LBNL-40682 Rev.
May 2005

Program Description

A PC Program

RESFEN5

for Calculating the Heating and Cooling Energy Use of Windows in Residential Buildings

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This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State and Community Programs, Office of Building Systems of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

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LBNL-40682 Rev.
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RESFEN5: Program Description

A PC Program for Calculating the Heating and Cooling Energy Use of Windows in Residential Buildings

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1. INTRODUCTION

1.1. Overview

Today's energy-efficient windows can dramatically lower the heating and cooling costs associated with windows while increasing occupant comfort and minimizing window surface condensation problems. However, consumers are often confused about how to pick the most efficient window for a residence. Product information typically offers window properties: U-factors or R-values, Solar Heat Gain Coefficients or Shading Coefficients, and air leakage rates. However, the relative importance of these properties depends on site- and building-specific conditions. Furthermore, these properties are based on static evaluation conditions that are very different from the real situation a window will be used in.

A computer tool such as RESFEN can help consumers and builders pick the most energy-efficient and cost-effective window for a given application, whether it is a new home, an addition, or a window replacement. It calculates heating and cooling energy use and associated costs as well as peak heating and cooling demand for specific window products. Users define a specific "scenario" by specifying house type (single-story or two-story), geographic location, orientation, electricity and gas cost, and building configuration details (such as wall, floor, and HVAC system type). Users also specify size, shading, and thermal properties of the window they wish to investigate. The thermal properties that RESFEN requires are: U-factor, Solar Heat Gain Coefficient, and air leakage rate. RESFEN calculates the energy and cost implications of the window compared to an insulated wall. The relative energy and cost impacts of two different windows can be compared.

RESFEN 3.0 was a major improvement over previous versions because it performs hourly calculations using a version of the DOE 2.1E (LBL 1980, Winkelmann et al. 1993) energy analysis simulation program. RESFEN 3.1 incorporates additional improvements including input assumptions for the base case buildings taken from the National Fenestration Rating Council (NFRC) Annual Energy Subcommittee's efforts.

Table 6-2 lists the input assumptions used in RESFEN 3.1, along with those from the previous version. These assumptions are reviewed continually and may be refined in future versions to more accurately reflect typical building configurations and operation.

Update information, future releases, and program information about RESFEN and other software tools (such as WINDOW, THERM, and Optics) from the Windows and Daylighting Group at LBNL can be found on the World Wide Web at URL: http://windows.lbl.gov, in the Software section. To obtain RESFEN, WINDOW, or THERM, check the web site first to see if it is downloadable; if not, fax your shipping address and phone number to "RESFEN 3.1 Software Request" at (510) 486-4089.

1.2. Changes from RESFEN 3.1

The significant changes that differentiate RESFEN5 from RESFEN 3.1 are listed below. Some of these changes affect program results. A major change to the program is that it is now based on a database structure (Microsoft Access™), which allows for a much more flexible file system for storing data.

Addition of Libraries:

RESFEN5 is now made up of a set of "Libraries" which is where information is stored and input. Each library has a "List" view, where all the records (rows) in the library can be viewed, and a "Detail" view, where all the data (or fields) in each record can be viewed. Section 4.5, "Libraries in General" explains the library structure in detail.

- **House Library:** The House Library in RESFEN5 is similar to the main screen in RESFEN 3.1, but with the ability to see multiple input sets at the same time from the List View.
- **Locations Library:** RESFEN5 has a Locations Library which can be used to create new locations that reference specific weather data and insulation packages. In the default database that is installed, called RESFEN5.mdb, there are 240 locations for the United States, as well as four for Canada. There are also other databases (for Canada, Chile and China) with more locations defined.
- **Window Library:** RESFEN5 has a Window Library that allows data for specific windows to be imported from the WINDOW5 program. A default set of WINDOW5 data is installed with RESFEN5, and other data can be imported as needed or provided by manufacturers or other sources.
- **Packages Library:** RESFEN5 has a Packages Library, which allows the user to create new insulation packages that can be associated with a Location to create customized modeling situations.
- **Results Library:** RESFEN5 has a Results Library, which allows the user to view results from multiple runs, as well as export those results to comma separated text files that can be imported into a spreadsheet program.
- **Electric Rates Library:** RESFEN5 has an Electric Rates Library, which allows the user to add new rates or change existing rates. The default library contains one rate for each US state, based on data from the Energy Information Administration (http://www.eia.doe.gov/)
- **Gas Rates Library:** RESFEN5 has a Gas Rates Library, which allows the user to add new rates or change existing rates. The default library contains one rate for each US state, based on data from the Energy Information Administration (http://www.eia.doe.gov/)

2. QUICK START

- Install the RESFEN program (see Chapter 3, "Installation").
- When the program is installed, **double click** on the RESFEN icon.

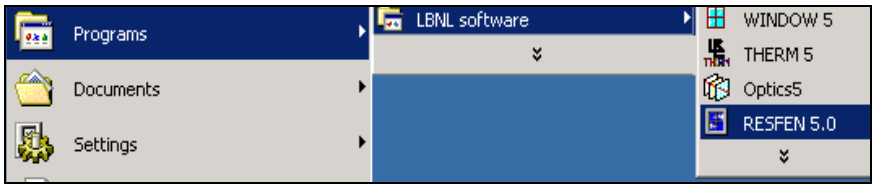


Figure 2-1. Click on the RESFEN icon in the Programs/LBNL Software list.

- The program will open with the default database, called RESFEN5.mdb.
- Change any input values that are not correct for the case you wish to model. For example, you can change the location to another city, change the HVAC system type, or input another window type. When you change an input value, the **Calculate** button becomes active and the values in the **Results** tabs are set to zero.

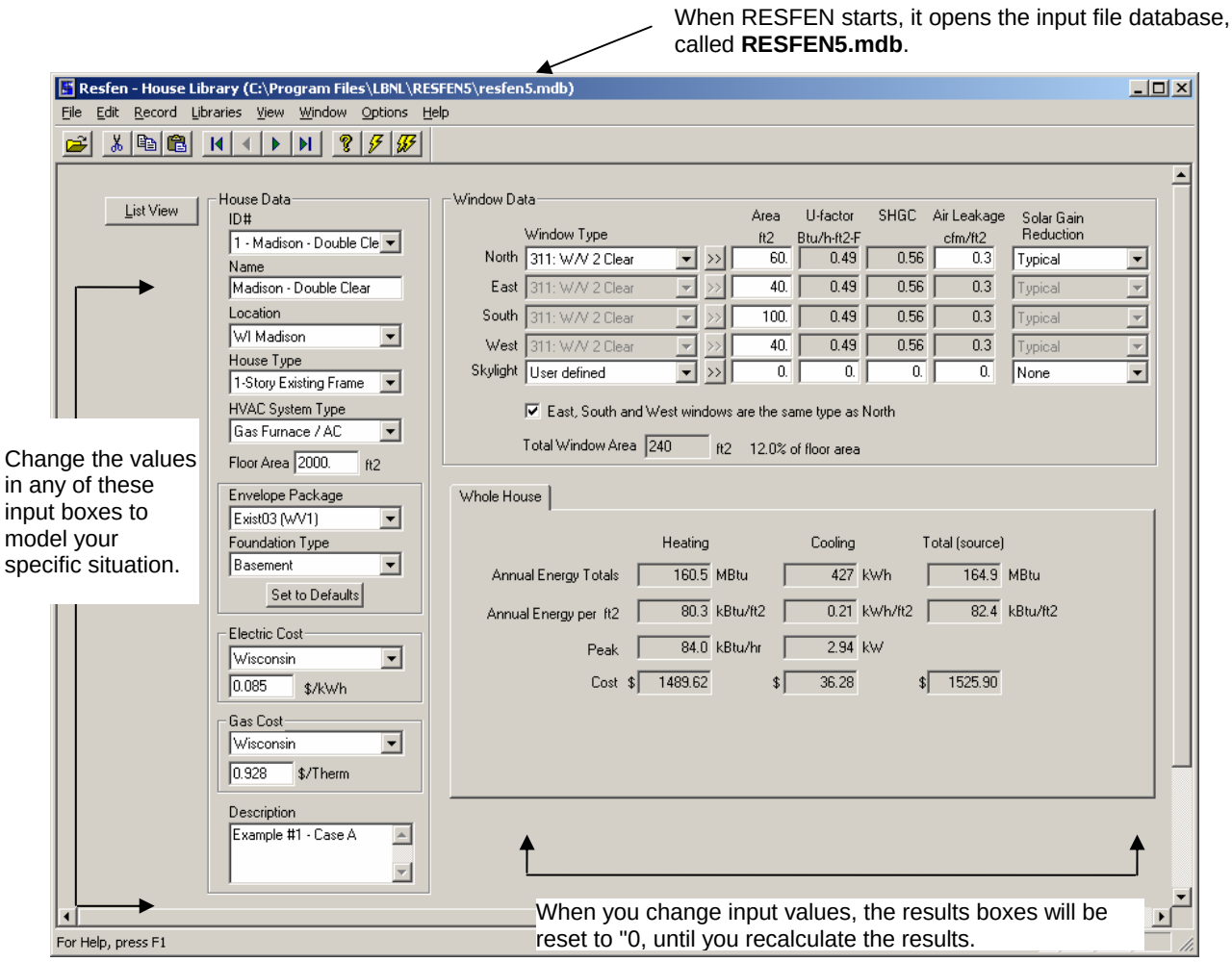


Figure 2-2. Change input values as needed for your building.

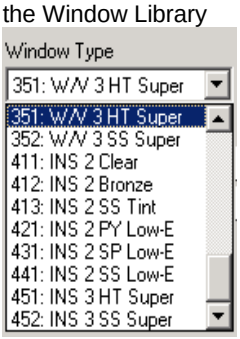
You can change the **Window Data** section either by entering all the values for each orientation by hand or by picking windows from a library of predetermined generic window products created with the WINDOW 5 software. This library contains values for typical casement windows, but these values can be used for sliders and fixed windows because their properties are essentially the same. See Section 6.5, "Making Custom WINDOW 5 Libraries" for detailed information about making your own libraries.

Type the total area of all windows on each of the four cardinal orientations into the Window input boxes.

Input the infiltration value (**Cfm/ft2**) for the window you are analyzing.

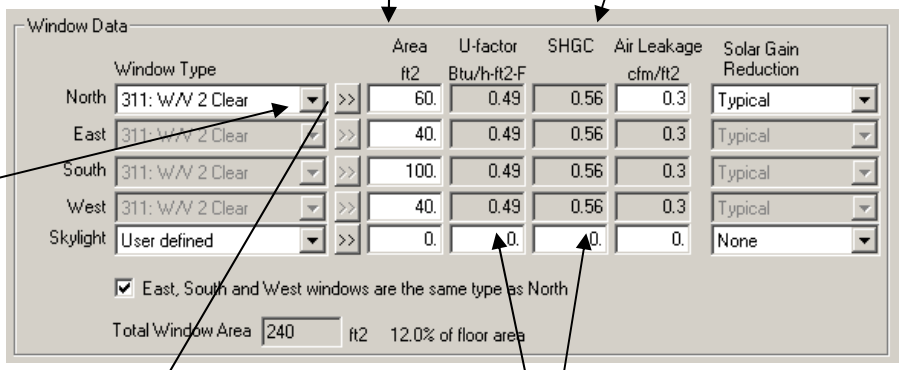
Select the Window Type by either:

- Clicking on the pulldown arrow to show the list from the Window Library



OR

- Click on the double arrow button to the right of the pulldown list to show more details from the Window Library list.



Highlight a window from the library, and click on the OK button to select it.

The values for **U-factor** and **SHGC** will automatically update to the values of the selected window.

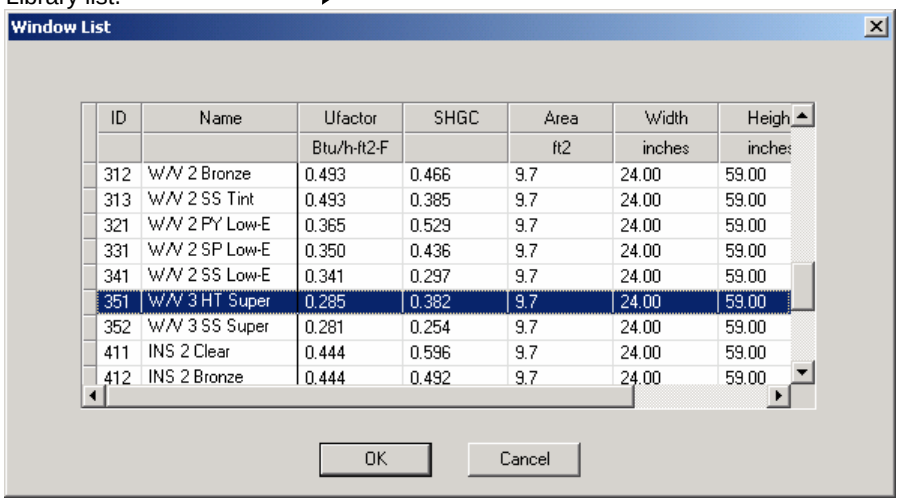


Figure 2-3. Use the WINDOW 5 library to select windows foryour building.

Press the **Calculate** button -- the single lightning bolt calculates only **Whole House** results, and the double lightning bolt calculates both **Whole House** and **Window Orientation** results.

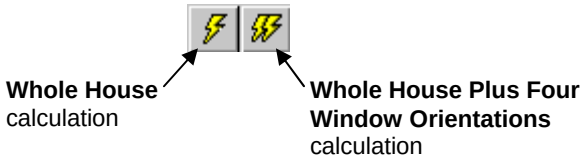
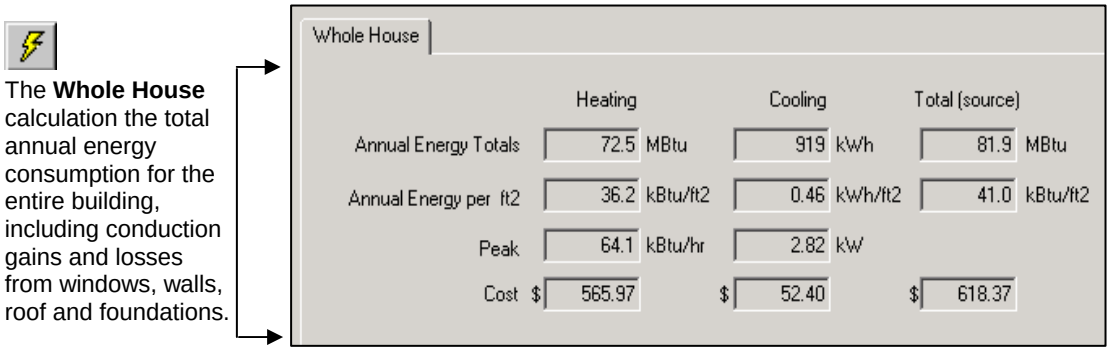


Figure 2-4. There are two calculation options, accessed with the lightning bolt toolbar buttons.

- An hourly simulation using DOE2 will be performed, which may take a few seconds for **the Whole House** only calculation, or up to a few minutes for the **Whole House + 4 Orientations** calculation, depending on the speed of your computer. When the calculation is finished, the values in the **Results** tabs will be updated.



The **Whole House + 4 Orientations** calculation produces results for the Whole House as well as the four window orientations, which are displayed on the **Window Annual Energy**, **Window Energy Cost**, and **Window Peak Energy** tabs. The results for the four window orientations are relative to a standard insulated wall for each orientation.

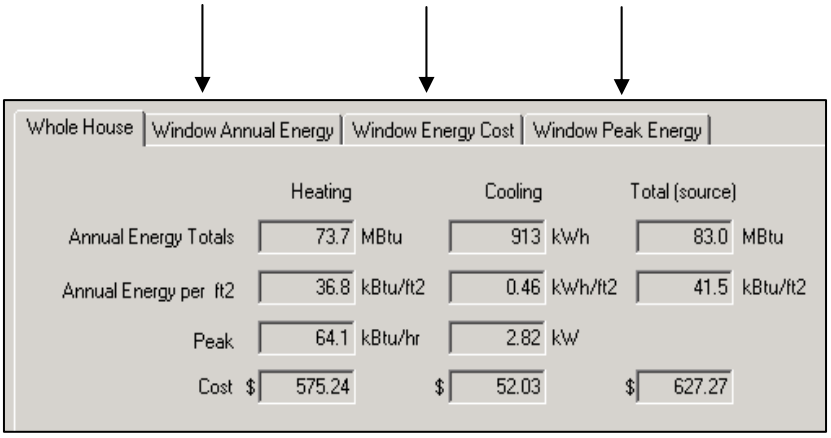


Figure 2-5. The two calculation options are used to calculate different types of results.

3. INSTALLATION

3.1. Hardware Requirements

First, make sure your computer system meets these specifications:

- 100% IBM-compatible pentium or higher with a math co-processor. A 400 MHz pentium computer will take about 9 seconds to perform a whole house simulation, and 16 seconds to perform a whole house + four orientations simulation.
- At least 16 MB of random access memory (RAM), configured as extended memory. 32 MB of RAM is preferred for optimum operation.
- Microsoft Windows 95™, Windows 98™ or Windows NT™, Windows 2000™ or Windows XP™.
- Hard disk drive with at least 10 megabytes of available disk space.
- Monitor and mouse.
- Optional: Printer supported by Microsoft Windows 95™, Windows 98™, or Windows NT™, Windows 2000™ or Windows XP™ (serial, parallel, or shared over a network).

3.2. Setup

The installation program can be downloaded from the LBNL website at http://windows.lbl.gov/software/resfen/. If the installation program is too big for your internet connections, CDs are available upon request by emailing RESFENHelp@lbl.gov.

The first step is to uninstall any previous versions of the RESFEN5 programs. However, RESFEN 3.1 can remain on your computer and does not have to be uninstalled.

1. Insert the installation CD into the CD-ROM drive on your computer.
2. In Microsoft Windows 95™, Windows 98™, or Windows NT™, Windows 2000™ or Windows XP™, if your computer doesn't automatically recognize the CD and start the installation process, click the **Start** toolbar button and select **Run**:

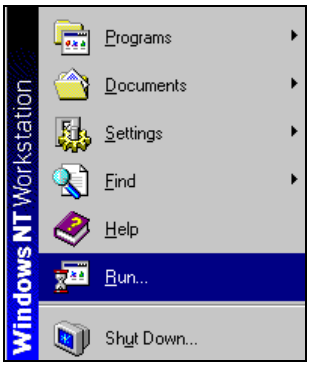


*Figure 3-1. Pick **Run** from the Start toolbar.*

In the **Run** window, type

<CDROM drive>:RESFEN5Setup.exe

where <CDROM> is the drive letter of the CD-ROM drive on your machine, such as "**D:**" or "**E:**"

Press the **OK** button in the **Run** dialog box.

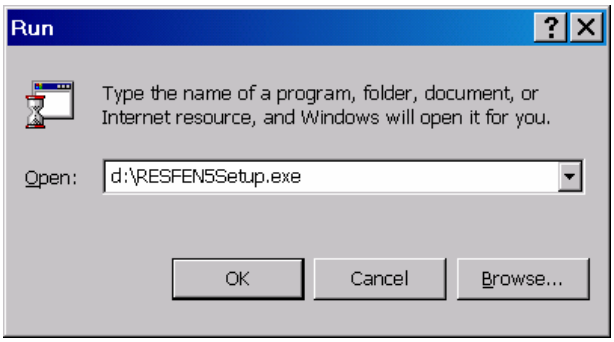


*Figure 3-2. Type <drive letter>: RESFEN5Setup.exe and press **OK**.*

3. The initial RESFEN **Setup** window will appear..

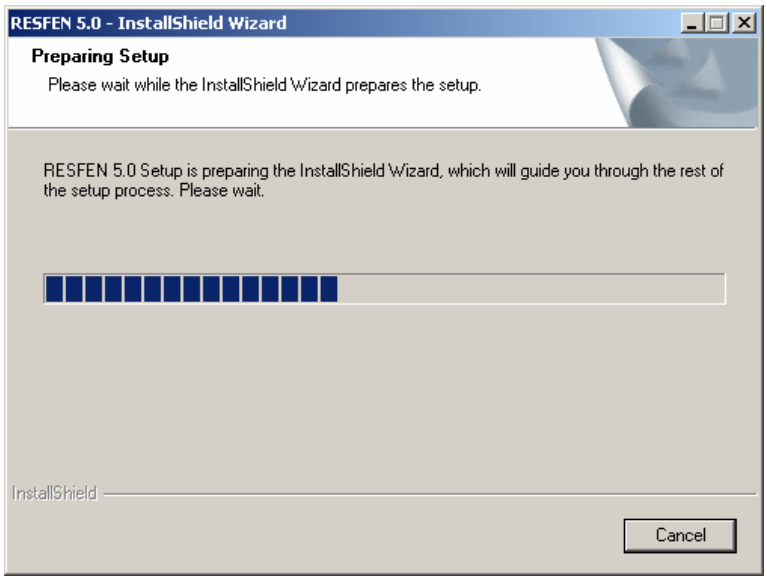


Figure 3-3. The initial RESFEN Setup window.

4. When the initial **Setup** window has finished, a Welcome window will display. Click the **Next** button to proceed with the installation, or **Cancel** to stop.

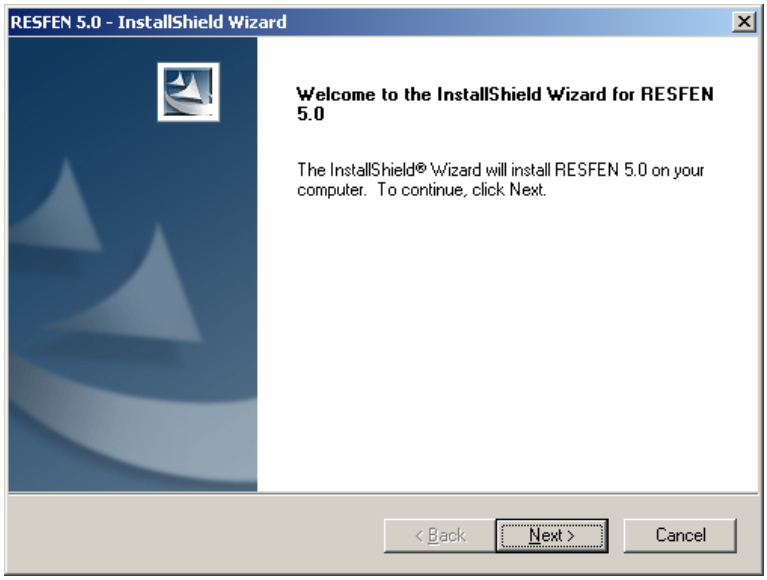


Figure 3-4. The initial RESFEN Setup window.

5. The **Software License Agreement** window will display next. Read through the license and make sure you agree to all the terms before proceeding. To proceed with the installation, click on the **Yes** button, or click on **No** to stop.

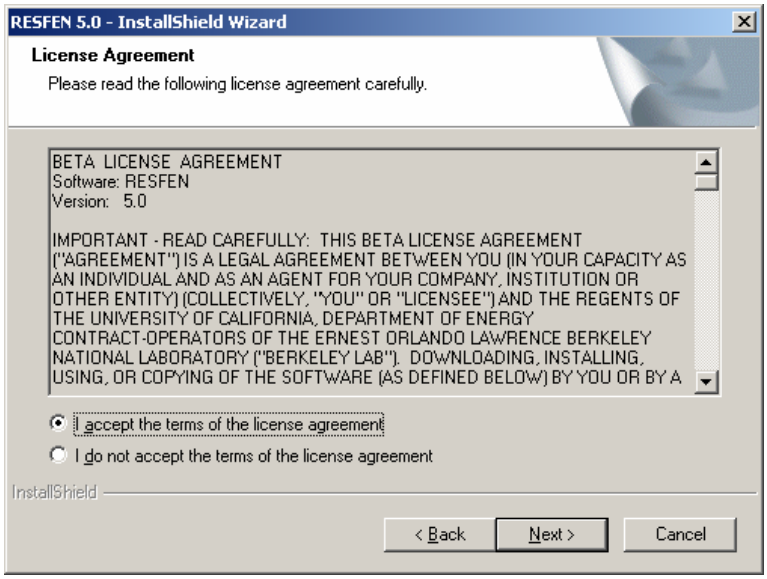


Figure 3-5. The initial RESFEN Setup window.

6. The **Setup Type** window will display next.

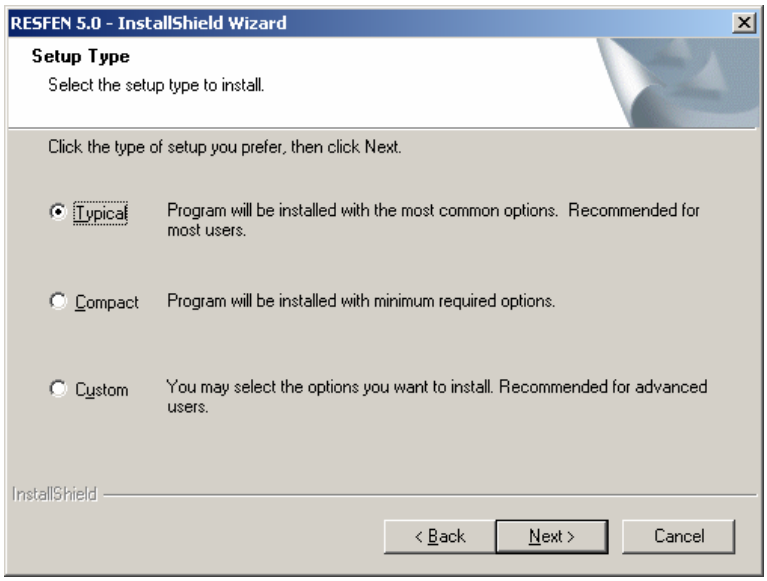


Figure 3-6. The Setup Type window.

The three choices are:

Typical: This will install the program with US weather file locations

Compact: This will install just the program and the US Weather files, without documentation.

Custom: This choice will cause another screen to display with choices of what to install, including weather files other than the United States. These weather files will all get installed in the Weathr directory of the RESFEN5 folder.

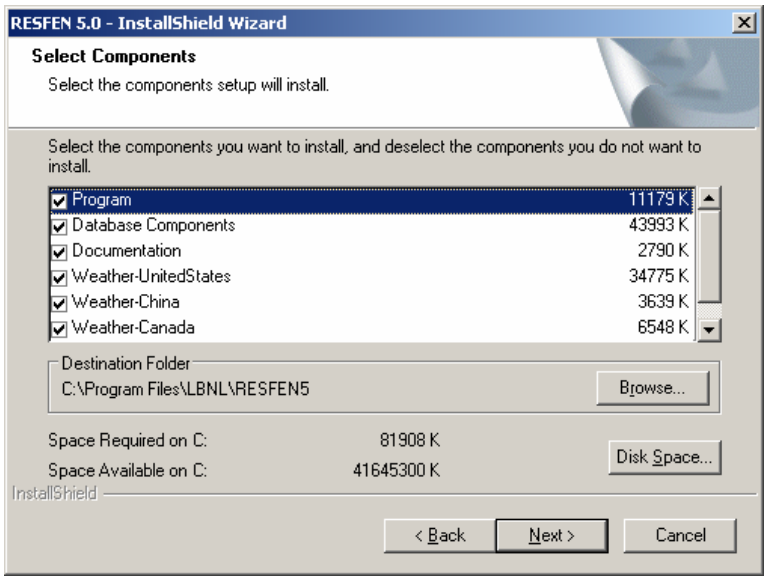


Figure 3-7. The Setup Type window for the Custom Setup choice, which shows the components of the program.

7. The **Ready to Install the Program** window will display next. The default directory where the program will be installed is C:\Program File\LBNL\RESFEN5. However, if you want to install the program in another directory on your computer, you can use the **Browse** button to specify the location.

   Press the **Next** button when you are satisfied with the Destination Directory.

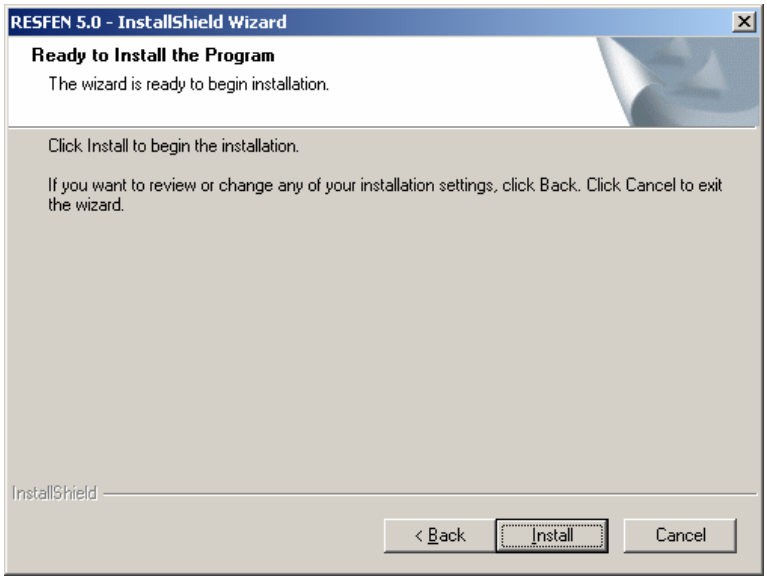


*Figure 3-8. **Ready to Install the Program** screen. The next screen to display is **Start Copying Files**, which shows where the installation settings, including where the program will be installed.*

*Press the **Next** button.*

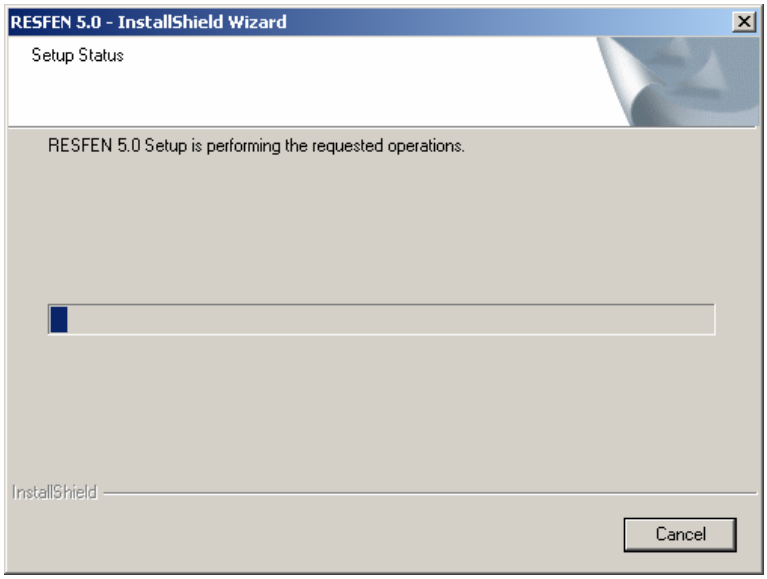


*Figure 3-9. The **Start Copying Files** screen shows the installation settings. Then press **Next** to go to the next screen.*

8. Setup will automatically install RESFEN into the specified destination directory on your computer.

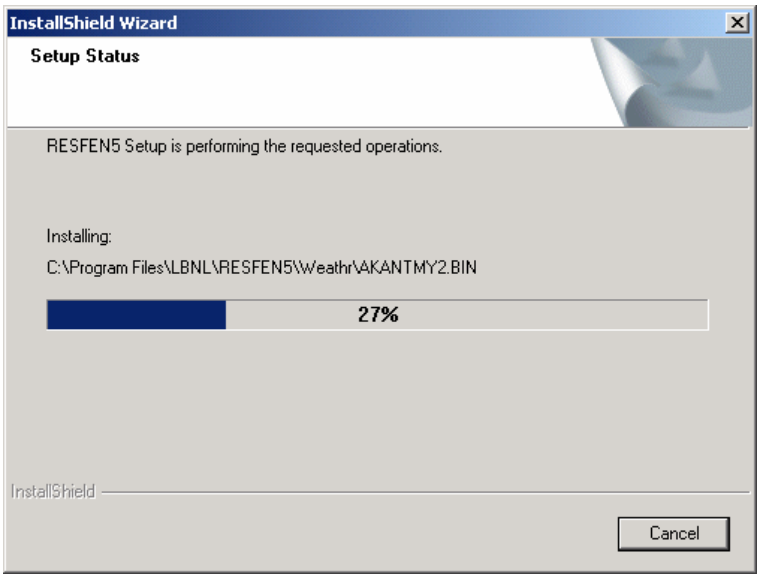


Figure 3-10. Setup will decompress and copy the program files into the specified destination directory.

9. When the installation is complete, the **InstallShield Wizard Complete** screen will be displayed. Press **Finish** to finalize the installation. Sometimes this screen will appear, but you can't click the **Finish** button. In this case, click on another area of the screen, then click back to this screen and you should be able to click on the **Finish** button.

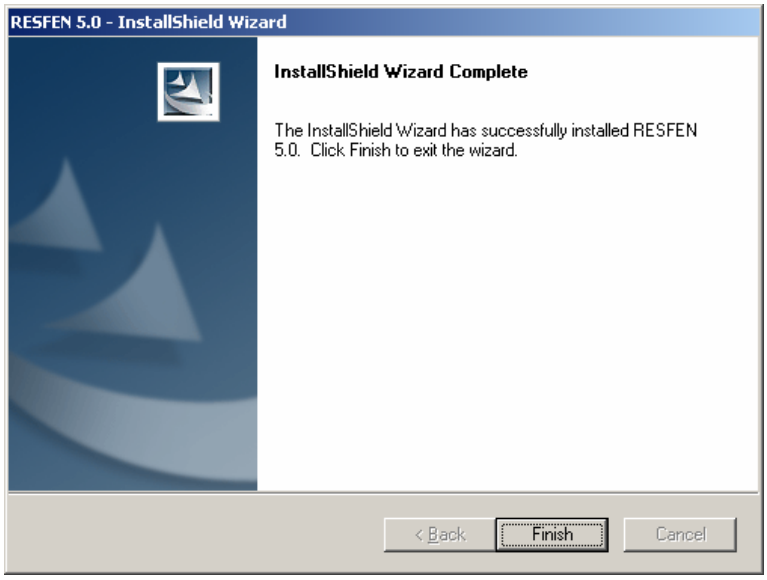


*Figure 3-11. The **InstallShield Wizard Complete** screen will display when the installation is finished. Press the **Finish** button to finalize the installation.*

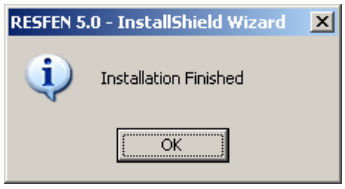


*Figure 3-12. The**Intallation Finished** screen will display when the installation is finished. Click on the **OK** button to finalize the installation.*

10. Setup will automatically put a RESFEN Icon in the **Programs** menu under the **LBNL Software** group, accessed from the **Start** button.

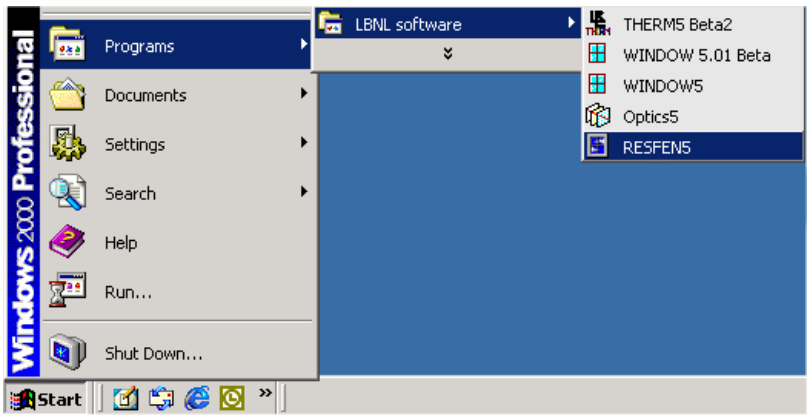


Figure 3-13. Program icon to run RESFEN.

3.3. Running RESFEN5

To run RESFEN5, click on the Windows95™, Windows98™ or WindowsNT™ **Start** button, go to the **Programs** menu, single click on the **LBNL Software** group, and single click on the **RESFEN5** icon:

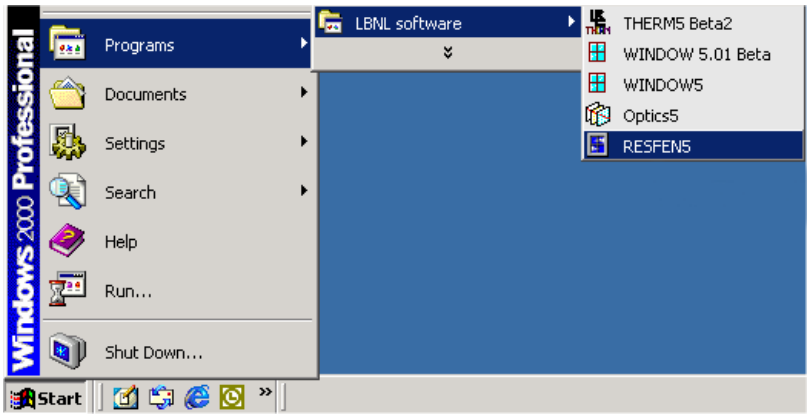


Figure 3-14. Click on Start / Programs / LBNL Software / RESFEN 3.1

A "splash" screen, shown in the figure below, is briefly displayed when you start the program.

