

**Program Description**

*A PC Program*



## **RESFEN5**

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

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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

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## 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.

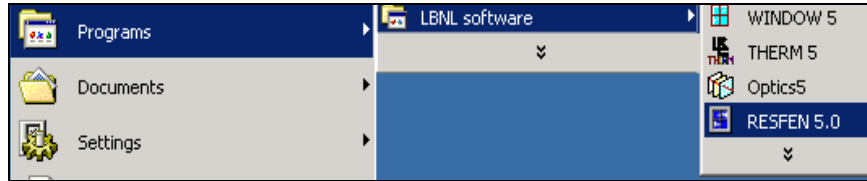


Figure 2-1. Click on the RESFEN icon in the Programs/LBNL Software list.

- 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.

When RESFEN starts, it opens the input file database, called **RESFEN5.mdb**.

Change the values in any of these input boxes to model your specific situation.

When you change input values, the results boxes will be reset to "0, until you recalculate the results.

Window Type	Area (ft <sup>2</sup> )	U-factor (Btu/h-ft <sup>2</sup> -F)	SHGC	Air Leakage (cfm/ft <sup>2</sup> )	Solar Gain Reduction
North: 311: W/W 2 Clear	60	0.49	0.56	0.3	Typical
East: 311: W/W 2 Clear	40	0.49	0.56	0.3	Typical
South: 311: W/W 2 Clear	100	0.49	0.56	0.3	Typical
West: 311: W/W 2 Clear	40	0.49	0.56	0.3	Typical
Skylight: User defined	0	0	0	0	None

	Heating	Cooling	Total (source)
Annual Energy Totals	160.5 MBtu	427 kWh	164.9 MBtu
Annual Energy per ft <sup>2</sup>	80.3 kBtu/ft <sup>2</sup>	0.21 kWh/ft <sup>2</sup>	82.4 kBtu/ft <sup>2</sup>
Peak	84.0 kBtu/hr	2.94 kW	
Cost \$	1489.62	36.28	1525.90

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.

Orientation	Window Type	Area (ft2)	U-factor (Btu/h-ft2-F)	SHGC	Air Leakage (cfm/ft2)	Solar Gain Reduction
North	311: W/W 2 Clear	60.	0.49	0.56	0.3	Typical
East	311: W/W 2 Clear	40.	0.49	0.56	0.3	Typical
South	311: W/W 2 Clear	100.	0.49	0.56	0.3	Typical
West	311: W/W 2 Clear	40.	0.49	0.56	0.3	Typical
Skylight	User defined	0.	0.	0.	0.	None

ID	Name	Ufactor (Btu/h-ft2-F)	SHGC	Area (ft2)	Width (inches)	Height (inches)
312	W/W 2 Bronze	0.493	0.466	9.7	24.00	59.00
313	W/W 2 SS Tint	0.493	0.385	9.7	24.00	59.00
321	W/W 2 PY Low-E	0.365	0.529	9.7	24.00	59.00
331	W/W 2 SP Low-E	0.350	0.436	9.7	24.00	59.00
341	W/W 2 SS Low-E	0.341	0.297	9.7	24.00	59.00
351	W/W 3 HT Super	0.285	0.382	9.7	24.00	59.00
352	W/W 3 SS Super	0.281	0.254	9.7	24.00	59.00
411	INS 2 Clear	0.444	0.596	9.7	24.00	59.00
412	INS 2 Bronze	0.444	0.492	9.7	24.00	59.00

Figure 2-3. Use the WINDOW 5 library to select windows for your 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.

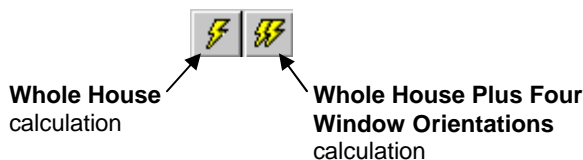



Figure 2-4. There are two calculation options, accessed with the lightning bolt toolbar buttons.

- 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.

