hour the fan should run to deliver the required CFM.**

This Nugget is intended to be used with these ZipTest Pro^{3™} features:

1. New Construction ASHRAE 62.2 (F2-Tools, New Const 62.2);
2. ASHRAE 62.2 for existing construction (F1-PRGMs, 2: Ventilation, 1: ASHRAE 62.2); and
3. Building Tightness Limit advanced (F1-PRGMs, 2: Ventilation, 2: BTLA).

FAN RUN-TIME NUGGET

Required CFM: 40

Fan CFM: 90

Min/Hr Fan On: 27

Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

In the example at the left, the required whole building ventilation is to be 40 CFM. The actual CFM of the fan available is 90. The “Min/Hr Fan On” is calculated to be 27, in other words, the fan should operate for twenty-seven minutes each hour at a flow rate of 90 CFM to achieve an effective ventilation rate of 40 CFM.

2:Vent heat energy (Annual cost of space heating for ventilation)

Nugget Inputs/Outputs

1. **\$/Yr Vent Heating = annual cost of space heating energy for ventilation.**
2. CFM = actual Cubic Feet per Minute of ventilation fans. Note that this equation assumes there is no heat recovery for this ventilation. If there is heat recovery, such as with heat recovery balanced ventilation, determine the actual CFM flow that is not recovered and use this as the CFM.
3. Air Density = density of air (at sea level 0.075 pounds per cubic foot). See Air Density Correction Factors on page 113.
4. Hrs/Day Fan On = Hours of average daily run time of ventilation fan(s).
5. HDD = heating degree days, base 65 F°.
6. \$/Therm Fuel = dollar cost per therm of space heating fuel, input value.
7. % Seasonal Eff = the estimated seasonal efficiency of the heating system. **Enter as a percentage.**

Note: this equation does not assume any interaction with air leakage from stack or wind effects.

3:Vent elec energy (Annual cost of electricity for ventilation)

Nugget Inputs/Outputs

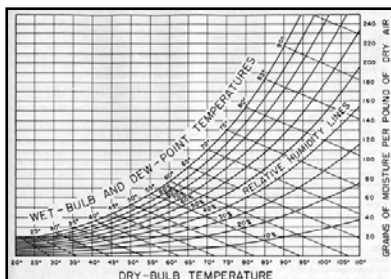
1. **\$/Yr Vent Elec = annual electrical cost to operate the ventilation fan.**
2. Fan Watts = rated power consumption of fan in Watts.
3. Hrs/Day Fan On = Hours of average daily run time of ventilation fan.
4. Heating Days = the number of heating days per year. A heating day is any day having an average outdoor temperature of less than 65 F°.
5. \$/kWh = cost of electricity in kWh.

7: Psychrometrics

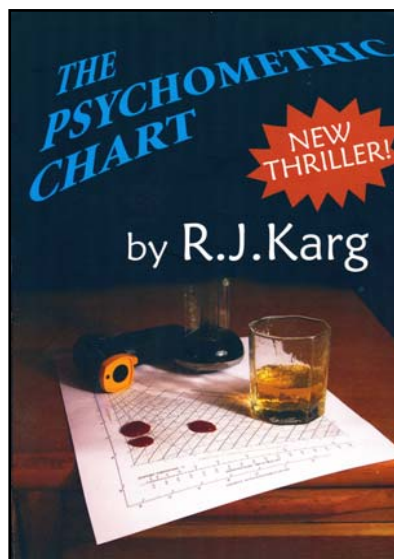
1: Dew point

Nugget Inputs/Outputs

1. Dewpoint = the temperature at which air becomes saturated with water vapor or the temperature at which the air reaches 100 percent relative humidity, F° .
2. Rel Humidity = a measurement of the amount of water vapor in the air at a given temperature. The ratio of the actual specific humidity in the air to the maximum specific humidity the air can hold at a given temperature.
3. Air Temp = the temperature of the air, F° .



Sample Psychrometric Chart



A bit of raillery

If the dew point temperature falls below freezing it is often called the frost point because the water vapor no longer condenses to dew (liquid water), but creates frost (or hoarfrost) by desublimation, the reverse of sublimation.

Below is a table showing the relationship between the dew point temperature and human comfort. Of course, dew point temperatures affect people differently, but it is safe to say that if the dew point temperature is greater than 75 F° everyone will feel discomfort.

<i>Relationship Between Dew Point Temperature and Human Comfort</i>		
Dew Point Temp	Human Perception of Comfort	Relative Humidity at 90 F°
Greater than 75 F°	Very uncomfortable, can be oppressive	Greater than 62%
70 - 74 F°	Very humid, quite uncomfortable	52 - 60%
65 - 69 F°	Uncomfortable for most people	44 - 52%
60 - 64 F°	Uncomfortable for some people	37 - 46%
55 - 59 F°	Comfortable for most	31 - 41%
50 - 54 F°	Very comfortable for most	26 - 30%
Less than 49 F°	A bit dry for some people	Less than 30%
Based on chart at http://en.wikipedia.org/wiki/Dew_point		

8: Thermal comfort

1: Wind chill v2001

Nugget Inputs/Outputs

1. **Wind Chill = equivalent wind chill temperature.** If you enter a number here, it must be from -98 to 44 F^o.
2. **Air Temp = temperature in F^o.** If the temperature is below zero, enter a negative sign before the temperature by pressing the [-] key. This number must be from -45 to 45 F^o.
3. **Wind Speed = the wind speed in miles per hour.** This number must be from 3 to 60 miles per hour.

Comment

This version of the wind chill equation has been used since 2001 by the National Weather Service.

9: Finance

1: Loan payments

Nugget Inputs/Outputs

1. **Payment = principle and interest payment each period, usually each month.**
2. **Loan Amount = the amount of the loan or present value.**
3. **Interest = the interest payment per period.** A 12 percent annual interest rate on a loan paid back monthly is 12/12 months per year = 1.0 percent interest per payment period. **Enter this per-period interest rate as a percentage**, not a decimal.
4. **# Periods = the number of periods of the loan.** A five year loan with a monthly payment has a “# Periods” of 60. This must be entered as a whole number.

TIP

Don't forget, with this and all the other Nuggets, you can solve for ANY of the variables by entering values in all the fill boxes, but leaving blank the one for which you want a solution.

2:SIR (Savings-to-Investment Ratio)

Nugget Inputs/Outputs

1. **SIR = the simple Savings-to-Investment Ratio.**
2. Savings = the dollar savings the first year as a result of the installing the energy-saving measure.
3. Cost = the dollar cost of installing the energy-saving measure.
4. Life = reasonable life of upgrade equipment or replacement heating system. May also use for this variable the Uniform Present Value (UPV) which represents a discounted life value. Discount values (UPV or uniform present value) are usually published very April by the National Institute of Standards and Technology (NIST). Please see *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis - April 2008*, NIST. This document is available on the Internet.

If the SIR is less than one, the energy-saving measure is not worth implementing; if it is more than one, it is worth implementing. The greater the SIR value, the better.

A:Air speed

1:Air speed, fpm

Nugget Inputs/Outputs

1. **Air Speed = the air speed in units of feet per minute.**
2. Velocity Press = the velocity pressure in Pascals. Enter as a positive value. Enter as a positive number.

This equation is for sea-level air density. This equation will give the pressure against the side of a building if the wind speed, in feet per minute, at the side of the building is known. Also, you can measure the velocity pressure of moving air with a digital manometer; enter the value into the Nugget and solve for "Air Speed".

2: Air speed, mph

Nugget Inputs/Outputs

1. **Air Speed = the air speed in units of miles per hour.**
2. Velocity Press = the velocity pressure in Pascals. Enter as a positive value.
Enter as a positive number.

AIR SPEED, MPH NUGGET

Air Speed: 20.6

Velocity Press: 50.0

Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

This equation is for sea-level air density. You can measure the velocity pressure of moving air with a manometer; enter the value into the Nugget and solve for "Air Speed".

In the example to the left the Velocity pressure of 50 Pascals was entered; "Air Speed" was left blank. A velocity pressure of 50 Pascals is the equivalent to a 20.6 mile per hour wind. Have you ever heard that depressurizing a house to -50 Pascals is the equivalent of a 20 mile per hour wind against all sides of the house simultaneously?

B: Miscellaneous

1: Body Mass Index

Nugget Inputs/Outputs

1. **Body Mass Index = the Body Mass Index (BMI).** This is used by physicians to determine if an adult is overweight. This equation has nothing to do with building diagnostics, but it might have a lot to do with how many doughnuts you eat at break time. A healthy BMI is 25 or under, overweight is 25 to 30, and a BMI above 30 is considered obese.
2. Weight = person's weight in pounds.
3. Height = person's height in inches.