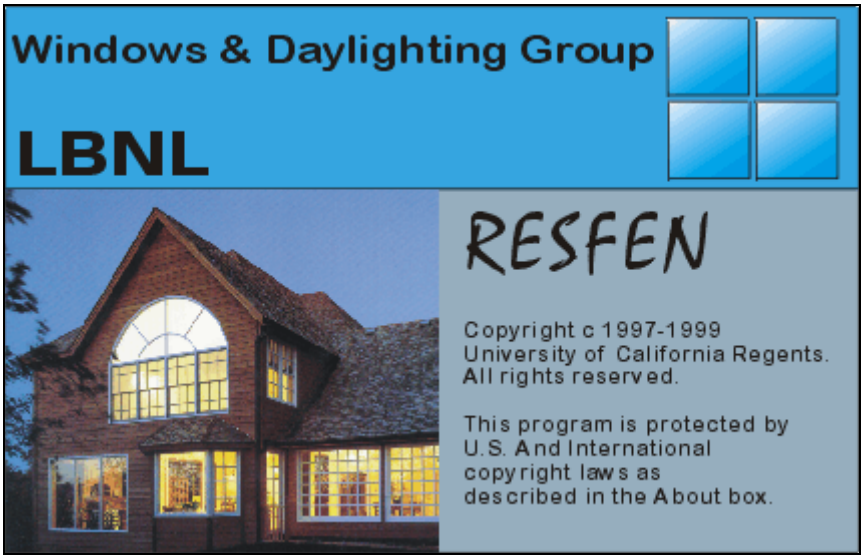


Figure 3-15. RESFEN Splash Screen

The main program screen appears and starts by opening the default RESFEN database, called "RESFEN5.mdb", as shown below.

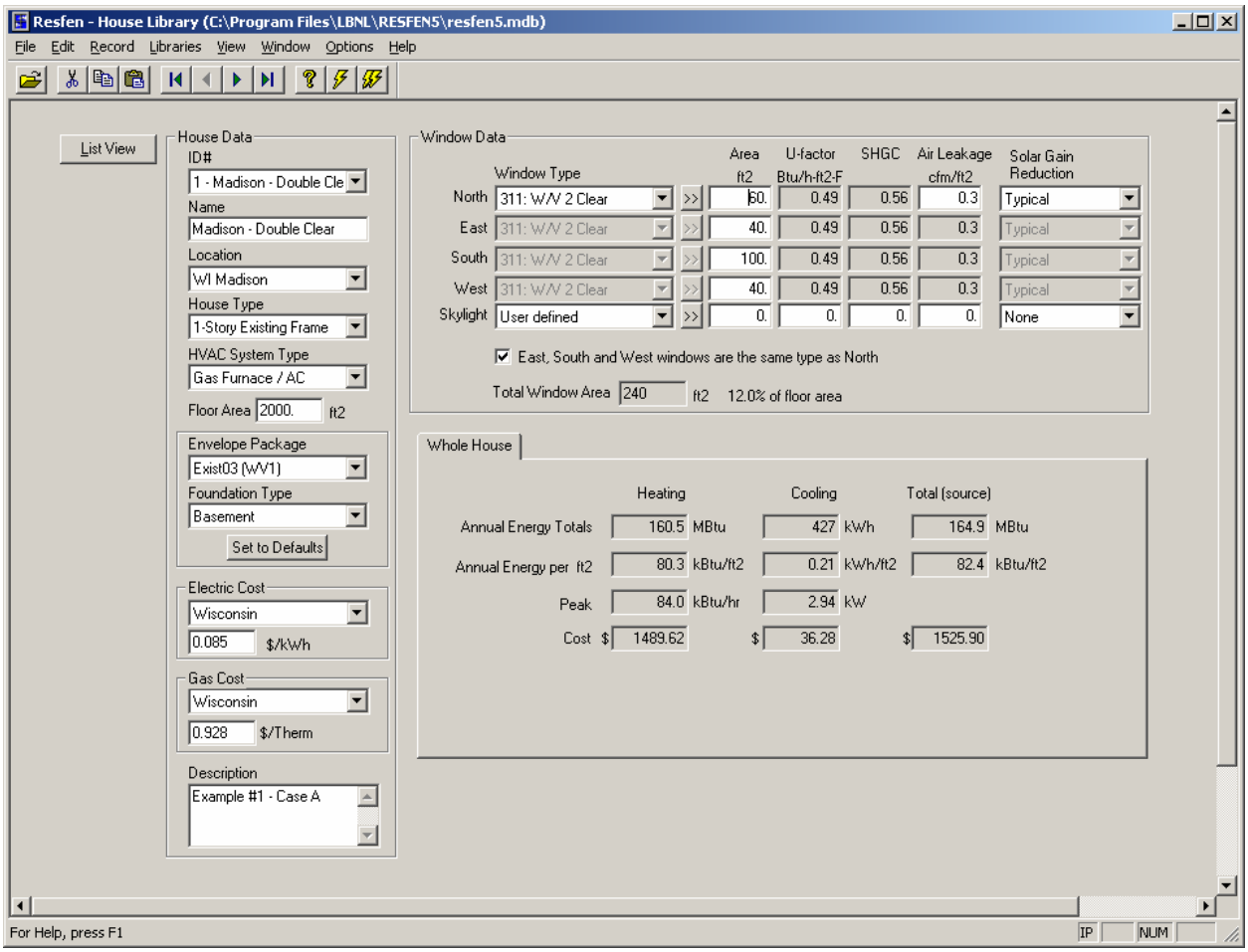


Figure 3-16. Main RESFEN screen.

3.4. Modifying the Installation

It is possible to add program components after the program has been installed. Specifically, the documentation and extra weather files can be added after the original installation if they were not installed at that time.

Rerun the installation file, by following the steps below.

1. Insert the installation CD into the CD-ROM drive on your computer.

2. In Microsoft Windows 95™, Windows 98™, or Windows NT™, if your computer doesn't automatically recognize the CD and start the installation process, click the **Start** toolbar button and select **Run**:

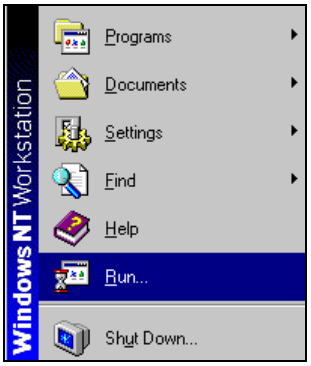


*Figure 3-17. Pick **Run** from the Start toolbar.*

In the **Run** window, type

<CDROM drive>:RESFEN5Setup.exe

where <CDROM> is the drive letter of the CD-ROM drive on your machine, such as "**D:**" or "**E:**"

Press the **OK** button in the **Run** dialog box.

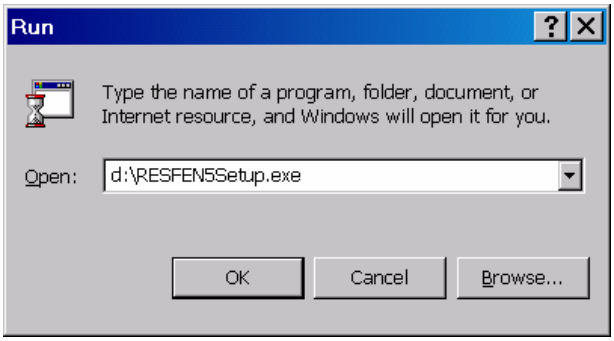


*Figure 3-18. Type <drive letter>: RESFEN5Setup.exe and press **OK**.*

3. The installation program will detect that RESFEN5 is already installed, and will put up the screen below. Click on the Modify radio button and then click the Next button to add program components.

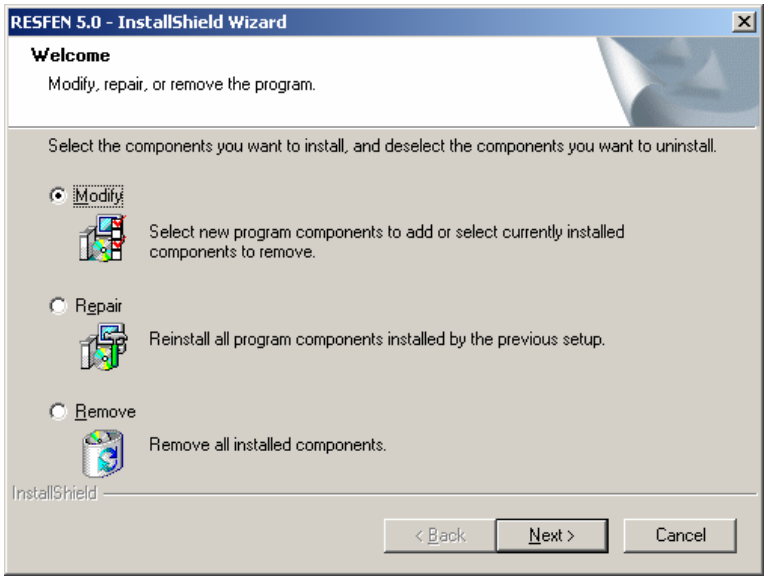


Figure 3-19. Once RESFEN has been installed, running the installation program again will produce this screen. Click on Modify to add program components, such as more weather files.

4. The Select Components screen will appear, and the components to be added can be selected by clicking on the checkboxes (such as Canadian and Chinese weather as shown in the example), and components already installed can be deselected. Click Next to add the selected components.

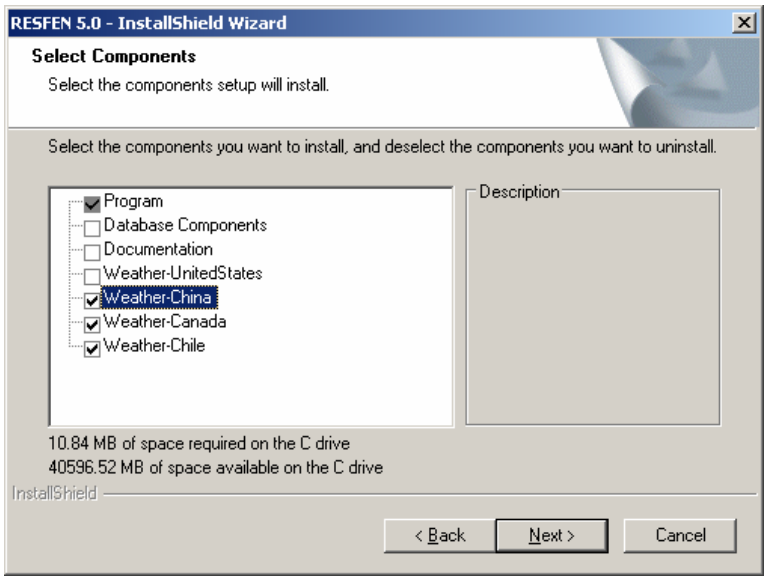


Figure 3-20. Once RESFEN has been installed, running the installation program again will produce this screen. Click on Modify to add program components, such as more weather files.

3.5. Uninstalling RESFEN

If you need to uninstall RESFEN, follow the steps below.

1. Go to the Control Panel (via Start/ Settings/Control Panel) and go to the Add/Remove Programs choice

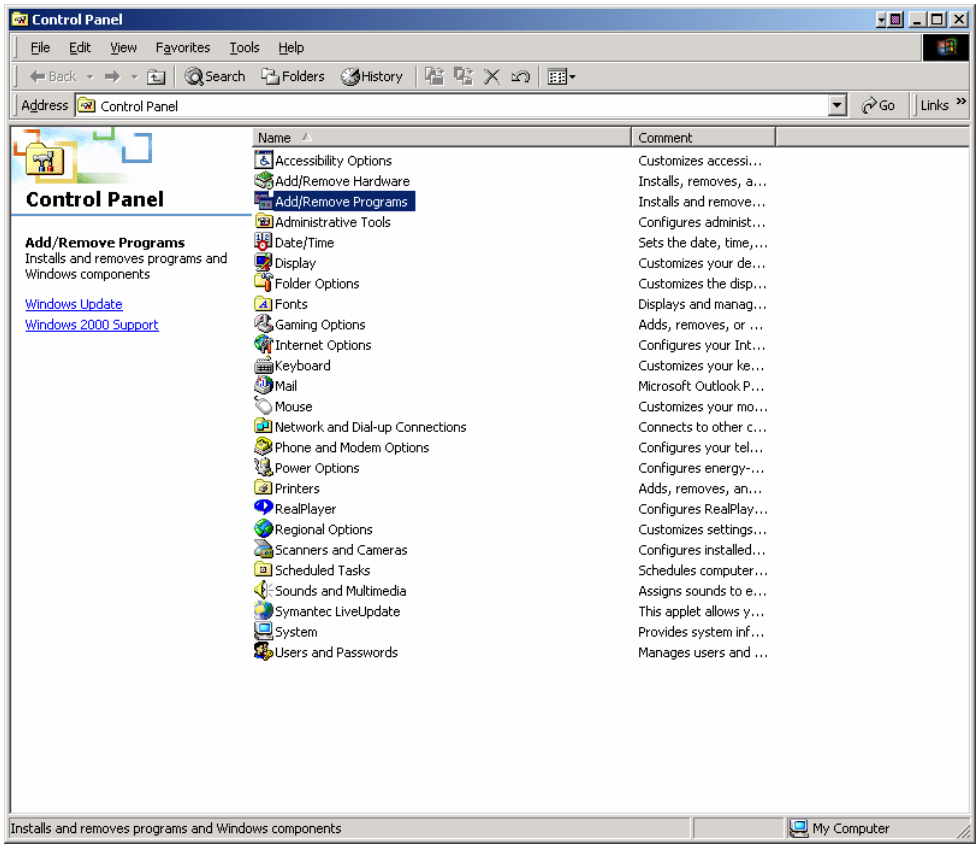


Figure 3-21. Go to the Control Panel (Start/Settings/Control Panel) and click on Add/Remove Programs.

2. Select RESFEN5 from the list of currently installed programs and click on the Change/Remove button.

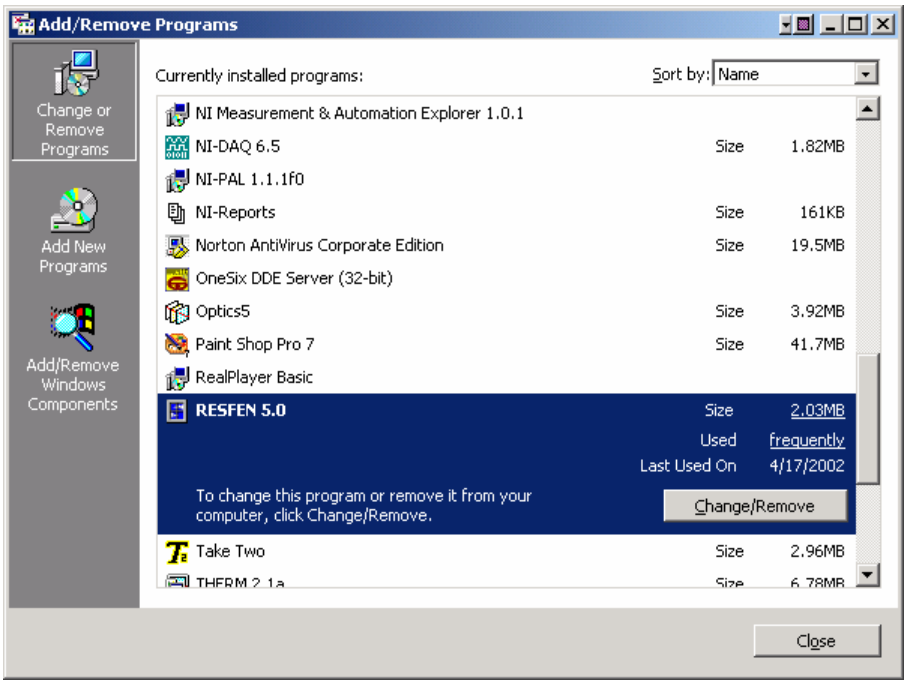


Figure 3-22. Select RESFEN5 from the list of currently installed programs.

3. The InstallShield Wizard appears.

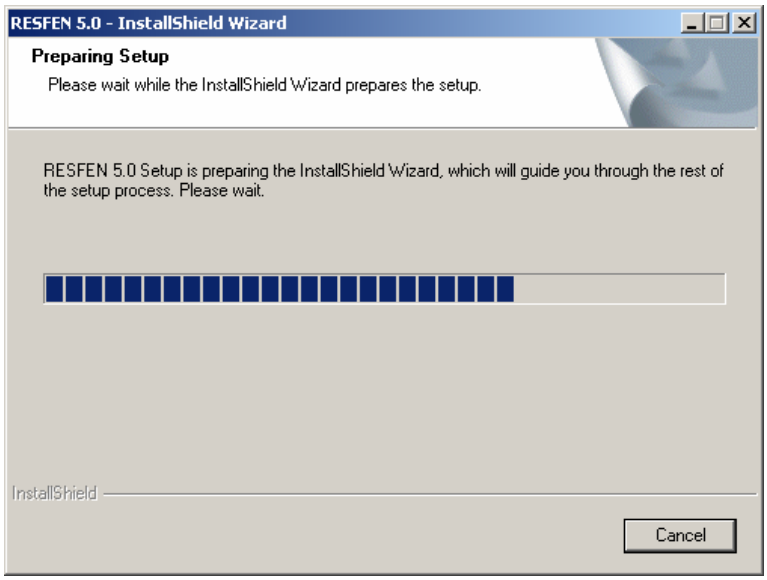


Figure 3-23. The InstallShield Wizard appears.

4. The Welcome Screen appears with three choices. Click on the **Remove** radio button and then click on the Next button.

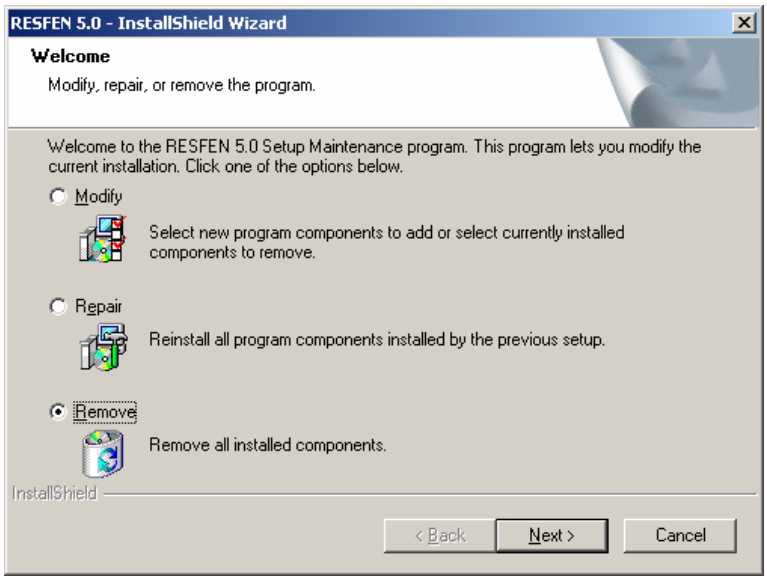


Figure 3-24. The InstallShield Wizard appears.

5. The program will ask if you want to completely remove the application. Click **OK** to uninstall the program, or **Cancel** to cancel the uninstall process.

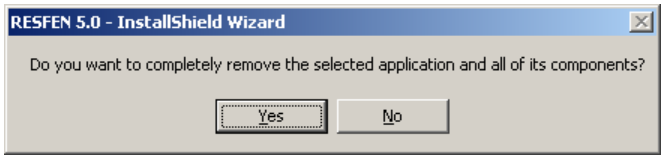


Figure 3-25. Click OK to continue with the uninstall process.

6. You may get a message about restarting your computer. You can choose the “No I will restart my computer later” option.

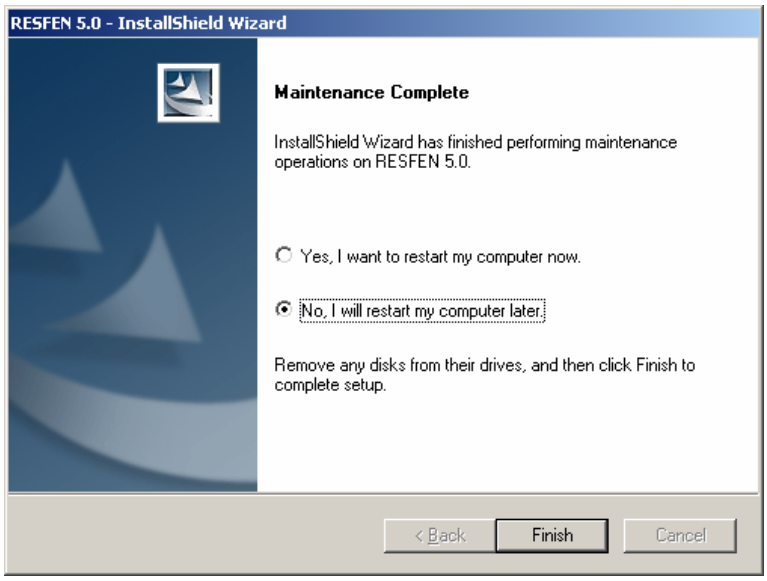


Figure 3-26.You can choose to restart your computer later. You may not always see this screen when uninstalling the program.

7. When the uninstall process is complete, the **Maintenance Complete** screen appears. Click **Finish** to complete the uninstall.

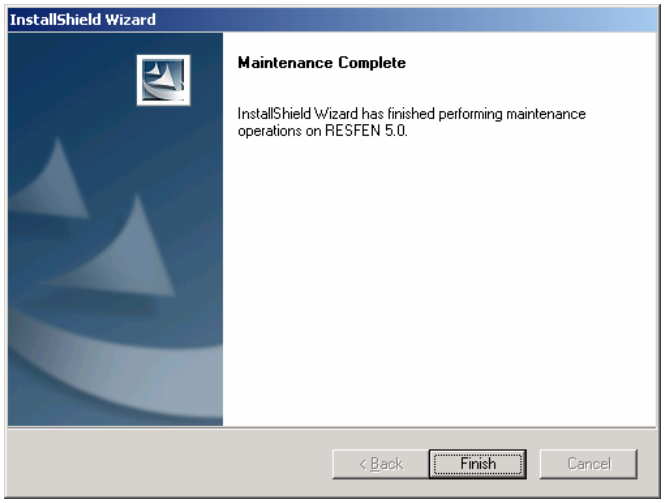


*Figure 3-27. Click **Finish** to complete the uninstall process.*

3.6. Troubleshooting

When you first run the program after installing it, the results may show as zeros after the first calculation. If you have this problem, close the program, run it again, and the problem should go away.

Please send E-mail to RESFENhelp@lbl.gov, or send a fax to (510) 486-4089 if you have any trouble running the program.

4. PROGRAM DESCRIPTION

4.1. Overview

RESFEN is a program with a simple user interface, shown in Figure 4-1, tied to a powerful analytical tool, DOE-2 (Lawrence Berkeley Laboratory, 1980; Winkelmann, 1993). The RESFEN default screen which opens when the program starts is the House Library Detailed View, which has several components:

- Main Menu
- Toolbar
- House Data input section
- Window Data input section
- Results section

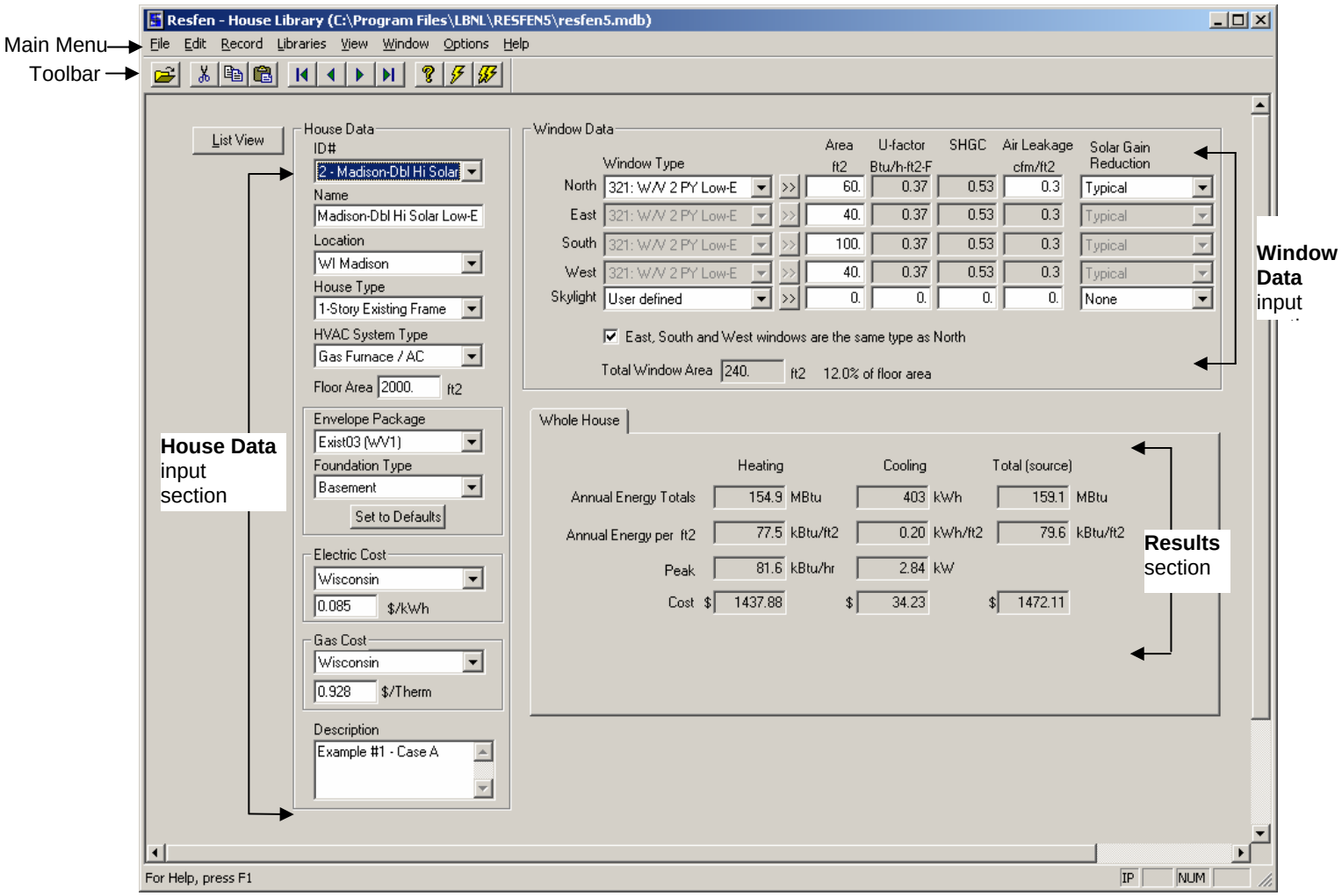


Figure 4-1. Components of the RESFEN House Library Screen

4.2. Steps to complete a RESFEN run

The primary steps to complete a RESFEN calculation are:

- Describe the building configuration by entering the appropriate input values in the **House Data** section
- Describe the windows in the building by entering the appropriate input values in the **Window Data** section
- Click on one of the lightning bolt tool buttons to do either a **Whole House** or **Whole House + 4 Orientations** calculation.
- View the answers in the **Results** section when the simulation has finished.

The following sections of this chapter describe the program in detail.

4.3. Toolbar

RESFEN has a toolbar with buttons for the most commonly used functions, shown below.

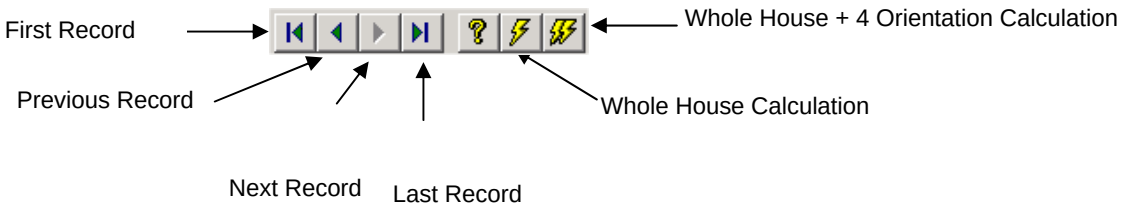


Figure 4-2. Toolbar

4.4. Menus

Each menu can be accessed with the mouse, by pointing and clicking on the menu choice, or with the keyboard, by pressing the **Alt** key and then typing the first letter of the menu name. For example, **Alt-F** would access the **File** menu. To select a menu choice, you can click on the choice with your mouse, type the underlined character of each menu choice, or use the **Up** and **Down** arrow keys. Keyboard shortcuts are indicated to the right of the menu item when available.

4.4.1. File

The **File** menu is used to manipulate the RESFEN input files, to print the current screen, and to exit the program. Each set of input values on the main screen makes up a file, and different input configurations can be saved with different file names, so you can retrieve the input values as well as the results by opening the files that you save. RESFEN automatically opens the input file named "default.rsf" when the program starts. You can make changes to this file and save the changes to a new file name. RESFEN automatically adds the "RSF" extension to the file name that you provide.

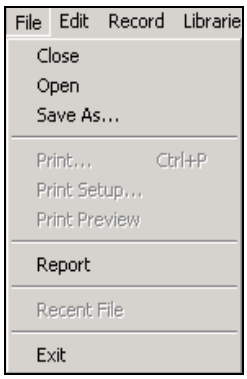


*Figure 4-3. The **File** menu*

Close Close the RESFEN program. Equivalent to Exit.

Open Open a RESFEN database, which will have an "mdb" extension.

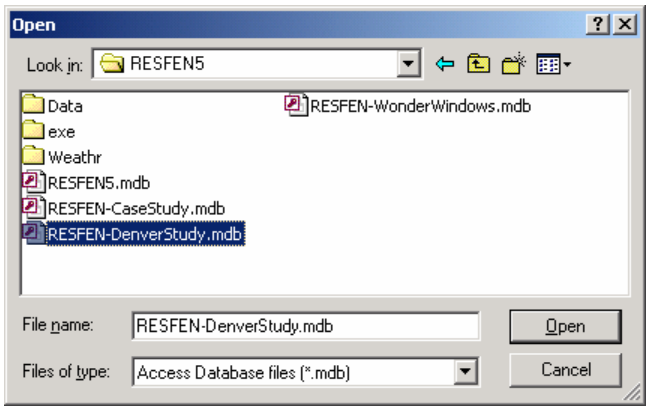


*Figure 4-4. The **File Open** dialog box.*

Save As Save the current database into another database. You can use this feature to develop different modeling scenarios and save them for future use. RESFEN5 supports the Windows 95™, Windows 98™, and WindowsNT™ long file-naming convention.

When the RESFEN program starts, it opens the last database opened. If changes are made to this file, and you want to save it into a different database, use the **Save As** menu choice.

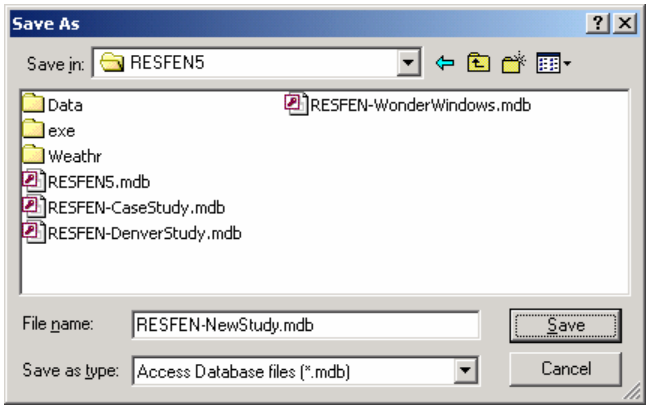


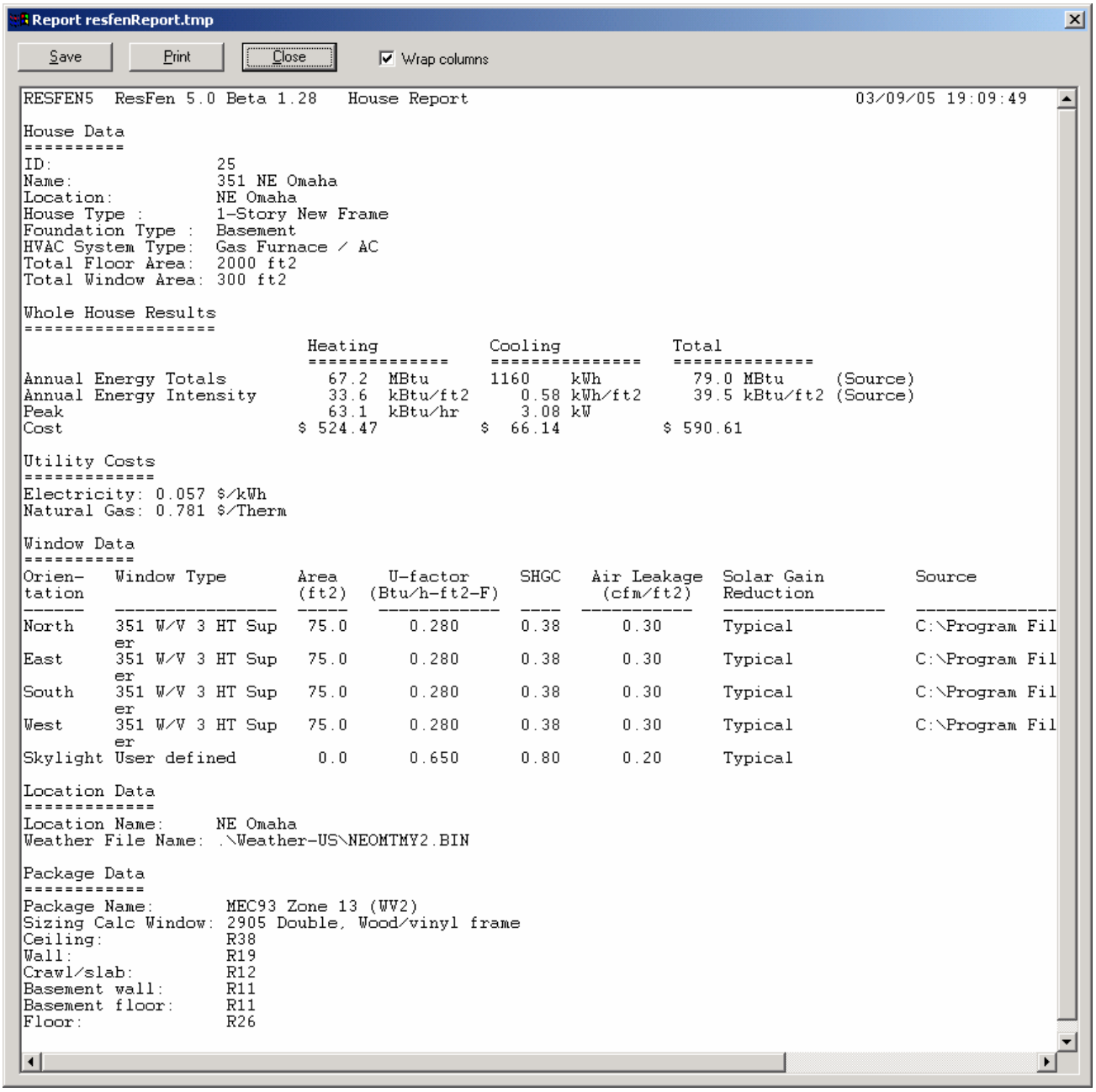
*Figure 4-5. Use the **Save As** feature to save the database under a different name for future use.*

Print *Not currently implemented*

Print Setup — *Not currently implemented.*

Print Preview — *Not currently implemented.*

Report — If there are results from a calculation, the results can be viewed in a report, as shown in the figure below. The report can be saved to a text file using the Save button, or printed using the Print button. If the "Wrap columns" checkbox is not checked, any data wider than the column will be truncated.




```
RESFEN5  ResFen 5.0 Beta 1.28   House Report                                   03/09/05 19:09:49

House Data
==========
ID:                  25
Name:                351 NE Omaha
Location:            NE Omaha
House Type :         1-Story New Frame
Foundation Type :    Basement
HVAC System Type:    Gas Furnace / AC
Total Floor Area:    2000 ft2
Total Window Area:   300 ft2

Whole House Results
===================
                            Heating            Cooling            Total
                            ==============     ===============    ==============
Annual Energy Totals          67.2  MBtu       1160    kWh          79.0 MBtu     (Source)
Annual Energy Intensity       33.6  kBtu/ft2      0.58 kWh/ft2      39.5 kBtu/ft2 (Source)
Peak                          63.1  kBtu/hr       3.08 kW
Cost                        $ 524.47          $  66.14          $ 590.61

Utility Costs
=============
Electricity: 0.057 $/kWh
Natural Gas: 0.781 $/Therm

Window Data
===========
Orien-   Window Type       Area     U-factor     SHGC   Air Leakage  Solar Gain         Source
tation                     (ft2)  (Btu/h-ft2-F)          (cfm/ft2)   Reduction
------   ----------------  -----   ------------  ----  -----------  ----------------   --------------
North    351 W/V 3 HT Sup   75.0      0.280      0.38      0.30      Typical            C:\Program Fil
         er
East     351 W/V 3 HT Sup   75.0      0.280      0.38      0.30      Typical            C:\Program Fil
         er
South    351 W/V 3 HT Sup   75.0      0.280      0.38      0.30      Typical            C:\Program Fil
         er
West     351 W/V 3 HT Sup   75.0      0.280      0.38      0.30      Typical            C:\Program Fil
         er
Skylight User defined        0.0      0.650      0.80      0.20      Typical

Location Data
=============
Location Name:       NE Omaha
Weather File Name:   .\Weather-US\NEOMTMY2.BIN

Package Data
============
Package Name:        MEC93 Zone 13 (WV2)
Sizing Calc Window:  2905 Double, Wood/vinyl frame
Ceiling:             R38
Wall:                R19
Crawl/slab:          R12
Basement wall:       R11
Basement floor:      R11
Floor:               R26
```

*Figure 4-6. The **Report** dialog box.*

Recent File — Shows the four most recently opened RESFEN databases.

Exit — Quits the program.

4.4.2. Edit

The **Edit** menu functions can be accessed from the Edit menu, and also using the standard shortcut keys listed in the menu.

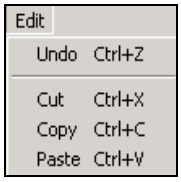


*Figure 4-7. The **Record** menu*

4.4.3. Record

The Record menu can be used to move between records (rows) in any of the Library screens, as well as to save edits made to the currently open record.