	Heating	Cooling	Total (source)
Annual Energy Totals	72.5 MBtu	919 kWh	81.9 MBtu
Annual Energy per ft2	36.2 kBtu/ft2	0.46 kWh/ft2	41.0 kBtu/ft2
Peak	64.1 kBtu/hr	2.82 kW	
Cost \$	565.97	52.40	618.37

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.

	Heating	Cooling	Total (source)
Annual Energy Totals	73.7 MBtu	913 kWh	83.0 MBtu
Annual Energy per ft2	36.8 kBtu/ft2	0.46 kWh/ft2	41.5 kBtu/ft2
Peak	64.1 kBtu/hr	2.82 kW	
Cost \$	575.24	52.03	627.27

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](mailto: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**:

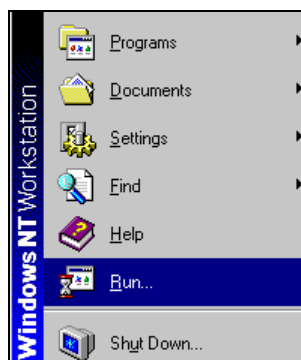


Figure 3-1. Pick **Run** from the Start toolbar.

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.

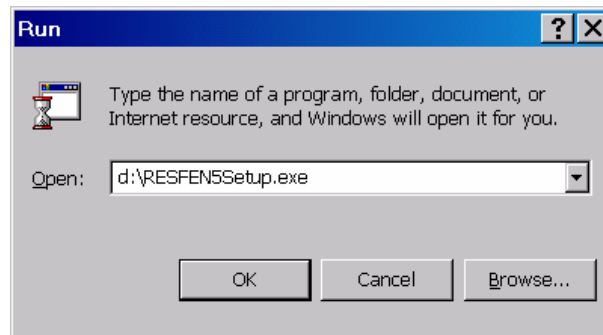


Figure 3-2. Type <drive letter>: RESFEN5Setup.exe and press **OK**.

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

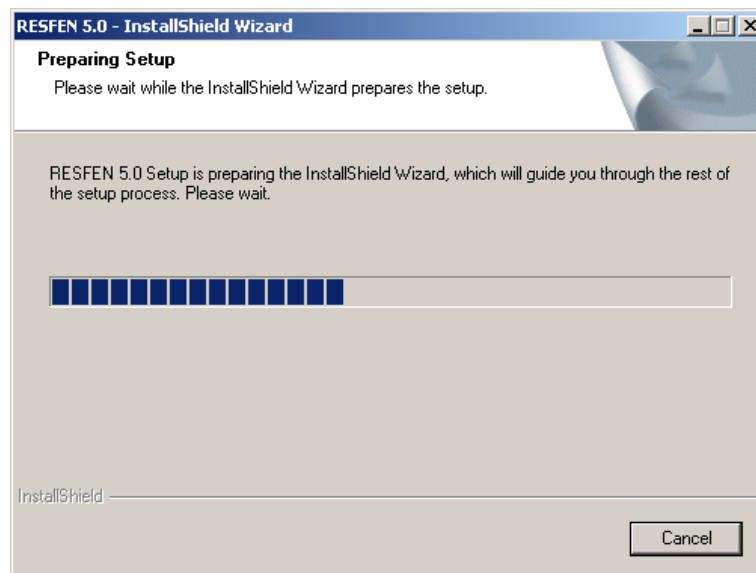


Figure 3-3. The initial **RESFEN Setup** window.

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.