BODY MASS INDEX NUGGET

Body Mass Index: 26.53

Weight: 190.0

Height: 71.0

Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

BODY MASS INDEX NUGGET

Body Mass Index: 24.00

Weight: 171.9

Height: 71.0

Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

If Sam weighs 190 pounds and is 71 inches tall, his BMI, as shown at the left is 26.53. Sam wants to know how much weight he must lose to reduce his BMI to 24. All he has to do is enter 24 for the "Body Mass Index" value and leave the "Weight" fill box blank. Sam must get his weight down to about 172 pounds for a BMI of 24. No more doughnuts at break time

Chapter 5

Reports

Reports-F4

This feature of ZipTest Pro³ allows you to save up to eight reports for later review. A report includes the input values you entered and the answers of a program or a tool. The results from Nuggets cannot be saved as reports, however you can save them as screen captures to print or include in a report (please see “Printing a Screen Image or Adding an Image to a Report” on page 1).

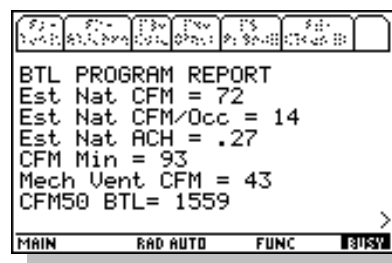
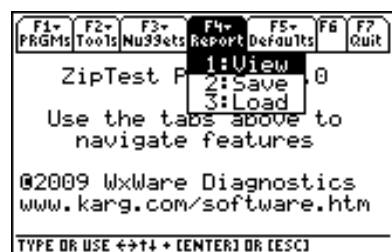
Saving reports allows you to view reports back at your office or share them with your crew, subcontractors, colleagues, or supervisor.

1:View

This feature allows you to view the report resulting from the **last** calculated program or tool answers or loaded by the “F4-Reports, 3:Load” feature. Do not use this menu choice if you want to view a report saved in one of the eight report memory slots, unless it was the last report you generated or loaded (please see “3:Load” below).

2:Save

After you view a program or a tool report following a calculation, you cannot navigate directly to the report menu tab, F4-Reports (note that when a report is showing, such as the sample report to the left, the navigation tabs at the top of the screen are inactive, so

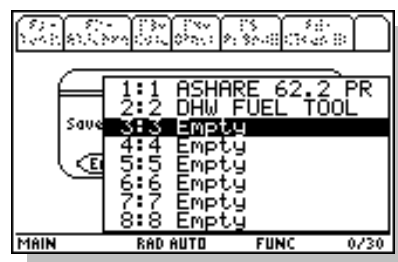


you cannot go to the report menu directly). You must first leave the report screen by pressing [ENTER] or [ESC] to return to the ZipTest Pro³ home screen.



Now press [F4] for F4-Reports and then select "2:Save". You will be asked to which of eight report memory slots you would like to save your report.

Because there are reports already saved in the example to the left, and because we don't want to overwrite either of these saved reports, we must select an empty report memory slot. The screen at the left asks if we want to save the report to the first memory slot. Because we don't want to do this for this example, press the right cursor key to see the eight memory slot names.

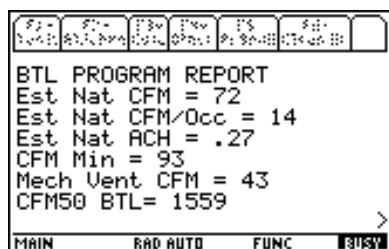
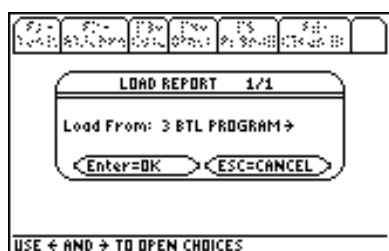
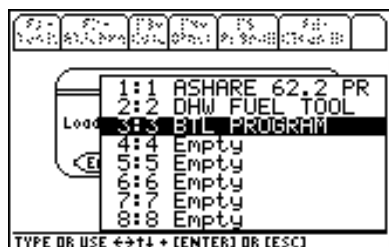


The first memory slot contains the report for the use of the "ASHRAE 62.2 PROGRAM" and the second for "DHW FUEL TOOL". Scroll down to memory slot 3, which is empty and press [ENTER] to save the results of the BTL program report to this memory slot.

After you press [ENTER] to save the BTL report to memory slot 3, the BTL report will show on the screen again. Now you may press [ENTER] or [ESC] to return to the ZipTest Pro³ home screen.

Because you have no control of the saved report name (you cannot alter the given name or assign a date to a report), we recommend you keep a brief written record of the jobs to which your saved reports apply and their saved date.

You may write over saved reports if you need to; the written-over report is deleted and replaced by the new report. It is important to know that when you select "NEW SESSION" after loading the ZipTest Pro³ software into the working area of your TI-89 Titanium calculator, all saved reports are deleted. On the other hand, if you select "CONTINUE SESSION" your existing reports are not deleted. Please refer to Session choice: "NEW SESSION" or "CONTINUE SESSION" on page 5.



3:Load

This feature allows you to view any saved report by loading it into the memory so that it can be viewed. On the sample screen to the left, notice three reports have been saved; five memory slots are still empty. Let's assume we want to view the "BTL PROGRAM" report in memory slot 3. Highlight this report and press [ENTER].

The "LOAD REPORT" input dialogue box will appear with the message "Load From: 3:BTL PROGRAM". If you decide at this time that this is not the report you want to load, press [ESC] to go back to the list of reports to select another. If this is the report you want to view, press [ENTER] to select it. The selected report will appear next on the screen, similar to the sample at the left.

Notice at the bottom right corner of the screen there is a ">" indicated there is more to the report that what shows on the screen. Scroll downward to additional items by pressing the down cursor key. You can also press the [♦] key (lime green) and the down cursor key to scroll larger segments of the report, or the [2nd] (light blue) and then the down cursor key to scroll to the end of the report. These key actions also allow you to scroll up.

Chapter 6

Defaults and Quitting

F5-Defaults

The default menu makes solving problems with the ZipTest Pro³ software much easier. Reasonable default values are set at the ZipTest software factory, but you can change these values any time you wish to streamline your input entry into programs, tools, and Nuggets.

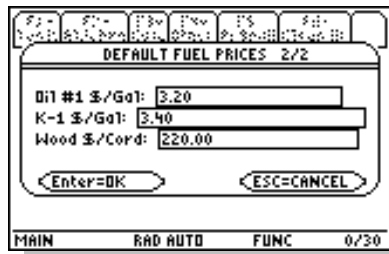
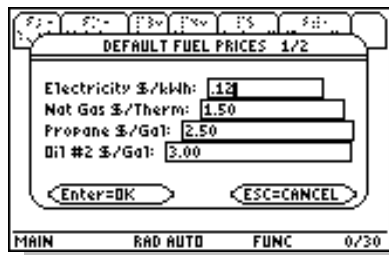
When you press [F5] the dropdown default menu appears. The choices on this menu are shown at the left. Each of the four choices is explained below.

A special comment for those of you who are working as part of a state weatherization or other program: The administrators of your program are likely to want to control the default values you use so that they have the capability to compare calculated data and ensure that the results you get in the field are valid and consistent. We urge you to use your program administrators recommended default values.

1:Edit

When you select “1:Edit”, you are able to change any default value to suit your needs. There are many reasons to change default values, including fuel price changes, customizing your default values for your climate, and setting heating system efficiencies to correspond to the systems you most often find in the field.





Notice the 5th choice in the default edit menu is “Quit Editor”. This choice saves all the changes you have made to your permanent default menu.

Let’s look at an example of editing the price of some fuels. With “1:Fuel Prices” highlighted, as it is at the left, press [ENTER]. The title of the input dialogue box is “DEFALT FUEL PRICES 1/2”. The “1/2” indicates this is the first of two dialogue boxes for default fuel prices. Change any of these fuel prices you wish by entering the new price. Don’t forget to enter decimal points. When you are ready to move to the next dialogue box, press [ENTER].

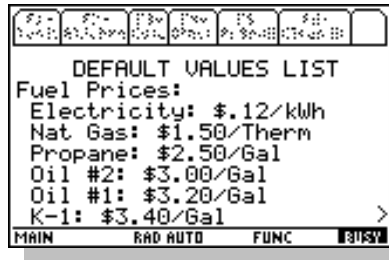
After changing any default values in this second of two input dialogue boxes for fuel prices, press [ENTER] to return to the default edit menu. If you wish to edit default values in other categories, select those categories and alter any of the default values you wish.

When you are finished with editing, select the fifth option from the menu, “5:Quit Editor” to return to the ZipTest Pro³ home screen.

2:View

If you select this option, you can only view the default values, you cannot change them. This might seem limited, but when you view the default values there is no chance that you will change a value by mistake.