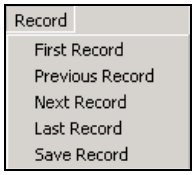


*Figure 4-8. The **Record** menu*

4.4.4. Libraries

The RESFEN5 program consists of Libraries which are used to define a building model. The figure below shows the options in the Libraries menu.

*Figure 4-9. The **Libraries** menu*

The Libraries, which are described in detail in the rest of this section, are:

House	The House Library is where the definition of a specific building to be modeled is specified. The building data, location, and window data are all specified in the House Library.
Locations	The Location Library is used to specify information about a location for the RESFEN calculation engine, including the weather file for the DOE2 simulation, the building insulation packages to be used in the simulation, and the utility rates associated with the location.
Window	The Window Library is used to define a set of windows that can be used in the House Library window definitions. Records in the Window Library can be imported from the LBNL WINDOW5 program, or user defined.
Packages	The Packages Library is used to construct a set of building envelope insulation definitions, such as the insulation level for the walls, floors, ceilings and foundation. These packages are then associated with a Location in the Location Library.

Results The Results Library is where the results of each of the input definitions is stored. Different views of the results are possible from this library, and the results of multiple input definitions can be viewed at once, as well as exported to a comma separated text file which can be imported into a spreadsheet program for further analysis.

Electric Rates The Electric Rates Library contains a list of electric rates which can be selected from in the Location Library.

Gas Rates The Gas Rates Library contains a list of electric rates which can be selected from in the Location Library.

4.4.5. View

The View menu is used to control the toolbar and status bar display settings.

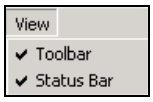


*Figure 4-10. The **View** menu*

4.4.6. Options

The Options menus is used to set program level default values.

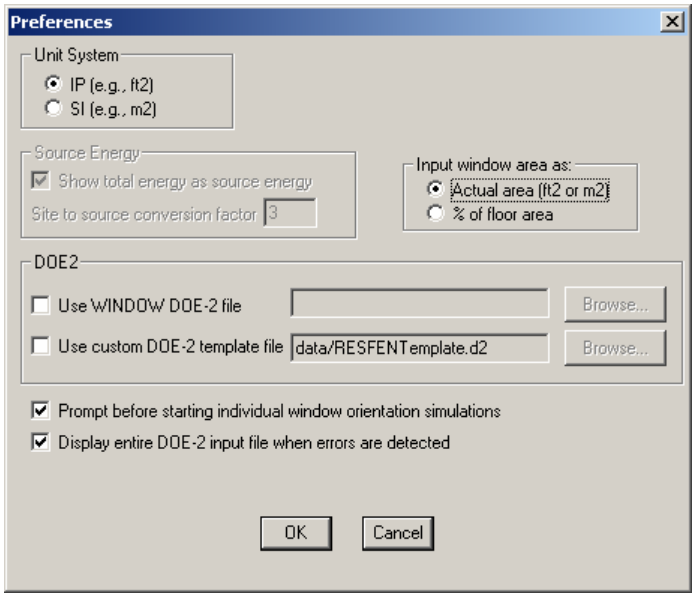


*Figure 4-11. The **Options** menu*

Unit System The system of units, from the choice of either:

- IP: Inch pounds
- SI: International units

Input Window Area as

- Area (sf): this option allows input of the window as actual area. **Units:** square feet (IP); square meters (SI).
- % of floor area: *Currently inactive.* (This option allows input of the window area based on the floor area.)

DOE2

Use WINDOW DOE-2 file

This option allows specification of a DOE2 "dat" file, such as that generated by the WINDOW5 program, for one or more windows, to provide the DOE2 calculation engine with more detailed information about the window glazing characteristics. If this option is used, the House Library window input must use the WINDOW5 library option, and the ID numbers in the DAT file must match the ID numbers in WINDOW5 library. See Chapter 6, Section 6.4, "Using WINDOW5 DOE2 Input File for RESFEN Calculations" for more details about this option.

Use custom DOE-2 template File

Because RESFEN uses the DOE2 simulation engine to calculate the results, the program must have a DOE2 input file as a basis for that calculation. By default the program uses an encrypted file called RESFENTemplate.d2 for that input file. However, it is possible to use other DOE2 input files if they are constructed so that RESFEN can interpret them properly. In general, using an input file other than the default one supplied with the program is not advised. However, advanced users familiar with DOE2 may want to use this option. If so, it is best to start with a default text file that RESFEN can read, which is supplied with the program, called Template.new. This file can be edited (with extreme care not to make the file uninterpretable by RESFEN and DOE2) and then referenced from this Preferences option. If a file other than the default one is used, RESFEN will report that fact on the House Library Detail view as well as in the report.

Prompt before Starting individual Window orientation Simulations

If this box is checked, when the "double lightning bolt" button is clicked to generate results for the four orientations, RESFEN will put up the message box shown in the figure below. If this message is annoying, it can be eliminated by unchecking this box in the Preferences dialog box.

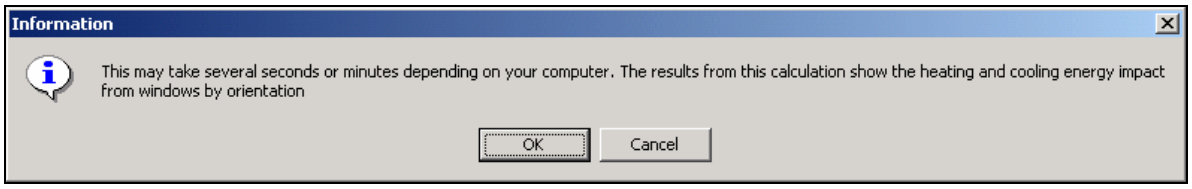


Figure 4-12. Message displayed before the House + 4 Orientations run begins.

Display entire DOE-2 input file When errors are Detected

In the hopefully unlikely event that the DOE2 simulation engine cannot perform the calculation because of input errors, this option allows the user to see the raw DOE2 input file, with the errors indicated. This input file is not for the faint-of-heart, and will only make sense to someone very familiar with DOE2, which the typical RESFEN user should not need to be. If this happens (and it bascially never should), the best option is to contact LBNL at RESFENHelp@lbl.gov.

4.4.7. Help

About Information about RESFEN, including the version number of the program.

4.5. Libraries in General

Libraries are the main components of the RESFEN5 program, and each library contains characteristics necessary for the calculations.

4.5.1. List and Detail Views

There is a "List" and a "Detail" view of the data in each library. The List View shows all the records (rows) in the library but only some of the fields (columns with data), and the Detail View shows all the data (or fields) for one record. Most changes to the library records are made in the Detail View.

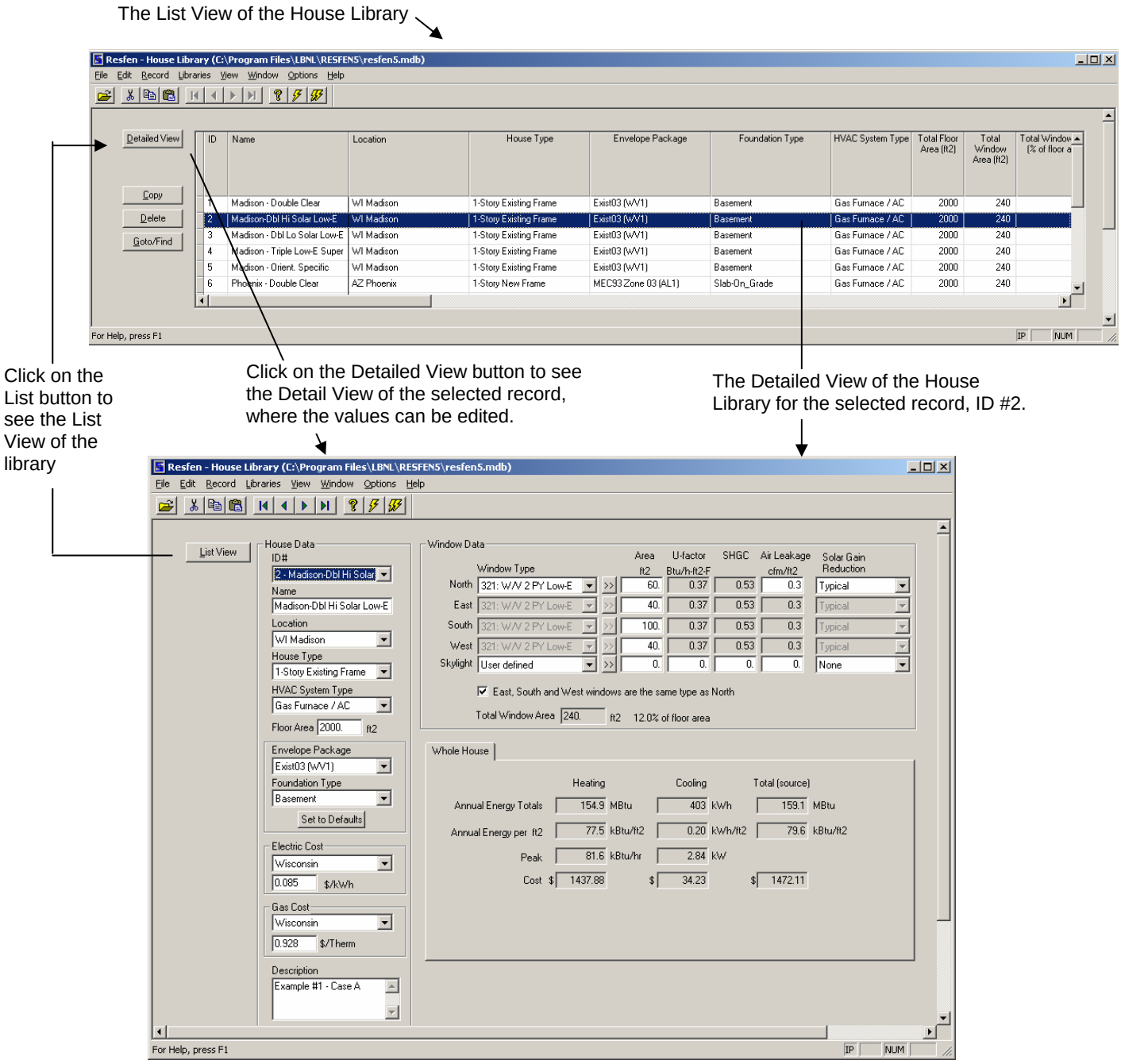
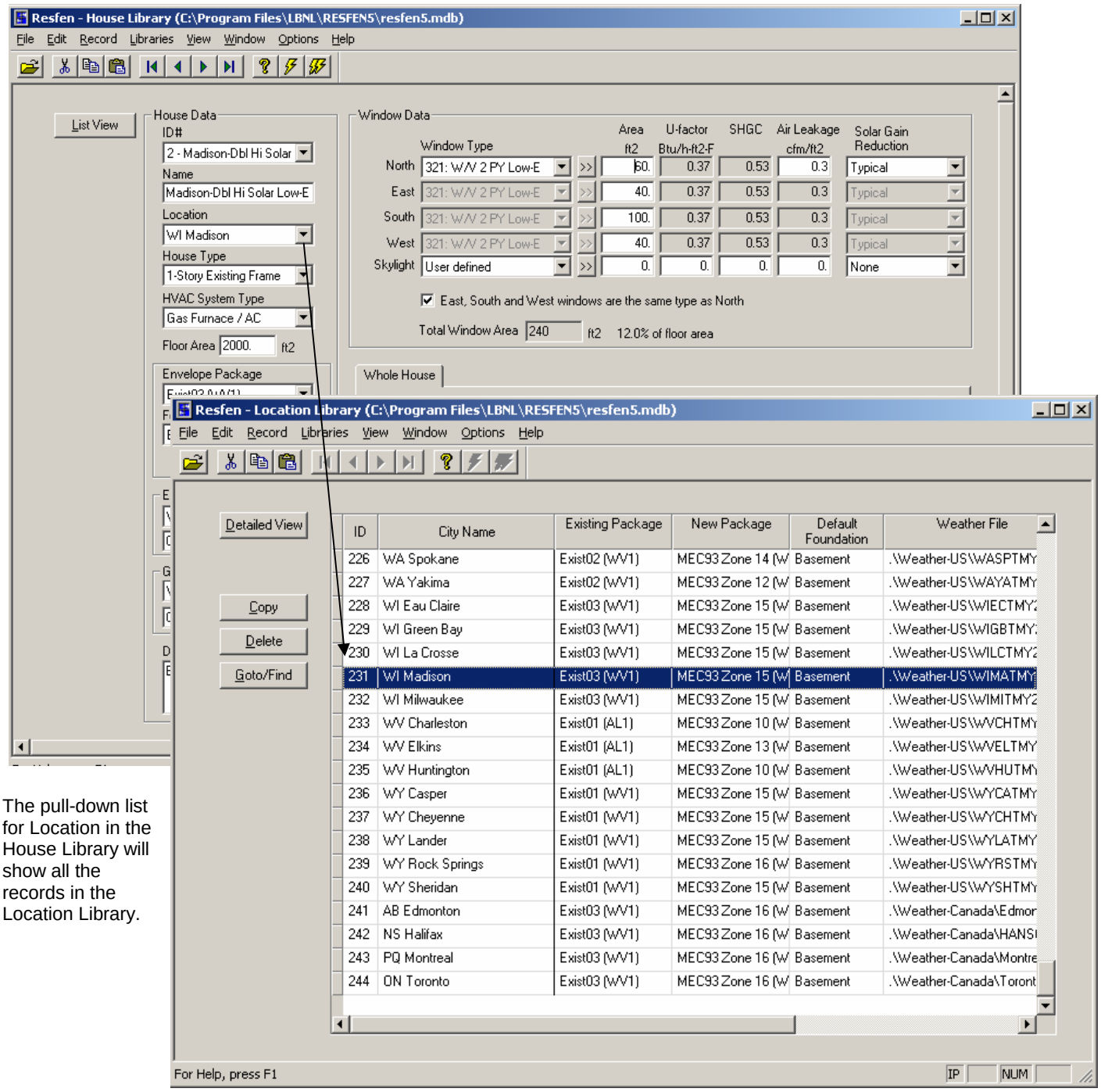


Figure 4-13. Switching between the List View and Detail View in a Library.

4.5.2. Selecting Records from Libraries

From many of the libraries, it is necessary to select records from other libraries. For example, in the Location Library Detail View, in order to define a location, it is necessary to select records from the Packages Library, the Gas Rates Library, and the Electric Rates Library. There are pull-down boxes for each of these inputs that will display the choices from the appropriate library.



The pull-down list for Location in the House Library will show all the records in the Location Library.

Figure 4-14. Selecting a record from another library.

4.5.3. Moving Between Records in Detail View

There are several ways to move between records in the Library Detail View:

- The **Record Menu** contains choices for First Record, Previous Record, Next Record, Last Record
- The **Toolbar** has buttons for first , previous , next , and last record to move between records.

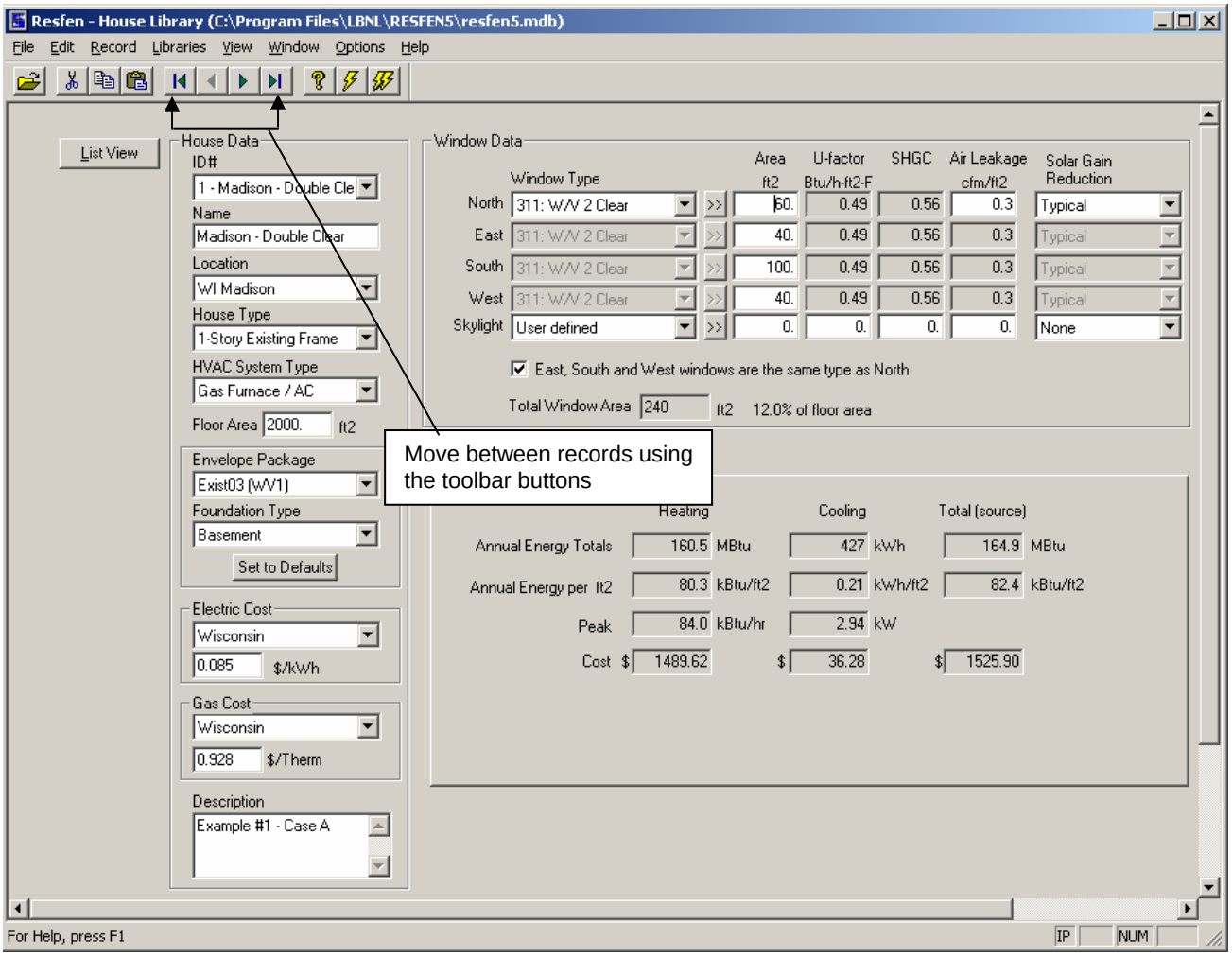


Figure 4-15. Use the Toolbar buttons to move between records.

4.5.4. Creating New Records

New records can be created in all the libraries by copying an existing record (by highlighting it and clicking on the Copy button in the List View) and then editing the new record with the desired values in the Detailed View. The ID number for the new record is automatically incremented by the program based on the last ID number that was used. That value can be changed to any other number by the user, as long as the ID is unique. If the ID entered for the new record already exists, the program will ask if the existing record should be overwritten. There is also a checkbox in the "Adding a record" dialog box which tells the program to overwrite existing records without asking.

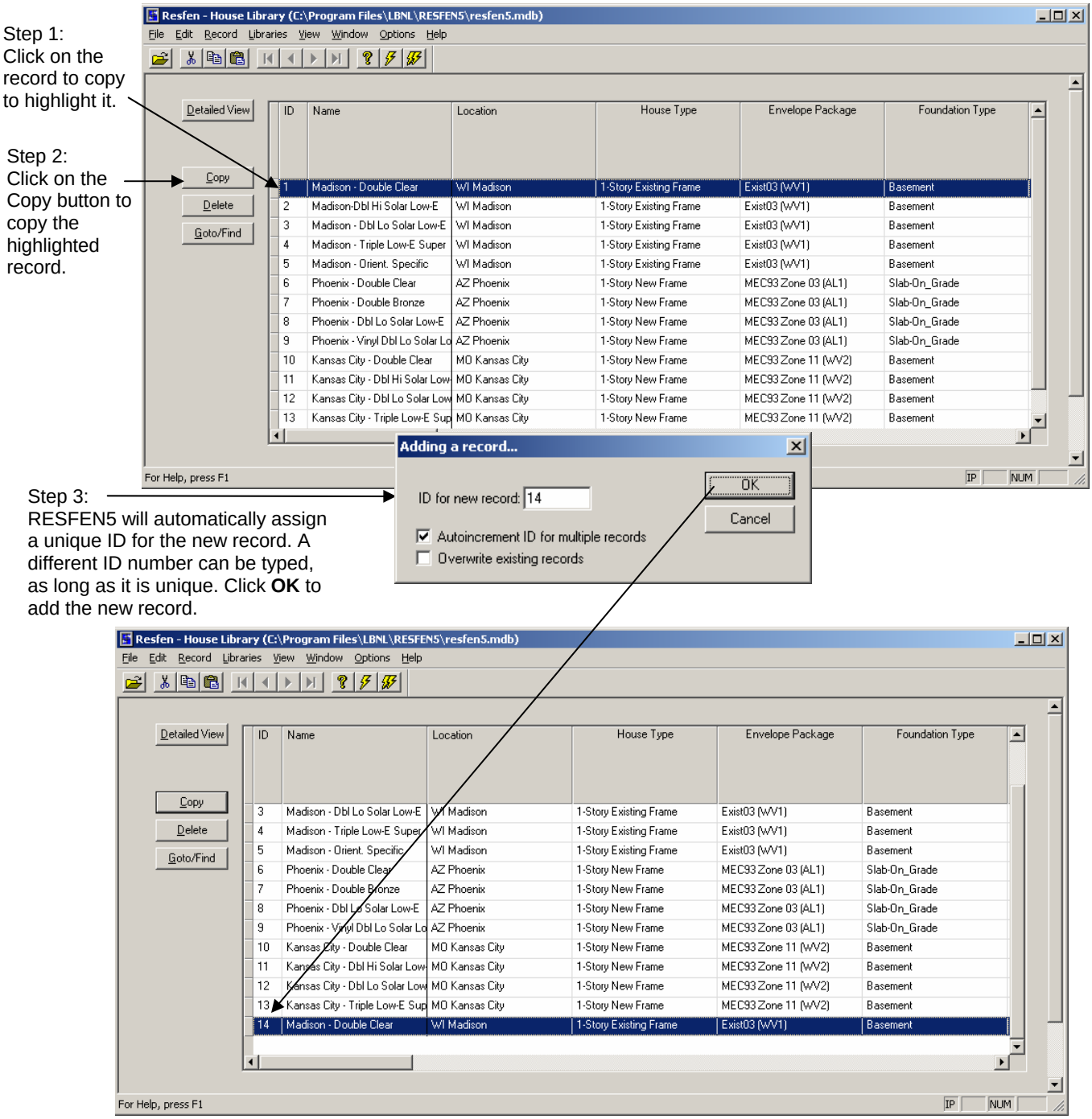
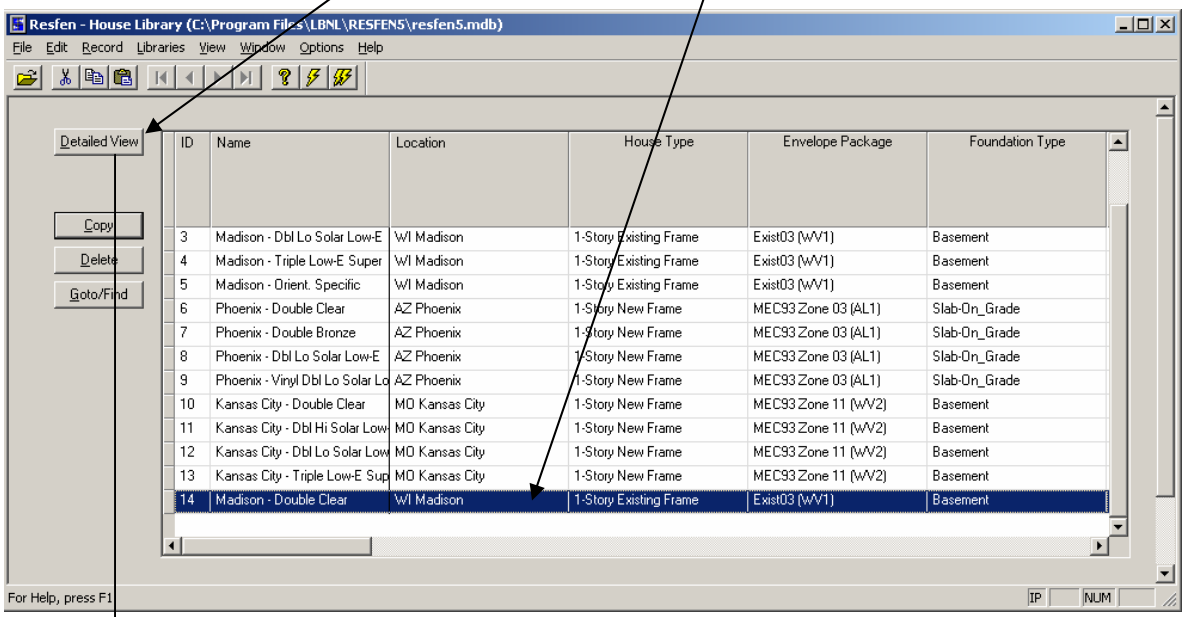


Figure 4-16. Create a n ew record by copying an exi sting record in the List View of any library.

Step 5:
To edit the copied record, highlight the record and click the Detailed View button.



Step 6:
The detailed view of the highlighted record will open, and values can be edited as desired.

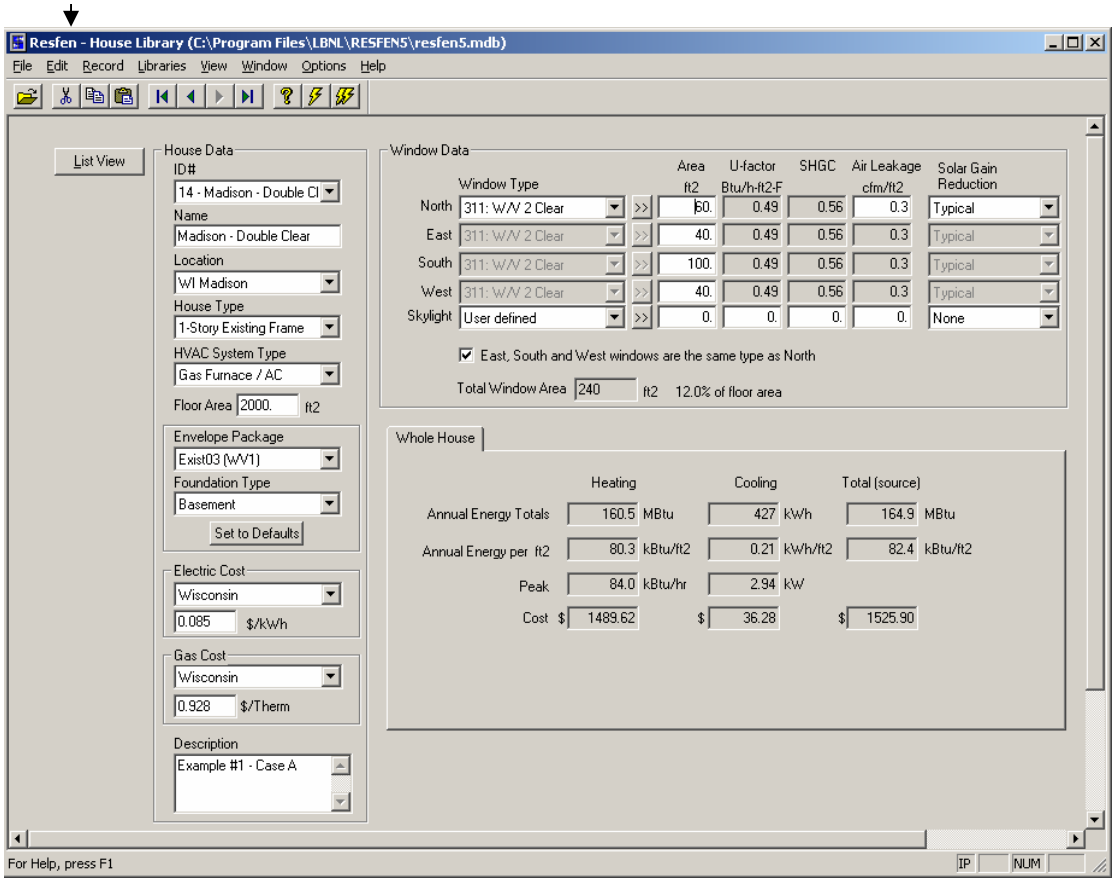


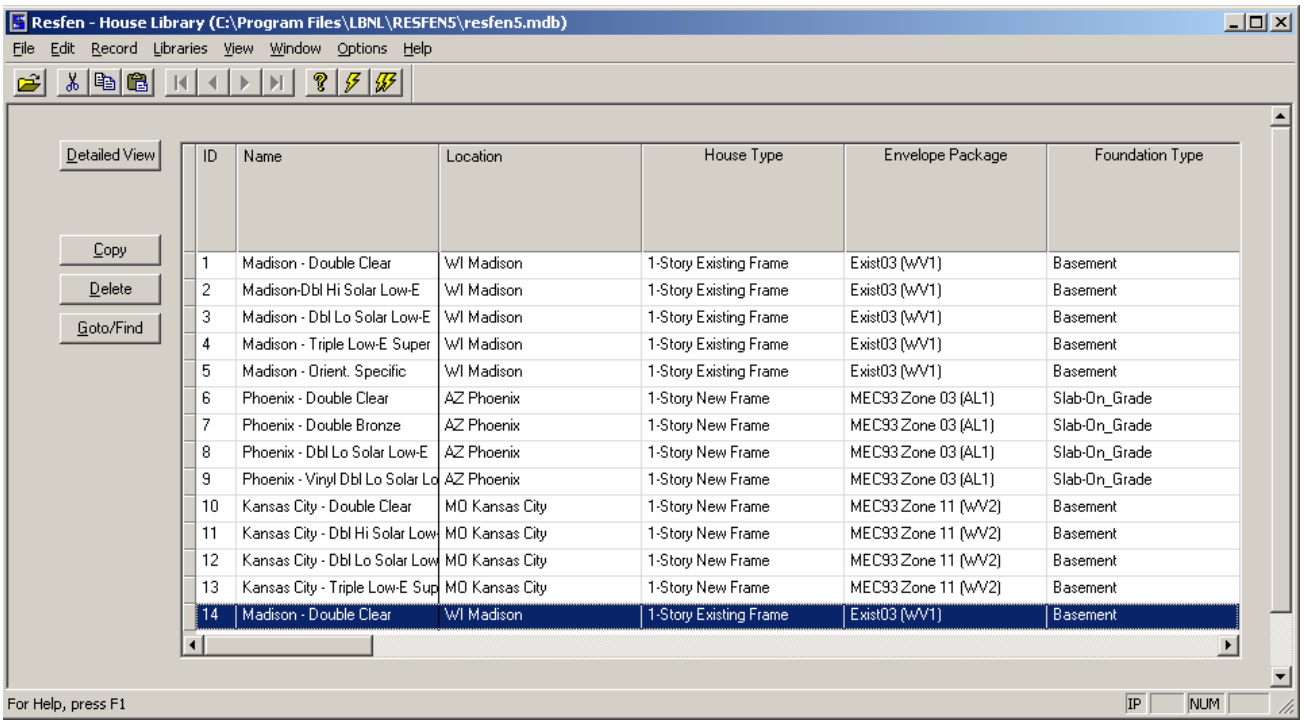
Figure 4-17. Edit the newly created record in the Library Detail View.

4.6. House Library

The House Library is where the building to be analyzed is defined. Because RESFEN5 is structured around a database, each building configuration can be defined as a separate record in the House Library.

4.6.1. House Library List View

As with the other libraries, the House Library List View shows all the records in the currently open database.



ID	Name	Location	House Type	Envelope Package	Foundation Type
1	Madison - Double Clear	WI Madison	1-Story Existing Frame	Exist03 (WV1)	Basement
2	Madison-Dbl Hi Solar Low-E	WI Madison	1-Story Existing Frame	Exist03 (WV1)	Basement
3	Madison - Dbl Lo Solar Low-E	WI Madison	1-Story Existing Frame	Exist03 (WV1)	Basement
4	Madison - Triple Low-E Super	WI Madison	1-Story Existing Frame	Exist03 (WV1)	Basement
5	Madison - Orient. Specific	WI Madison	1-Story Existing Frame	Exist03 (WV1)	Basement
6	Phoenix - Double Clear	AZ Phoenix	1-Story New Frame	MEC93 Zone 03 (AL1)	Slab-On_Grade
7	Phoenix - Double Bronze	AZ Phoenix	1-Story New Frame	MEC93 Zone 03 (AL1)	Slab-On_Grade
8	Phoenix - Dbl Lo Solar Low-E	AZ Phoenix	1-Story New Frame	MEC93 Zone 03 (AL1)	Slab-On_Grade
9	Phoenix - Vinyl Dbl Lo Solar Lo	AZ Phoenix	1-Story New Frame	MEC93 Zone 03 (AL1)	Slab-On_Grade
10	Kansas City - Double Clear	MO Kansas City	1-Story New Frame	MEC93 Zone 11 (WV2)	Basement
11	Kansas City - Dbl Hi Solar Low-	MO Kansas City	1-Story New Frame	MEC93 Zone 11 (WV2)	Basement
12	Kansas City - Dbl Lo Solar Low	MO Kansas City	1-Story New Frame	MEC93 Zone 11 (WV2)	Basement
13	Kansas City - Triple Low-E Sup	MO Kansas City	1-Story New Frame	MEC93 Zone 11 (WV2)	Basement
14	Madison - Double Clear	WI Madison	1-Story Existing Frame	Exist03 (WV1)	Basement

Figure 4-18. The House Library Detail View.

Detailed View — Used to change to the Detailed View of the highlighted record in order to edit the input values.

Copy — Used to copy existing records to create new records which can then be edited as needed. Highlight the record or records to be copied (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Copy** button. By default the program will increment the ID number based on the last ID value, but this can be changed by the user as long as the ID will unique for this library.

Delete — Used to delete existing records. Highlight the record or records to be deleted (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Delete** button.

Goto/Find — Used to find a record in the library based on the **Name** field. When this button is clicked, a small dialog box will appear, and the beginning letters of the name can be typed, and the first record whose **Name** field starts with those letters will be highlighted.

4.6.2. House Library Detailed View

The detailed view of the House Library allows editing of all the building definition fields.

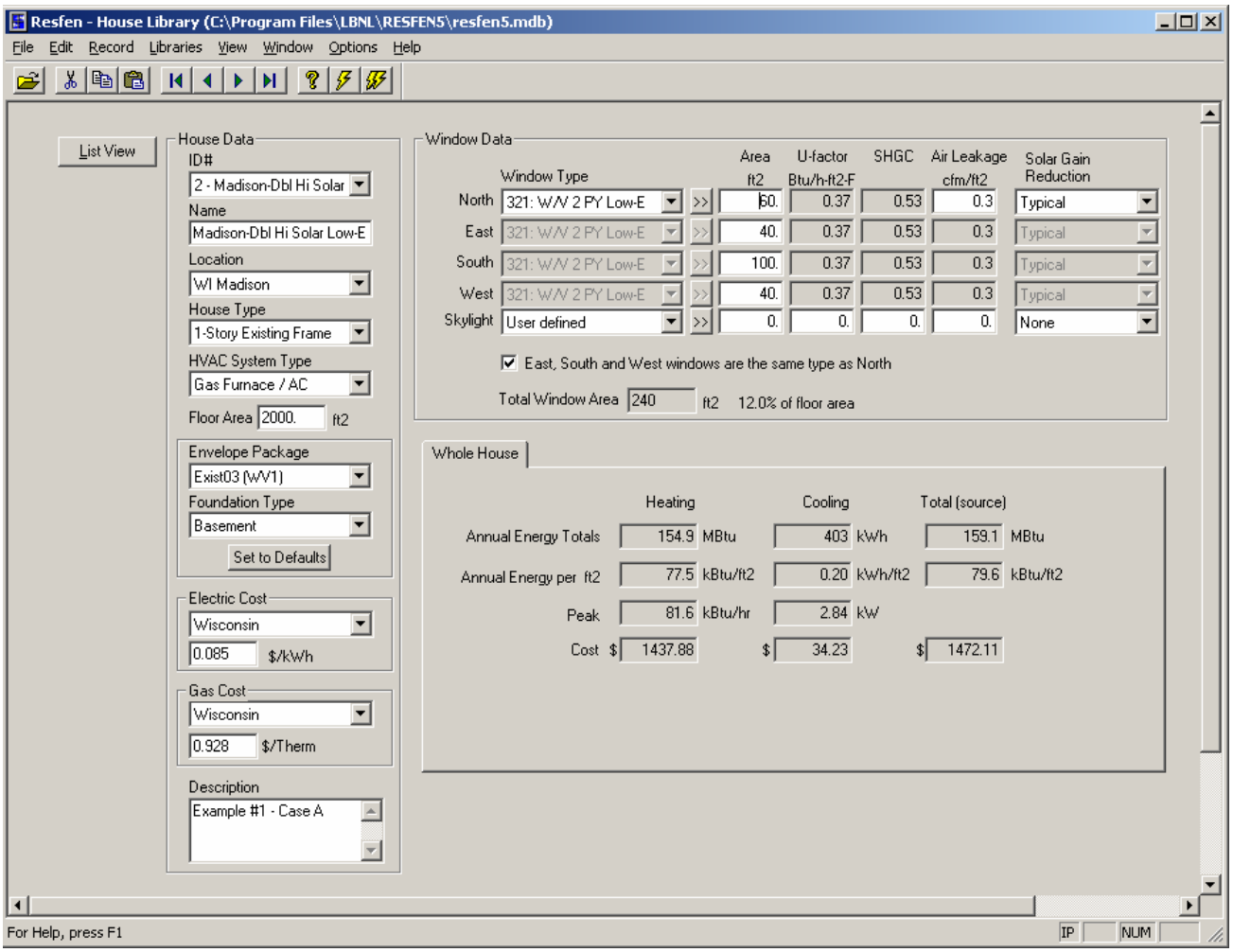


Figure 4-19. The House Library Detail View.