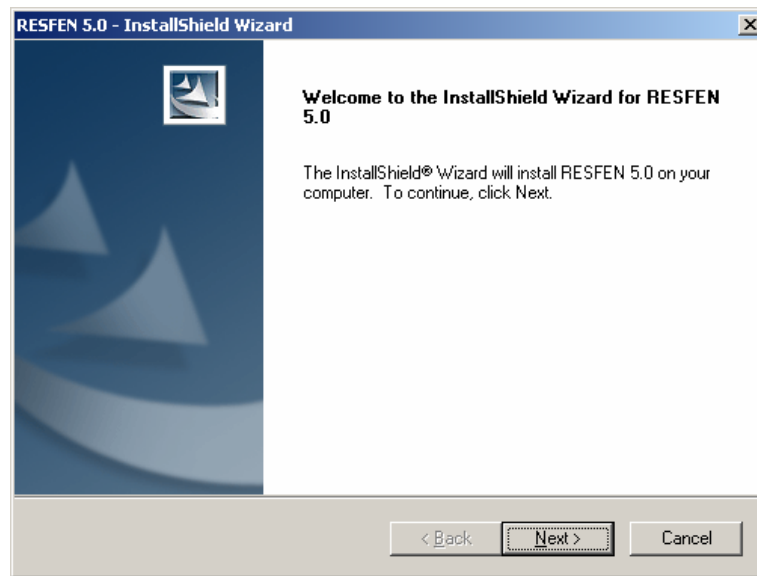


Figure 3-4. The initial RESFEN Setup window.

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.

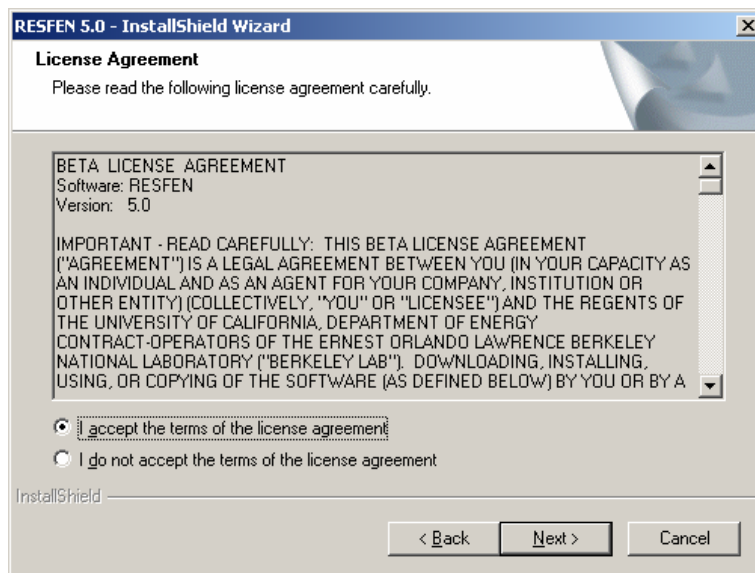


Figure 3-5. The initial RESFEN Setup window.

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

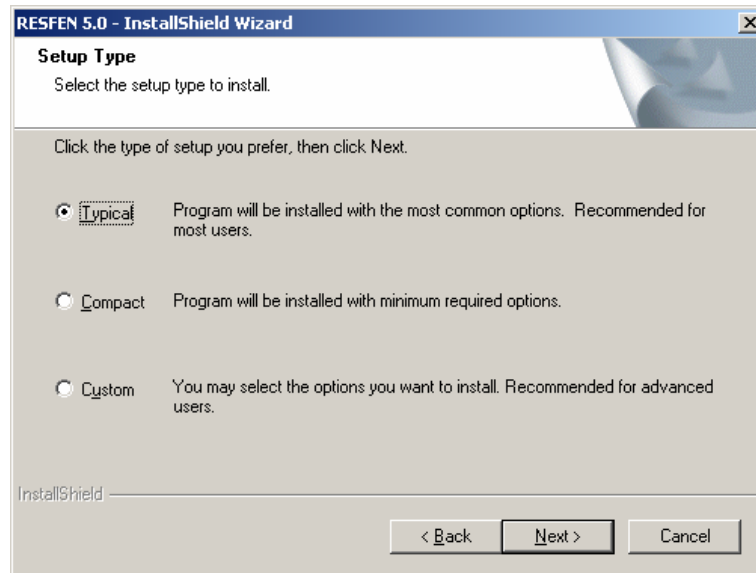


Figure 3-6. The Setup Type window.

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.