There is no menu to select a group of default values to view; the entire list is displayed for viewing. Scroll downward to additional items by pressing the down cursor key. You can also press the [♦] key (lime green) and the down cursor key to scroll larger



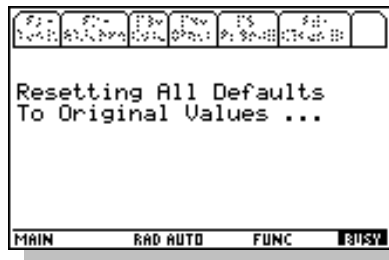
segments of the defaults list, or the [2nd] (light blue) and then the down cursor key to scroll to the end of the list. These key actions also allow you to scroll up.

The sample screen to the left shows the first part of the default values list after selecting “2:View”. This full list is not displayed; you must scroll down to see all the values on the list.

Press [ESC] to go back to the ZipTest Pro³ home screen. If you press [ENTER] you can view the last report calculated for a program or tool or loaded by the “F4-Reports, 3:Load” feature.

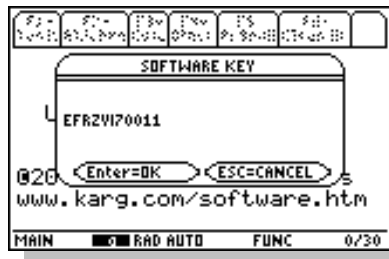
3:Reset

If you select “3:Reset”, the default values revert back to the values that were set in the software package when it was loaded into your TI-89 Titanium calculator, sometimes called factory default values. When you select this option, your TI-89 calculator screen will look similar to the sample screen at the left during the reset process. When the reset process is complete, you will be returned to the ZipTest Pro³ home screen.



4:Software Key

This allows you to quickly view your unique eleven-character software key for your ZipTest Pro³ software package. The sample screen at the left shows the software key screen. The software key for each TI-89 Titanium calculator is unique, so please don’t try using the software key to the left; it will not work.



Quit – F7

Press the [2nd] and then [F2] to activate the [F7] function for “Quit”. This quits the ZipTest Pro³ software package and takes you back to the TI-89 home screen. To load the ZipTest Pro³ software package again in the working memory of the calculator, simply press the [♦] key (lime green) and then the [3] key. After a few seconds the ZipTest Pro³ home screen will appear. Now you are ready to diagnose, analyze, and save energy.

Chapter

7

Appendices

ZipTest Pro² compared to ZipTest Pro³

1 - Calculation Features Comparison of ZipTest Pro ² and ZipTest Pro ³ Software Packages (listed in the same order in which they appear in the ZipTest Pro ² software manual)		
ZipTest Pro ²	ZipTest Pro ³	Comments
Programs	F1-PRGMs	
BTL1	F1-PRGMs, 2:Ventilation	Indoor air quality and ventilation
BTL (ASHRAE 62-1989)	F1-PRGMs, 2:Ventilation, 3:BTL	Now calculates ventilation CFM
BTLa (ASHRAE 62-1989)	F1-PRGMs, 2:Ventilation, 2:BTLa	
ASHRAE 62.2	F1-PRGMs, 2:Ventilation, 1:ASHRAE 62.2 and F2-Tools, New Const 62.2	See also F2-Tools, 4:New Constr 62.2
BTUDD	F1-PRGMs, 1:Energy index	Calculation of energy index
W/FQ	F1-PRGMs, 1:Energy index	Determines Btu/ft ² ,HDD from fuel quantity
W/F\$	F2-Tools, 2:Fuel, 2:Cost to Units now converts dollars of fuel to units of fuel	If need to convert \$ to units before using F1-PRGMs, 1:Energy index, use F2-Tools, 2:Fuel, 2:Cost to Units
DTL	Now a Tool (see below)	Depressurization Tightness Limit
CFM50 DTL	F3-Nuggets, 1:Air press/leak, 1:Depress tight Lim	Now F3-Nuggets, 1:Air press/leak, 1:Depress tight Lim solves
cfm Exhaust limit	(As above)	Now F3-Nuggets, 1:Air press/leak, 1:Depress tight Lim solves
Resulting ΔP	(As above)	Now F3-Nuggets, 1:Air press/leak, 1:Depress tight Lim solves

2 - Calculation Features Comparison of ZipTest Pro ² and ZipTest Pro ³ Software Packages (listed in the same order in which they appear in the ZipTest Pro ² software manual)		
ZipTest Pro ²	ZipTest Pro ³	Comments
PRESS		Pressure diagnostics programs
Mbd3	F2-Tools, 1:Blower Door, 1:Minn BD3	See also F2-Tools, 2:Adj CFM50
BLDΔP (ZPD)	F1-PRGMs, ZPD	Zone Pressure Diagnostics
Hole Method	F1-PRGMs, ZPD, 1:Hole Method	Add-a-hole method
Door Method	F1-PRGMs, ZPD, 2:Door Method	Open-a-door method
Vent Method	Not included	Method not credible
BLSTR (Duct Blaster)	F2-Tools, 3: Duct Blaster	Duct Blaster™ brand only
DUCΔP	Not included because of low use	Duct series leakage diagnostics
HOLE	Not included because of low use	Add-a-hole method
MODSB	Not included because of low use	Blower-door-subtraction method
NELSN	Not included because of low use	Full-Nelson method
TWIST	Not included because of low use	Nelson-with-NFR-twist method
WCEG	F1-PRGMs, 3: WCEG	Weatherization Cost Effective Guidelines
ZPDa	Not included because of low use	Zone Pressure Diagnostics advanced
Multi-Point Blower Door and Duct Blower Testing	Not included because of low use	Regression analysis for testing, with graphing capabilities
Equation Nuggets	F3-Nuggets	Much easier to use Nuggets now
ABMI	F3-Nuggets, 8:Miscellaneous, 1: Body Mass Index	Body Mass Index (BMI)
ACFM	F3-Nuggets, 1:Air press/leak, 1:Depress tight Lim	Pressure created by exhaust devices
ACFM1	Not included. See F1-PRGMs, 2:Ventilation	Determination of vent fan size
ACFMd	F2-Tools, 1:Blower Door, 2:Adj CFM50	Blower door depressurization temperature adjustment
ACFMp	(As above)	Blower door pressurization temperature adjustment
ACH50	F3-Nuggets, 1:Air press/leak, 3:ACH at 50 Pascals	Air changes per hour at 50 Pascals of pressure difference
ACHIL	F3-Nuggets, 8:Thermal comfort, 1: Wind chill v2001	This is the 2001 version of this calculation
ACHN	F3-Nuggets, 1:Air press/leak, 2:ACH natural	Air changes per hour natural average over season
ACIRa	F3-Nuggets, 4:Geometry, 2:Area of circle	Area of a circle
ACIRc	F3-Nuggets, 4:Geometry, 2:Circum of circle	Circumference of a circle

3 - Calculation Features Comparison of ZipTest Pro2 and ZipTest Pro3 Software Packages (listed in the same order in which they appear in the ZipTest Pro2 software manual)		
ZipTest Pro ²	ZipTest Pro ³	Comments
Equation Nuggets	F3-Nuggets	[Continued from previous page]
ACLG1	F3-Nuggets, 1:Air press/leak, A:Cooling \$ air leak	Annual cooling cost of air leakage
ACLG2	F3-Nuggets, 1:Air press/leak, B:Cooling CEG	Cooling cost-effective guideline for air sealing
ACO2O	Not included because of low use	Air-free CO from #2 oil
ACOAR	F3-Nuggets, 5:Carbon monoxide, 1:CO air-free	Air-free CO from as-measured CO
ACOLP	Not included because of low use	Air-free CO from LPG
ACONG	Not included because of low use	Air-free CO from natural gas
ACORM	Not included because of low use	CO concentrations in room. . .
ADEWP	F3-Nuggets, 7:Psychrometrics, 1:Dew point	Dew point temperature determination
ADUCT	F3-Nuggets, 4:Geometry, 4:Duct round to rect	Round duct diameter to rectangular
AELA	F3-Nuggets, 1:Air press/leak, C:Effective leakage	Effective leakage area
AEQLA	F3-Nuggets, 1:Air press/leak, D:Equivalent leakage F1-PRGMs, 2:Ventilation, 2:BTLa and 1:ASHRAE 62.2	Equivalent leakage area
AFCOM	F3-Nuggets, 9:Finance, 1:Loan payments	Payments on loan, interest. . .
AFUEL	F3-Nuggets, 2:Heating/Cooling, 1:\$/therm of fuel. Also, F2-Tools, 2:Fuel, 1:\$/Therm	Cost per therm of fuel
AH2O	F2-Tools, 2:Fuel, 3:DHW Fuel	Annual DHW energy consumption
AHET1	F3-Nuggets, 2:Heating/Cooling, 2:Annual heating	Annual space heating cost
AHET2	F3-Nuggets, 2:Heating/Cooling, 3:Eff improve saving	Savings from heating system efficiency improvements
AHET3	F3-Nuggets, 1:Air press/leak, 7:Heating \$ air leakage	Annual heating cost of air leakage
AHET4	F3-Nuggets, 1:Air press/leak, 8:Heating CEG	Heating cost-effective guideline for air sealing
AHET5	F3-Nuggets, 3:Heat transfer, 1:Surface transfer	Transmission heat transfer through as surface
AHET6	F3-Nuggets, 1:Air press/leak, 9:Air leak heat loss	Air leakage heat loss per year