The following discussion explains the different sections of the House Library Detail View.

4.6.2.1. House Data

The left side of the main screen contains the **House Data** section, a series of pull-down lists that allow you to specify geographic location, house type, foundation type, HVAC type, floor area, and utility costs.

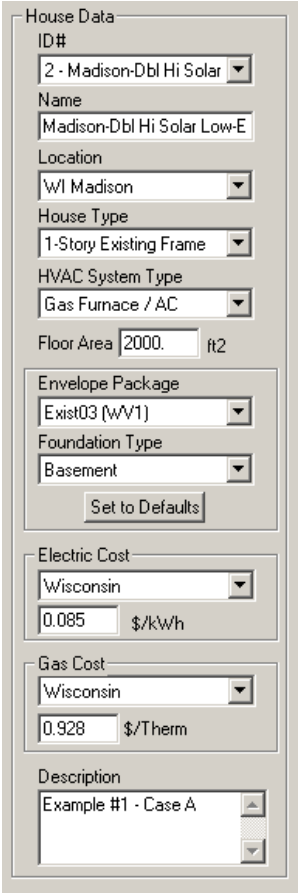


*Figure 4-20. The **House Data** portion of the main screen*

ID# — The **ID#** field is automatically created by the program, and is a combination of the record number (generated by the program when the record is created, such as using the Copy button in the List View) and the **Name** field (entered below). This value is in a pull-down list, which shows all the House Library records, and is another way to move between records in this library.

Name — Name of the record, input by the user. The Name is appended to the record ID number and used in the previous field.

Location — A pull-down list showing the entries in the Location Library. The location chosen is used by RESFEN to specify Typical Meteorological Year (TMY2) weather data used for the DOE-2 simulation. The location selection determines the default values for:

- Envelope Package
- Foundation Type

House Type — A pull-down list for specifying whether the building is one story or two story, new or existing construction, and what the predominant construction type is – either frame or masonry. For a two-story building case, the program assumes an equal floor area on each floor, based on the total floor area that you specify in the **Floor Area** input box.

- 1-Story New Frame

- 1-Story New Masonry
- 1-Story Existing Frame
- 1-Story Existing Masonry
- 2-Story New Frame
- 2-Story New Masonry
- 2-Story Existing Frame
- 2-Story Existing Masonry

Default: 1-Story New Frame

HVAC System Type

A pull-down list for specifying the house's heating and cooling system. The efficiencies are different for **New** and **Existing Construction** (see Section 6.2, "RESFEN Modeling Assumptions" for details).

- Gas Furnace / AC
- Electric Heat Pump

Floor Area

The total floor area of the house.
Units: square feet (ft^2) (IP); square meters (m^2)(SI)
Legal values*:* 1,000 to 4,000 square feet

Envelope Package

A pull-down list for specifying the insulation package for the building envelope. The choices in this list are from the Packages Library. The default values are based on the Location, but can be overridden by the user from this pulldown. When the Location is changed, the program will ask whether to use the default package from that Location. If the user says “Yes”, the package will be set to that associated with the Location in the Location Library. If the user says“No”, any package can be chosen from this list. The default packages in the Packages Library are based on the Model Energy Code (MEC) from 1993, and more packages can be created in the Packages Library. For more details about the Packages Library, see Section 4.10.

Foundation Type

A pull-down list for specifying the predominant type of foundation construction. The default value used by the program is based on the Default Foundation Type specified in the Location Library. However, it is possible to change that default value here in the House Library Detailed view. The possible foundation types are.

- Basement
- Slab-on-Grade
- Crawlspace

Default: dependent on the location selected.

Set to Defaults

Clicking on this button will reset the Envelope Package and the Foundation Type to the values defined in the Location Library.

Electric Cost

There are two input boxes for Electric Cost.

The first is a pull-down list, which shows the records in the Electric Rates Library. The default records that come with the program are one value per state. (See Section 4.12 for more details about the Electric Rates Library). Based on the selection from the pull-down list, electric rate in the box below it will change. The first choice in the pull-down list is User Defined, which allows the input of any value, overriding the value from the Electric Rates Library.

The second input box is a value representing the average cost of electricity for the location. This value initially is based on the choice from the Electric Rates Library, but can be edited by the user to any value. This number is multiplied by the energy consumption to calculate total cost.

Legal Values*:* Any number.

Units: $/kWh

Gas Cost

There are two input boxes for Gas Cost.

The first is a pull-down list, which shows the records in the Gas Rates Library. The default records that come with the program are one value per state. (See Section 4.12 for more details about the Gas Rates Library). Based on the selection from the pull-down list, Gas rate in the box below it will change. The first choice in the pull-down list is User Defined, which allows the input of any value, overriding the value from the Gas Rates Library.

The second input box is a value representing the average cost of Gas for the location. This value initially is based on the choice from the Gas Rates Library, but can be edited by the user to any value. This number is multiplied by the energy consumption to calculate total cost.

Legal Values: Any number.

Units: $/Therm

Description

An optional field that can be used to record information about the case being modeled.
Legal Values: Any character or number, up to 50 characters.

4.6.2.2. Window Data

The upper right-hand section of the screen is used to input information about the windows in the house for each of the four orientations, **North**, **East**, **South** and **West**, as well as **Skylights**, as shown in the figure below. Use your mouse, the **Tab** key or the **arrow** keys to move between the fields.

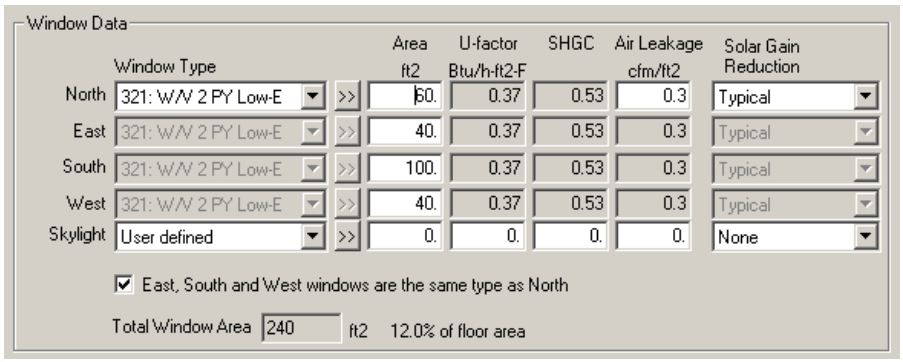


*Figure 4-21. The **Window Data** portion of the screen*

When modeling the windows in your house, group the windows on an orientation together to determine the total area by orientation. If your windows do not face the exact cardinal orientations (north, south, east and west), use the closest orientations. The program has the capability of varying fenestration system parameters for each orientation. The NFRC total product properties, which include the glazing and frame, should be used for the area, U-factor, solar heat gain coefficient (SHGC), and infiltration (CFM per unit area). The **Area** parameter represents the total window area on any one facade in square feet or as a percentage of the total floor area (see detailed **Area** explanation below).

Skylights are modeled as vertical glazing in the roof of the building, with solar heat gain reduced by 50% to account for skylight-well effects. This correction factor is a placeholder; research is ongoing to improve the skylight well solar correction.

Because it is necessary to group windows by orientation, use the window properties for the window type that predominates on an orientation if the building has different types of windows on the same orientation. Input the total window area. For example, if all the windows on the west orientation are wood casements except for one aluminum frame picture window or one patio door with an area significantly less than the sum of the wood windows, model the west-facing windows as all wood casements. You could also obtain the properties for each window type on a given orientation and area-weight these values based on the square footage of each window type.

Window Type

There are two options for **Window Type**, which are accessed by clicking on the **Window Type** pulldown list for each orientation:

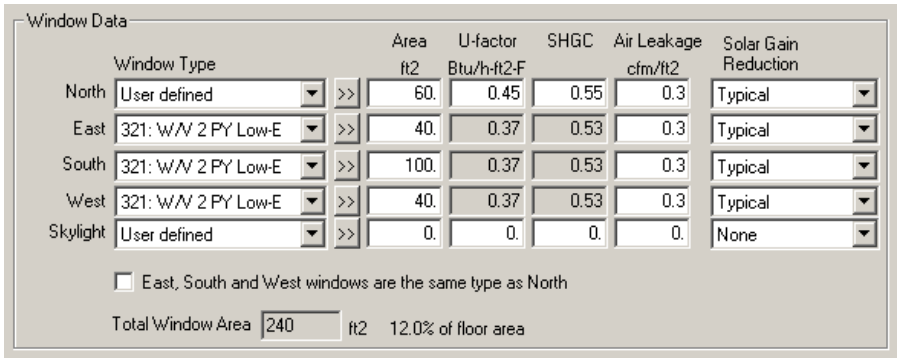
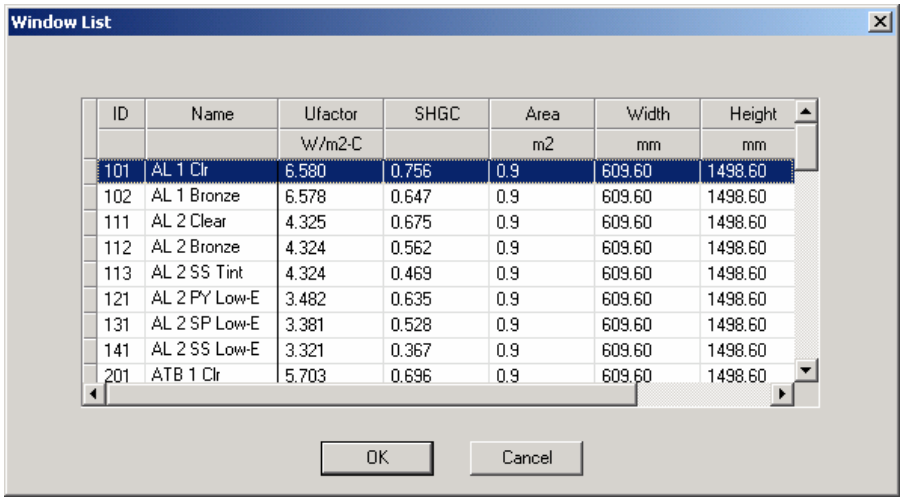


Figure 4-22. *Two* ***Window Type*** *choices,* ***User specified*** *or* ***Window4 Lib****.*

- **User Defined:** Selecting the first choice in the pull-down list, User Defined, allows the user to enter the U-factor and SHGC window properties for each orientation. This choice can be used when comparing windows to get general trends about window technologies, but are not concerned about a detailed analysis for a particluar window.
- **Window Library Selection:** All the other choices in the pull-down list other than User Defined are records from the Window Library. In the Window Library, the user can create more windows, or import records created by the WINDOW5 program (see the *WINDOW 5.0 User Manual*). The U-factor and SHGC values from the Window Library are input automatically into those fields in the House Library Window Data. A default WINDOW5 library, **RESFEN5Windows.mdb,** has been imported into the default REFEN database (RESFEN5.mdb) and is included in the installation files. The values contained in this library are for single casement windows, but can be used for sliders and fixed windows because their properties are essentially the same.

The double arrow button next to the pull-down list arrow shows the same records as the pull-down list, but displays more information about each record in a



row/column grid, also allowing sorting by the grid column headings.

Figure 4-23. ***The double arrow selection button displays more information about the records in the Window Library.***

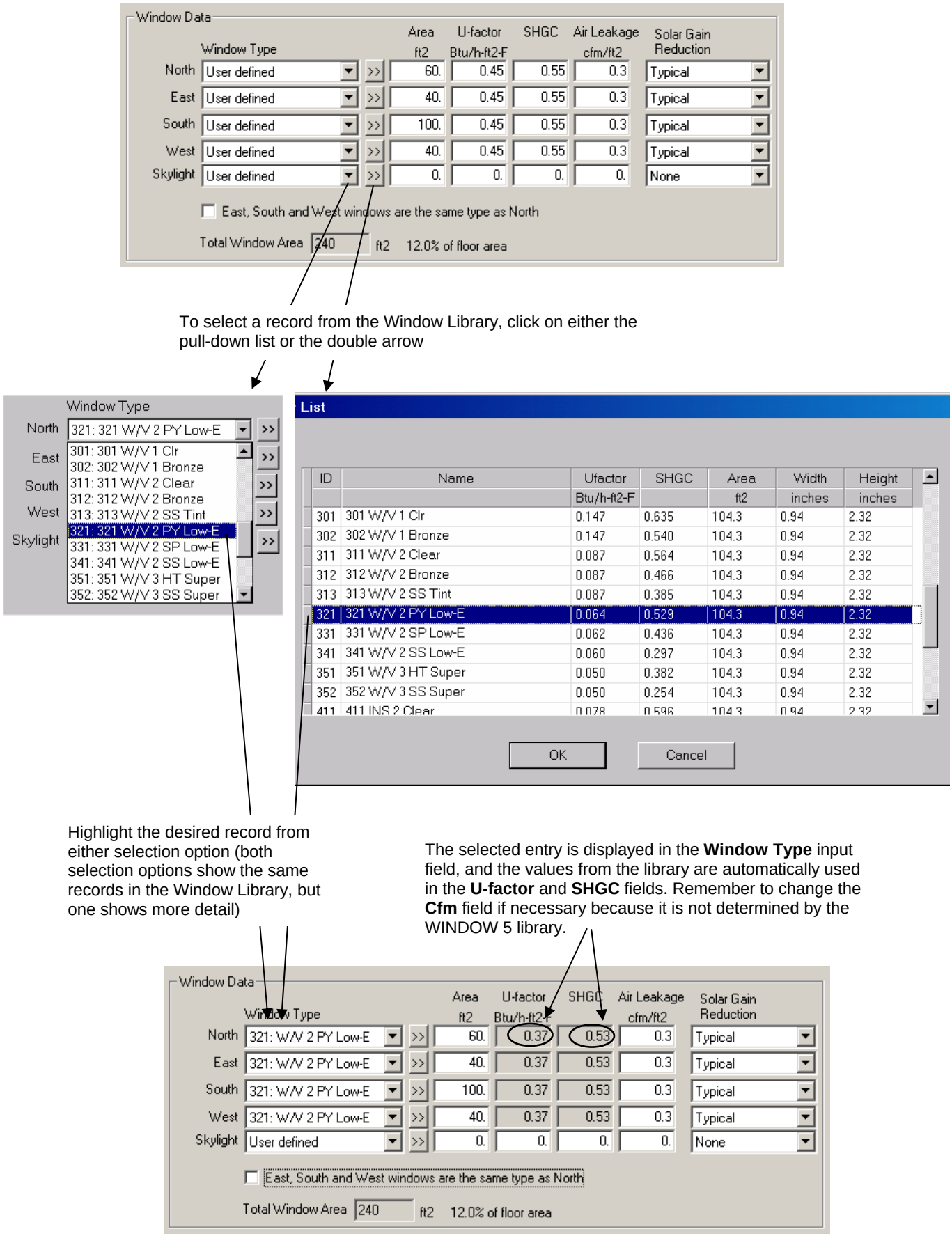


Figure 4-24. Select window properties from the Window Library

Window

Total window area input as either total area or percent of total house floor area for each of four orientations. For example, if you want to model four windows that are 3′ x 4′ on the south orientation, the total window area for that orientation is 36 square feet, which is 2.3% for a house whose floor area is 1,560 ft^2 (36/1540).
Units: square feet (ft^2)(IP), square meters (m^2)(SI), or % of floor area (% Flr Area), depending on the settings in the **Options** menu.
Legal values*:* 0% to 12% per orientation; 0 to 480 square feet (4,000 square feet maximum floor area * 0.12 = 480); the sum of the percentages for the four orientations cannot exceed 48% of the floor area.

U-Factor

The U-factor of the total fenestration product at standard NFRC winter conditions, which includes the frame as well as the glazing, from a source such as the window NFRC label, manufacturer's literature, or a WINDOW 5 analysis.

Units: Btu/hr-ft^2-°F (IP), W/m^2-° C (SI).

Legal values: between 0.05 and 1.40 Btu/hr-ft^2-°F at standard NFRC winter conditions.

SHGC

The Solar Heat Gain Coefficient of the total fenestration product, which includes the frame as well as the glazing, from a source such as the window NFRC label, manufacturer's literature, or a WINDOW 4.1 analysis.

Legal values: between 0.05 and 0.90.

CFM/Area

The infiltration of the total fenestration product (from ASTM E283 tests or equivalent), which includes the frame as well as the glazing.

Units: CFM/ft^2.

Legal values: between 0.05 and 2.0 CFM/ft^2.

Solar Gain Reduction

The type of solar gain reduction for the building, from the following list:

- **Typical:** A statistically average solar gain reduction which includes some interior shade, overhangs, exterior obstructions and screens. See Section 6.2, "RESFEN Modeling Assumptions" for specific details.
- **None:** No interior shading, exterior overhangs, or obstructions.
- **Interior:** Interior drapes. See Section 6.2, "RESFEN Modeling Assumptions" for specific details.
- **Overhang:** two-foot exterior overhang at roof line.
- **Obstruction:** Used to model large obstructions, such as neighboring houses or other buildings. See Section 6.2, "RESFEN Modeling Assumptions" for details.
- **Int+Ovh:** A combination of the Interior and Overhang options.
- **Ovh + Obs:** A combination of the Overhang and Obstruction options.
- **Int + Obs:** A combination of the Interior and Obstruction options.
- **All:** A combination of the Interior, Overhang, and Obstruction options.

East, South and West windows are The Same type as North

Checking this box will set the Window Type values for the East, South and West windows to that of the North window. The program will ask you if you want to also set the window area to the same value as the North window.

Total Area Window

Feedback only. This box displays the total window area of all the building orientations, including skylights; this total is calculated automatically by the program.

Units: square feet (ft^2) (IP), square meters (m^2)(SI), or percentage of floor area (%), depending on the settings in the **Options** menu choice for **Window Area**.

4.6.2.3. Results

The lower portion of the screen shows the results of the calculations, in the **Results** section. There are four tabs in this section, which display the following results:

- **Whole House:** the total annual energy consumption for the building, including conduction gains and losses from windows, walls, roof, and foundations.
- **Window Annual Energy:** the portion of the annual energy consumption attributed to the windows, broken down by four window orientations.
- **Window Energy Cost:** the portion of the annual energy cost attributed to the windows, broken down by four window orientations.
- **Window Peak Energy:** the portion of the peak energy consumption attributed to the windows, broken down by four window orientations.

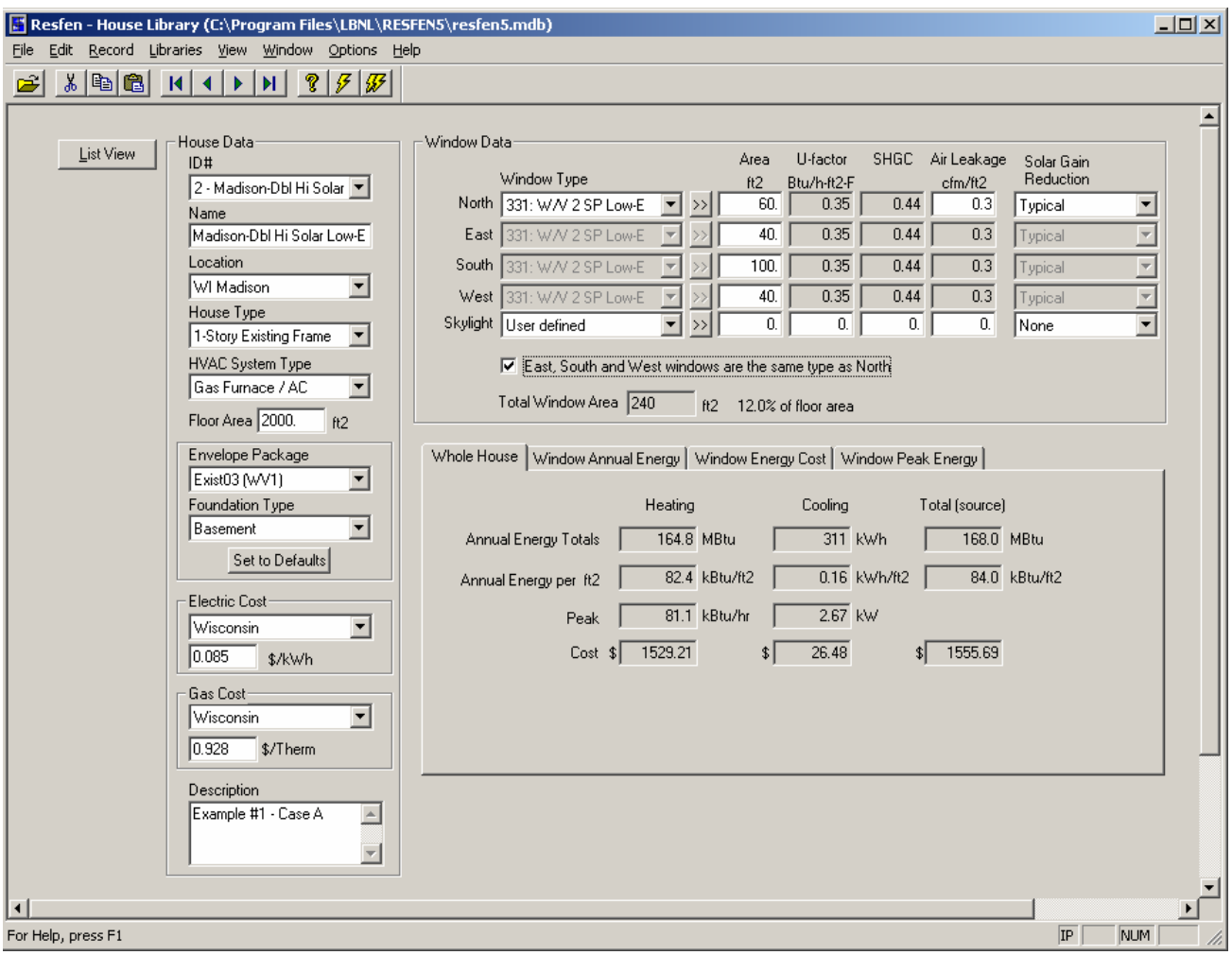


*Figure 4-25. The **Results** section contains four different sets of results.*

When you have input all the appropriate values into the **House Data** and **Window Data** sections, to start the simulations, click either:

- the **Whole House Calculation** toolbar button

or

- the **Whole House + 4 Orientations** toolbar.

These two different calculation types are described below:

- **Whole House:** this option calculates the energy consumption for the entire house. It includes energy use attributable to the building windows, walls, roof, and foundation (including infiltration). It does not include lighting or appliance or hot water energy consumption. If this calculation is selected, only the Whole House tab will be displayed in the Results section.
- **Whole House + 4 orientations:** this option calculates the energy consumption of the entire house and also the energy attributed to only the windows, for each orientation. Because separate simulations are run for the whole house and each window orientation, this calculation can take some time, depending on the speed of your computer. If this calculation is selected, all four tabs will be displayed in the Results section.

  The window results by orientation are all relative to a standard insulated windowless wall. Positive values mean that the window uses *more* energy than an insulated wall with no windows; negative values mean that the window uses *less* energy than an insulated wall with no windows. All cooling results will be positive, but heating energy use can be either positive or negative. If the results are positive, the smallest value will be the most energy-efficient window configuration. If the results are negative, the largest negative value will be the most energy-efficient window configuration. When comparing positive and negative results, the window configurations with negative results will be the most energy efficient. It is possible for a window configuration to use less heating energy than an insulated wall (and thus have a negative result) because the solar heat gain from the window provides heat to the space and reduces the heating requirements of the building.

The results are reset to 0 whenever any changes are made to the input values, so you must recalculate the results.

4.6.3. Whole House

The **Whole House** results show the total annual energy consumption for the building, broken into the following results:

- Energy Totals
- Energy per ft^2
- Total Cost

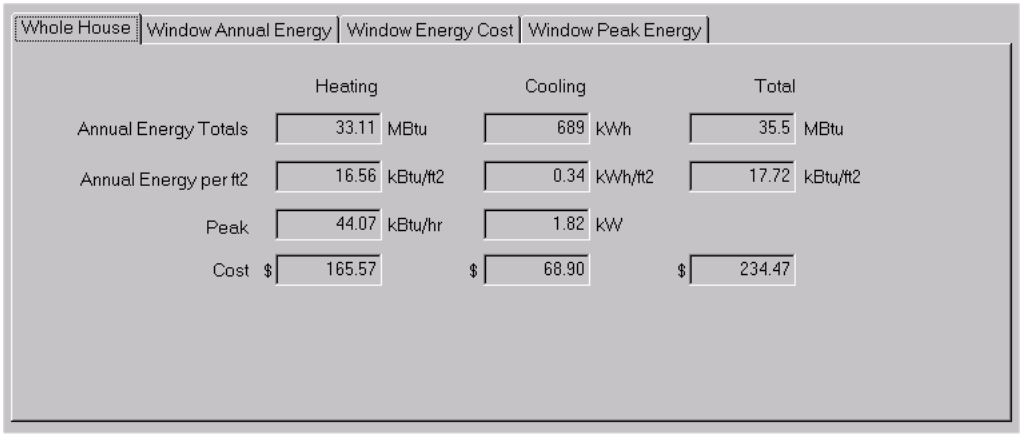


*Figure 4-26. The **Results** tab for the **Whole House calculation**.*

Annual Energy Totals

Total annual energy consumption for the entire house, broken into the following components:

- **Heating:** The annual heating energy consumption for the entire house.
  Units: MBtu/year (IP), GJ (SI) for Gas Furnace; kWh/year (IP and SI) for Electric Heat Pump.
- **Cooling:** The annual cooling energy consumption for the entire house.
  Units: kWh/year (IP and SI).
- **Total:** The annual total energy consumption for the entire house.
  Units: MBtu/year (IP), GJ/year (SI) for Gas Furnace/AC ; kWh/year (IP and SI) for Electric Heat Pump.

Energy per ft2

The annual energy consumption for the entire house divided by the area of the house, broken into the following components:

- **Heating:** The annual heating energy consumption for the entire house per floor area.
  Units: kBtu/ ft^2 (IP), GJ/m^2 (SI) for Gas Furnace; kWh/ ft^2 (IP), kWh/ m^2 (SI) for Electric Heat Pump.
- **Cooling:** The annual cooling energy consumption for the entire house per floor area.
  Units: kWh / ft^2 (IP), kWh /m^2 (SI).
- **Total:** The annual total energy consumption for the entire house per floor area.
  Units: MBtu/ ft^2 (IP), GJ/ m^2 (SI) for Gas Furnace/AC ; kWh/ ft^2 (IP), kWh/ m^2 (SI) for Electric Heat Pump.

Total Cost

The cost of the annual energy consumption for the entire house, which is the energy totals multiplied by electricity and gas prices, broken into the following components:

- **Cooling:** The cost of the annual cooling energy consumption for the entire house. This value should equal the **Cooling Energy Total** multiplied by the **Electricity** cost.
  Units: $/year
- **Heating:** The cost of the annual heating energy consumption for the entire house. This value is the **Heating Energy Total** multiplied by either the **Gas** cost for gas furnaces or the **Electricity** cost for heat pumps.
  Units: $/year
- **Total:** The total cost of the annual energy consumption for the entire house. This value is the sum of the heating and cooling costs.
  Units: $/year

4.6.3.1. Window Annual Energy

The **Window Annual Energy** results show the portion of the annual energy consumption of a building that can be attributed to the window being modeled. Positive values mean that the window adds that amount to the energy consumption of the house on an annual basis. Negative values can occur for heating, meaning that the window provides heating in the form of useful solar gain, which more than compensates for heat lost, and helps to lower the house's heating energy consumption. The first four columns represent the four window orientations (north, east, south and west). The fifth column represents skylights.

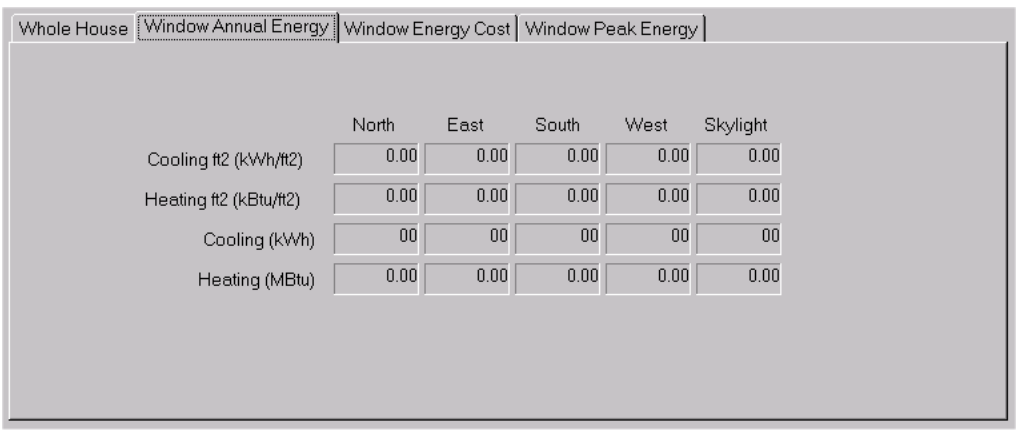
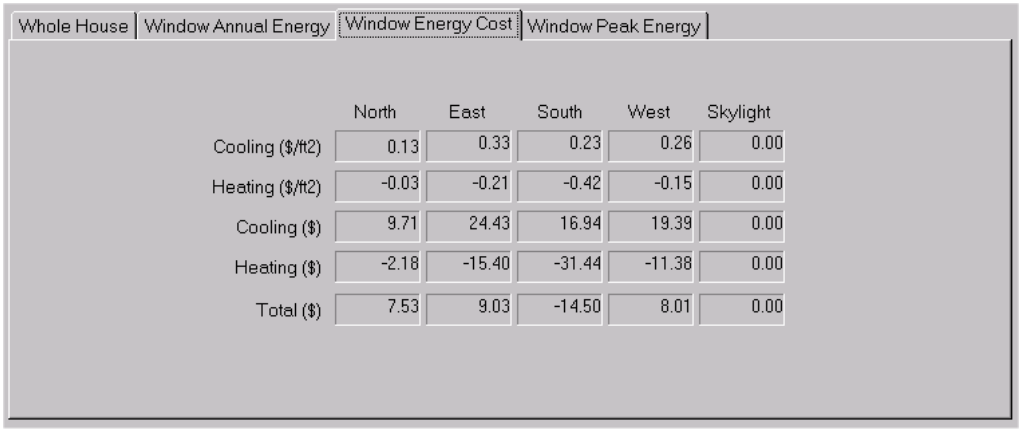


*Figure 4-27. The **Results** tab for **Window Annual Energy**.*

Cooling/ft²	Cooling energy per unit window area. **Units**: kWh/ft²-year (IP), kWh/m²-year (SI).
Heating/ft²	Heating energy per unit window area. **Units:** kBtu/ft²-year (IP), GJ/m²-year (SI) for **Gas Furnace;** kWh/ft²-year (IP), kWh/m²-year (SI), for **HeatPump**.
Cooling Energy	Cooling energy attributed to windows. **Units:** kWh/year (IP and SI)
Heating Energy	Heating energy attributed to windows. **Units:** MBtu/year (IP), GJ/year (SI) for **Gas Furnace**, or kWh/year (IP and SI) for **HeatPump**.

4.6.3.2. Window Annual Cost

The **Window Annual Cost** result shows the difference between the annual energy cost of a building with the window being modeled and with a windowless wall. The energy use values in the **Window Annual Energy** result are converted to costs using the input values for electricity and gas. Positive values mean that the window uses *more* energy than a standard insulated wall with no windows; negative values for heating mean that the window uses *less* energy than a standard insulated wall with no windows. Negative values represent economic savings that will offset other energy-consuming features in the house, thus reducing the total home heating bill.



	North	East	South	West	Skylight
Cooling ($/ft2)	0.13	0.33	0.23	0.26	0.00
Heating ($/ft2)	-0.03	-0.21	-0.42	-0.15	0.00
Cooling ($)	9.71	24.43	16.94	19.39	0.00
Heating ($)	-2.18	-15.40	-31.44	-11.38	0.00
Total ($)	7.53	9.03	-14.50	8.01	0.00

*Figure 4-28. The **Results** tab for **Window Energy Cost**.*

Cooling ($/area) Cooling energy per unit window area.
Units: $/ft^2-year (IP), . $/m^2 (SI)

Heat ($/area) Heating energy per unit window area.
Units: $/ft^2-year (IP), . $/m^2 (SI)

Cooling ($) Cooling energy attributed to windows.
Units: $/year.

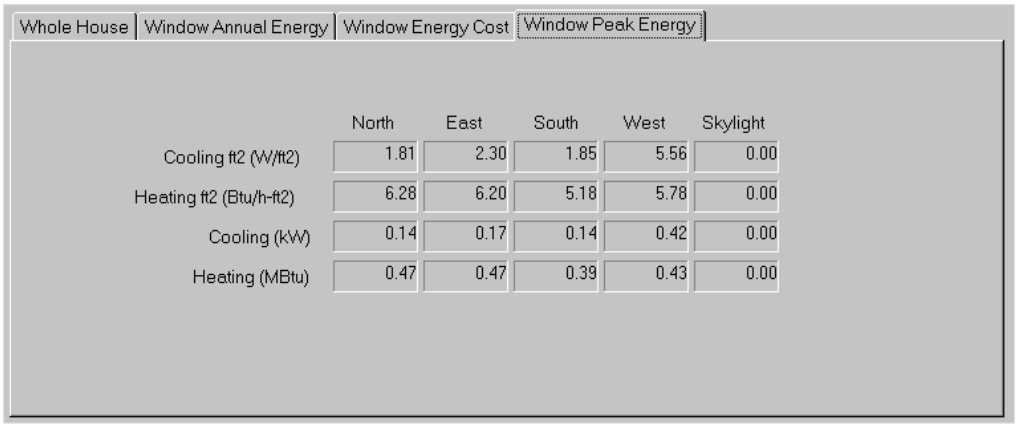
Heating ($) Heating energy attributed to windows.
Units: $/year.

Total Energy ($) Sum of the Cooling and Heating Energy Cost.
Units: $/year.

4.6.3.3. Window Peak Demand

The **Window Peak Demand** result shows the difference between the peak energy demand of a building with the window being modeled and with a windowless wall. Positive values mean that the window has a higher peak demand than a standard insulated wall with no windows; negative values mean that the window has a lower peak demand than a standard insulated wall with no windows.

Peak heating and cooling loads determine the required size of the furnace and air conditioner needed to meet maximum thermal loads. Lower peak demand means smaller, less expensive equipment. Peak heating conditions typically occur on cold winter nights, and peak cooling conditions typically occur on hot, sunny summer afternoons. Make sure that the equipment sizing calculations done by your HVAC contractor take into account the benefits of high-performance windows.



	North	East	South	West	Skylight
Cooling ft2 (W/ft2)	1.81	2.30	1.85	5.56	0.00
Heating ft2 (Btu/h-ft2)	6.28	6.20	5.18	5.78	0.00
Cooling (kW)	0.14	0.17	0.14	0.42	0.00
Heating (MBtu)	0.47	0.47	0.39	0.43	0.00

*Figure 4-29. The **Results** tab for **Window Peak Energy**.*

Cool Peak/ Unit Area — Cooling peak per unit window area.
Units: W/ft^2 (IP).

Heat Peak/ Unit Area — Heating peak per unit window area.
Units: Btu/ ft^2 (IP). or kW (IP and SI) for HeatPump.

Cooling Peak — Cooling peak attributed to windows.
Units: kW (IP and SI).

Heating Peak — Heating peak attributed to windows.
Units: kBtu/hr (SI and IP) or kW (SI and IP) for HeatPump.4.7. Location Library

The Location Library is used to define new locations for calculations. RESFEN5 comes with over 200 locations predefined, and if the appropriate weather files for the DOE2 simulation can be obtained, more locations can be added.

The information contained in the Location Library includes:

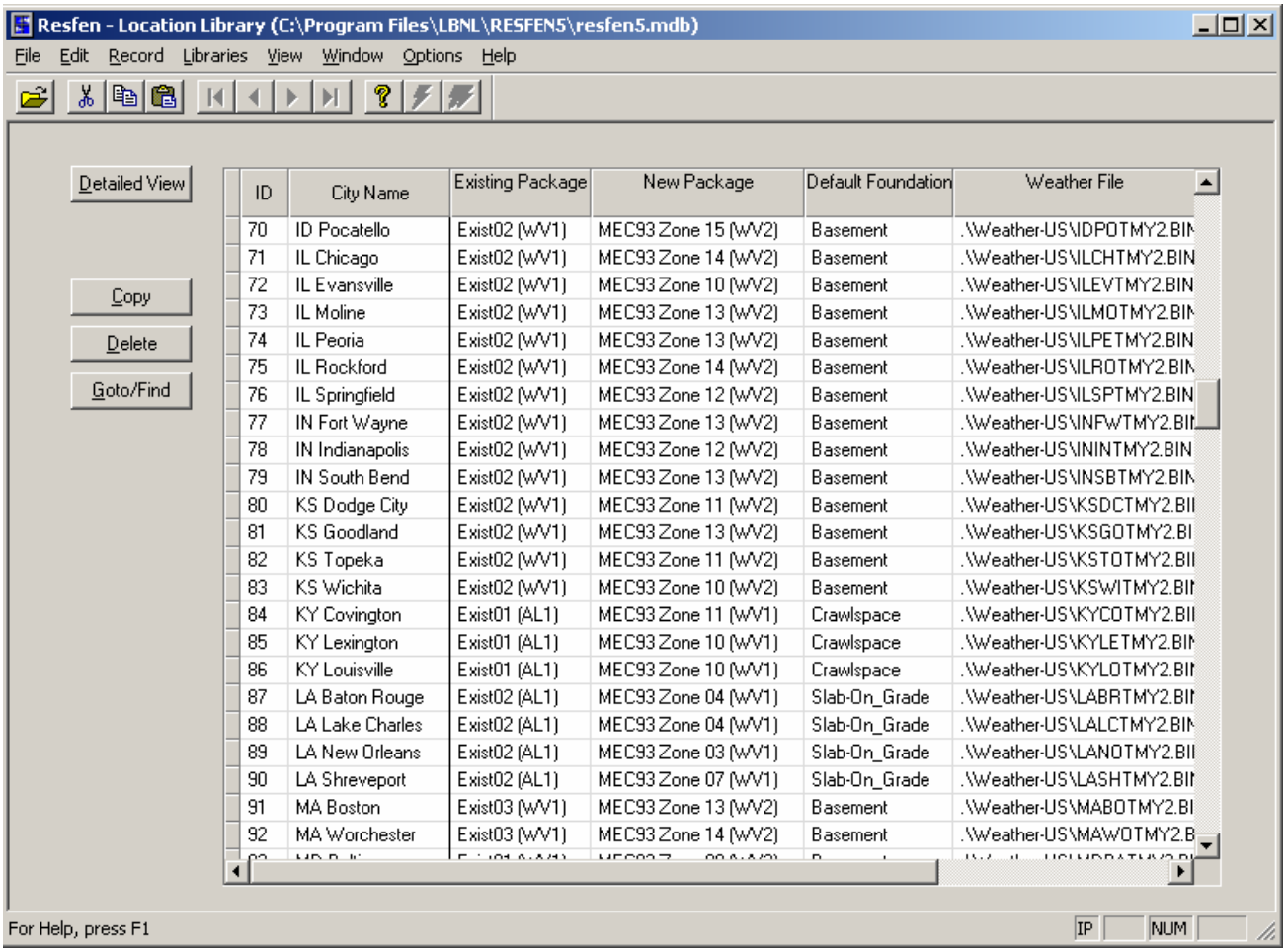
- Weather file for the DOE2 simulation
- Insulation package which determines the level of insulation for the building envelope
- Utility rates for that location which are used to calculate the building energy costs

Because the insulation levels for the calculation are contained in the Location Library, it is possible to make a new record in this library, using the same weather file and utility rates, but specifying a different insulation package.

4.8. Location Library

4.8.1. Location Library List View

The Location Library List view shows all the records that are in the library. Some of the records in the Location Library do not have all the information defined, such as the insulation packages. These records have an "*" in front of the name, and should not be used for calculations.



ID	City Name	Existing Package	New Package	Default Foundation	Weather File
70	ID Pocatello	Exist02 (WV1)	MEC93 Zone 15 (WV2)	Basement	.\Weather-US\IDPOTMY2.BIN
71	IL Chicago	Exist02 (WV1)	MEC93 Zone 14 (WV2)	Basement	.\Weather-US\ILCHTMY2.BIN
72	IL Evansville	Exist02 (WV1)	MEC93 Zone 10 (WV2)	Basement	.\Weather-US\ILEVTMY2.BIN
73	IL Moline	Exist02 (WV1)	MEC93 Zone 13 (WV2)	Basement	.\Weather-US\ILMOTMY2.BIN
74	IL Peoria	Exist02 (WV1)	MEC93 Zone 13 (WV2)	Basement	.\Weather-US\ILPETMY2.BIN
75	IL Rockford	Exist02 (WV1)	MEC93 Zone 14 (WV2)	Basement	.\Weather-US\ILROTMY2.BIN
76	IL Springfield	Exist02 (WV1)	MEC93 Zone 12 (WV2)	Basement	.\Weather-US\ILSPTMY2.BIN
77	IN Fort Wayne	Exist02 (WV1)	MEC93 Zone 13 (WV2)	Basement	.\Weather-US\INFWTMY2.BIN
78	IN Indianapolis	Exist02 (WV1)	MEC93 Zone 12 (WV2)	Basement	.\Weather-US\ININTMY2.BIN
79	IN South Bend	Exist02 (WV1)	MEC93 Zone 13 (WV2)	Basement	.\Weather-US\INSBTMY2.BIN
80	KS Dodge City	Exist02 (WV1)	MEC93 Zone 11 (WV2)	Basement	.\Weather-US\KSDCTMY2.BIN
81	KS Goodland	Exist02 (WV1)	MEC93 Zone 13 (WV2)	Basement	.\Weather-US\KSGOTMY2.BIN
82	KS Topeka	Exist02 (WV1)	MEC93 Zone 11 (WV2)	Basement	.\Weather-US\KSTOTMY2.BIN
83	KS Wichita	Exist02 (WV1)	MEC93 Zone 10 (WV2)	Basement	.\Weather-US\KSWITMY2.BIN
84	KY Covington	Exist01 (AL1)	MEC93 Zone 11 (WV1)	Crawlspace	.\Weather-US\KYCOTMY2.BIN
85	KY Lexington	Exist01 (AL1)	MEC93 Zone 10 (WV1)	Crawlspace	.\Weather-US\KYLETMY2.BIN
86	KY Louisville	Exist01 (AL1)	MEC93 Zone 10 (WV1)	Crawlspace	.\Weather-US\KYLOTMY2.BIN
87	LA Baton Rouge	Exist02 (AL1)	MEC93 Zone 04 (WV1)	Slab-On_Grade	.\Weather-US\LABRTMY2.BIN
88	LA Lake Charles	Exist02 (AL1)	MEC93 Zone 04 (WV1)	Slab-On_Grade	.\Weather-US\LALCTMY2.BIN
89	LA New Orleans	Exist02 (AL1)	MEC93 Zone 03 (WV1)	Slab-On_Grade	.\Weather-US\LANOTMY2.BIN
90	LA Shreveport	Exist02 (AL1)	MEC93 Zone 07 (WV1)	Slab-On_Grade	.\Weather-US\LASHTMY2.BIN
91	MA Boston	Exist03 (WV1)	MEC93 Zone 13 (WV2)	Basement	.\Weather-US\MABOTMY2.BIN
92	MA Worchester	Exist03 (WV1)	MEC93 Zone 14 (WV2)	Basement	.\Weather-US\MAWOTMY2.BIN

Figure 4-30. The Location Library List View.

Detailed View Used to change to the Detailed View of the highlighted record in order to edit the input values.

Copy Used to copy existing records to create new records which can then be edited as needed. Highlight the record or records to be copied (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Copy** button. By default the program will increment the ID number based on the last ID value, but this can be changed by the user as long as the ID will unique for this library.

Delete Used to delete existing records. Highlight the record or records to be deleted (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Delete** button.

Goto/Find Used to find a record in the library based on the **Name** field. When this button is clicked, a small dialog box will appear, and the beginning letters of the name can be typed, and the first record whose **Name** field starts with those letters will be highlighted.

4.8.2. Location Library Detail View

The Location Library detailed view shows all the input values for each individual record, as shown in the figure below.

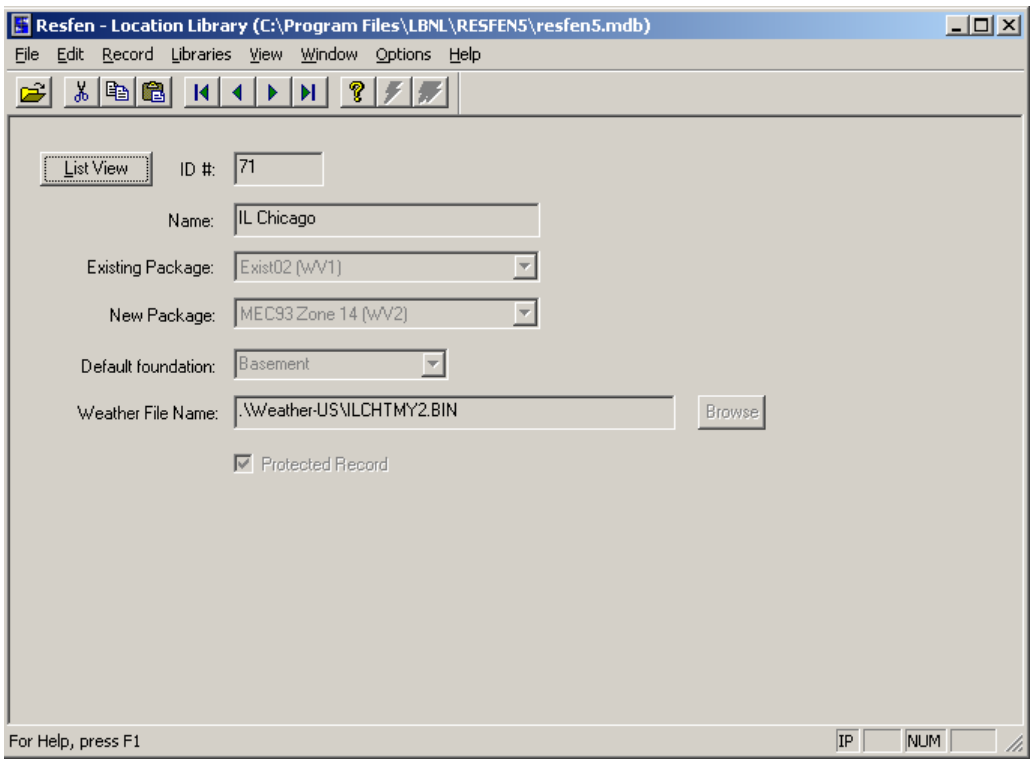


Figure 4-31. The Location Library Detail View.

The fields in the Location Library detailed view are the following:

ID The ID of the record, set automatically by the program or by the user when copying an existing record. This ID must be unique.

Name The name of the record, which can be any text. The default locations are named by the state abbreviation first, then the city name.

Existing Package The building envelope insulation package to be used for this location, from the **Package Library**. This insulation package will be used if "Existing" is selected in the **House Type** pull-down in the House Library. See the section on Package Library in this manual for more information about adding new insulation packages to that library. This value can be changed from the House Library for a particular modeling scenario.

New Package The building envelope insulation package to be used for this location, from the **Package Library**. This insulation package will be used if "New" is selected in the **House Type** pull-down in the House Library. See the section on Package Library in this manual for more information about adding new insulation packages to that library. This value can be changed from the House Library for a particular modeling scenario.

Default foundation The default foundation type for the location. This value can be changed from the House Library for a particular modeling scenario. The types to select are:

- Crawlspace
- Slab-On-Grade
- Basement

Weather File Name The name of the DOE2 weather file, which must exist in the Weathr directory under the RESFEN program directory. These are binary files that contain weather data specifically formatted for the DOE2 simulation program which RESFEN uses for the calculations. In general, these weather files need to come from LBNL and cannot be generated by the user.

4.8.3. Location Databases

Each record in the Location Library references a weather file for RESFEN to use in the building calculation. There are default databases that come with the program which reference different sets of weather files. Currently there are four databases that are shipped with the program:

- **RESFEN5.mdb:** the default database that RESFEN opens, which contains all the US cities defined in the Location Library, with a few example House Library records
- **RESFEN5-CanadaWthr.mdb:** a database which has all the Canadian cities (locations with DOE2 weather data) in the Location Library, with a sample record for each location defined in the House Library.
- **RESFEN5-Chile.mdb:** a database which has all the US cities defined in the Location Library, and a House Library record defined for each of those US locations
- **RESFEN5-ChinaWeather.mdb:** a database which has all the Chinese cities (locations with DOE2 weather data) in the Location Library, with a sample record for each location defined in the House Library.

4.9. WIndow Library

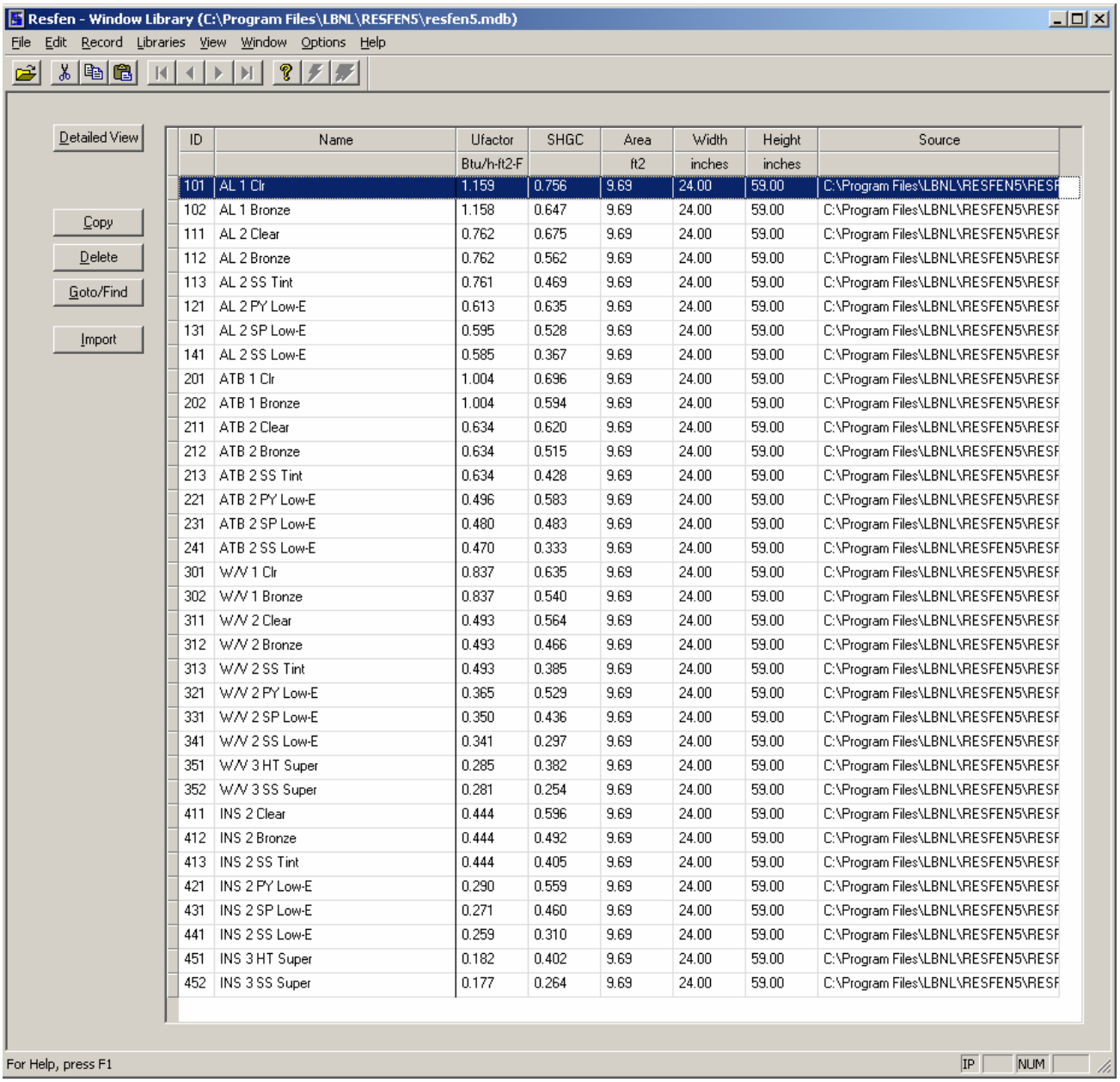
The Window Library is used to define windows that can be used in the House Library input. The records in the Window Library can be imported from WINDOW5 databases, or they can be defined by the user.

4.9.1. Window Library List View

The Window Library List view shows all the records that are in the library. The default records in the library were imported from a WINDOW5 library (RESFEN5Windows.mdb, which is installed automatically in the RESFEN program directory). These default windows correspond to the default windows shown on the Efficient Windows Collaborative website (www.efficientwindows.org). It is possible to create new records in this library by either:

- Copying an existing window using the Copy button in the List View. Then highlight that record and click the Detailed View button and edit the input values for the new window as needed.
- Importing records from a WINDOW5 database using the Import button. This method is explained in more detail later in this section

The screen below shows the List View of the Window Library.



ID	Name	Ufactor	SHGC	Area	Width	Height	Source
		Btu/h-ft2-F		ft2	inches	inches	
101	AL 1 Clr	1.159	0.756	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
102	AL 1 Bronze	1.158	0.647	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
111	AL 2 Clear	0.762	0.675	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
112	AL 2 Bronze	0.762	0.562	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
113	AL 2 SS Tint	0.761	0.469	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
121	AL 2 PY Low-E	0.613	0.635	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
131	AL 2 SP Low-E	0.595	0.528	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
141	AL 2 SS Low-E	0.585	0.367	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
201	ATB 1 Clr	1.004	0.696	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
202	ATB 1 Bronze	1.004	0.594	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
211	ATB 2 Clear	0.634	0.620	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
212	ATB 2 Bronze	0.634	0.515	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
213	ATB 2 SS Tint	0.634	0.428	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
221	ATB 2 PY Low-E	0.496	0.583	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
231	ATB 2 SP Low-E	0.480	0.483	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
241	ATB 2 SS Low-E	0.470	0.333	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
301	W/V 1 Clr	0.837	0.635	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
302	W/V 1 Bronze	0.837	0.540	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
311	W/V 2 Clear	0.493	0.564	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
312	W/V 2 Bronze	0.493	0.466	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
313	W/V 2 SS Tint	0.493	0.385	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
321	W/V 2 PY Low-E	0.365	0.529	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
331	W/V 2 SP Low-E	0.350	0.436	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
341	W/V 2 SS Low-E	0.341	0.297	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
351	W/V 3 HT Super	0.285	0.382	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
352	W/V 3 SS Super	0.281	0.254	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
411	INS 2 Clear	0.444	0.596	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
412	INS 2 Bronze	0.444	0.492	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
413	INS 2 SS Tint	0.444	0.405	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
421	INS 2 PY Low-E	0.290	0.559	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
431	INS 2 SP Low-E	0.271	0.460	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
441	INS 2 SS Low-E	0.259	0.310	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
451	INS 3 HT Super	0.182	0.402	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF
452	INS 3 SS Super	0.177	0.264	9.69	24.00	59.00	C:\Program Files\LBNL\RESFEN5\RESF

Figure 4-32. The Window Library List View.

Detailed View Used to change to the Detailed View of the highlighted record in order to edit the input values.

Copy Used to copy existing records to create new records which can then be edited as needed. Highlight the record or records to be copied (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Copy** button. By default the program will increment the ID number based on the last ID value, but this can be changed by the user as long as the ID will unique for this library.

Delete Used to delete existing records. Highlight the record or records to be deleted (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Delete** button.

Goto/Find Used to find a record in the library based on the **Name** field. When this button is clicked, a small dialog box will appear, and the beginning letters of the name can be typed, and the first record whose **Name** field starts with those letters will be highlighted.

Import Used to import window records from a WINDOW5 database. To use this feature, windows need to be created in the WINDOW5 program, which is used to define accurate U-value and SHGC values from detailed information about the window frame and glazing system. See the *WINDOW5 User's Manual* for details about making that database, or visit the website at http://windows.lbl.gov/software.

To import records from the WINDOW5 database, click the Import button. A dialog box will appear, where the WINDOW5 database can be specified

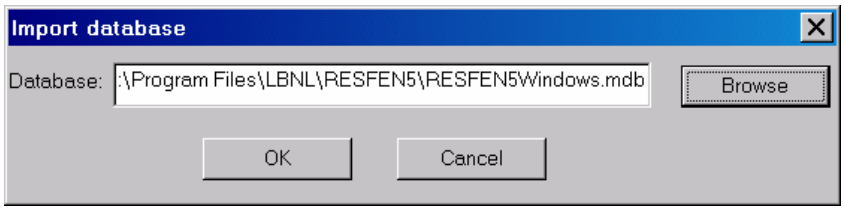
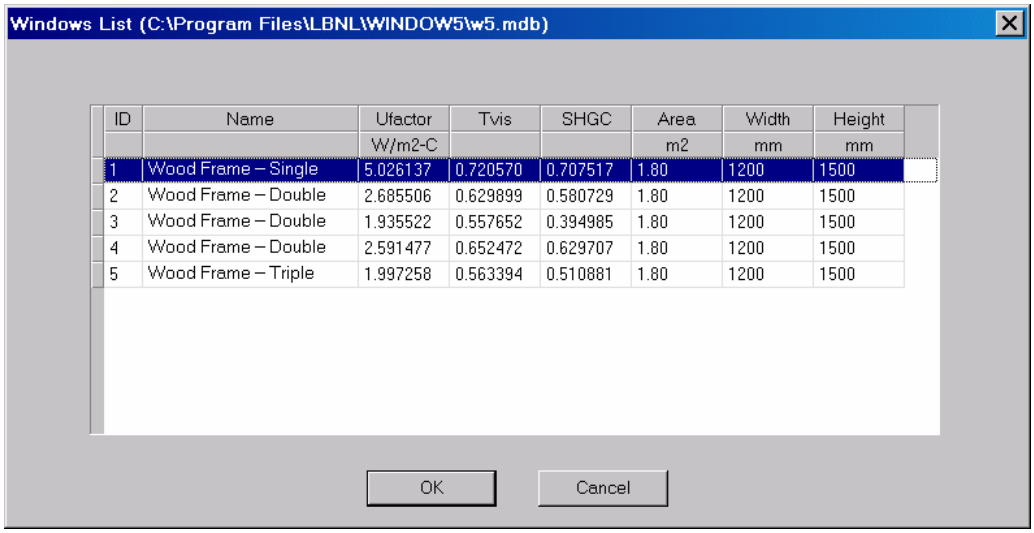


Figure 4-33. Importing a WINDOW5 window database.

The Browse button can be used to locate the WINDOW5 database. The default WINDOW5 database installed with RESFEN is called RESFEN5Windows.mdb, and the records in that database are the default records in the RESFEN Window Library.

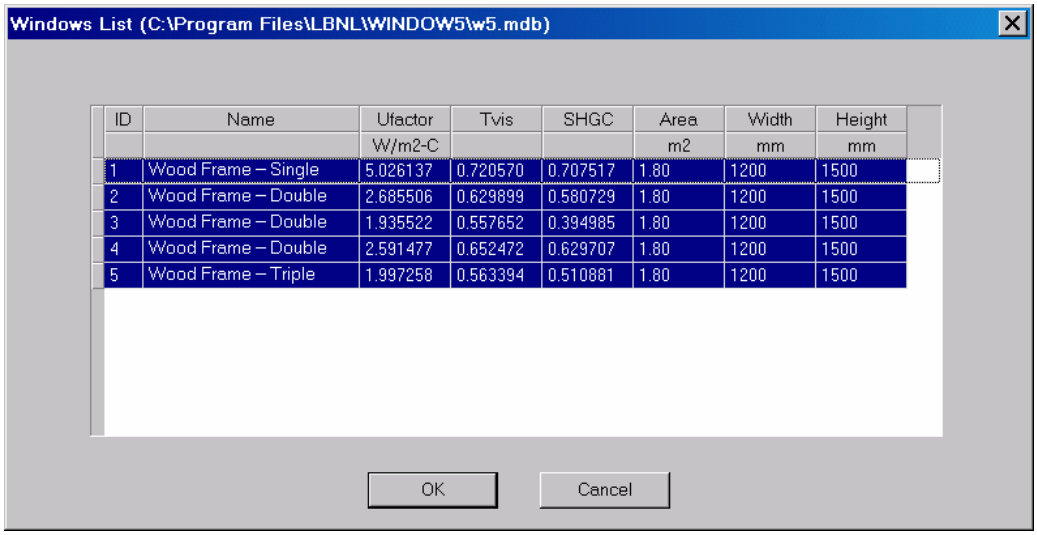
Click OK when the database path has been entered, and the program will open the database and display the records that can be imported.



ID	Name	Ufactor	Tvis	SHGC	Area	Width	Height
		W/m2-C			m2	mm	mm
1	Wood Frame – Single	5.026137	0.720570	0.707517	1.80	1200	1500
2	Wood Frame – Double	2.685506	0.629899	0.580729	1.80	1200	1500
3	Wood Frame – Double	1.935522	0.557652	0.394985	1.80	1200	1500
4	Wood Frame – Double	2.591477	0.652472	0.629707	1.80	1200	1500
5	Wood Frame – Triple	1.997258	0.563394	0.510881	1.80	1200	1500

Figure 4-34. Select records from the WINDOW5 window database to be imported into the RESFEN Window Library.

Select the records to be imported (multiple records can be highlighted using Ctl and Shift with mouse clicks) into the RESFEN Window Library, and click the OK button.



ID	Name	Ufactor	Tvis	SHGC	Area	Width	Height
		W/m2-C			m2	mm	mm
1	Wood Frame – Single	5.026137	0.720570	0.707517	1.80	1200	1500
2	Wood Frame – Double	2.685506	0.629899	0.580729	1.80	1200	1500
3	Wood Frame – Double	1.935522	0.557652	0.394985	1.80	1200	1500
4	Wood Frame – Double	2.591477	0.652472	0.629707	1.80	1200	1500
5	Wood Frame – Triple	1.997258	0.563394	0.510881	1.80	1200	1500

Figure 4-35. Select records from the WINDOW5 window database to be imported into the RESFEN Window Library.

4.9.2. Window Library Detail View

The Window Library detailed view shows all the input values for each individual record, as shown in the figure below.

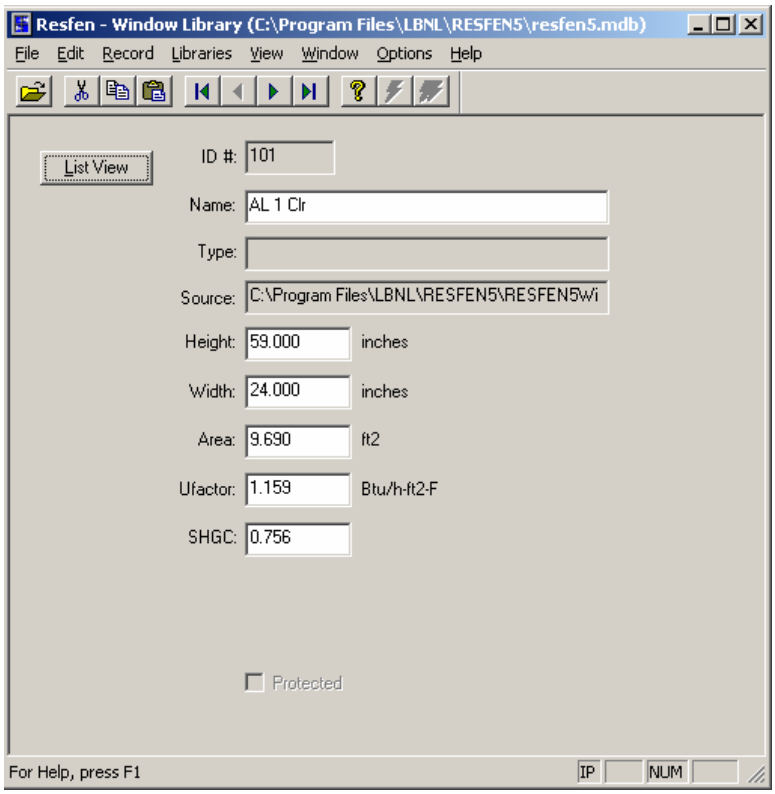


Figure 4-36. The Package Library List View.

The fields in the Package Library detailed view are the following:

ID	The ID of the record, set automatically by the program or by the user when copying an existing record. This ID must be unique.
Name	The name of the record, which can be any text. If the records were imported from WINDOW5, the Name is the same as the Name value in the WINDOW5 database.
Type	Unused
Source	The source of the data. For records imported from a WINDOW5 database: The name of the WINDOW5 database where the record was imported from, including the computer path of the database location. For records copied from an existing record: Set automatically to User
Height	The height of the window, either from the WINDOW5 database or input by the user. **Units:** inches (IP)
Width	The width of the window, either from the WINDOW5 database or input by the user. **Units:** inches (IP)
Area	The area of the window, either from the WINDOW5 database or input by the user. **Units:** square feet (IP)
Ufactor	The U-factor of the window, either from the WINDOW5 database or input by the user

.	**Units:** Btu/ft^2-h-^{o}F (IP)
SHGC	The Solar Heat Gain Coefficient, either from the WINDOW5 database or input by the user.
Protected	This field controls whether the data in the record can be edited. If it is checked, the fields in the record cannot be edited, and that field cannot be unchecked. If it is not checked, the data can be edited. Records imported from a WINDOW5 database automatically have the Protected field checked. Fields created by copying another record, even a record from a WINDOW5 database, are not protected.

4.10. Packages Library

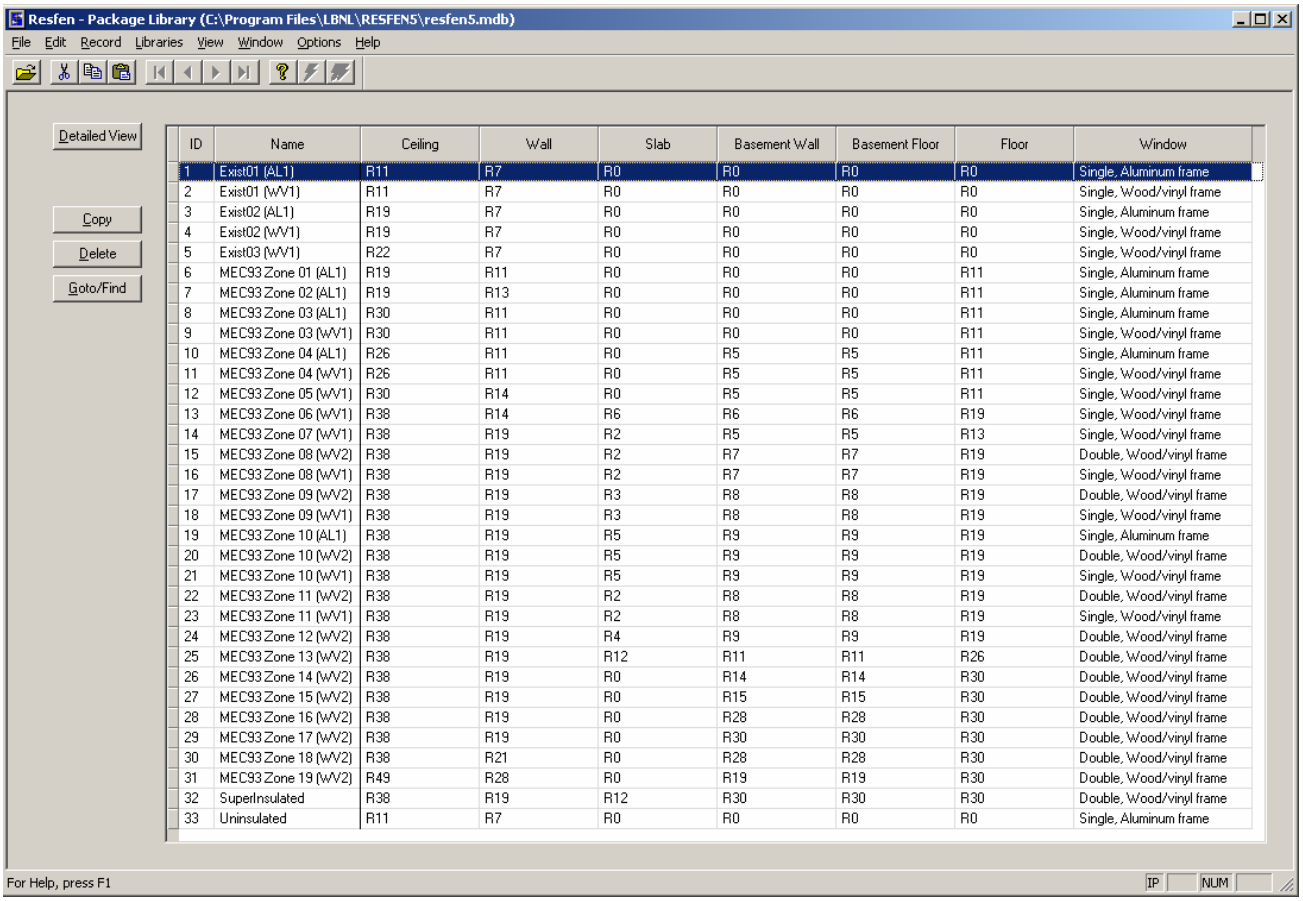
The Package Library is used to defined the building envelope insulation levels for the following building components:

- Ceiling
- Wall
- Floor
- Crawlspace
- Basement

These packages are referenced from the Location Library and are used in to define the building when that location is referenced in the House Library.

4.10.1. Packages Library List View

The Package Library List view shows all the records that are in the library. The default records in the library are based on the requirements for the default locations that come with the program. It is possible to make new insulation packages in this library by copying an existing package using the Copy button in the List View. Then highlight that record and click the Detailed View button and edit the input values for the new package, including the name, as needed.



ID	Name	Ceiling	Wall	Slab	Basement Wall	Basement Floor	Floor	Window
1	Exist01 (AL1)	R11	R7	R0	R0	R0	R0	Single, Aluminum frame
2	Exist01 (WV1)	R11	R7	R0	R0	R0	R0	Single, Wood/vinyl frame
3	Exist02 (AL1)	R19	R7	R0	R0	R0	R0	Single, Aluminum frame
4	Exist02 (WV1)	R19	R7	R0	R0	R0	R0	Single, Wood/vinyl frame
5	Exist03 (WV1)	R22	R7	R0	R0	R0	R0	Single, Wood/vinyl frame
6	MEC93 Zone 01 (AL1)	R19	R11	R0	R0	R0	R11	Single, Aluminum frame
7	MEC93 Zone 02 (AL1)	R19	R13	R0	R0	R0	R11	Single, Aluminum frame
8	MEC93 Zone 03 (AL1)	R30	R11	R0	R0	R0	R11	Single, Aluminum frame
9	MEC93 Zone 03 (WV1)	R30	R11	R0	R0	R0	R11	Single, Wood/vinyl frame
10	MEC93 Zone 04 (AL1)	R26	R11	R0	R5	R5	R11	Single, Aluminum frame
11	MEC93 Zone 04 (WV1)	R26	R11	R0	R5	R5	R11	Single, Wood/vinyl frame
12	MEC93 Zone 05 (WV1)	R30	R14	R0	R5	R5	R11	Single, Wood/vinyl frame
13	MEC93 Zone 06 (WV1)	R38	R14	R6	R6	R6	R19	Single, Wood/vinyl frame
14	MEC93 Zone 07 (WV1)	R38	R19	R2	R5	R5	R13	Single, Wood/vinyl frame
15	MEC93 Zone 08 (WV2)	R38	R19	R2	R7	R7	R19	Double, Wood/vinyl frame
16	MEC93 Zone 08 (WV1)	R38	R19	R2	R7	R7	R19	Single, Wood/vinyl frame
17	MEC93 Zone 09 (WV2)	R38	R19	R3	R8	R8	R19	Double, Wood/vinyl frame
18	MEC93 Zone 09 (WV1)	R38	R19	R3	R8	R8	R19	Single, Wood/vinyl frame
19	MEC93 Zone 10 (AL1)	R38	R19	R5	R9	R9	R19	Single, Aluminum frame
20	MEC93 Zone 10 (WV2)	R38	R19	R5	R9	R9	R19	Double, Wood/vinyl frame
21	MEC93 Zone 10 (WV1)	R38	R19	R5	R9	R9	R19	Single, Wood/vinyl frame
22	MEC93 Zone 11 (WV2)	R38	R19	R2	R8	R8	R19	Double, Wood/vinyl frame
23	MEC93 Zone 11 (WV1)	R38	R19	R2	R8	R8	R19	Single, Wood/vinyl frame
24	MEC93 Zone 12 (WV2)	R38	R19	R4	R9	R9	R19	Double, Wood/vinyl frame
25	MEC93 Zone 13 (WV2)	R38	R19	R12	R11	R11	R26	Double, Wood/vinyl frame
26	MEC93 Zone 14 (WV2)	R38	R19	R0	R14	R14	R30	Double, Wood/vinyl frame
27	MEC93 Zone 15 (WV2)	R38	R19	R0	R15	R15	R30	Double, Wood/vinyl frame
28	MEC93 Zone 16 (WV2)	R38	R19	R0	R28	R28	R30	Double, Wood/vinyl frame
29	MEC93 Zone 17 (WV2)	R38	R19	R0	R30	R30	R30	Double, Wood/vinyl frame
30	MEC93 Zone 18 (WV2)	R38	R21	R0	R28	R28	R30	Double, Wood/vinyl frame
31	MEC93 Zone 19 (WV2)	R49	R28	R0	R19	R19	R30	Double, Wood/vinyl frame
32	SuperInsulated	R38	R19	R12	R30	R30	R30	Double, Wood/vinyl frame
33	Uninsulated	R11	R7	R0	R0	R0	R0	Single, Aluminum frame

Figure 4-37. The Package Library List View.

Detailed View — Used to change to the Detailed View of the highlighted record in order to edit the input values.

Copy — Used to copy existing records to create new records which can then be edited as needed. Highlight the record or records to be copied (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Copy** button. By default the program will increment the ID number based on the last ID value, but this can be changed by the user as long as the ID will unique for this library.

Delete — Used to delete existing records. Highlight the record or records to be deleted (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Delete** button.

Goto/Find — Used to find a record in the library based on the **Name** field. When this button is clicked, a small dialog box will appear, and the beginning letters of the name can be typed, and the first record whose **Name** field starts with those letters will be highlighted.

4.10.2. Packages Library Detail View

The Location Library detailed view shows all the input values for each individual record, as shown in the figure below.