4 - Calculation Features Comparison of ZipTest Pro ² and ZipTest Pro ³ Software Packages (listed in the same order in which they appear in the ZipTest Pro ² software manual)		
Equation Nuggets	F3-Nuggets	[Continued from previous page]
AHET7	F3-Nuggets, 2:Heating/Cooling, 4:SIR system replace	Analysis for heating system replacement
AHI	F2-Tools, 5:Heat Index	Heat index or apparent temperature
AHRAT	F3-Nuggets, 7:Psychrometrics, 1:Dew point	Humidity ratio
AIEEQ	F3-Nuggets, 1:Air press/leak, 4:Air equation	Building air flow rate or air equation
AIRSF	F3-Nuggets, A:Air speed, 1:Air speed, fpm	Air speed in units of feet per minute
AIRSP	F3-Nuggets, A:Air speed, 2:Air speed, mph	Air speed in units of miles per hour
AMLR	F3-Nuggets, 1:Air press/leak, 5:Spec leak ratio	Specific (Minneapolis) leakage ratio
APYTH	F3-Nuggets, 4:Geometry, 5:Pythagorean	Pythagorean theorem
AREFR	F2-Tools, 6:Refrig SIR	SIR for refrigerator replacement
ARISR	F3-Nuggets, 2:Heating/Cooling, 5:Sensible/total	Sensible to total capacity ratio for air-to-air cooling equipment
ARITC	F3-Nuggets, 2:Heating/Cooling, 6:Total capacity	Total capacity ratio for air-to-air cooling equipment
ARVAL	F3-Nuggets, 3:Heat transfer, 2:R-value infrared	R-value calculator with non-contact (infrared) thermometer
ASERP	Not included because of low use	Building-to-zone percentage of zone-to-outdoor leakage rate
ASIR	F3-Nuggets, 9:Finance, 2:SIR	Simple savings-to-investment ratio
ASTAK	F3-Nuggets, 1:Air press/leak, 6:Stack pressure	Building stack pressure at given height
ATRIa	F3-Nuggets, 4:Geometry, 1:Area of triangle	Area of triangle
AVNT1	F3-Nuggets, 6:Ventilation, 2:Vent heat energy	Space heating energy consumption for mechanical ventilation
AVNT2	F3-Nuggets, 6:Ventilation, 3:Vent elec energy	Annual electrical consumption for operating mechanical ventilation
AWATC	Not included because of low use	Cost to operate a water pump
AWATP	Not included because of low use	Horsepower needed to pump water

5 - Calculations New to ZipTest Pro ³ that were not part of ZipTest Pro ²		
ZipTest Pro ³ Feature	ZipTest Pro ³ Name	Comments
ASHRAE 62.2-2007 appendix for existing dwellings (2009)	F2-Tools, 7:62.2 Alt Comp See page 64	This feature is called up automatically during the F1-PRGMs, 2:Ventilation, 1:ASHRAE 62.2 routine. It can be used as a separate feature at F2-Tools, 7:62.2 Alt Comp.
Lawrence Berkeley Laboratory number calculator	F2-Tools, 8:LBL# See page 68	This feature is called up automatically during the F1-PRGMs, 2:Ventilation, 3:BTL routine and the F1-PRGMs, 3: WCEG routine. It can be used as a separate feature at F2-Tools, 8:LBL#.
ZipTest Pro number calculator	F2-Tools, 9:ZTP# See page 69	This feature is called up automatically during the F1-PRGMs, 2:Ventilation, 2:BTLa routine and the F1-PRGMs, 2:Ventilation, 1:ASHRAE 62.2 routine. It can be used as a separate feature at F2-Tools, 9:ZTP#
Ventilation fan run-time calculator	F3-Nuggets, 6:Ventilation, 1:Fan run-time See page 89	Calculates “required CFM”, “fan CFM”, or “min per hour fan on”.

Weather Factors for North America (W in units of ACH)

Comment

Weather Factors account for the effect of local weather, in units of Air Changes per Hour (ACH). These Factors are needed in a number of the ZipTest Pro³ programs, and tools, including BTLA, ASHRAE 62.2, and ZTP#.

City, State	w[ACH]	Source
Adak, AK	1.16	TMY
Annette, AK	0.94	TMY
Bethel, AK	1.21	TMY
Big Delta, AK	0.99	TMY
Fairbanks, AK	0.90	TMY
Gulkana, AK	0.95	TMY
Homcr, AK	0.87	TMY
Juneau, AK	0.95	TMY
King Salmon, AK	1.09	TMY
Kodiak, AK	0.93	TMY
McGrath, AK	0.90	TMY
Summit, AK	1.12	TMY
Birmingham, AL	0.69	TMY
Mobile, AL	0.76	TMY
Calgary, AB	0.94	CAN
Edmonton, AB	0.88	CAN
Fort Smith, AR	0.76	TMY
Little Rock, AR	0.75	TMY
Phoenix, AZ	0.68	TMY
Prescott, AZ	0.81	TMY
Tucson, AZ	0.79	TMY
Winslow, AZ	0.82	TMY
Yuma, AZ	0.77	TMY
Castlegar, BC	0.71	CAN
Fort St. John, BC	0.93	CAN
Prince Rupert, BC	0.88	CAN
Vancouver, BC	0.78	WYEC
Victoria, BC	0.69	CAN
Williams Lake, BC	0.83	CAN
Arcata, CA	0.74	TMY
Bakersfield, CA	0.68	TMY
China Lake, CA	0.67	TMY
Dagget, CA	0.90	TMY
El Toro, CA	0.57	TMY
Fresno, CA	0.69	TMY
Long Beach, CA	0.64	TMY
Los Angeles, CA	0.66	TMY
Mount Shasta, CA	0.78	TMY
Point Mugu, CA	0.63	TMY
Red Bluff, CA	0.81	TMY
Sacramento, CA	0.75	TMY
San Diego, CA	0.67	TMY
San Francisco, CA	0.92	TMY
Santa Maria, Ca	0.70	TMY
Sunnyvale, CA	0.63	TMY

City, State	w[ACH]	Source
Colorado Springs, CO	0.98	TMY
Denver, CO	0.87	TMY
Eagle, CO	0.80	TMY
Grand Junction, CO	0.87	TMY
Pueblo, CO	0.85	TMY
Hartford, CT	0.86	TMY
Washington, DC	0.76	TMY
Wilmington, DE	0.84	TMY
Apalachicola, FL	0.63	TMY
Daytona, FL	0.73	TMY
Jacksonville, FL	0.77	TMY
Miami, FL	0.69	TMY
Orlando, FL	0.73	TMY
Tallahassee, FL	0.63	TMY
Tampa, FL	0.75	TMY
Augusta, GA	0.69	TMY
Atlanta, GA	0.75	TMY
Savannah, GA	0.75	TMY
Hilo, HI	0.60	TMY
Honolulu, HI	0.81	TMY
Lihue, HI	0.94	TMY
Burlington, IA	0.90	TMY
Des Moines, IA	0.93	TMY
Mason City, IA	1.01	TMY
Sioux City, IA	0.99	TMY
Boise, ID	0.87	TMY
Lewiston, ID	0.71	TMY
Pocatello, ID	0.95	TMY
Chicago, IL	0.93	TMY
Moline, IL	0.86	TMY
Springfield, IL	0.93	TMY
Evansville, IN	0.76	TMY
Fort Wayne, IN	0.92	TMY
Indianapolis, IN	0.86	TMY
South Bend, IN	0.89	TMY
Dodge City, KS	1.11	TMY
Goodland, KS	1.09	TMY
Topeka, KS	0.87	TMY
Lexington, KY	0.80	TMY

Reproduced from *A Method of Determining Air Change Rates in Detached Dwellings*, ANSI/ASHRAE 136-1993.