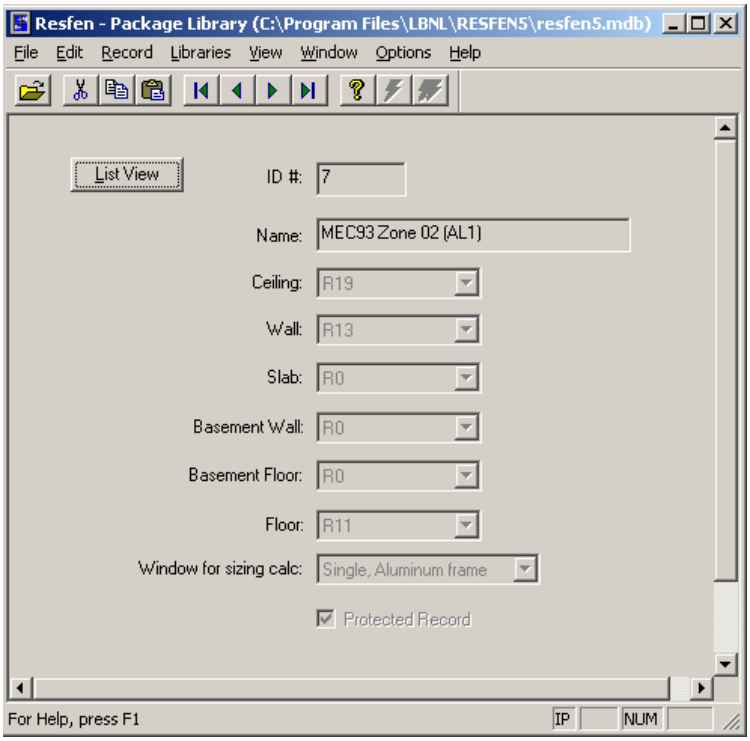


Figure 4-38. The Package Library Detail View.

The fields in the Package Library detailed view are the following:

ID — The ID of the record, set automatically by the program or by the user when copying an existing record. This ID must be unique.

Name — The name of the record, which can be any text. The default packages are used in the default locations, and are named according to whether they are to be used to define the insulation levels for New or Existing construction.

Residential Construction Values

The names of the insulation levels reflect the R-value of the insulating layer, not the overall R-value of the wall. The U-values that correspond to these R-value constructions are documented in Table 6-5.

Ceiling — The level of ceiling insulation for this package, from the predefined list of the following values:

- R11
- R19
- R22
- R26
- R30
- R38
- R49

Wall The level of wall insulation for this package, from the predefined list of the following values:

- R7
- R11
- R13
- R14
- R19
- R21
- R28

Crawl Slab The level of crawlspace insulation for this package, from the predefined list of the following values:

- R0
- R2
- R3
- R4
- R5
- R6
- R12

Basement Wall The level of basement wall insulation for this package, from the predefined list of the following values:

- R0
- R5
- R6
- R7
- R8
- R9
- R11
- R14
- R15
- R19
- R28
- R30

Basement Floor The level of basement floor insulation for this package, from the predefined list of the following values:

- R0
- R5
- R6
- R7

- R8
- R9
- R11
- R14
- R15
- R19
- R28
- R30

Floor The level of ceiling insulation for this package, from the predefined list of the following values:

- R0
- R11
- R13
- R14
- R19
- R26
- R28
- R30

Window for Sizing calc

Base Window The base window to be used for this location. This window is what the program uses to calculate the orientation specific results.

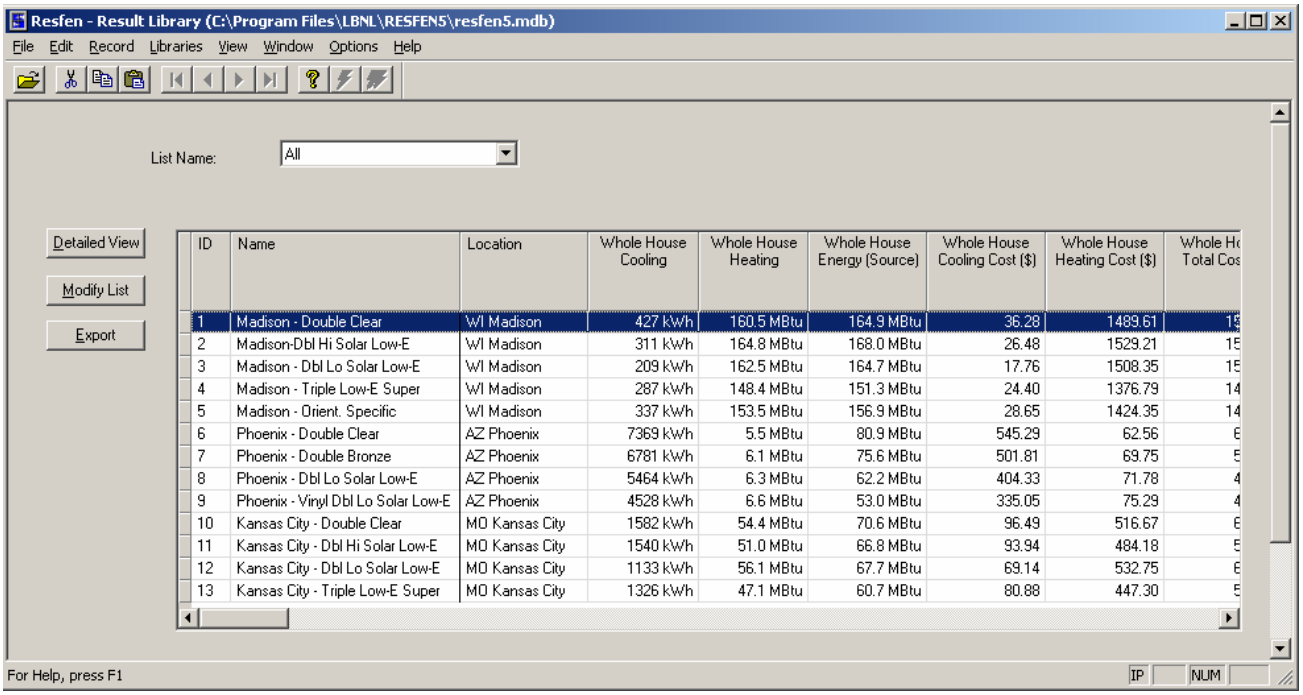
Protected Record If this box is checked, the record is protected from editing. Protected records are generally those that are shipped with the program. Copying a protected record turns off the protection and allows the user to edit the copied record.

4.11. Results Library

The Results Library is used to view results from multiple records from the House Library. This can be extremely useful when trying to compare the impact of different window configurations on a building. The Results Library also has a feature that allows the data from these results to be exported to a file that can be imported into a spreadsheet program.

4.11.1. Results Library List View

The Results Library List View shows the results from the House Library calculations.



ID	Name	Location	Whole House Cooling	Whole House Heating	Whole House Energy (Source)	Whole House Cooling Cost ($)	Whole House Heating Cost ($)	Whole Ho Total Cos
1	Madison - Double Clear	WI Madison	427 kWh	160.5 MBtu	164.9 MBtu	36.28	1489.61	19
2	Madison-Dbl Hi Solar Low-E	WI Madison	311 kWh	164.8 MBtu	168.0 MBtu	26.48	1529.21	15
3	Madison - Dbl Lo Solar Low-E	WI Madison	209 kWh	162.5 MBtu	164.7 MBtu	17.76	1508.35	15
4	Madison - Triple Low-E Super	WI Madison	287 kWh	148.4 MBtu	151.3 MBtu	24.40	1376.79	14
5	Madison - Orient. Specific	WI Madison	337 kWh	153.5 MBtu	156.9 MBtu	28.65	1424.35	14
6	Phoenix - Double Clear	AZ Phoenix	7369 kWh	5.5 MBtu	80.9 MBtu	545.29	62.56	6
7	Phoenix - Double Bronze	AZ Phoenix	6781 kWh	6.1 MBtu	75.6 MBtu	501.81	69.75	5
8	Phoenix - Dbl Lo Solar Low-E	AZ Phoenix	5464 kWh	6.3 MBtu	62.2 MBtu	404.33	71.78	4
9	Phoenix - Vinyl Dbl Lo Solar Low-E	AZ Phoenix	4528 kWh	6.6 MBtu	53.0 MBtu	335.05	75.29	4
10	Kansas City - Double Clear	MO Kansas City	1582 kWh	54.4 MBtu	70.6 MBtu	96.49	516.67	6
11	Kansas City - Dbl Hi Solar Low-E	MO Kansas City	1540 kWh	51.0 MBtu	66.8 MBtu	93.94	484.18	5
12	Kansas City - Dbl Lo Solar Low-E	MO Kansas City	1133 kWh	56.1 MBtu	67.7 MBtu	69.14	532.75	6
13	Kansas City - Triple Low-E Super	MO Kansas City	1326 kWh	47.1 MBtu	60.7 MBtu	80.88	447.30	5

*Figure 4-39. The **Results** Library List View.*

Detailed View Used to change to the Detailed View of the highlighted record in order to edit the input values.

Modify List This allows the user to create lists that allow different collections of the results, by defining which results records are to be associated with each list. Clicking this button opens another dialog box where the results for each list can be defined, as shown in the following figure.

The fields in the Modify List dialog box are:

- **List Name**: This is the name of the List, input by the user, which will appear in the List Name pull-down in the Results Library List View.
- **Description**: This is a description of the List, input by the user.
- **Left hand table**: The left hand table shows the House Library results that are not currently part of the current list.
- **Selection buttons**: the Selection buttons are used to move results from the left hand table to the right hand table. The single arrow buttons move the currently highlighted records, the double arrow buttons move all the records.
- **Right hand table**: The right hand table shows the House Library results that have been selected to be associated with this list. They can be removed with the "left pointing" Selection buttons, which will put them back into the left hand table.

- **New List** button: This button is used to make a new list. Clicking this button will open a new list with the the List Name and Description fields blank, and all the House Library results listed on the left hand table.
- **OK**: The OK button is used to accept the changes to the List and return to the Results Library List View display.
- **Cancel**: The Cancel button is used to return to the Results Library List View display without saving any changes made to the list.

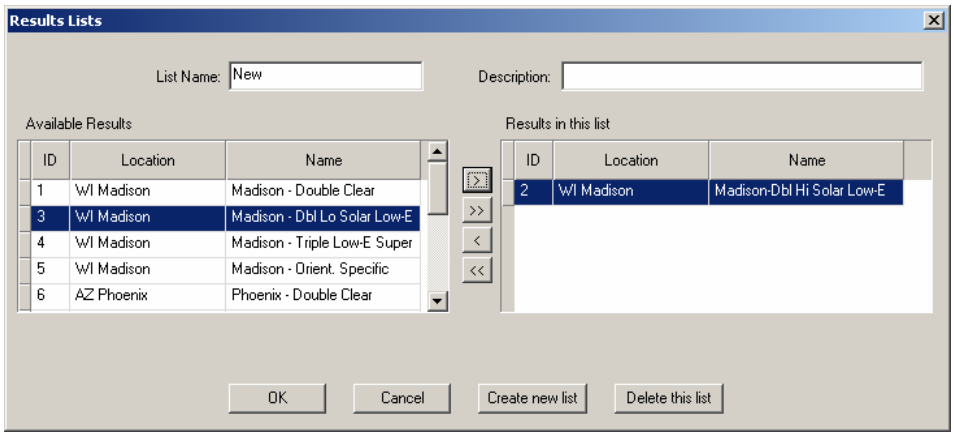


*Figure 4-40. The **Modify List dialog box**.*

Export Used to export the results in the list to a comma separated ASCII text file, which can then be imported into a spreadsheet program.

Bar Chart Used to find a record in the library based on the **Name** field. When this button is clicked, a small dialog box will appear, and the beginning letters of the name can be typed, and the first record whose **Name** field starts with those letters will be highlighted.

4.11.2. Results Library Detail View

The Results Library Detail View is similar to the House Library Detail View except that the input values are not editable. It is merely a way to quickly see what the input variables were for a set of results.

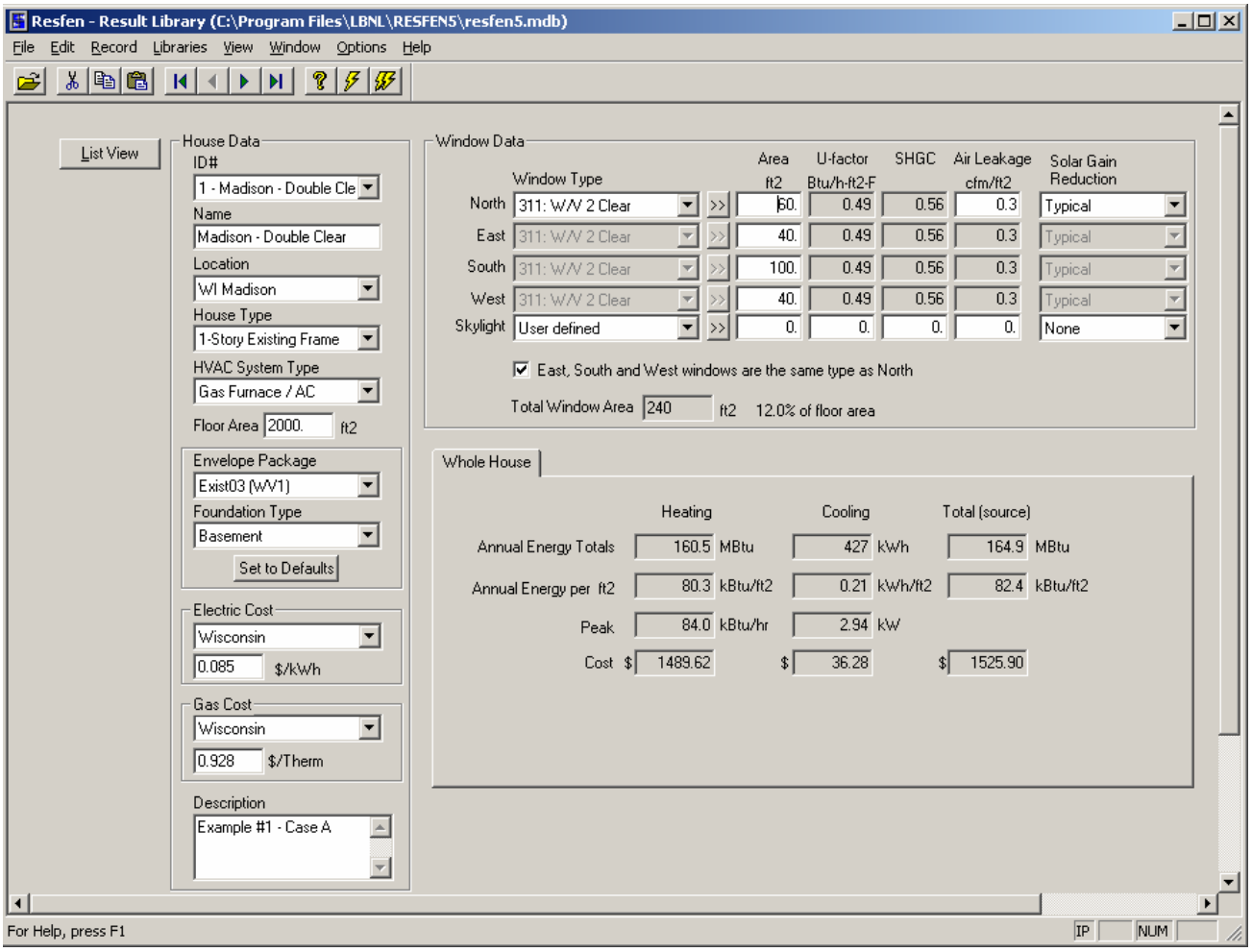


Figure 4-41. The Results Library Detail View.

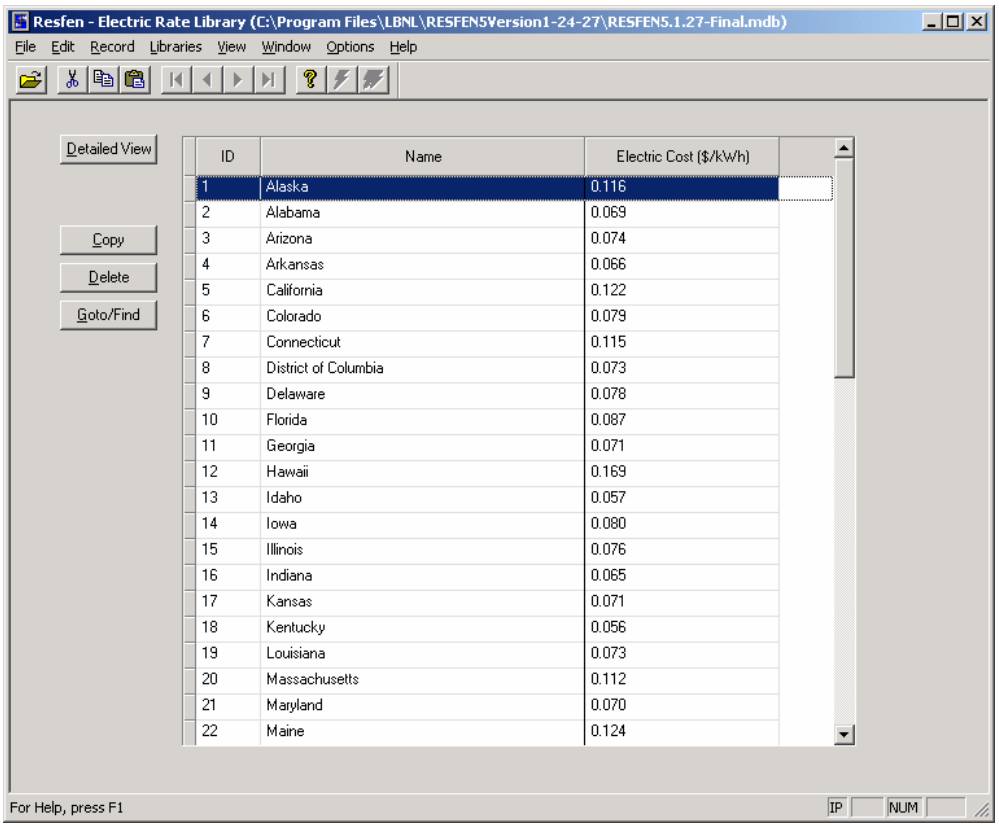
4.12. Electric Rate Library

The Electric Rate Library is used to define electricity rates that are then used in the Location Library definitions and in the House Library Detail View in the House Data section. New rates can be added to the library and then used in the Location Library

The default utility data for each location is from the National Association of Regulatory Utility Commissioners (NARUC) -- "Residential Electric Bills, Winter 1994-95", published May 31, 1996.

4.12.1. Electric Rate Library List View

The Electric Rate Library List View shows all the electricity cost records in the currently open database.



ID	Name	Electric Cost ($/kWh)
1	Alaska	0.116
2	Alabama	0.069
3	Arizona	0.074
4	Arkansas	0.066
5	California	0.122
6	Colorado	0.079
7	Connecticut	0.115
8	District of Columbia	0.073
9	Delaware	0.078
10	Florida	0.087
11	Georgia	0.071
12	Hawaii	0.169
13	Idaho	0.057
14	Iowa	0.080
15	Illinois	0.076
16	Indiana	0.065
17	Kansas	0.071
18	Kentucky	0.056
19	Louisiana	0.073
20	Massachusetts	0.112
21	Maryland	0.070
22	Maine	0.124

Figure 4-42. The Electric Rate Library List View.

Detailed View Used to change to the Detailed View of the highlighted record in order to edit the input values.

Copy Used to copy existing records to create new records which can then be edited as needed. Highlight the record or records to be copied (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Copy** button. By default the program will increment the ID number based on the last ID value, but this can be changed by the user as long as the ID will unique for this library.

Delete Used to delete existing records. Highlight the record or records to be deleted (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Delete** button.

Goto/Find Used to find a record in the library based on the **Name** field. When this button is clicked, a small dialog box will appear, and the beginning letters of the name can be typed, and the first record whose **Name** field starts with those letters will be highlighted.

4.12.2. Electric Rates Library Detail View

The Electric Rate Library Detail View shows the input values for each individual record, as shown in the figure below. The input values for this library are quite simple, just the actual electricity cost. The default values are from the Efficient Windows Collaborative website (updated 2004), with one record per state. These values can be changed to reflect different prices, or new records can be created for specific cases.

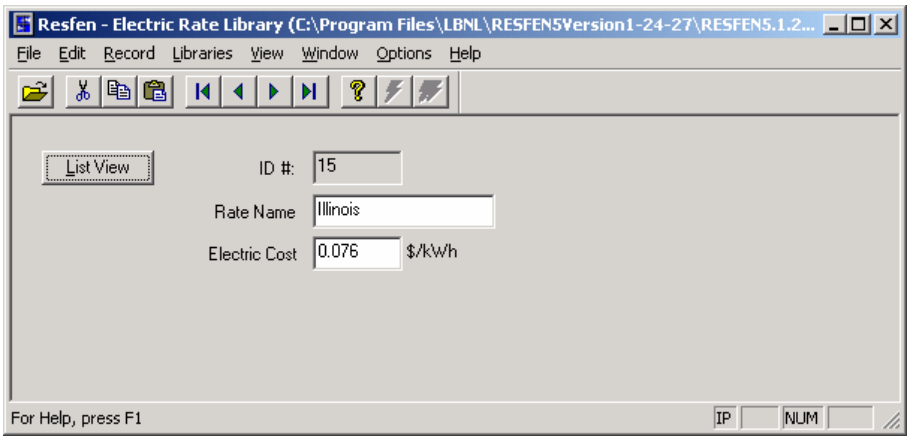


Figure 4-43. The Electric Rate Library Detail View.

The fields in the Electric Rate Library detailed view are the following:

ID	The ID of the record, set automatically by the program or by the user when copying an existing record. This ID must be unique.
Rate Name	Name of electric rate.
Electric Cost	The electricity rate. **Units:** $0.00/kWh (IP and SI). **Legal Values:** any number.
List View Button	This button is used to return to the List View of the library.

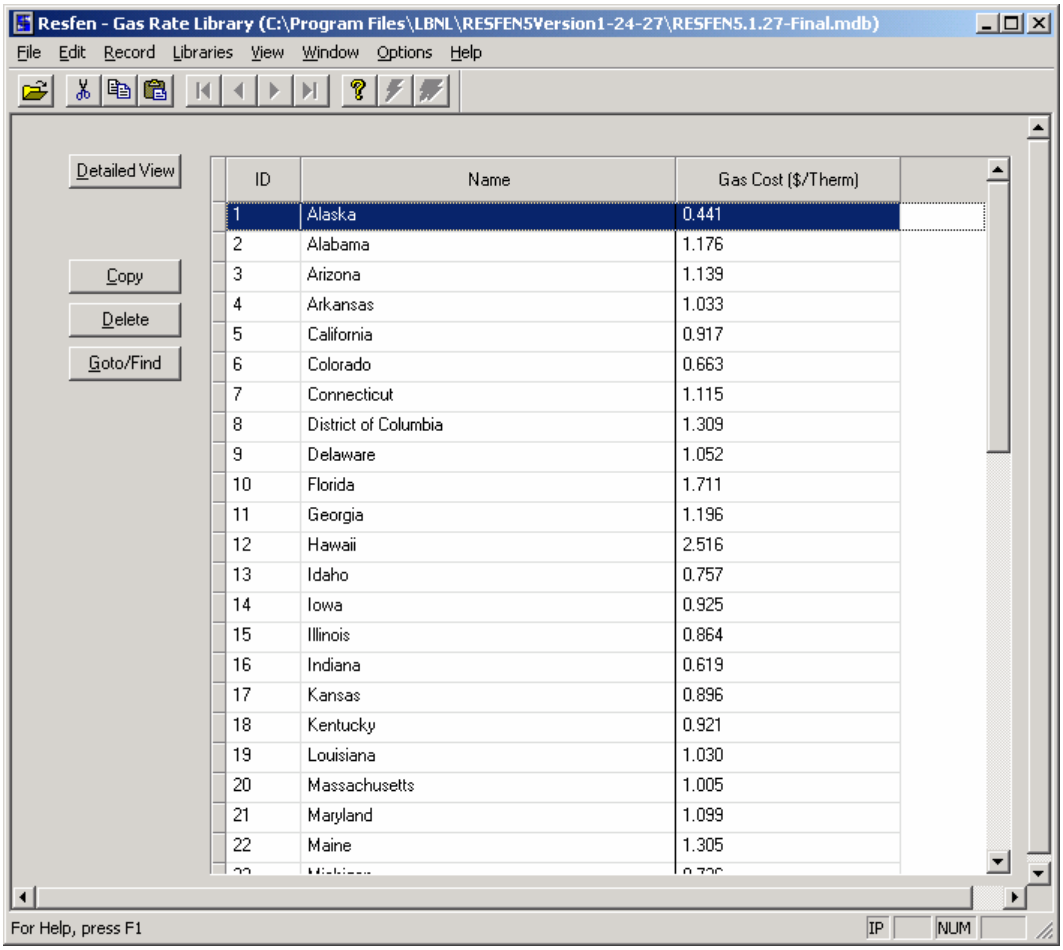
4.13. Gas Rates Library

The Gas Rate Library is used to define natural gas rates that are then used in the House Library Detail View in the House Data section. The default values are from the Efficient Windows Collaborative website (updated 2004), with one record per state. These values can be changed to reflect different prices, or new records can be created for specific cases.

The default utility data for each location is from the National Association of Regulatory Utility Commissioners (NARUC) -- "Residential Gas Bills, Summer 1995", published Jan. 18, 1996.

4.13.1. Gas Rates Library List View

The Gas Rate Library List View shows all the electricity cost records in the currently open database.



ID	Name	Gas Cost ($/Therm)
1	Alaska	0.441
2	Alabama	1.176
3	Arizona	1.139
4	Arkansas	1.033
5	California	0.917
6	Colorado	0.663
7	Connecticut	1.115
8	District of Columbia	1.309
9	Delaware	1.052
10	Florida	1.711
11	Georgia	1.196
12	Hawaii	2.516
13	Idaho	0.757
14	Iowa	0.925
15	Illinois	0.864
16	Indiana	0.619
17	Kansas	0.896
18	Kentucky	0.921
19	Louisiana	1.030
20	Massachusetts	1.005
21	Maryland	1.099
22	Maine	1.305

Figure 4-44. The Gas Rate Library List View.

Detailed View Used to change to the Detailed View of the highlighted record in order to edit the input values.

Copy Used to copy existing records to create new records which can then be edited as needed. Highlight the record or records to be copied (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Copy** button. By default the program will increment the ID number based on the last ID value, but this can be changed by the user as long as the ID will unique for this library.

Delete Used to delete existing records. Highlight the record or records to be deleted (use Shift + left mouse click to select multiple contiguous records, or Ctrl + left mouse click to select multiple non-contiguous records), and click the **Delete** button.

Goto/Find Used to find a record in the library based on the **Name** field. When this button is clicked, a small dialog box will appear, and the beginning letters of the name can be typed, and the first record whose **Name** field starts with those letters will be highlighted.

4.13.2. Gas Rates Library Detail View

The Gas Rate Library Detail View shows the input values for each individual record, as shown in the figure below. The input values for this library are quite simple, just the actual gas cost.

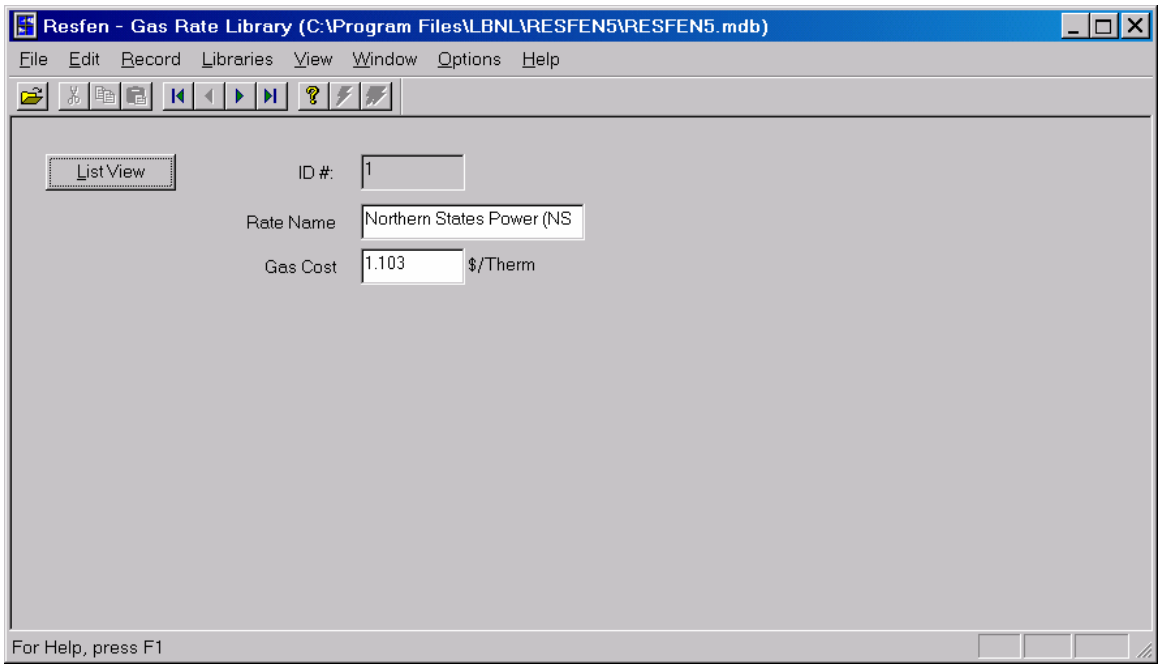


Figure 4-45. The Gas Rate Library Detail View.

The fields in the Electric Rate Library detailed view are the following:

ID The ID of the record, set automatically by the program or by the user when copying an existing record. This ID must be unique.

Rate Name Name of gas rate.

Gas Cost The natural gas rate.

Units: $0.00/kWh (IP and SI).

Legal Values: any number.

List View Button This button is used to return to the List View of the library.

5. EXAMPLES

To be completed

6. TECHNICAL REFERENCE

6.1. Location Library Data

Locations whose rows are yellow or gray are still under development in terms of defining the insulation packages or the base window configuration. These Location names are also preceded by an "*", and if used in the RESFEN program, will create an error in the calculation.

Table 6-1. RESFEN 3.1 Locations

ID	State Abbreviation / City Name	Weather File	Existing Construction Insulation Pkg	Existing Construction Sizing	New Construction Insulation Pkg	New Construction Sizing Window	Default Foundation	Default Electric Cost	Default Gas Cost
1	AK Anchorage	AKANTMY2.BIN	Exist03	2913	New17	2905	Basement		
2	AK Annette	AKATTMY2.BIN	Exist03	2913	New15	2905	Basement		
3	AK Barrow	AKBATMY2.BIN	Exist03	2913	New19	2905	Basement		
4	AK Bethel	AKBETMY2.BIN	Exist03	2913	New18	2905	Basement		
5	AK Bettles	AKBLTMY2.BIN	Exist03	2913	New19	2905	Basement		
6	AK Big Delta	AKBDTMY2.BIN	Exist03	2913	New18	2905	Basement		
7	AK Cold Bay	AKCBTMY2.BIN	Exist03	2913	New17	2905	Basement		
8	AK Fairbanks	AKFATMY2.BIN	Exist03	2913	New18	2905	Basement		
9	AK Gulkana	AKGUTMY2.BIN	Exist03	2913	New17	2905	Basement		
10	AK King Salmon	AKKITMY2.BIN	Exist03	2913	New17	2905	Basement		
11	AK Kodiak	AKKKTMY2.BIN	Exist03	2913	New16	2905	Basement		
12	AK Kotzebue	AKKTTMY2.BIN	Exist03	2913	New19	2905	Basement		
13	AK McGrath	AKMCTMY2.BIN	Exist03	2913	New19	2905	Basement		
14	AK Nome	AKNOTMY2.BIN	Exist03	2913	New19	2905	Basement		
15	AK St. Paul Island	AKSITMY2.BIN	Exist03	2913	New18	2905	Basement		
16	AK Talkeetna	AKTATMY2.BIN	Exist03	2913	New17	2905	Basement		
17	AK Yakutat	AKYATMY2.BIN	Exist03	2913	New17	2905	Basement		
18	AL Birmingham	ALBITMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
19	AL Huntsville	ALHUTMY2.BIN	Exist02	1901	New08	2913	Slab-On-		
20	AL Mobile	ALMBTMY2.BIN	Exist02	1901	New04	2913	Slab-On-		
21	AL Montgomery	ALMNTMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
22	AR Fort Smith	ARFSTMY2.BIN	Exist02	1901	New08	2913	Slab-On-		
23	AR Little Rock	ARLRTMY2.BIN	Exist02	1901	New07	2913	Slab-On-		
24	AZ Flagstaff	AZFLTMY2.BIN	Exist01	1901	New14	2905	Slab-On-		
25	AZ Phoenix	AZPHTMY2.BIN	Exist01	1901	New03	1901	Slab-On-		
26	AZ Prescott	AZPRTMY2.BIN	Exist01	1901	New10	1901	Slab-On-		
27	AZ Tucson	AZTUTMY2.BIN	Exist01	1901	New04	1901	Slab-On-		
28	CA Arcata	CAARTMY2.BIN	Exist04	1901	New09	2905	Slab-On-		
29	CA Bakersfield	CABATMY2.BIN	Exist04	1901	New05	2913	Slab-On-		
30	CA Daggett	CADATMY2.BIN	Exist04	1901	New04	2913	Slab-On-		
31	CA Fresno	CAFRTMY2.BIN	Exist04	1901	New06	2913	Slab-On-		
32	CA Long Beach	CALBTMY2.BIN	Exist04	1901	New04	2913	Slab-On-		
33	CA Los Angeles	CALATMY2.BIN	Exist04	1901	New04	2913	Slab-On-		
34	CA Red Bluff	AKANTMY2.BIN	Exist04	1901	New06	2913	Slab-On-		

ID	State Abbreviation / City Name	Weather File	Existing Construction Insulation Pkg	Existing Construction Sizing	New Construction Insulation Pkg	New Construction Sizing Window	Default Foundation	Default Electric Cost	Default Gas Cost
35	CA Sacramento	CASCTMY2.BIN	Exist04	1901	New03	1901	Slab-On-		
36	CA San Diego	CASDTMY2.BIN	Exist04	1901	New03	1901	Slab-On-		
37	CA San Francisco	CASFTMY2.BIN	Exist04	1901	New06	2913	Slab-On-		
38	CA Santa Maria	CASMTMY2.BIN	Exist04	1901	New05	2913	Slab-On-		
39	CO Alamosa	COALTMY2.BIN	Exist01	2913	New16	2905	Basement		
40	CO Denver	COBOTMY2.BIN	Exist01	2913	New13	2905	Basement		
41	CO Colorado Springs	COCSTMY2.BIN	Exist01	2913	New13	2905	Basement		
42	CO Eagle	COEATMY2.BIN	Exist01	2913	New15	2905	Basement		
43	CO Grand Junction	COGJTMY2.BIN	Exist01	2913	New13	2905	Basement		
44	CO Pueblo	COPUTMY2.BIN	Exist01	2913	New11	2905	Basement		
45	CT Bridgeport	CTBRTMY2.BIN	Exist03	2913	New12	2905	Basement		
46	CT Hartford	CTHATMY2.BIN	Exist03	2913	New13	2905	Basement		
47	DE Wilmington	DEWLTMY2.BIN	Exist01	2913	New10	2905	Basement		
48	FL Daytona Beach	FLDBTMY2.BIN	Exist01	1901	New02	1901	Slab-On-		
49	FL Jacksonville	FLJATMY2.BIN	Exist01	1901	New03	1901	Slab-On-		
50	FL Key West	FLKWTMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
51	FL Miami	FLMITMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
52	FL Tallahassee	FLTLTMY2.BIN	Exist01	1901	New04	1901	Slab-On-		
53	FL Tampa	FLTMTMY2.BIN	Exist01	1901	New02	1901	Slab-On-		
54	FL West Palm Beach	FLWPTMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
55	GA Athens	GAANTMY2.BIN	Exist01	1901	New07	2913	Slab-On-		
56	GA Atlanta	GAATTMY2.BIN	Exist01	1901	New07	2913	Slab-On-		
57	GA Augusta	GAAUTMY2.BIN	Exist01	1901	New06	2913	Slab-On-		
58	GA Columbus	GACOTMY2.BIN	Exist01	1901	New05	2913	Slab-On-		
59	GA Macon	GAMATMY2.BIN	Exist01	1901	New05	2913	Slab-On-		
60	GA Savannah	GASATMY2.BIN	Exist01	1901	New04	2913	Slab-On-		
61	HI Hilo	HIHITMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
62	HI Honolulu	HIHOTMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
63	HI Kahului	HIKATMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
64	HI Lihue	HILITMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
65	IA Des Moines	IADMTMY2.BIN	Exist02	2913	New14	2905	Basement		
66	IA Mason City	IAMCTMY2.BIN	Exist02	2913	New15	2905	Basement		
67	IA Sioux City	IASCTMY2.BIN	Exist02	2913	New15	2905	Basement		
68	IA Waterloo	IAWATMY2.BIN	Exist02	2913	New15	2905	Basement		
69	ID Boise	IDBOTMY2.BIN	Exist02	2913	New12	2905	Basement		
70	ID Pocatello	IDPOTMY2.BIN	Exist02	2913	New15	2905	Basement		
71	IL Chicago	ILCHTMY2.BIN	Exist02	2913	New14	2905	Basement		
72	IL Moline	ILMOTMY2.BIN	Exist02	2913	New13	2905	Basement		
73	IL Peoria	ILPETMY2.BIN	Exist02	2913	New13	2905	Basement		
75	IL Rockford	ILROTMY2.BIN	Exist02	2913	New14	2905	Basement		
76	IN Evansville	INEVTMY2.BIN	Exist02	2913	New10	2905	Basement		
77	IN Fort Wayne	INFWTMY2.BIN	Exist02	2913	New13	2905	Basement		
78	IN Indianapolis	ININTMY2.BIN	Exist02	2913	New12	2905	Basement		
79	IN South Bend	INSBTMY2.BIN	Exist02	2913	New13	2905	Basement		