City, State	w[ACH]	Source
Baton Rouge, LA	0.70	TMY
Lake Charles, LA	0.72	TMY
New Orleans, LA	0.71	TMY
Shreveport, LA	0.77	TMY
Boston, MA	1.07	TMY
Churchill, MB	1.24	CAN
Thompson, MB	0.92	CAN
Baltimore, MD	0.82	TMY
Bangor, ME	0.75	TMY
Caribou, ME	1.00	TMY
Portland, ME	0.91	TMY
Alpena, MI	0.82	TMY
Detroit, MI	0.92	TMY
Flint, MI	0.90	TMY
Grand Rapids, MI	0.89	TMY
Sault Ste Marie, MI	0.95	TMY
Traverse City, MI	0.94	TMY
Duluth, MN	1.00	TMY
International Falls, MN	0.98	TMY
Minneapolis, MN	0.97	TMY
Rochester, MN	1.03	TMY
Kansas City, MO	0.85	WYEC
Springfield, MO	0.95	TMY
St. Louis, MO	0.87	TMY
Jackson, MS	0.68	TMY
Meridian, MS	0.62	TMY
Billings, MT	1.07	TMY
Cut Bank, MT	1.04	TMY
Dillon, MT	0.90	TMY
Glasgow, MT	1.02	TMY
Great Falls, MT	1.05	TMY
Helena, MT	0.89	TMY
Lewistown, MT	0.90	TMY
Missoula, MT	0.79	TMY
Saint John, NB	0.95	CAN
Asheville, NC	0.69	TMY
Cape Hatteras, NC	0.94	TMY
Charlotte, NC	0.74	TMY
Greensboro, NC	0.72	TMY
Raleigh, NC	0.72	WYEC
Bismarck, ND	0.99	TMY
Fargo, ND	1.10	TMY
Grand Island, NE	1.06	TMY
North Platte, NE	0.95	TMY
Omaha, NE	0.87	TMY
Scottsbluff, NE	0.99	TMY

City, State	w[ACH]	Source
Stephenville, NF	1.03	CAN
Concord, NH	0.76	TMY
Lakehurst, NJ	0.70	TMY
Albuquerque, NM	0.80	TMY
Clayton, NM	1.06	TMY
Roswell, NM	0.86	TMY
Truth or Conseq, NM	0.79	TMY
Tucumcari, NM	0.87	TMY
Shearwater, NS	0.87	CAN
Baker Lake, NT	1.25	CAN
Fort Smith, NT	0.92	CAN
Inuvik, NT	1.01	CAN
Elko, NV	0.77	TMY
Ely, NV	0.98	TMY
Las Vegas, NV	0.81	TMY
Lovelock, NV	0.78	TMY
Reno, NV	0.75	TMY
Tonopah, NV	0.90	TMY
Winnemucca, NV	0.84	TMY
Yucca Flats, NV	0.77	TMY
Buffalo, NY	0.99	TMY
Massena, NY	0.90	TMY
New York Cen. Pk, NY	0.98	TMY
New York LaGuar., NY	0.99	TMY
Rochester, NY	0.92	TMY
Syracuse, NY	0.88	TMY
Akron, OH	0.91	TMY
Cincinnati, OH	0.84	TMY
Cleveland, OH	0.96	WYEC
Columbus, OH	0.86	TMY
Dayton, OH	0.86	TMY
Toledo, OH	0.90	TMY
Youngstown, OH	0.92	TMY
Oklahoma City, OK	1.05	TMY
Tulsa, OK	0.93	TMY
Kapuskasing, ON	0.92	CAN
Sault Ste. Marie, ON	0.90	CAN
Thunder Bay, ON	0.86	CAN
Toronto, ON	0.82	WYEC
Windsor, ON	0.87	CAN
Astoria, OR	0.85	TMY
Medford, OR	0.67	TMY
North Bend, OR	0.90	TMY
Portland, OR	0.76	TMY
Redmond, OR	0.80	TMY
Salem, OR	0.80	TMY

Reproduced from *A Method of Determining Air Change Rates in Detached Dwellings*, ANSI/ASHRAE 136-1993.

City, State	w[ACH]	Source
Allentown, PA	0.80	TMY
Erie, PA	1.00	TMY
Harrisburg, PA	0.76	TMY
Philadelphia, PA	0.85	TMY
Pittsburgh, PA	0.85	TMY
Charlottetown, PE	1.04	CAN
Quebec, PQ	0.84	CAN
Schefferville, PQ	1.13	CAN
Sept Iles, PQ	0.96	CAN
Montreal, PQ	0.86	WYEC
Providence, RI	0.91	TMY
Charleston, SC	0.77	TMY
Columbia, SC	0.67	TMY
Greenville, SC	0.69	TMY
Huron, SD	1.09	TMY
Pierre, SD	1.00	TMY
Sioux Falls, SD	1.05	TMY
Regina, SK	1.05	CAN
Saskatoon, SK	0.98	CAN
Chattanooga, TN	0.64	TMY
Knoxville, TN	0.68	TMY
Memphis, TN	0.78	TMY
Nashville, TN	0.74	WYEC
Abilene, TX	1.05	TMY
Amarillo, TX	1.14	TMY
Austin, TX	0.80	TMY
Brownsville, TX	0.90	TMY
Corpus Christi, TX	0.86	TMY
El Paso, TX	0.76	TMY

City, State	w[ACH]	Source
Fort Worth, TX	0.89	TMY
Houston, TX	0.81	TMY
Kingsville, TX	0.72	TMY
Laredo, TX	0.91	TMY
Lubbock, TX	1.00	TMY
Lufkin, TX	0.64	TMY
Midland Odessa, TX	0.96	TMY
Port Arthur, TX	0.79	TMY
San Angelo, TX	0.84	TMY
San Antonio, TX	0.83	TMY
Sherman, TX	0.80	TMY
Waco, TX	0.92	TMY
Wichita Falls, TX	0.99	TMY
Cedar City, UT	0.81	TMY
Salt Lake City, UT	0.87	TMY
Norfolk, VA	0.84	TMY
Richmond, VA	0.75	TMY
Roanoke, VA	0.74	TMY
Olympia, WA	0.77	TMY
Seattle, WA	0.85	TMY
Spokane, WA	0.87	TMY
Yakima, WA	0.81	TMY
Eau Claire, WI	0.93	TMY
Green Bay, WI	0.94	TMY
La Crosse, WI	0.86	TMY
Madison, WI	0.91	TMY
Milwaukee, WI	1.00	TMY
Charleston, WV	0.66	TMY
Casper, WY	1.15	TMY
Cheyenne, WY	1.08	TMY
Rock Springs, WY	0.98	TMY
Sheridan, WY	0.83	TMY
Whitehorse, YT	0.94	CAN

Reproduced from *A Method of Determining Air Change Rates in Detached Dwellings*, ANSI/ASHRAE 136-1993.

Notes:

W[ACH] = a weather factor accounting for the effect of local weather, in Air Changes per Hour (ACH). For cities not included in the Weather Factor table, values of W may be estimated by using the value of the nearest location.

“Source” indicates the source of the weather data.

- WYEC = the weather year for the energy calculations.
- TMY = typical meteorological year.
- CAN = average of the ten recent years of weather data.

LBL Climate Zone Map

The map of North America is for use with the Lawrence Berkeley Laboratories (LBL) procedure for determining the LBL#. Please refer to "8:LBL#" on page 68 for a detailed explanation of this procedure. On the map below, all areas in North America and Hawaii are assigned a climate zone number from 1 to 4, depending on prevailing wind speed.



Heating Degree Day Correction Factors

Because oil and propane distributors had no way of predicting when to make a delivery to their customers, in the 1920s J.H. Walker of Detroit Edison Company and George Segeler of the American Gas Association introduced the concept of the degree day.² Heating Degree Days (HDD) for one day is calculated with this equation:

² *The Quiet Indoor Revolution* by Seichi Konzo with Marylee MacDonald, Small Homes Council-Building Research Council, University of Illinois, 1992, page 51.

$$HDD = 65F^{\circ} \left[\frac{Temp_{high} + Temp_{low}}{2} \right]$$

To determine the heating degree days for an entire season, the weather bureau simply adds up the values for each day (a day with an average temperature of 65 F° or greater has no heating degree days). The balance-point temperature is the temperature at which the internal heat gain from people, appliances, lights, etc., just balances or equals the heat loss. Walker and Segeler found that this was 65 F° for an average house during the 1920s. Because houses today are better insulated and tighter, the balance point is often lower than 65 F°.

Use the table of heating degree day correction factors to adjust heating degree days for homes having a lower balance point temperature than 65 F°. The construction definitions in the table are rather subjective, but do the best you can selecting the right row for the house you are analyzing.

<i>Heating Degree Day Correction Factors</i>									
Quality of Construction and Baseload Use	Number of Heating Degree Days, base 65 F°								
	1000	2000	3000	4000	5000	6000	7000	8000	9000
Well-Constructed House. Large quantities of insulation, fit on doors and windows, well sealed openings. Large availability of solar energy at the house. High baseload use	0.48	0.45	0.42	0.39	0.36	0.37	0.38	0.39	0.40
House of Average Construction. Average quantities of insulation, average fit on doors and windows, partially sealed openings. Average availability of solar energy at the house. Average baseload use.	0.80	0.76	0.70	0.65	0.60	0.61	0.62	0.69	0.67
Poorly Constructed House. Small quantities of insulation, poor fit on doors and windows, unsealed openings. Small availability of solar energy at the house. Low baseload use.	1.12	10.4	0.98	0.90	0.82	0.85	0.88	0.90	0.92
Source: ASHRAE									

Air Density Correction Factors

TIP

Multiply standard air density at sea level (0.075 pounds per cubic foot) by the appropriate correction factor.

Altitude (ft)	Sea Level	1000	2000	3000	4000	5000	6000	7000	8000	9000	10,000
Barometer (in.Hg)	29.92	28.86	27.82	26.82	25.84	24.90	23.98	23.09	22.22	21.39	20.58
(in.w.g.)	407.5	392.8	378.6	365.0	351.7	338.9	326.4	314.3	302.1	291.1	280.1
Air Temp. -40°	1.26	1.22	1.17	1.13	1.09	1.05	1.01	0.97	0.93	0.90	0.87
°F 0°	1.15	1.11	1.07	1.03	0.99	0.95	0.91	0.89	0.85	0.82	0.79
40°	1.06	1.02	0.99	0.95	0.92	0.88	0.85	0.82	0.79	0.76	0.73
70°	1.00	0.96	0.93	0.89	0.86	0.83	0.80	0.77	0.74	0.71	0.69
100°	0.95	0.92	0.88	0.85	0.81	0.78	0.75	0.73	0.70	0.68	0.65
150°	0.87	0.84	0.81	0.78	0.75	0.72	0.69	0.67	0.65	0.62	0.60
200°	0.80	0.77	0.74	0.71	0.69	0.66	0.64	0.62	0.60	0.57	0.55
250°	0.75	0.72	0.70	0.67	0.64	0.62	0.60	0.58	0.56	0.54	0.51
300°	0.70	0.67	0.65	0.62	0.60	0.58	0.56	0.54	0.52	0.50	0.48
350°	0.65	0.62	0.60	0.58	0.56	0.54	0.52	0.51	0.49	0.47	0.45
400°	0.62	0.60	0.57	0.55	0.53	0.51	0.49	0.48	0.46	0.44	0.42
450°	0.58	0.56	0.54	0.52	0.50	0.48	0.46	0.45	0.43	0.42	0.40
500°	0.55	0.53	0.51	0.49	0.47	0.45	0.44	0.43	0.41	0.39	0.38
550°	0.53	0.51	0.49	0.47	0.45	0.44	0.42	0.41	0.39	0.38	0.36
600°	0.50	0.48	0.46	0.45	0.43	0.41	0.40	0.39	0.37	0.35	0.34
700°	0.46	0.44	0.43	0.41	0.39	0.38	0.37	0.35	0.34	0.33	0.32
800°	0.42	0.40	0.39	0.37	0.36	0.35	0.33	0.32	0.31	0.30	0.29
900°	0.39	0.37	0.36	0.35	0.33	0.32	0.31	0.30	0.29	0.28	0.27
1000°	0.36	0.35	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25

Standard Air Density, Sea Level, 70°F = 0.075 lb/cu ft at 29.92 in. Hg

Source: HVAC Systems Duct Design, SMACNA, 1981, page 6.54.

TI-89 Cable Functionality and Support

The black USB cable (Standard A to Mini-B USB Connectivity Cable) that ships with the TI-89 Titanium (July 2009) might not work properly with TI Connect (the software that ships with the calculator) and your computer. **If you find this is the case, we regret that we cannot support this problem.** We have contacted Texas Instruments about this; they have told us that when TI Connect software does not properly communicate with a computer, their technical support people will:

1. Fully support Windows 2000, Windows XP SP1 and SP2, Windows Vista (32-bit versions only);
2. Offer limited support for Windows XP SP3, Windows Vista SP1 (SP stands for Service Pack); and
3. Provide no support for Windows XP 64-bit, Windows Vista 64 bit.

We have been told that Windows XP SP2 should work just fine with TI Connect software and the black cable that shipped with your calculator, unless it is a 64-bit version of Windows XP.

Below is a list of troubleshooting steps a technical support person at Texas Instruments has customers perform who cannot get the black USB cable that is supplied with the calculator to work on their computer:

1. Un-install and re-install TI Connect
2. Temporarily disable any anti-virus, anti-spam, spyware or pop-up blocker software. Remember to re-enable whatever software is disabled.
3. Manually install the driver for the black USB cable.

If none of the above troubleshooting steps resolve the issue, please contact Texas Instruments technical support, do not contact WxWare Diagnostics.

Our experience has demonstrated that a different cable, the Silverlink USB Cable, that is available as a TI accessory, works with all computers when connecting to the TI-89 Titanium when using the TI Connect software. This cable is available from Texas Instruments and other vendors. It is sometimes referred to as the Silverlink USB cable.

Contact "TI Cares Customer Support" at ti-cares@ti.com or call 800-842-2737 for support. You may also make use of the TI Cares Knowledge Base at http://epsstore.ti.com/OA_HTML/cskmbasicsrch.jsp

Ordering Information

This software may be ordered by e-mailing us at rjkarg@karg.com, downloading it from our website, or by sending your Texas Instruments TI-89 calculator to WxWare Diagnostics for loading. Before ordering the software by e-mail or downloading it from the website, you must already have your TI-89 Titanium calculator because you need the unique identification number. Please see "Loading the Software" starting on page 11.

Support and Updates

Support is available to registered users only. You may:

1. Write to us at
WxWare Diagnostics
596 Grover Hill Road
Bethel, ME 04217
2. Call 207-824-0025, or
3. E-mail: rjkarg@karg.com

If you are a registered user, you will be informed of program updates by e-mail. WxWare Diagnostics has attempted to make the program calculations accurate, but it does not guarantee the accuracy of the calculations.

For information, updates, and frequently asked questions (FAQ), check our website at www.karg.com/software.htm. These instructions are available in Adobe Acrobat format on the website.

Software Training

Training for the use of ZipTest Pro³ software is available for groups. Contact WxWare Diagnostics for information.

Some Important Details

Deleting Files from the ZipTest Pro³ software package

Do not delete any of the files in the ZipTest Pro³ software package. If you do, you will find that some features of your software package will not work. If this happens, merely reload the software package from your computer with the use of the TI Connect software. See “Using TI Connect to Load ZipTest Pro³ into Your TI-89” on page 13.

Battery Management

The TI-89 uses four AAA batteries and a lithium backup battery. All are in the battery compartment accessible from the back of the calculator. To avoid loss of data, do not

remove the lithium battery unless four fresh AAA batteries are installed. Replace the lithium backup battery about every three or four years.

As the four AAA batteries run down, the screen display will begin to dim (especially during calculations). This also happens when the batteries are cold and give off less power. To compensate for this, adjust the contrast to a higher setting (see Contrast Adjustment, below). If you find it necessary to increase the contrast setting frequently, it is probably time to replace batteries. To assist you, a BATT indicator (BATT) will display in the status line area when the batteries have drained down to the point when you should replace them soon. When the BATT indicator is displayed in reverse text (**BATT**), you should replace the AAA batteries very soon.

If you do not remove the AAA batteries and the lithium backup battery at the same time or allow them to run down completely, you can change either type of battery without losing anything in memory.

Automatic Power Down (APD)

The calculator's Automatic Power Down™ (APD) feature prolongs battery life by turning off the calculator automatically after a few minutes of inactivity. When you turn the calculator back on:

The display, cursor, and any error conditions are exactly the same as just before it automatically shut down.

All settings and memory contents are retained.

TIP

This is a great feature for on-site work. If your TI-89 shuts down when you are interrupted, just hit [ON] to pick up where you left off.

Note: APD does not occur if a calculation or program is in progress, unless the program is paused. If a program is running but waiting for a key press, APD will occur after several minutes of inactivity.

Contrast Adjustment

The most common call over the last fifteen years of supporting ZipTest software running on a Texas Instruments calculator has been related to the contrast adjustment. Because batteries give off less energy when they are cold, the screen contrast might be significantly reduced -- or even invisible -- when the calculator is left in a cold

environment. In such a case, the contrast must be increased to see what is on the screen. To increase the contrast, press and hold [♦] while you tap [+]. When the batteries warm up and give off more energy, you might find the screen contrast is too great. To reduce the contrast, press and hold [♦] while you tap [-].

Adding Programs to Your TI-89 Titanium

We strongly recommend that you do not add other software to your TI-89 Titanium calculator. There are two reasons for this recommendation. First, the memory of your calculator is limited and most of it is being used by the ZipTest Pro³ software package. If you add programs, you might experience calculator memory problems. In fact, we recommend you delete all programs in your TI-89 before installing the ZipTest Pro³ software package (please see “Texas Instruments Memory, Applications, and Loading ZipTest Pro³” on page 8).