ID	State Abbreviation / City Name	Weather File	Existing Construction Insulation Pkg	Existing Construction Sizing	New Construction Insulation Pkg	New Construction Sizing Window	Default Foundation	Default Electric Cost	Default Gas Cost
80	KS Dodge City	KSDCTMY2.BIN	Exist02	2913	New11	2905	Basement		
81	KS Goodland	KSGOTMY2.BIN	Exist02	2913	New13	2905	Basement		
82	KS Topeka	KSTOTMY2.BIN	Exist02	2913	New11	2905	Basement		
83	KS Wichita	KSWITMY2.BIN	Exist02	2913	New10	2905	Basement		
84	KY Covington	KYCOTMY2.BIN	Exist01	1901	New11	2913	Crawlspace		
85	KY Lexington	KYLETMY2.BIN	Exist01	1901	New10	2913	Crawlspace		
86	KY Louisville	KYLOTMY2.BIN	Exist01	1901	New10	2913	Crawlspace		
87	LA Baton Rouge	LABRTMY2.BIN	Exist02	1901	New04	2913	Slab-On-		
88	LA Lake Charles	LALCTMY2.BIN	Exist02	1901	New04	2913	Slab-On-		
89	LA New Orleans	LANOTMY2.BIN	Exist02	1901	New03	2913	Slab-On-		
90	LA Shreveport	LASHTMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
91	MA Boston	MABOTMY2.BIN	Exist03	2913	New13	2905	Basement		
92	MA Worchester	MAWOTMY2.BIN	Exist03	2913	New14	2905	Basement		
93	MD Baltimore	MDBATMY2.BIN	Exist01	2913	New09	2905	Basement		
94	ME Caribou	MECATMY2.BIN	Exist03	2913	New17	2905	Basement		
95	ME Portland	MEPOTMY2.BIN	Exist03	2913	New15	2905	Basement		
96	MI Alpena	MIALTMY2.BIN	Exist03	2913	New15	2905	Basement		
97	MI Detroit	MIDETMY2.BIN	Exist03	2913	New13	2905	Basement		
98	MI Flint	MIFLTMY2.BIN	Exist03	2913	New14	2905	Basement		
99	MI Grand Rapids	MIGRTMY2.BIN	Exist03	2913	New14	2905	Basement		
100	MI Houghton	MIHOTMY2.BIN	Exist03	2913	New17	2905	Basement		
101	MI Lansing	MILATMY2.BIN	Exist03	2913	New14	2905	Basement		
102	MI Muskegon	MIMUTMY2.BIN	Exist03	2913	New14	2905	Basement		
103	MI Sault Ste. Marie	MISMTMY2.BIN	Exist03	2913	New16	2905	Basement		
105	MI Traverse City	MITCTMY2.BIN	Exist03	2913	New15	2905	Basement		
106	MN International	MNIFTMY2.BIN	Exist03	2913	New17	2905	Basement		
107	MN Minneapolis	MNMITMY2.BIN	Exist03	2913	New15	2905	Basement		
108	MN Rochester	MNROTMY2.BIN	Exist03	2913	New15	2905	Basement		
109	MN Saint Cloud	MNSCTMY2.BIN	Exist03	2913	New15	2905	Basement		
110	MO Columbia	MOCOTMY2.BIN	Exist03	2913	New11	2905	Basement		
111	MO Kansas City	MOKCTMY2.BIN	Exist03	2913	New11	2905	Basement		
112	MO Springfield	MOSPTMY2.BIN	Exist03	2913	New10	2905	Basement		
113	MO St. Louis	MOSTTMY2.BIN	Exist03	2913	New10	2905	Basement		
114	MS Jackson	MSJATMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
115	MS Meridian	MSMETMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
116	MT Billings	MTBITMY2.BIN	Exist02	2913	New15	2905	Basement		
117	MT Cut Bank	MTCBTMY2.BIN	Exist02	2913	New16	2905	Basement		
118	MT Glasgow	MTGLTMY2.BIN	Exist02	2913	New16	2905	Basement		
119	MT Great Falls	MTGRTMY2.BIN	Exist02	2913	New15	2905	Basement		
120	MT Helena	MTHETMY2.BIN	Exist02	2913	New15	2905	Basement		
121	MT Kalispell	MTKATMY2.BIN	Exist02	2913	New16	2905	Basement		
122	MT Lewistown	MTLETMY2.BIN	Exist02	2913	New15	2905	Basement		
123	MT Miles City	MTMCTMY2.BIN	Exist02	2913	New15	2905	Basement		
124	MT Missoula	MTMITMY2.BIN	Exist02	2913	New15	2905	Basement		

ID	State Abbreviation / City Name	Weather File	Existing Construction Insulation Pkg	Existing Construction Sizing	New Construction Insulation Pkg	New Construction Sizing Window	Default Foundation	Default Electric Cost	Default Gas Cost
125	NC Asheville	NCASTMY2.BIN	Exist01	1901	New09	2913	Crawlspace		
126	NC Cape Hatteras	NCCHTMY2.BIN	Exist01	1901	New06	2913	Crawlspace		
127	NC Charlotte	NCCRTMY2.BIN	Exist01	1901	New07	2913	Crawlspace		
128	NC Greensboro	NCGRTMY2.BIN	Exist01	1901	New08	2913	Crawlspace		
129	NC Raleigh	NCRATMY2.BIN	Exist01	1901	New07	2913	Crawlspace		
130	NC Wilmington	NCWITMY2.BIN	Exist01	1901	New06	2913	Crawlspace		
131	ND Bismarck	NDBITMY2.BIN	Exist03	2913	New16	2905	Basement		
132	ND Fargo	NDFATMY2.BIN	Exist03	2913	New17	2905	Basement		
133	ND Minot	NDMITMY2.BIN	Exist03	2913	New17	2905	Basement		
134	NE Grand Island	NEGITMY2.BIN	Exist02	2913	New13	2905	Basement		
135	NE Norfolk	NENOTMY2.BIN	Exist02	2913	New14	2905	Basement		
136	NE North Platte	NENPTMY2.BIN	Exist02	2913	New14	2905	Basement		
137	NE Omaha	NEOMTMY2.BIN	Exist02	2913	New13	2905	Basement		
138	NE Scottsbluff	NESCTMY2.BIN	Exist02	2913	New14	2905	Basement		
139	NH Concord	NHCOTMY2.BIN	Exist03	2913	New15	2905	Basement		
140	NJ Atlantic City	NJACTMY2.BIN	Exist01	2913	New10	2905	Basement		
141	NJ Newark	NJNETMY2.BIN	Exist01	2913	New11	2905	Basement		
142	NM Albuquerque	NMALTMY2.BIN	Exist01	1901	New09	2905	Slab-On-		
143	NM Tucumcari	NMTUTMY2.BIN	Exist01	1901	New08	2905	Slab-On-		
144	NV Elko	NVEKTMY2.BIN	Exist01	2913	New15	2905	Slab-On-		
145	NV Ely	NVELTMY2.BIN	Exist01	2913	New15	2905	Slab-On-		
146	NV Las Vegas	NVLVTMY2.BIN	Exist01	1901	New05	2913	Slab-On-		
147	NV Reno	NVRETMY2.BIN	Exist01	2913	New12	2905	Slab-On-		
148	NV Tonopah	NVTOTMY2.BIN	Exist01	2913	New12	2905	Slab-On-		
149	NV Winnemucca	NVWITMY2.BIN	Exist01	2913	New13	2905	Slab-On-		
150	NY Albany	NYALTMY2.BIN	Exist01	2913	New14	2905	Basement		
151	NY Binghamton	NYBITMY2.BIN	Exist01	2913	New15	2905	Basement		
152	NY Buffalo	NYBUTMY2.BIN	Exist01	2913	New14	2905	Basement		
153	NY Massena	NYMATMY2.BIN	Exist01	2913	New15	2905	Basement		
154	NY New York City	NYNYTMY2.BIN	Exist01	2913	New10	2905	Basement		
155	NY Rochester	NYROTMY2.BIN	Exist01	2913	New14	2905	Basement		
156	NY Syracuse	NYSYTMY2.BIN	Exist01	2913	New14	2905	Basement		
157	OH Akron	OHAKTMY2.BIN	Exist02	2913	New13	2905	Basement		
158	OH Cleveland	OHCLTMY2.BIN	Exist02	2913	New13	2905	Basement		
159	OH Columbus	OHCOTMY2.BIN	Exist02	2913	New13	2905	Basement		
160	OH Dayton	OHDATMY2.BIN	Exist02	2913	New12	2905	Basement		
161	OH Mansfield	OHMATMY2.BIN	Exist02	2913	New13	2905	Basement		
162	OH Toledo	OHTOTMY2.BIN	Exist02	2913	New14	2905	Basement		
163	OH Youngstown	OHYOTMY2.BIN	Exist02	2913	New13	2905	Basement		
164	OK Oklahoma City	OKOCTMY2.BIN	Exist02	1901	New08	2913	Slab-On-		
165	OK Tulsa	OKTUTMY2.BIN	Exist02	1901	New08	2913	Slab-On-		
166	OR Astoria	ORASTMY2.BIN	Exist02	2913	New11	2905	Crawlspace		
167	OR Burns	ORBUTMY2.BIN	Exist02	2913	New15	2905	Crawlspace		
168	OR Eugene	OREUTMY2.BIN	Exist02	2913	New10	2905	Crawlspace		

ID	State Abbreviation / City Name	Weather File	Existing Construction Insulation Pkg	Existing Construction Sizing	New Construction Insulation Pkg	New Construction Sizing Window	Default Foundation	Default Electric Cost	Default Gas Cost
169	OR Medford	ORMETMY2.BIN	Exist02	2913	New11	2905	Crawlspace		
170	OR North Bend	ORNBTMY2.BIN	Exist02	2913	New09	2905	Crawlspace		
171	OR Pendleton	ORPETMY2.BIN	Exist02	2913	New12	2905	Crawlspace		
172	OR Portland	ORPOTMY2.BIN	Exist02	2913	New10	2905	Crawlspace		
173	OR Redmond	ORRETMY2.BIN	Exist02	2913	New14	2905	Crawlspace		
174	OR Salem	ORSATMY2.BIN	Exist02	2913	New10	2905	Crawlspace		
175	PA Allentown	PAALTMY2.BIN	Exist01	2913	New12	2905	Basement		
176	PA Bradford	PABRTMY2.BIN	Exist01	2913	New15	2905	Basement		
177	PA Erie	PAERTMY2.BIN	Exist01	2913	New14	2905	Basement		
178	PA Harrisburg	PAHATMY2.BIN	Exist01	2913	New12	2905	Basement		
179	PA Philadelphia	PAPHTMY2.BIN	Exist01	2913	New10	2905	Basement		
180	PA Pittsburgh	PAPITMY2.BIN	Exist01	2913	New12	2905	Basement		
181	PA Wilkes-Barre	PAWBTMY2.BIN	Exist01	2913	New13	2905	Basement		
182	PA Williamsport	PAWITMY2.BIN	Exist01	2913	New13	2905	Basement		
183	PI Guam	PIGUTMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
184	PR San Juan	PRSJTMY2.BIN	Exist01	1901	New01	1901	Slab-On-		
185	RI Providence	RIPRTMY2.BIN	Exist03	2913	New14	2905	Basement		
190	SC Charleston	SCCHTMY2.BIN	Exist01	1901	New05	2913	Crawlspace		
191	SD Rapid City	SDRCTMY2.BIN	Exist03	2913	New15	2905	Basement		
192	SD Sioux Falls	SDSFTMY2.BIN	Exist03	2913	New15	2905	Basement		
193	TN Bristol	TNBRTMY2.BIN	Exist01	1901	New09	2913	Crawlspace		
194	TN Chattanooga	TNCHTMY2.BIN	Exist01	1901	New08	2913	Crawlspace		
195	TN Knoxville	TNKNTMY2.BIN	Exist01	1901	New08	2913	Crawlspace		
196	TN Memphis	TNMETMY2.BIN	Exist01	1901	New07	2913	Crawlspace		
197	TN Nashville	TNNATMY2.BIN	Exist01	1901	New08	2913	Crawlspace		
198	TX Abilene	TXABTMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
199	TX Amarillo	TXAMTMY2.BIN	Exist02	1901	New09	2913	Slab-On-		
200	TX Austin	TXAUTMY2.BIN	Exist02	1901	New05	2913	Slab-On-		
201	TX Brownsville	TXBRTMY2.BIN	Exist02	1901	New02	1901	Slab-On-		
202	TX Corpus Christi	TXCCTMY2.BIN	Exist02	1901	New03	1901	Slab-On-		
203	TX El Paso	TXEPTMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
204	TX Fort Worth	TXFWTMY2.BIN	Exist02	1901	New05	2913	Slab-On-		
205	TX Houston	TXHOTMY2.BIN	Exist02	1901	New04	2913	Slab-On-		
206	TX Lubbock	TXLBTMY2.BIN	Exist02	1901	New07	2913	Slab-On-		
207	TX Lufkin	TXLFTMY2.BIN	Exist02	1901	New05	2913	Slab-On-		
208	TX Midland	TXMITMY2.BIN	Exist02	1901	New06	2913	Slab-On-		
209	TX Port Arthur	TXPATMY2.BIN	Exist02	1901	New04	2913	Slab-On-		
210	TX San Angelo	TXSGTMY2.BIN	Exist02	1901	New05	2913	Slab-On-		
211	TX San Antonio	TXSNTMY2.BIN	Exist02	1901	New04	2913	Slab-On-		
212	TX Victoria	TXVITMY2.BIN	Exist02	1901	New03	1901	Slab-On-		
213	TX Waco	TXWATMY2.BIN	Exist02	1901	New05	2913	Slab-On-		
214	TX Wichita Falls	TXWFTMY2.BIN	Exist02	1901	New07	2913	Slab-On-		
215	UT Cedar City	UTCCTMY2.BIN	Exist01	2913	New12	2905	Basement		
216	UT Salt Lake City	UTSLTMY2.BIN	Exist01	2913	New12	2905	Basement		

ID	State Abbreviation / City Name	Weather File	Existing Construction Insulation Pkg	Existing Construction Sizing	New Construction Insulation Pkg	New Construction Sizing Window	Default Foundation	Default Electric Cost	Default Gas Cost
217	VA Lynchburg	VALYTMY2.BIN	Exist01	1901	New09	2913	Basement		
218	VA Norfolk	VANOTMY2.BIN	Exist01	1901	New08	2913	Basement		
219	VA Richmond	VARITMY2.BIN	Exist01	1901	New08	2913	Basement		
220	VA Roanoke	VAROTMY2.BIN	Exist01	1901	New09	2913	Basement		
221	VA Sterling	VASTTMY2.BIN	Exist01	1901	New10	2905	Basement		
222	VT Burlington	VTBUTMY2.BIN	Exist03	2913	New15	2905	Basement		
223	WA Olympia	WAOLTMY2.BIN	Exist02	2913	New11	2905	Basement		
224	WA Quillayute	WAQUTMY2.BIN	Exist02	2913	New12	2905	Basement		
225	WA Seattle	WASETMY2.BIN	Exist02	2913	New10	2905	Basement		
226	WA Spokane	WASPTMY2.BIN	Exist02	2913	New14	2905	Basement		
227	WA Yakima	WAYATMY2.BIN	Exist02	2913	New12	2905	Basement		
228	WI Eau Claire	WIECTMY2.BIN	Exist03	2913	New15	2905	Basement		
229	WI Green Bay	WIGBTMY2.BIN	Exist03	2913	New15	2905	Basement		
230	WI La Crosse	WILCTMY2.BIN	Exist03	2913	New15	2905	Basement		
231	WI Madison	WIMATMY2.BIN	Exist03	2913	New15	2905	Basement		
232	WI Milwaukee	WIMITMY2.BIN	Exist03	2913	New15	2905	Basement		
233	WV Charleston	WVCHTMY2.BIN	Exist01	1901	New10	2905	Basement		
234	WV Elkins	WVELTMY2.BIN	Exist01	1901	New13	2905	Basement		
235	WV Huntington	WVHUTMY2.BIN	Exist01	1901	New10	2905	Basement		
236	*WY Casper	WYCATMY2.BIN	Exist01	2913	New15	2905	Basement		
237	WY Cheyenne	WYCHTMY2.BIN	Exist01	2913	New15	2905	Basement		
238	*WY Lander	WYLATMY2.BIN	Exist01	2913	New15	2905	Basement		
239	*WY Rock Springs	WYRSTMY2.BIN	Exist01	2913	New16	2905	Basement		
240	*WY Sheridan	WYSHTMY2.BIN	Exist01	2913	New15	2905	Basement		
241	AB Edmonton	CNEDTMY2.BIN	Exist03	2913	New16	2905	Basement		
242	NS Halifax	CNHATMY2.BIN	Exist03	2913	New16	2905	Basement		
243	PQ Montreal	CNMNTMY2.BIN	Exist03	2913	New16	2905	Basement		
244	ON Toronto	CNTOTMY2.BIN	Exist03	2913	New16	2905	Basement		

6.2. RESFEN Modeling Assumptions

The following table compares the input value assumptions used for the DOE2 simulations in RESFEN versions 3.1 and 5.0 Beta 1. The assumptions are consistent with efforts by NFRC Annual Energy Rating Subcommittee to develop an Annual Energy Rating Procedure (1998). These assumptions are under review and may be updated in the final version of RESFEN5.

Table 6-2. Modeling Assumptions

PARAMETER	DESCRIPTION
Floor Area (ft^2 & dimensions)	Variable, from 1,000 to 4,000 square feet, input by user.
House Type	New Construction Existing Construction
Foundation	Foundation is based on location. There are a maximum of three options per climate zone, chosen from: Basement Slab-on-Grade Crawlspace See Table 6-2. [b]
Insulation	Envelope insulation levels are based on location. See Table 6-1 for a list of Packages that correspond to each location. See Tables 6-3 and 6-4 for a list of R-values for each building component for each location. See Table 6-_ for a list of U-factors that correspond to the R-value constructions. **New construction:** See Table 6-4. (Council of American Building Officials, 1993) [c] **Existing construction:** See Table 6-5. (Ritschard, et al. 1992)
Infiltration	**New Construction:** ELA=0.77 ft^2 (0.58 ACH) **Existing Construction:** ELA=1.00 ft^2 (0.70 ACH)
Structural Mass (lb/ft^2)	3.5 lb/ft^2 of floor area, in accordance with the Model Energy Code and NFRC Annual Energy Performance Subcommittee recommendation (September 1998).
Internal Mass Furniture (lb/ft^2)	8.0 lb/ft^2 of floor area, in accordance with the Model Energy Code and NFRC Annual Energy Performance Subcommittee recommendation (September 1998).
Solar Gain Reduction	**Options:** **None:** No solar gain reduction **Overhang:** 2′ Exterior Overhangs **Obstruction:** Exterior Obstructions, a completely opaque (τ=0.0), same-height obstruction 20 feet away, intended to represent adjacent buildings. **Interior:** Interior shades with a Seasonal SHGC multiplier, summer value = 0.80, winter value = 0.90. **Int+Ovh:** Interior shades & 2' overhangs **Ovh+Obs:** 2' overhangs & obstructions **All:** Interior shades, 2' overhangs, & obstructions **Typical**[d]**:** to represent a statistically average solar gain reduction for a generic house, this option includes: Interior shades (Seasonal SHGC multiplier, summer value = 0.80, winter value = 0.90); 1' overhang; a 67% transmitting same-height obstruction 20' away intended to represent adjacent buildings. To account for other sources of solar heat gain reduction (insect screens, trees, dirt, building & window self-shading), the SHGC multiplier was further reduced by 0.1. This results in a final winter SHGC multiplier of 0.8 and a final summer SHGC multiplier of 0.7.
Window Area (% Floor Area)	Variable
Window Type	Variable
Window Distribution	Variable
HVAC System	Furnace & A/C, Heat Pump
HVAC System Sizing	For each climate, system sizes are fixed for all window options. Fixed sizes are based on the use of DOE-2 auto-sizing for the same house as defined in the analysis, with the most representative window for that specific climate. An auto-sizing multiplier of 1.3 used to account for a typical safety factor. [e]
HVAC Efficiency	**New Construction:** AFUE = 0.78, A/C SEER=10.0 **Existing Construction:** AFUE = 0.70, A/C SEER= 8.0

Duct Losses	Heating: 10% (fixed) Cooling: 10% (fixed)
Part-Load Performance	New part-load curves for DOE2 (Henderson 1998) for both new and existing house types
Thermostat Settings	Heating: 70°F, Cooling: 78°F Basement (partially conditioned): Heating 62°F, Cooling 85°F
Night Heating Setback	65°F (11 PM – 6 AM[f])
PARAMETER	**DESCRIPTION**
Internal Loads	Sensible: 43,033 Btu/day + (floor area * 8.42 Btu/ft²-day for lighting) Latent: 12.2 kBtu/day
Natural Ventilation	Enthalpic – Sherman-Grimsrud (78°F / 72°F based on 4 days' history[g])
Weather Data	All TMY2[h]
Number of Locations	239 US cities[h] 4 Canadian cities
Calculation Tool	DOE-2.1E

Footnotes:

(a) RESFEN allows the floor area to vary, so floor-area-dependent parameters (such as exterior and interior wall area, perimeter area, internal gains, infiltration, and so forth) are calculated for each specific case.

(b) In Table 2, the default foundation option is the most common foundation type in that location; the other options are other foundation types found in more than 10% of the houses according to a National Association of Homebuilder's survey (Labs et al. 1988).

(c) The wall insulation R-values listed in the 1993 MEC (Council of American Building Officials, 1993) are the same for frame and masonry walls, as stated in the documentation for Prescriptive Packages: "Wall R-values represent the sum of the wall cavity insulation plus insulating sheathing (if used). Do not include exterior siding, structural sheathing, and interior drywall. For examples, an R-19 requirement could be met EITHER by R-19 cavity insulation OR R-13 cavity insulation plus R-6 insulating sheathing. Wall requirements apply to wood-frame or mass (concrete, masonry, log) wall constructions, but do not apply to metal-frame construction."

(d) These assumptions are intended to represent the average solar heat gain reduction for a large sample of houses. A one-foot overhang is assumed on all four orientations in order to represent the average of a two-foot overhang and no overhang. A 67% transmitting obstruction 20 feet away on all four orientations represents the average of obstructions (such as neighboring buildings and trees) 20 feet away on one-third of the total windows and no obstructions in front of the remaining two-thirds of windows. An interior shade is assumed to have a Solar Heat Gain Coefficient multiplier of 0.9 during the winter and 0.8 during the summer. To account for solar heat gain reducing effects from other sources such as screens, trees, dirt, and self-shading of the building, the SHGC multiplier was further reduced by 0.1 throughout the year. This amounts to a 12.5% decrease in the summer and an 11.1% decrease in the winter. The final SHGC multipliers (0.8 in the winter and 0.7 in the summer) thus reflect the combined effects of shading devices and other sources.

(e) For each climate, DOE-2's auto-sizing feature was used with the window most likely to be installed in new construction (assumed to be the MEC default). Tables 6.4 and 6.5 show the required prescriptive U-factors for windows for the 52 climates. For climates where the U-factor requirement is greater than or equal to 1.0, an aluminum frame window with single glazing (U-factor = 1.30; SHGC = 0.74) is used. For climates where the U-factor requirement is between 0.65 and 1.0, an aluminum frame window with double glazing (U-factor = 0.87; SHGC = 0.66) is used. For climates where the U-factor requirements are below 0.65, as well as in the four Canadian climates, a vinyl frame window with double glazing (U-factor = 0.49; SHGC = 0.57) is used for the sizing calculation.

(f) RESFEN models a moderate setback of 65° F in recognition that some but not all houses may use night setbacks. Recent studies of residential indoor conditions have shown that, during the heating season, nighttime temperatures are significantly lower than daytime temperatures (Ref: "Occupancy Patterns and Energy Consumption in New California Houses," Berkeley Solar Group for the California Energy Commission, 1990).

(g) RESFEN uses a feature in DOE-2 that allows the ventilation temperature to switch between a higher heating (or winter) and a lower cooling (or summer) temperature based on the cooling load over the previous four days.

(h) RESFEN uses Typical Meteorologcal Year (TMY2) weather tapes from the National Renewable Energy Laboratory. There are 239 TMY2 locations with average weather data compiled from 30+ years of historical weather data. (National Renewable Energy Laboratory, 1995).

6.3. Simulation Envelope Insulation Values

Table 6-3. RESFEN5 New Construction Insulation Values (Council of American Building Officials, 1993)

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
0	AK Anchorage	New17	R19	R0	R30	R30	R30	R38
1	AK Annette	New15	R19	R0	R15	R30	R15	R38
2	AK Barrow	New19	R28	R0	R19	R30	R19	R49
3	AK Bethel	New18	R21	R0	R28	R30	R28	R38
4	AK Bettles	New19	R28	R0	R19	R30	R19	R49
5	AK Big Delta	New18	R21	R0	R28	R30	R28	R38
6	AK Cold Bay	New17	R19	R0	R30	R30	R30	R38
7	AK Fairbanks	New18	R21	R0	R28	R30	R28	R38
8	AK Gulkana	New17	R19	R0	R30	R30	R30	R38
9	AK King Salmon	New17	R19	R0	R30	R30	R30	R38
10	AK Kodiak	New16	R19	R0	R28	R30	R28	R38
11	AK Kotzebue	New19	R28	R0	R19	R30	R19	R49
12	AK McGrath	New19	R28	R0	R19	R30	R19	R49
13	AK Nome	New19	R28	R0	R19	R30	R19	R49
14	AK St. Paul Island	New18	R21	R0	R28	R30	R28	R38
15	AK Talkeetna	New17	R19	R0	R30	R30	R30	R38
16	AK Yakutat	New17	R19	R0	R30	R30	R30	R38
17	AL Birmingham	New06	R14	R6	R6	R19	R6	R38
18	AL Huntsville	New08	R19	R2	R7	R19	R7	R38
19	AL Mobile	New04	R11	R0	R5	R11	R5	R26
20	AL Montgomery	New06	R14	R6	R6	R19	R6	R38
21	AR Fort Smith	New08	R19	R2	R7	R19	R7	R38
22	AR Little Rock	New07	R19	R2	R5	R13	R5	R38
23	AZ Flagstaff	New14	R19	R0	R14	R30	R14	R38
24	AZ Phoenix	New03	R11	R0	R0	R11	R0	R30
25	AZ Prescott	New10	R19	R5	R9	R19	R9	R38
26	AZ Tucson	New04	R11	R0	R5	R11	R5	R26
27	CA Arcata	New09	R19	R3	R8	R19	R8	R38
28	CA Bakersfield	New05	R14	R0	R5	R11	R5	R30
29	CA Daggett	New04	R11	R0	R5	R11	R5	R26
30	CA Fresno	New06	R14	R6	R6	R19	R6	R38
31	CA Long Beach	New04	R11	R0	R5	R11	R5	R26
32	CA Los Angeles	New04	R11	R0	R5	R11	R5	R26
33	CA Red Bluff	New06	R14	R6	R6	R19	R6	R38
34	CA Sacramento	New03	R11	R0	R0	R11	R0	R30
35	CA San Diego	New03	R11	R0	R0	R11	R0	R30
36	CA San Francisco	New06	R14	R6	R6	R19	R6	R38
37	CA Santa Maria	New05	R14	R0	R5	R11	R5	R30
38	CO Alamosa	New16	R19	R0	R28	R30	R28	R38
39	CO Denver	New13	R19	R12	R11	R26	R11	R38
40	CO Colorado Springs	New13	R19	R12	R11	R26	R11	R38
41	CO Eagle	New15	R19	R0	R15	R30	R15	R38
42	CO Grand Junction	New13	R19	R12	R11	R26	R11	R38

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
43	CO Pueblo	New11	R19	R2	R8	R19	R8	R38
44	CT Bridgeport	New12	R19	R4	R9	R19	R9	R38
45	CT Hartford	New13	R19	R12	R11	R26	R11	R38
46	DE Wilmington	New10	R19	R5	R9	R19	R9	R38
47	FL Daytona Beach	New02	R13	R0	R0	R11	R0	R19
48	FL Jacksonville	New03	R11	R0	R0	R11	R0	R30
49	FL Key West	New01	R11	R0	R0	R11	R0	R19
50	FL Miami	New01	R11	R0	R0	R11	R0	R19
51	FL Tallahassee	New04	R11	R0	R5	R11	R5	R26
52	FL Tampa	New02	R13	R0	R0	R11	R0	R19
53	FL West Palm Beach	New01	R11	R0	R0	R11	R0	R19
54	GA Athens	New07	R19	R2	R5	R13	R5	R38
55	GA Atlanta	New07	R19	R2	R5	R13	R5	R38
56	GA Augusta	New06	R14	R6	R6	R19	R6	R38
57	GA Columbus	New05	R14	R0	R5	R11	R5	R30
58	GA Macon	New05	R14	R0	R5	R11	R5	R30
59	GA Savannah	New04	R11	R0	R5	R11	R5	R26
60	HI Hilo	New01	R11	R0	R0	R11	R0	R19
61	HI Honolulu	New01	R11	R0	R0	R11	R0	R19
62	HI Kahului	New01	R11	R0	R0	R11	R0	R19
63	HI Lihue	New01	R11	R0	R0	R11	R0	R19
64	IA Des Moines	New14	R19	R0	R14	R30	R14	R38
65	IA Mason City	New15	R19	R0	R15	R30	R15	R38
66	IA Sioux City	New15	R19	R0	R15	R30	R15	R38
67	IA Waterloo	New15	R19	R0	R15	R30	R15	R38
68	ID Boise	New12	R19	R4	R9	R19	R9	R38
69	ID Pocatello	New15	R19	R0	R15	R30	R15	R38
70	IL Chicago	New14	R19	R0	R14	R30	R14	R38
71	IL Moline	New13	R19	R12	R11	R26	R11	R38
72	IL Peoria	New13	R19	R12	R11	R26	R11	R38
73	IL Rockford	New14	R19	R0	R14	R30	R14	R38
75	IN Evansville	New10	R19	R5	R9	R19	R9	R38
76	IN Fort Wayne	New13	R19	R12	R11	R26	R11	R38
77	IN Indianapolis	New12	R19	R4	R9	R19	R9	R38
78	IN South Bend	New13	R19	R12	R11	R26	R11	R38
79	KS Dodge City	New11	R19	R2	R8	R19	R8	R38
80	KS Goodland	New13	R19	R12	R11	R26	R11	R38
81	KS Topeka	New11	R19	R2	R8	R19	R8	R38
82	KS Wichita	New10	R19	R5	R9	R19	R9	R38
83	KY Covington	New11	R19	R2	R8	R19	R8	R38
84	KY Lexington	New10	R19	R5	R9	R19	R9	R38
85	KY Louisville	New10	R19	R5	R9	R19	R9	R38
86	LA Baton Rouge	New04	R11	R0	R5	R11	R5	R26
87	LA Lake Charles	New04	R11	R0	R5	R11	R5	R26
88	LA New Orleans	New03	R11	R0	R0	R11	R0	R30

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
89	LA Shreveport	New06	R14	R6	R6	R19	R6	R38
90	MA Boston	New13	R19	R12	R11	R26	R11	R38
91	MA Worchester	New14	R19	R0	R14	R30	R14	R38
92	MD Baltimore	New09	R19	R3	R8	R19	R8	R38
93	ME Caribou	New17	R19	R0	R30	R30	R30	R38
94	ME Portland	New15	R19	R0	R15	R30	R15	R38
95	MI Alpena	New15	R19	R0	R15	R30	R15	R38
96	MI Detroit	New13	R19	R12	R11	R26	R11	R38
97	MI Flint	New14	R19	R0	R14	R30	R14	R38
98	MI Grand Rapids	New14	R19	R0	R14	R30	R14	R38
99	MI Houghton	New17	R19	R0	R30	R30	R30	R38
100	MI Lansing	New14	R19	R0	R14	R30	R14	R38
101	MI Muskegon	New14	R19	R0	R14	R30	R14	R38
102	MI Sault Ste. Marie	New16	R19	R0	R28	R30	R28	R38
103	MI Traverse City	New15	R19	R0	R15	R30	R15	R38
105	MN International Falls	New17	R19	R0	R30	R30	R30	R38
106	MN Minneapolis	New15	R19	R0	R15	R30	R15	R38
107	MN Rochester	New15	R19	R0	R15	R30	R15	R38
108	MN Saint Cloud	New15	R19	R0	R15	R30	R15	R38
109	MO Columbia	New11	R19	R2	R8	R19	R8	R38
110	MO Kansas City	New11	R19	R2	R8	R19	R8	R38
111	MO Springfield	New10	R19	R5	R9	R19	R9	R38
112	MO St. Louis	New10	R19	R5	R9	R19	R9	R38
113	MS Jackson	New06	R14	R6	R6	R19	R6	R38
114	MS Meridian	New06	R14	R6	R6	R19	R6	R38
115	MT Billings	New15	R19	R0	R15	R30	R15	R38
116	MT Cut Bank	New16	R19	R0	R28	R30	R28	R38
117	MT Glasgow	New16	R19	R0	R28	R30	R28	R38
118	MT Great Falls	New15	R19	R0	R15	R30	R15	R38
119	MT Helena	New15	R19	R0	R15	R30	R15	R38
120	MT Kalispell	New16	R19	R0	R28	R30	R28	R38
121	MT Lewistown	New15	R19	R0	R15	R30	R15	R38
122	MT Miles City	New15	R19	R0	R15	R30	R15	R38
123	MT Missoula	New15	R19	R0	R15	R30	R15	R38
124	NC Asheville	New09	R19	R3	R8	R19	R8	R38
125	NC Cape Hatteras	New06	R14	R6	R6	R19	R6	R38
126	NC Charlotte	New07	R19	R2	R5	R13	R5	R38
127	NC Greensboro	New08	R19	R2	R7	R19	R7	R38
128	NC Raleigh	New07	R19	R2	R5	R13	R5	R38
129	NC Wilmington	New06	R14	R6	R6	R19	R6	R38
130	ND Bismarck	New16	R19	R0	R28	R30	R28	R38
131	ND Fargo	New17	R19	R0	R30	R30	R30	R38
132	ND Minot	New17	R19	R0	R30	R30	R30	R38
133	NE Grand Island	New13	R19	R12	R11	R26	R11	R38
134	NE Norfolk	New14	R19	R0	R14	R30	R14	R38

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
135	NE North Platte	New14	R19	R0	R14	R30	R14	R38
136	NE Omaha	New13	R19	R12	R11	R26	R11	R38
137	NE Scottsbluff	New14	R19	R0	R14	R30	R14	R38
138	NH Concord	New15	R19	R0	R15	R30	R15	R38
139	NJ Atlantic City	New10	R19	R5	R9	R19	R9	R38
140	NJ Newark	New11	R19	R2	R8	R19	R8	R38
141	NM Albuquerque	New09	R19	R3	R8	R19	R8	R38
142	NM Tucumcari	New08	R19	R2	R7	R19	R7	R38
143	NV Elko	New15	R19	R0	R15	R30	R15	R38
144	NV Ely	New15	R19	R0	R15	R30	R15	R38
145	NV Las Vegas	New05	R14	R0	R5	R11	R5	R30
146	NV Reno	New12	R19	R4	R9	R19	R9	R38
147	NV Tonopah	New12	R19	R4	R9	R19	R9	R38
148	NV Winnemucca	New13	R19	R12	R11	R26	R11	R38
149	NY Albany	New14	R19	R0	R14	R30	R14	R38
150	NY Binghamton	New15	R19	R0	R15	R30	R15	R38
151	NY Buffalo	New14	R19	R0	R14	R30	R14	R38
152	NY Massena	New15	R19	R0	R15	R30	R15	R38
153	NY New York City	New10	R19	R5	R9	R19	R9	R38
154	NY Rochester	New14	R19	R0	R14	R30	R14	R38
155	NY Syracuse	New14	R19	R0	R14	R30	R14	R38
156	OH Akron	New13	R19	R12	R11	R26	R11	R38
157	OH Cleveland	New13	R19	R12	R11	R26	R11	R38
158	OH Columbus	New13	R19	R12	R11	R26	R11	R38
159	OH Dayton	New12	R19	R4	R9	R19	R9	R38
160	OH Mansfield	New13	R19	R12	R11	R26	R11	R38
161	OH Toledo	New14	R19	R0	R14	R30	R14	R38
162	OH Youngstown	New13	R19	R12	R11	R26	R11	R38
163	OK Oklahoma City	New08	R19	R2	R7	R19	R7	R38
164	OK Tulsa	New08	R19	R2	R7	R19	R7	R38
165	OR Astoria	New11	R19	R2	R8	R19	R8	R38
166	OR Burns	New15	R19	R0	R15	R30	R15	R38
167	OR Eugene	New10	R19	R5	R9	R19	R9	R38
168	OR Medford	New11	R19	R2	R8	R19	R8	R38
169	OR North Bend	New09	R19	R3	R8	R19	R8	R38
170	OR Pendleton	New12	R19	R4	R9	R19	R9	R38
171	OR Portland	New10	R19	R5	R9	R19	R9	R38
172	OR Redmond	New14	R19	R0	R14	R30	R14	R38
173	OR Salem	New10	R19	R5	R9	R19	R9	R38
174	PA Allentown	New12	R19	R4	R9	R19	R9	R38
175	PA Bradford	New15	R19	R0	R15	R30	R15	R38
176	PA Erie	New14	R19	R0	R14	R30	R14	R38
177	PA Harrisburg	New12	R19	R4	R9	R19	R9	R38
178	PA Philadelphia	New10	R19	R5	R9	R19	R9	R38
179	PA Pittsburgh	New12	R19	R4	R9	R19	R9	R38

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
180	PA Wilkes-Barre	New13	R19	R12	R11	R26	R11	R38
181	PA Williamsport	New13	R19	R12	R11	R26	R11	R38
182	PI Guam	New01	R11	R0	R0	R11	R0	R19
183	PR San Juan	New01	R11	R0	R0	R11	R0	R19
184	RI Providence	New14	R19	R0	R14	R30	R14	R38
185	SC Charleston	New05	R14	R0	R5	R11	R5	R30
190	SD Rapid City	New15	R19	R0	R15	R30	R15	R38
191	SD Sioux Falls	New15	R19	R0	R15	R30	R15	R38
192	TN Bristol	New09	R19	R3	R8	R19	R8	R38
193	TN Chattanooga	New08	R19	R2	R7	R19	R7	R38
194	TN Knoxville	New08	R19	R2	R7	R19	R7	R38
195	TN Memphis	New07	R19	R2	R5	R13	R5	R38
196	TN Nashville	New08	R19	R2	R7	R19	R7	R38
197	TX Abilene	New06	R14	R6	R6	R19	R6	R38
198	TX Amarillo	New09	R19	R3	R8	R19	R8	R38
199	TX Austin	New05	R14	R0	R5	R11	R5	R30
200	TX Brownsville	New02	R13	R0	R0	R11	R0	R19
201	TX Corpus Christi	New03	R11	R0	R0	R11	R0	R30
202	TX El Paso	New06	R14	R6	R6	R19	R6	R38
203	TX Fort Worth	New05	R14	R0	R5	R11	R5	R30
204	TX Houston	New04	R11	R0	R5	R11	R5	R26
205	TX Lubbock	New07	R19	R2	R5	R13	R5	R38
206	TX Lufkin	New05	R14	R0	R5	R11	R5	R30
207	TX Midland	New06	R14	R6	R6	R19	R6	R38
208	TX Port Arthur	New04	R11	R0	R5	R11	R5	R26
209	TX San Angelo	New05	R14	R0	R5	R11	R5	R30
210	TX San Antonio	New04	R11	R0	R5	R11	R5	R26
211	TX Victoria	New03	R11	R0	R0	R11	R0	R30
212	TX Waco	New05	R14	R0	R5	R11	R5	R30
213	TX Wichita Falls	New07	R19	R2	R5	R13	R5	R38
214	UT Cedar City	New12	R19	R4	R9	R19	R9	R38
215	UT Salt Lake City	New12	R19	R4	R9	R19	R9	R38
216	VA Lynchburg	New09	R19	R3	R8	R19	R8	R38
217	VA Norfolk	New08	R19	R2	R7	R19	R7	R38
218	VA Richmond	New08	R19	R2	R7	R19	R7	R38
219	VA Roanoke	New09	R19	R3	R8	R19	R8	R38
220	VA Sterling	New10	R19	R5	R9	R19	R9	R38
221	VT Burlington	New15	R19	R0	R15	R30	R15	R38
222	WA Olympia	New11	R19	R2	R8	R19	R8	R38
223	WA Quillayute	New12	R19	R4	R9	R19	R9	R38
224	WA Seattle	New10	R19	R5	R9	R19	R9	R38
225	WA Spokane	New14	R19	R0	R14	R30	R14	R38
226	WA Yakima	New12	R19	R4	R9	R19	R9	R38
227	WI Eau Claire	New15	R19	R0	R15	R30	R15	R38
228	WI Green Bay	New15	R19	R0	R15	R30	R15	R38

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
229	WI La Crosse	New15	R19	R0	R15	R30	R15	R38
230	WI Madison	New15	R19	R0	R15	R30	R15	R38
231	WI Milwaukee	New15	R19	R0	R15	R30	R15	R38
232	WV Charleston	New10	R19	R5	R9	R19	R9	R38
233	WV Elkins	New13	R19	R12	R11	R26	R11	R38
234	WV Huntington	New10	R19	R5	R9	R19	R9	R38
235	*WY Casper	New15	R19	R0	R15	R30	R15	R38
236	WY Cheyenne	New15	R19	R0	R15	R30	R15	R38
237	*WY Lander	New15	R19	R0	R15	R30	R15	R38
238	*WY Rock Springs	New16	R19	R0	R28	R30	R28	R38
239	*WY Sheridan	New15	R19	R0	R15	R30	R15	R38
240	AB Edmonton	New16	R19	R0	R28	R30	R28	R38
241	NS Halifax	New16	R19	R0	R28	R30	R28	R38
242	PQ Montreal	New16	R19	R0	R28	R30	R28	R38
243	ON Toronto	New16	R19	R0	R28	R30	R28	R38

Table 6-4. RESFEN5 Existing Construction Insulation Values. (Ritschard, et. al. 1992)

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
0	AK Anchorage	Exist03	R7	R0	R0	R0	R0	R22
1	AK Annette	Exist03	R7	R0	R0	R0	R0	R22
2	AK Barrow	Exist03	R7	R0	R0	R0	R0	R22
3	AK Bethel	Exist03	R7	R0	R0	R0	R0	R22
4	AK Bettles	Exist03	R7	R0	R0	R0	R0	R22
5	AK Big Delta	Exist03	R7	R0	R0	R0	R0	R22
6	AK Cold Bay	Exist03	R7	R0	R0	R0	R0	R22
7	AK Fairbanks	Exist03	R7	R0	R0	R0	R0	R22
8	AK Gulkana	Exist03	R7	R0	R0	R0	R0	R22
9	AK King Salmon	Exist03	R7	R0	R0	R0	R0	R22
10	AK Kodiak	Exist03	R7	R0	R0	R0	R0	R22
11	AK Kotzebue	Exist03	R7	R0	R0	R0	R0	R22
12	AK McGrath	Exist03	R7	R0	R0	R0	R0	R22
13	AK Nome	Exist03	R7	R0	R0	R0	R0	R22
14	AK St. Paul Island	Exist03	R7	R0	R0	R0	R0	R22
15	AK Talkeetna	Exist03	R7	R0	R0	R0	R0	R22
16	AK Yakutat	Exist03	R7	R0	R0	R0	R0	R22
17	AL Birmingham	Exist02	R7	R0	R0	R0	R0	R19
18	AL Huntsville	Exist02	R7	R0	R0	R0	R0	R19
19	AL Mobile	Exist02	R7	R0	R0	R0	R0	R19
20	AL Montgomery	Exist02	R7	R0	R0	R0	R0	R19
21	AR Fort Smith	Exist02	R7	R0	R0	R0	R0	R19
22	AR Little Rock	Exist02	R7	R0	R0	R0	R0	R19
23	AZ Flagstaff	Exist01	R7	R0	R0	R0	R0	R11
24	AZ Phoenix	Exist01	R7	R0	R0	R0	R0	R11
25	AZ Prescott	Exist01	R7	R0	R0	R0	R0	R11
26	AZ Tucson	Exist01	R7	R0	R0	R0	R0	R11
27	CA Arcata	Exist04	R7	R0	R0	R0	R0	R11
28	CA Bakersfield	Exist04	R7	R0	R0	R0	R0	R11
29	CA Daggett	Exist04	R7	R0	R0	R0	R0	R11
30	CA Fresno	Exist04	R7	R0	R0	R0	R0	R11
31	CA Long Beach	Exist04	R7	R0	R0	R0	R0	R11
32	CA Los Angeles	Exist04	R7	R0	R0	R0	R0	R11
33	CA Red Bluff	Exist04	R7	R0	R0	R0	R0	R11
34	CA Sacramento	Exist04	R7	R0	R0	R0	R0	R11
35	CA San Diego	Exist04	R7	R0	R0	R0	R0	R11
36	CA San Francisco	Exist04	R7	R0	R0	R0	R0	R11
37	CA Santa Maria	Exist04	R7	R0	R0	R0	R0	R11
38	CO Alamosa	Exist01	R7	R0	R0	R0	R0	R11
39	CO Denver	Exist01	R7	R0	R0	R0	R0	R11
40	CO Colorado Springs	Exist01	R7	R0	R0	R0	R0	R11
41	CO Eagle	Exist01	R7	R0	R0	R0	R0	R11
42	CO Grand Junction	Exist01	R7	R0	R0	R0	R0	R11

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
43	CO Pueblo	Exist01	R7	R0	R0	R0	R0	R11
44	CT Bridgeport	Exist03	R7	R0	R0	R0	R0	R22
45	CT Hartford	Exist03	R7	R0	R0	R0	R0	R22
46	DE Wilmington	Exist01	R7	R0	R0	R0	R0	R11
47	FL Daytona Beach	Exist01	R7	R0	R0	R0	R0	R11
48	FL Jacksonville	Exist01	R7	R0	R0	R0	R0	R11
49	FL Key West	Exist01	R7	R0	R0	R0	R0	R11
50	FL Miami	Exist01	R7	R0	R0	R0	R0	R11
51	FL Tallahassee	Exist01	R7	R0	R0	R0	R0	R11
52	FL Tampa	Exist01	R7	R0	R0	R0	R0	R11
53	FL West Palm Beach	Exist01	R7	R0	R0	R0	R0	R11
54	GA Athens	Exist01	R7	R0	R0	R0	R0	R11
55	GA Atlanta	Exist01	R7	R0	R0	R0	R0	R11
56	GA Augusta	Exist01	R7	R0	R0	R0	R0	R11
57	GA Columbus	Exist01	R7	R0	R0	R0	R0	R11
58	GA Macon	Exist01	R7	R0	R0	R0	R0	R11
59	GA Savannah	Exist01	R7	R0	R0	R0	R0	R11
60	HI Hilo	Exist01	R7	R0	R0	R0	R0	R11
61	HI Honolulu	Exist01	R7	R0	R0	R0	R0	R11
62	HI Kahului	Exist01	R7	R0	R0	R0	R0	R11
63	HI Lihue	Exist01	R7	R0	R0	R0	R0	R11
64	IA Des Moines	Exist02	R7	R0	R0	R0	R0	R19
65	IA Mason City	Exist02	R7	R0	R0	R0	R0	R19
66	IA Sioux City	Exist02	R7	R0	R0	R0	R0	R19
67	IA Waterloo	Exist02	R7	R0	R0	R0	R0	R19
68	ID Boise	Exist02	R7	R0	R0	R0	R0	R19
69	ID Pocatello	Exist02	R7	R0	R0	R0	R0	R19
70	IL Chicago	Exist02	R7	R0	R0	R0	R0	R19
71	IL Evansville	Exist02	R7	R0	R0	R0	R0	R19
72	IL Moline	Exist02	R7	R0	R0	R0	R0	R19
73	IL Peoria	Exist02	R7	R0	R0	R0	R0	R19
74	IL Rockford	Exist02	R7	R0	R0	R0	R0	R19
75	IL Springfield	Exist02	R7	R0	R0	R0	R0	R19
76	IN Fort Wayne	Exist02	R7	R0	R0	R0	R0	R19
77	IN Indianapolis	Exist02	R7	R0	R0	R0	R0	R19
78	IN South Bend	Exist02	R7	R0	R0	R0	R0	R19
79	KS Dodge City	Exist02	R7	R0	R0	R0	R0	R19
80	KS Goodland	Exist02	R7	R0	R0	R0	R0	R19
81	KS Topeka	Exist02	R7	R0	R0	R0	R0	R19
82	KS Wichita	Exist02	R7	R0	R0	R0	R0	R19
83	KY Covington	Exist01	R7	R0	R0	R0	R0	R11
84	KY Lexington	Exist01	R7	R0	R0	R0	R0	R11
85	KY Louisville	Exist01	R7	R0	R0	R0	R0	R11
86	LA Baton Rouge	Exist02	R7	R0	R0	R0	R0	R19
87	LA Lake Charles	Exist02	R7	R0	R0	R0	R0	R19

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
88	LA New Orleans	Exist02	R7	R0	R0	R0	R0	R19
89	LA Shreveport	Exist02	R7	R0	R0	R0	R0	R19
90	MA Boston	Exist03	R7	R0	R0	R0	R0	R22
91	MA Worchester	Exist03	R7	R0	R0	R0	R0	R22
92	MD Baltimore	Exist01	R7	R0	R0	R0	R0	R11
93	ME Caribou	Exist03	R7	R0	R0	R0	R0	R22
94	ME Portland	Exist03	R7	R0	R0	R0	R0	R22
95	MI Alpena	Exist03	R7	R0	R0	R0	R0	R22
96	MI Detroit	Exist03	R7	R0	R0	R0	R0	R22
97	MI Flint	Exist03	R7	R0	R0	R0	R0	R22
98	MI Grand Rapids	Exist03	R7	R0	R0	R0	R0	R22
99	MI Houghton	Exist03	R7	R0	R0	R0	R0	R22
100	MI Lansing	Exist03	R7	R0	R0	R0	R0	R22
101	MI Muskegon	Exist03	R7	R0	R0	R0	R0	R22
102	MI Sault Ste. Marie	Exist03	R7	R0	R0	R0	R0	R22
103	MI Traverse City	Exist03	R7	R0	R0	R0	R0	R22
105	MN International Falls	Exist03	R7	R0	R0	R0	R0	R22
106	MN Minneapolis	Exist03	R7	R0	R0	R0	R0	R22
107	MN Rochester	Exist03	R7	R0	R0	R0	R0	R22
108	MN Saint Cloud	Exist03	R7	R0	R0	R0	R0	R22
109	MO Columbia	Exist03	R7	R0	R0	R0	R0	R22
110	MO Kansas City	Exist03	R7	R0	R0	R0	R0	R22
111	MO Springfield	Exist03	R7	R0	R0	R0	R0	R22
112	MO St. Louis	Exist03	R7	R0	R0	R0	R0	R22
113	MS Jackson	Exist02	R7	R0	R0	R0	R0	R19
114	MS Meridian	Exist02	R7	R0	R0	R0	R0	R19
115	MT Billings	Exist02	R7	R0	R0	R0	R0	R19
116	MT Cut Bank	Exist02	R7	R0	R0	R0	R0	R19
117	MT Glasgow	Exist02	R7	R0	R0	R0	R0	R19
118	MT Great Falls	Exist02	R7	R0	R0	R0	R0	R19
119	MT Helena	Exist02	R7	R0	R0	R0	R0	R19
120	MT Kalispell	Exist02	R7	R0	R0	R0	R0	R19
121	MT Lewistown	Exist02	R7	R0	R0	R0	R0	R19
122	MT Miles City	Exist02	R7	R0	R0	R0	R0	R19
123	MT Missoula	Exist02	R7	R0	R0	R0	R0	R19
124	NC Asheville	Exist01	R7	R0	R0	R0	R0	R11
125	NC Cape Hatteras	Exist01	R7	R0	R0	R0	R0	R11
126	NC Charlotte	Exist01	R7	R0	R0	R0	R0	R11
127	NC Greensboro	Exist01	R7	R0	R0	R0	R0	R11
128	NC Raleigh	Exist01	R7	R0	R0	R0	R0	R11
129	NC Wilmington	Exist01	R7	R0	R0	R0	R0	R11
130	ND Bismarck	Exist03	R7	R0	R0	R0	R0	R22
131	ND Fargo	Exist03	R7	R0	R0	R0	R0	R22
132	ND Minot	Exist03	R7	R0	R0	R0	R0	R22
133	NE Grand Island	Exist02	R7	R0	R0	R0	R0	R19

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
134	NE Norfolk	Exist02	R7	R0	R0	R0	R0	R19
135	NE North Platte	Exist02	R7	R0	R0	R0	R0	R19
136	NE Omaha	Exist02	R7	R0	R0	R0	R0	R19
137	NE Scottsbluff	Exist02	R7	R0	R0	R0	R0	R19
138	NH Concord	Exist03	R7	R0	R0	R0	R0	R22
139	NJ Atlantic City	Exist01	R7	R0	R0	R0	R0	R11
140	NJ Newark	Exist01	R7	R0	R0	R0	R0	R11
141	NM Albuquerque	Exist01	R7	R0	R0	R0	R0	R11
142	NM Tucumcari	Exist01	R7	R0	R0	R0	R0	R11
143	NV Elko	Exist01	R7	R0	R0	R0	R0	R11
144	NV Ely	Exist01	R7	R0	R0	R0	R0	R11
145	NV Las Vegas	Exist01	R7	R0	R0	R0	R0	R11
146	NV Reno	Exist01	R7	R0	R0	R0	R0	R11
147	NV Tonopah	Exist01	R7	R0	R0	R0	R0	R11
148	NV Winnemucca	Exist01	R7	R0	R0	R0	R0	R11
149	NY Albany	Exist01	R7	R0	R0	R0	R0	R11
150	NY Binghamton	Exist01	R7	R0	R0	R0	R0	R11
151	NY Buffalo	Exist01	R7	R0	R0	R0	R0	R11
152	NY Massena	Exist01	R7	R0	R0	R0	R0	R11
153	NY New York City	Exist01	R7	R0	R0	R0	R0	R11
154	NY Rochester	Exist01	R7	R0	R0	R0	R0	R11
155	NY Syracuse	Exist01	R7	R0	R0	R0	R0	R11
156	OH Akron	Exist02	R7	R0	R0	R0	R0	R19
157	OH Cleveland	Exist02	R7	R0	R0	R0	R0	R19
158	OH Columbus	Exist02	R7	R0	R0	R0	R0	R19
159	OH Dayton	Exist02	R7	R0	R0	R0	R0	R19
160	OH Mansfield	Exist02	R7	R0	R0	R0	R0	R19
161	OH Toledo	Exist02	R7	R0	R0	R0	R0	R19
162	OH Youngstown	Exist02	R7	R0	R0	R0	R0	R19
163	OK Oklahoma City	Exist02	R7	R0	R0	R0	R0	R19
164	OK Tulsa	Exist02	R7	R0	R0	R0	R0	R19
165	OR Astoria	Exist02	R7	R0	R0	R0	R0	R19
166	OR Burns	Exist02	R7	R0	R0	R0	R0	R19
167	OR Eugene	Exist02	R7	R0	R0	R0	R0	R19
168	OR Medford	Exist02	R7	R0	R0	R0	R0	R19
169	OR North Bend	Exist02	R7	R0	R0	R0	R0	R19
170	OR Pendleton	Exist02	R7	R0	R0	R0	R0	R19
171	OR Portland	Exist02	R7	R0	R0	R0	R0	R19
172	OR Redmond	Exist02	R7	R0	R0	R0	R0	R19
173	OR Salem	Exist02	R7	R0	R0	R0	R0	R19
174	PA Allentown	Exist01	R7	R0	R0	R0	R0	R11
175	PA Bradford	Exist01	R7	R0	R0	R0	R0	R11
176	PA Erie	Exist01	R7	R0	R0	R0	R0	R11
177	PA Harrisburg	Exist01	R7	R0	R0	R0	R0	R11
178	PA Philadelphia	Exist01	R7	R0	R0	R0	R0	R11

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
179	PA Pittsburgh	Exist01	R7	R0	R0	R0	R0	R11
180	PA Wilkes-Barre	Exist01	R7	R0	R0	R0	R0	R11
181	PA Williamsport	Exist01	R7	R0	R0	R0	R0	R11
182	PI Guam	Exist01	R7	R0	R0	R0	R0	R11
183	PR San Juan	Exist01	R7	R0	R0	R0	R0	R11
184	RI Providence	Exist03	R7	R0	R0	R0	R0	R22
185	SC Charleston	Exist01	R7	R0	R0	R0	R0	R11
190	SD Rapid City	Exist03	R7	R0	R0	R0	R0	R22
191	SD Sioux Falls	Exist03	R7	R0	R0	R0	R0	R22
192	TN Bristol	Exist01	R7	R0	R0	R0	R0	R11
193	TN Chattanooga	Exist01	R7	R0	R0	R0	R0	R11
194	TN Knoxville	Exist01	R7	R0	R0	R0	R0	R11
195	TN Memphis	Exist01	R7	R0	R0	R0	R0	R11
196	TN Nashville	Exist01	R7	R0	R0	R0	R0	R11
197	TX Abilene	Exist02	R7	R0	R0	R0	R0	R19
198	TX Amarillo	Exist02	R7	R0	R0	R0	R0	R19
199	TX Austin	Exist02	R7	R0	R0	R0	R0	R19
200	TX Brownsville	Exist02	R7	R0	R0	R0	R0	R19
201	TX Corpus Christi	Exist02	R7	R0	R0	R0	R0	R19
202	TX El Paso	Exist02	R7	R0	R0	R0	R0	R19
203	TX Fort Worth	Exist02	R7	R0	R0	R0	R0	R19
204	TX Houston	Exist02	R7	R0	R0	R0	R0	R19
205	TX Lubbock	Exist02	R7	R0	R0	R0	R0	R19
206	TX Lufkin	Exist02	R7	R0	R0	R0	R0	R19
207	TX Midland	Exist02	R7	R0	R0	R0	R0	R19
208	TX Port Arthur	Exist02	R7	R0	R0	R0	R0	R19
209	TX San Angelo	Exist02	R7	R0	R0	R0	R0	R19
210	TX San Antonio	Exist02	R7	R0	R0	R0	R0	R19
211	TX Victoria	Exist02	R7	R0	R0	R0	R0	R19
212	TX Waco	Exist02	R7	R0	R0	R0	R0	R19
213	TX Wichita Falls	Exist02	R7	R0	R0	R0	R0	R19
214	UT Cedar City	Exist01	R7	R0	R0	R0	R0	R11
215	UT Salt Lake City	Exist01	R7	R0	R0	R0	R0	R11
216	VA Lynchburg	Exist01	R7	R0	R0	R0	R0	R11
217	VA Norfolk	Exist01	R7	R0	R0	R0	R0	R11
218	VA Richmond	Exist01	R7	R0	R0	R0	R0	R11
219	VA Roanoke	Exist01	R7	R0	R0	R0	R0	R11
220	VA Sterling	Exist01	R7	R0	R0	R0	R0	R11
221	VT Burlington	Exist03	R7	R0	R0	R0	R0	R22
222	WA Olympia	Exist02	R7	R0	R0	R0	R0	R19
223	WA Quillayute	Exist02	R7	R0	R0	R0	R0	R19
224	WA Seattle	Exist02	R7	R0	R0	R0	R0	R19
225	WA Spokane	Exist02	R7	R0	R0	R0	R0	R19
226	WA Yakima	Exist02	R7	R0	R0	R0	R0	R19
227	WI Eau Claire	Exist03	R7	R0	R0	R0	R0	R22

ID	City Name	Insulation Package	Wall R-value	Slab R-value	Basement Wall R-value	Floor R-value	Basement Floor R-value	Ceiling R-value
228	WI Green Bay	Exist03	R7	R0	R0	R0	R0	R22
229	WI La Crosse	Exist03	R7	R0	R0	R0	R0	R22
230	WI Madison	Exist03	R7	R0	R0	R0	R0	R22
231	WI Milwaukee	Exist03	R7	R0	R0	R0	R0	R22
232	WV Charleston	Exist01	R7	R0	R0	R0	R0	R11
233	WV Elkins	Exist01	R7	R0	R0	R0	R0	R11
234	WV Huntington	Exist01	R7	R0	R0	R0	R0	R11
235	WY Casper	Exist01	R7	R0	R0	R0	R0	R11
236	WY Cheyenne	Exist01	R7	R0	R0	R0	R0	R11
237	WY Lander	Exist01	R7	R0	R0	R0	R0	R11
238	WY Rock Springs	Exist01	R7	R0	R0	R0	R0	R11
239	WY Sheridan	Exist01	R7	R0	R0	R0	R0	R11
240	AB Edmonton	Exist03	R7	R0	R0	R0	R0	R22
241	NS Halifax	Exist03	R7	R0	R0	R0	R0	R22
242	PQ Montreal	Exist03	R7	R0	R0	R0	R0	R22
243	ON Toronto	Exist03	R7	R0	R0	R0	R0	R22

Table 6-5. RESFEN5 Existing Construction Insulation Values. (Ritschard, et. al. 1992)

Layer Name	U-value w/air film	U-value w/o air
r0roof	0.3306	0.4456
r30ceil	0.0342	0.0351
r19rwall	0.0606	0.0633
iwalll	0.7971	1.7656
r0rcwall	0.2456	0.2980
r19flr	0.0489	0.0508
r19cblk	0.0607	0.0633
iflrl	0.2025	0.2393
r0slab	0.0772	0.0831
r2slab	0.0645	0.0685
r3slab	0.0610	0.0645
r4slab	0.0581	0.0614
r6slab	0.0549	0.0578
cgnd	0.1255	0.1389
r5bwall	0.0551	0.0573
r8bwall	0.0465	0.0480
r9bwall	0.0442	0.0456
r11bwall	0.0405	0.0416
r14bwall	0.0366	0.0375
r15bwall	0.0355	0.0363
r28bwall	0.0272	0.0278
r30bwall	0.0264	0.0573
r8bslab	0.0457	0.0474
r9bslab	0.0435	0.0450
r11bslab	0.0402	0.0415
r14bslab	0.0365	0.0376
r15bslab	0.0354	0.0363
r28bslab	0.0269	0.0275
r30bslab	0.0260	0.0265
roof	0.3306	0.4456
r19ceil	0.0573	0.0601
r26ceil	0.0398	0.0411
r38ceil	0.0269	0.0275
r11rwall	0.0895	0.0955
r13rwall	0.0758	0.0801
r14rwall	0.0658	0.0690
r19rwall	0.0606	0.0633
r11swall	0.1063	0.1149
r14swall	0.0798	0.0845
r13flr	0.0651	0.0685
r11flr	0.0732	0.0776
r0flr	0.2433	0.2984
r0flr	0.2433	0.2984
r11ceil	0.0824	0.0881
r22ceil	0.0436	0.0450
r7rwall	0.1047	0.1127
r7cblk	0.2237	0.2637
r11cblk	0.1180	0.1283
r13cblk	0.0955	0.1021

Table 6-6. RESFEN5 Existing Construction Insulation Values. (Ritschard, et. al. 1992) (continued)

Layer Name	U-value w/air film	U-value w/o air
r14cblk	0.0872	0.0927
r19cblk	0.0607	0.0633
r12slab	0.0485	0.0508
r0bwall	0.0999	0.1071
r6bwall	0.0519	0.0538
r7bwall	0.0491	0.0508
r19bwall	0.0323	0.0331
r0bslab	0.0982	0.1062
r6bslab	0.0514	0.0535
r7bslab	0.0484	0.0503
r19bslab	0.0320	0.0328
r26flr	0.0379	0.0390
r30flr	0.0336	0.0345
r5slab	0.0558	0.0588
r21rwall	0.0496	0.0515
r28rwall	0.0366	0.0376

6.4. Using WINDOW5 DOE2 Input File for RESFEN Calculations

Window databases created in WINDOW5 can be imported into the RESFEN Window Library. In addition, the detailed DOE2 input file generated by WINDOW5 for windows can also be used in the RESFEN analysis for a more accurate definition of the glazing in the window. Importing records from a WINDOW6 database are discussed in Section 4 in the Glass Library section.

To use the WINDOW5 DOE2 Input file in a RESFEN calculation, the *dat" file from WINDOW5 must be specified, and the calculation procedure "turned on". Both these functions are found in the Options dialog box, opened by clicking on the Options menu.

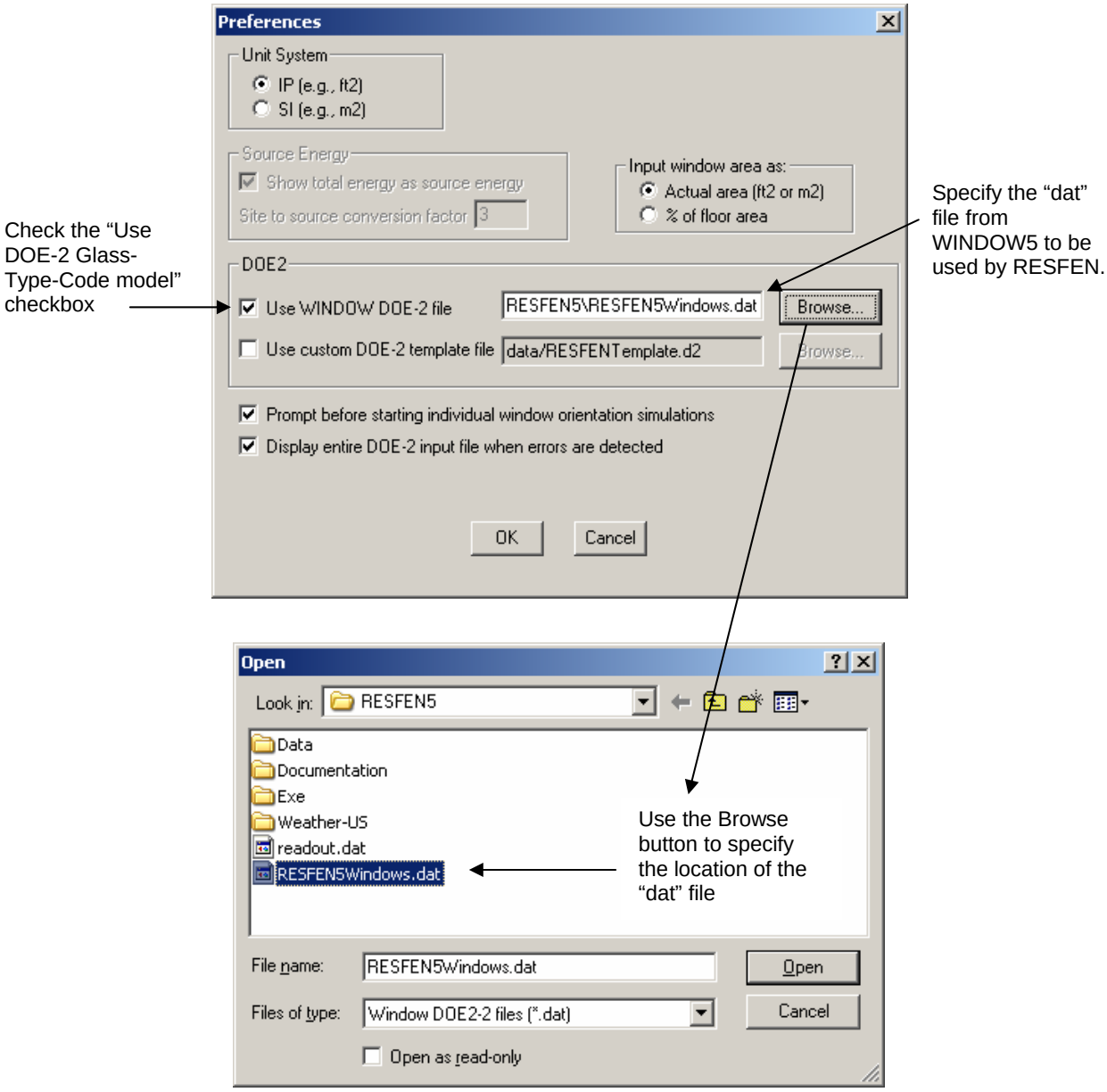


Figure 6-1. To use the DOE2 detailed input file from WINDOW5 (specified as a "dat" file), go to the Options dialog box from the Options menu.

6.5. RESFEN Window Library (from WINDOW 5) Documentation

ID #	Frame Type	# of glazings	Glazing Description	Gap (inch)	Gas (see Note for Air/Argon)	Total Window U-factor (Btu/hr-ft²-°F)	Total Window Solar Heat Gain Coefficient (SHGC)	Total Window Visible Transmittance (VT)
101	AL	1	Clear	n/a	n/a	1.16	0.76	0.75
102	AL	1	Bronze	n/a	n/a	1.16	0.65	0.56
111	AL	2	Clear	0.375	Air	0.76	0.67	0.67
112	AL	2	Bronze	0.375	Air	0.76	0.56	0.51
113	AL	2	SS Tint	0.375	Air	0.76	0.47	0.57
121	AL	2	PY Low-E	0.50	Argon	0.61	0.63	0.62
131	AL	2	SP Low-E	0.50	Argon	0.60	0.53	0.65
141	AL	2	SS Low-E	0.50	Argon	0.58	0.37	0.59
201	ATB	1	Clear	n/a	n/a	1.00	0.70	0.70
202	ATB	1	Bronze	n/a	n/a	1.00	0.59	0.53
211	ATB	2	Clear	0.50	Air	0.63	0.62	0.63
212	ATB	2	Bronze	0.50	Air	0.63	0.51	0.48
213	ATB	2	SS Tint	0.50	Air	0.63	0.43	0.54
221	ATB	2	PY Low-E	0.50	Argon	0.50	0.58	0.58
231	ATB	2	SP Low-E	0.50	Argon	0.48	0.48	0.60
241	ATB	2	SS Low-E	0.50	Argon	0.47	0.33	0.55
301	W/V	1	Clear	n/a	n/a	0.84	0.63	0.65
302	W/V	1	Bronze	n/a	n/a	0.84	0.54	0.49
311	W/V	2	Clear	0.50	Air	0.49	0.56	0.59
312	W/V	2	Bronze	0.50	Air	0.49	0.47	0.44
313	W/V	2	SS Tint	0.50	Air	0.49	0.39	0.50
321	W/V	2	PY Low-E	0.50	Argon	0.37	0.53	0.54
331	W/V	2	SP Low-E	0.50	Argon	0.35	0.44	0.56
341	W/V	2	SS Low-E	0.50	Argon	0.34	0.30	0.51
351	W/V	3	HT Super	0.50	Argon	0.28	0.38	0.47
352	W/V	3	SS Super	0.50	Argon	0.28	0.25	0.40
411	INS	2	Clear	0.50	Air	0.44	0.60	0.63
412	INS	2	Bronze	0.50	Air	0.44	0.49	0.48
413	INS	2	SS Tint	0.50	Air	0.44	0.41	0.54
421	INS	2	PY Low-E	0.50	Argon	0.29	0.56	0.58
431	INS	2	SP Low-E	0.50	Argon	0.27	0.46	0.60
441	INS	2	SS Low-E	0.50	Argon	0.26	0.31	0.55
451	INS	3	HT Super	0.50	Argon	0.18	0.40	0.50
452	INS	3	SS Super	0.50	Argon	0.18	0.26	0.43

NOTES:

FRAME TYPE CODES:
AL = Aluminum
ATB = Aluminum, Thermally Broken
W/V = Wood/Vinyl
INS = Insulated Frame

GLAZING TYPE CODES:
SS = Spectrally Selective (e ≈ 0.04, low solar gain)
PY = Pyrolitic coating (e ≈ 0.15 - 0.20, high solar gain)
SP = Sputter low-E coating (e ≈ 0.10, moderate solar gain)
SS Super = 3-layer insulating glazing, two layers with Spectrally Selective low-E coatings
HT Super = 3-layer insulating glazing, two layers with high solar transmitting low-E coatings.

ARGON GAS:
Consists of 90% air, 10% argon

The data presented here and in RESFEN are average properties for several commercially available products. Specific products will perform slightly above or below the average products defined here. Users are encouraged to only use these numbers as a general guide and to use specific manufacturer's product data (i.e. NFRC U-factors and Solar Heat Gain Coefficients) whenever possible.

The values in this table may differ slightly from those from RESFEN 3.1 because these windows were calculated with WINDOW 5 using the new ISO 15099 and NFRC modeling assumptions. See the WINDOW5 User Manual for more details.

6.6. Resources

The following listings are resources for learning more about energy-efficient windows:

6.6.1. Books

Residential Windows, A Guide to New Technologies and Energy Performance
by John Carmody, Stephen Selkowitz, and Lisa Heschong
W.W.W. Norton & Company, 1996.
Updated material from this book can be found at the web site www.efficientwindows.org.

6.6.2. Organizations

Efficient Windows Collaborative
Alliance to Save Energy
1200 18th Street N.W., Suite 900
Washington, DC 20036
Phone: (202) 857-0666
Fax: (202) 331-9588
Web site: www.efficientwindows.org

National Fenestration Rating Council
1300 Spring Street, Suite 500
Silver Spring, MD 20910
Phone: (301) 589-NFRC
Web site: www.nfrc.org

Windows and Daylighting Group
Lawrence Berkeley National Laboratory
MS 90-3111
1 Cyclotron Road
Berkeley, CA 94720
Web site: windows.lbl.gov

6.7. References

American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 1997. *WYEC2 User's Manual*, Atlanta GA.

Arasteh, D. K., E. U. Finlayson, and C. Huizenga. 1994. "WINDOW 4.1 : A PC program for analyzing window thermal performance in accordance with standard NFRC procedures". LBL-35298, Lawrence Berkeley Laboratory, Berkeley, Calif.

Council of American Building Officials (CABO). 1993. *Model Energy Code*. Falls Church, Va.

Henderson, H., Y. J. Huang, and D. Parker. 1999. "Residential equipment part-load curves for use in DOE-2". LBL-42145, Lawrence Berkeley National Laboratory, Berkeley, Calif.

Huang, Y. J., R. Ritschard, I. Turiel, S. Byrne, D. Wilson, C. Hsui, J. Bull, R. Sullivan, L. Chang, and P. Albrand. 1987. "Methodology and assumptions for evaluating heating and cooling energy requirements in new single-family residential buildings. Technical support document for the PEAR microcomputer program". LBL-19128, Lawrence Berkeley Laboratory, Berkeley, Calif.

Labs, K., J. Carmody, R. Sterling, L. Shen, Y. J. Huang, and D. Parker. 1988. *Building Foundation Design Handbook*. ORNL/Sub/86-72143/1, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Lawrence Berkeley Laboratory (LBL) and Los Alamos Scientific Laboratory. 1980. *DOE-2 Reference Manual, Parts 1 and 2*. LBL-8706 Rev. 1/LA-7689-M Ver 2.1, Lawrence Berkeley Laboratory, Berkeley, Calif.

National Energy Renewable Laboratory (NREL). 1995. *TMY2 User's Manual*. Golden, Colo.

Ritschard, R., J. W. Hanford, and A. O. Sezgen. 1992. "Single-family heating and cooling requirements: assumptions, methods, and summary results", GRI-91/0236, Gas Research Institute, Chicago, Ill.

Winkelmann, F. C., B. E. Birdsall, W. F. Buhl, K. L. Ellington, A. E. Erdem, J. J. Hirsch, and S. Gates. 1993. "DOE-2 Supplement. Version 2.1E", pp. 2-98 through 2-117 (Window Library), LBL-34947, Lawrence Berkeley Laboratory, Berkeley, Calif.

7. ACKNOWLEDGEMENTS

The development of RESFEN5 was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy; Office of Building Technology, State and Community Programs; Office of Building Systems of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098. The authors appreciate the assistance of the following colleagues in the design and development of RESFEN: Fred Buhl, Ender Erdem, Rob Hitchcock, Steve Selkowitz, and Fred Winkelmann. The user interface was developed by Santosh Philip of Gabel Associates, Berkeley, California. Development of the modeling assumptions for use in RESFEN was a collaborative process between LBNL staff and NFRC members; the authors wish to acknowledge the significant effort and contributions from many in the window community.