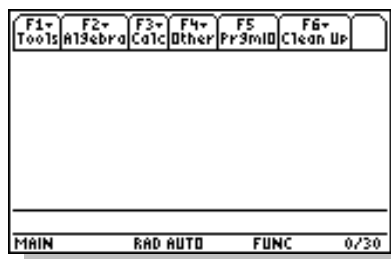
Converting from One Unit to Another

For this first release of ZipTest Pro³ it is only available in I-P (Inch-Pound) units, not in S-I (International System of Units), often referred to as the metric system. If there are requests for an S-I version of ZipTest Pro³, we will consider releasing an S-I version in the future.

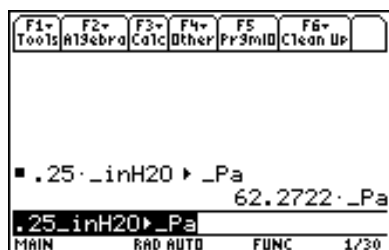
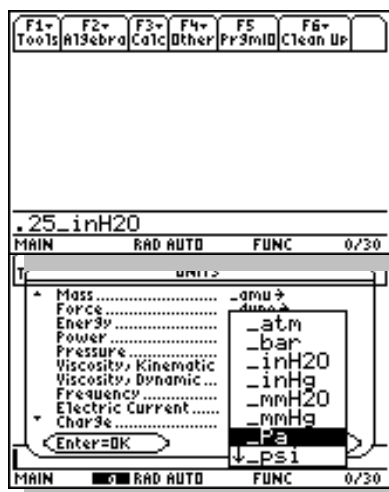
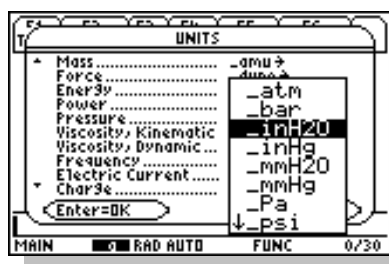
For those of you who would prefer S-I units, it might help to familiarize yourself with the units conversion features of the TI-89 Titanium.³ Here is a quick example showing the use of this feature.

Let’s assume we want to convert 0.25 inches of water column created by a large kitchen exhaust fan to Pascals. Follow the steps below:

1. First make sure you are viewing the TI-89 home screen. A sample of this screen is at the left. In order to get to the home screen, you must exit the ZipTest Pro³ software by pressing [2nd] and then [F7] (the second function of the [F2] key). If you are viewing the APPS screen, press the [HOME] key to get to the TI-89 home screen. You can see that this screen is blank except for the menu tabs at the top,



³ The “convert” feature is explained on page 287 of the TI-89 Titanium instruction manual that was boxed with our calculator purchased in June 2009. Instructions are outlined above.



some status code at the very bottom, and the math operations line just above the status codes.

2. Enter the number ".25" on the calculator key pad. ".25" will appear at the left on the math operations entry line. Now press [2nd] and then [UNITS] (the second function of the [3] key). You will see a screen similar to the one at the bottom left of the previous page listing all the unit categories you have to choose from. Scroll down to find the "Pressure" category and then press the right cursor key to see the choices for units of pressure. Now scroll down in this sub-list to "inH2O" (the abbreviation for inches of water column) and select it by pressing [ENTER] after you highlight "inH2O", as on the sample screen to the left. This action will return you to the TI-89 home screen and the math operations line will now read ".25_inH2O".
3. Now press the [2nd] key and then the [] key (the second function of the [MODE] key). ".25_inH2O ►" now appears in the math operations line. Now we must go back to the list of units to select Pascals.
4. Repeat much of step three, above, but select "Pa" (as on the sample screen to the left) and then press [ENTER]. "Pa" is the abbreviation for Pascals. You will be returned to the home screen where you will see "1_inH2O ► 15_Pa" in the math operations line.
5. Now press [ENTER] to see the answer for this unit conversion problem. The answer of 0.06029 is shown on the sample screen to the left.

We hope this example helps you understand how to convert from one unit to another.

Glossary

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers. This organization regularly updates and publishes many standards, including ASHRAE 62.2, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*.

Archive - Moves specified variables from RAM to user data archive memory.

Baseload – Energy used for any appliance other than space heating or space cooling.

Cord – A unit of measure for firewood. A cord is a stack of firewood measuring 4 feet deep by 4 feet high by 8 feet long. “Face cords” are 4 feet high, 8 feet long, but have no specified depth. If a face cord is two feet deep, it equates to one-half of a cord.

Device ID number – Please see ID# in this glossary.

Dialogue box – There are two types of dialogue boxes; the input dialogue box and the message dialogue box. Samples of each are shown at the left. The input dialogue box allows you to enter data or input for ZipTest Pro³ programs, tools, Nuggets, and defaults. For some input dialogue boxes you are offered a choice of options, such as seven fuel types, rather than a fill box for your entry.

A screenshot of a software window titled "HEATING & AIR LEAK NUGGET". It contains several input fields with labels: "Heating \$/Yr:" (with a value of 7000), "HDD:" (with a value of 7000), "\$/Unit Fuel:" (with a value of 2.00), "BTU/Unit Fuel:" (with a value of 138690), "CFM50:" (with a value of 2200), "LBL#:" (with a value of 15.8), and "% Seasonal Eff:" (with a value of 80). At the bottom, there are two buttons labeled "Enter=OK" and "ESC=CANCEL". The status bar at the very bottom shows "MAIN", "RAD AUTO", "FUNC", and "1/30".

Sample Input Dialogue Box

A screenshot of a software window titled "INPUT ERROR!". It contains a message box with the text "Leave exactly one input blank." and two buttons labeled "Enter=OK" and "ESC=CANCEL". The status bar at the very bottom shows "MAIN", "RAD AUTO", "FUNC", and "1/30".

Sample Message Dialogue Box

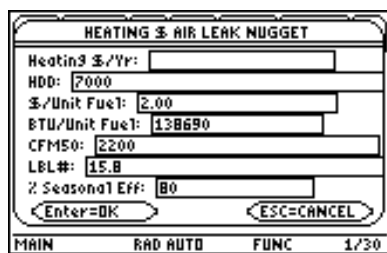
The message dialogue box might show up at any time, usually because you have made a mistake, such as not leaving a fill box blank in an input dialogue box for a Nugget. There is a sample is at the left.



Dropdown menu – A dropdown menu gives you a choice of options to select. There are two types of dropdown menus. The first actually drops down as a sub-menu. The first sample as the left shows this type of dropdown menu.



The second type of dropdown menu really doesn't drop down, it just appears. The sample at the left shows this type.



Factory default values – The default values set at the factory, in other words, the default values when you first loaded the ZipTest Pro³ software package into your TI-89 Titanium calculator.

Fill box – The area or rectangle in an input dialogue box designated for an entered value. Most input dialogue boxes include from two to seven fill boxes. Fill boxes always include text to the left of them to indicate the nature of the value you are to enter. See the sample to the left.



ID# - TI-89 calculator identification number. This number is unique to each calculator and is not the same as the serial number embossed on the back of your calculator. You **MUST** have your unique calculator ID# available *before* you purchase the ZipTest Pro³ software. A sample of a calculator ID# is shown at the left (do not use this sample number at the left when you order your software; it will not work). See “**Error!**”



Silverlink USB Cable

Reference source not found. on page **Error! Bookmark not defined.** for information about viewing your calculator's ID#.

Silverlink USB cable – This cable connects your TI-89 Titanium to your computer. A black USB cable was packaged with your calculator; the Silverlink cable is an extra purchase. We have found this cable to work with more computers than the black USB cable. This cable is sometimes called the GraphLink cable. You might be able to find this cable on the Internet or at RadioShack.



Software key – The software key is a unique code that is generated for your TI-89 Titanium. Without the proper software key entered during the process of loading the software into the calculator, the ZipTest Pro³ software will not operate. A sample eleven-digit software key has been entered on the sample screen to the left. Please see “Using TI Connect to Load ZipTest Pro3 into Your TI-89” on page 13 for more information.

Therm – 100,000 Btus (British thermal units) of thermal energy.



Work session – Use of the ZipTest Pro³ software package routines in a manner that does not delete the entered and calculated values from the global memory. A ZipTest Pro³ work session is ended by “F7 – Quit” and then starting a CONTINUE SESSION (press [♦] and then [3] for a CONTINUE SESSION or to CONTINUE SESSION). This will delete the calculated and entered variables from the previous work session. Otherwise the calculated and entered variables will be retained in the global memory. In order to retain the entered and calculated values from a work session, when you are asked to start “1:NEW SESSION” or “2:CONTINUE SESSION”, select “2:CONTINUE SESSION”.

ZipTest Pro³ work session – See Work session.

Index

- \$/Therm (Cost per therm of fuel) tool 54
- \$/therm of fuel Nugget..... 82
- 62.2 Alt Comp (ASHRAE 62.2 alternative compliance method) tool 64
- Bath(s) Affected? 65
- Introduction..... 64
- Kitchen Affected? 66
- ACH at 50 Pascals (Air Change per Hour at 50 Pascals) Nugget 76
- ACH natural (Air Change per Hour at natural conditions) Nugget..... 75
- Adding an Image to a Report..... 7
- Adding Programs to Your TI-89 Titanium 117
- Adj CFM50 (Temperature adjusted CFM50) tool 53
- Air Density Correction Factors 113
- Air equation (Building leakage air flow rate) Nugget..... 76
- Air leak heat loss Nugget..... 80
- Air speed, fpm Nugget..... 93
- Air speed, mph Nugget..... 94
- Annual heating Nugget..... 83
- Archive**..... 119
- Area of circle Nugget..... 87
- Area of triangle Nugget 87
- ASHRAE** – American Society of Heating, Refrigerating, and Air-Conditioning Engineers..... 119
- ASHRAE 62.2 program 28
- Automatic call-up feature 6
- Automatic Power Down (APD) 116
- Baseload**..... 119
- Battery Management 115
- Body Mass Index Nugget..... 94
- BTL (Building Tightness Limit) program .. 38
- BTLa (Building Tightness Limit advanced) program..... 34
- Calculator ID number..... 11
- Finding the ID# 12
- Charlie Holly.....ii
- Circum of circle (Circumference of circle) Nugget 87
- CO air-free (Carbon Monoxide air-free from CO as-measured) Nugget..... 88
- CONTINUE SESSION 5, 96, 121
- Contrast Adjustment 116
- Converting from One Unit to Another..... 117
- Cooling \$ air leak (Annual cooling cost of air leakage) Nugget 80
- Cooling CEG (Cooling Cost Effective Guideline for air sealing) Nugget 81
- Cord of firewood** 119
- Cost to Units (Fuel units from fuel cost) tool 56
- Defaults
 - Edit..... 99
 - Introduction..... 99
 - Reset..... 101
 - Software Key 101
 - View 100
- Depress Tight Lim (Depressurization Tightness Limit or DTL) Nugget..... 72
- Device ID number**..... 119
- Dew point Nugget 91
- DHW Fuel (Domestic hot water fuel units) tool..... 57
- Dialogue box**..... 119

Dropdown menu	120	New Const 62.2 (New construction	
Duct Blaster tool.....	59	ASHRAE 62.2) tool.....	60
Duct round to rect (Round duct to		NEW SESSION	5, 96, 121
rectangular) Nugget.....	87	Nuggets	
Eff improve saving (Savings from heating		\$/therm of fuel.....	82
system efficiency improvements) Nugget		ACH at 50 Pascals (Air Change per Hour at	
.....	84	50 Pascals)	76
Effective leakage Nugget	81	ACH natural (Air Change per Hour at natural	
Energy Index		conditions).....	75
Domestic Hot Water Use Calculation.....	23	Air equation (Building leakage air flow rate)	
Energy Index program	21	76
Equivalent leakage Nugget.....	82	Air leak heat loss.....	80
Factory default values	120	Air speed, fpm.....	93
Fan run-time Nugget.....	89	Air speed, mph	94
Heat Index tool.....	62	Annual heating	83
Heating \$ air leak (Annual heating cost of		Area of circle.....	87
air leakage) Nugget.....	78	Area of triangle	87
Heating CEG (Heating Cost Effective		Body Mass Index	94
Guideline for air sealing) Nugget.....	79	Circum of circle (Circumference of circle) ..	87
Heating Degree Day Correction Factors..	111	CO air-free (Carbon Monoxide air-free from	
History of ZipTest software.....	1	CO as-measured).....	88
ID#	120	Cooling \$ air leak (Annual cooling cost of air	
LBL Climate Zone Map	111	leakage)	80
LBL# (Lawrance Berkeley Laboratory		Cooling CEG (Cooling Cost Effective	
number) tool	68	Guideline for air sealing)	81
License agreement		Depress Tight Lim (Depressurization	
Limited warranty.....	i	Tightness Limit or DTL).....	72
Warranty services	ii	Dew point.....	91
Loading the Software		Duct round to rect (Round duct to rectangular)	
Introduction.....	11	87
Receiving the software by e-mail.....	13	Eff improve saving (Savings from heating	
Loan payments Nugget.....	92	system efficiency improvements).....	84
Math calculations on-the-fly	6	Effective leakage.....	81
Minn BD3 (Minneapolis Blower Door,		Equivalent leakage	82
Model 3 tool	52	Fan run-time.....	89
Navigating ZipTest Pro³	2	Heating \$ air leak (Annual heating cost of air	
Neil Moyer	ii, 1, 72	leakage)	78
		Heating CEG (Heating Cost Effective	
		Guideline for air sealing)	79
		Introduction.....	71

Loan payments	92	R-value infrared (Calculated R-value from infrared camera) Nugget	86
Pythagorean	88	Sensible/total (Cooling sensible-to-total load ratio) Nugget	85
R-value infrared (Calculated R-value from infrared camera)	86	Silverlink USB cable	121
Sensible/total (Cooling sensible-to-total load ratio)	85	SIR (Savings-to-Investment Ratio) Nugget	93
SIR (Savings-to-Investment Ratio)	93	SIR system replace (Savings-to-Investment Ratio for replacing a heating system)	84
SIR system replace (Savings-to-Investment Ratio for replacing a heating system)	84	software key	10, 11, 14, 16, 17, 101, 121
Spec leak ratio (Specific leakage ratio)	77	Software Training	115
Stack pressure	77	Spec leak ratio (Specific leakage ratio) Nugget	77
Surface transfer (Surface heat transfer)	86	Stack pressure Nugget	77
Total capacity (Cooling total capacity)	85	Surface transfer (Surface heat transfer) Nugget	86
Vent elec energy (Annual cost of electricity for ventilation)	90	Therm	121
Vent heat energy (Annual cost of space heating for ventilation)	90	Things to know early on	3
Wind chill v2001	92	TI Connect ... 7, 10, 11, 12, 13, 14, 15, 113, 114, 115, 121	
Ordering Information	114	TI-89 Cable Functionality and Support	
Printing a Screen Image	7, 95	black USB cable	113
Programs		Silverlink USB cable	114
ASHRAE 62.2	28	Texas Instruments Customer Support	114
BTL (Building Tightness Limit)	38	TI-89 memory	8
BTLa (Building Tightness Limit advanced)	34	Tools	
Energy Index	21	\$/Therm (Cost per therm of fuel)	54
Introduction	19	62.2 Alt Comp (ASHRAE 62.2 alternative compliance method)	64
WCEG (Weatherization Cost Effective Guideline)	42	Adj CFM50 (Temperature adjusted CFM50)	53
ZPD (Zone Pressure Diagnostics)	47	Cost to Units (Fuel units from fuel cost)	56
Pythagorean Nugget	88	DHW Fuel (Domestic hot water fuel units)	57
Quit	101	Duct Blaster	59
Refrig SIR (Refrigerator Savings-to-Investment Ratio) tool	63	Heat Index	62
Reports		Introduction	51
Introduction	95		
Load	97		
Save	95		
View	95		

LBL# (Lawrence Berkeley Laboratory number).....	68	BTL (Building Tightness Limit)	38
Minn BD3 (Minneapolis Blower Door, Model 3)	52	BTLa (Building Tightness Limit advanced)	34
New Const 62.2 (New construction ASHRAE 62.2)	60	Fan run-time Nugget	89
Refrig SIR (Refrigerator Savings-to- Investment Ratio).....	63	Introduction.....	27
ZTP# (ZipTest Pro number).....	69	New Const 62.2 (New construction ASHRAE 62.2)	60
Total capacity (Cooling total capacity) Nugget	85	Vent elec energy (Annual cost of electricity for ventilation Nugget)	90
unit conversions.....	117	Vent heat energy (Annual cost of space heating for ventilation Nugget.....)	90
Using TI Connect	10, 13, 115, 121	WCEG (Weatherization Cost Effective Guideline) program	42
Vent elec energy (Annual cost of electricity for ventilation) Nugget.....	90	Weather Factors for North America	108
Vent heat energy (Annual cost of space heating for ventilation) Nugget	90	Wind chill v2001 Nugget.....	92
Ventilation		Work session	121
62.2 Alt Comp (ASHRAE 62.2 alternative compliance method).....	64	ZipTest Pro ² compared to ZipTest Pro ³ ...	103
ASHRAE 62.2	28	ZipTest Pro³ work session	121
example	32	ZPD (Zone Pressure Diagnostics) program	
		Add-a-hole method	48
		Door method	49
		Introduction)	47
		ZTP# (ZipTest Pro number) tool.....	69