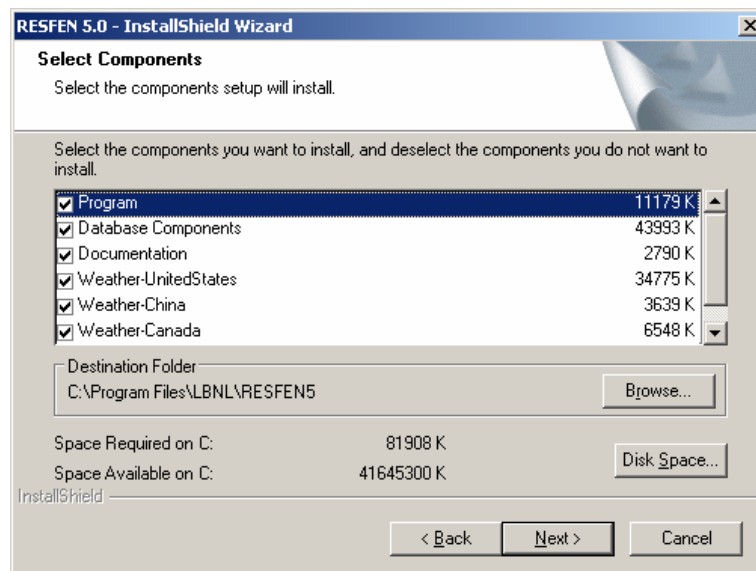


Figure 3-7. The Setup Type window for the Custom Setup choice, which shows the components of the program.

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.

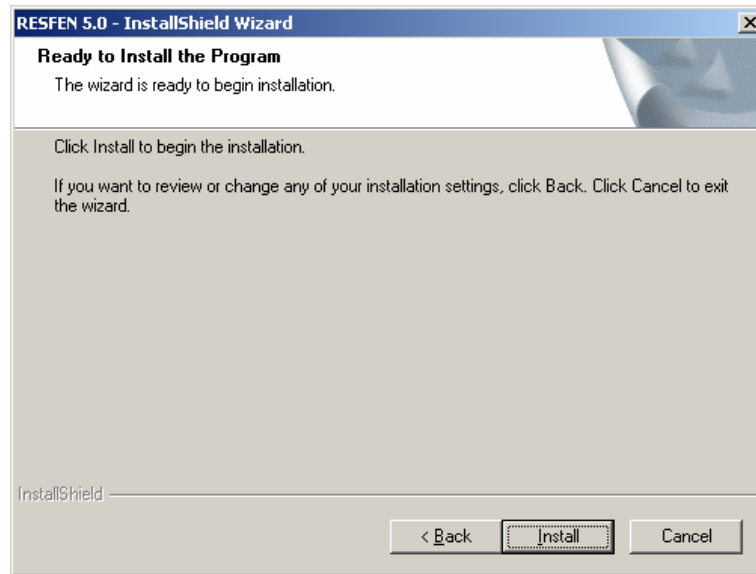


Figure 3-8. *Ready to Install the Program* screen. The next screen to display is *Start Copying Files*, which shows where the installation settings, including where the program will be installed.

Press the **Next** button.

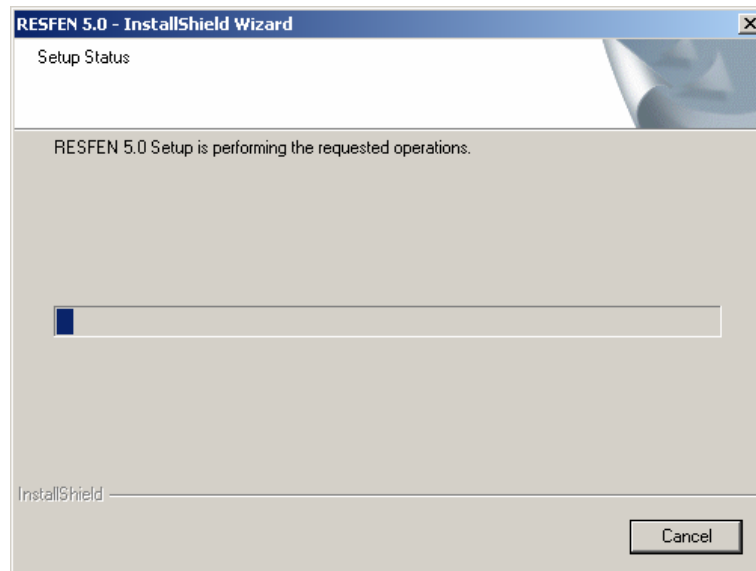


Figure 3-9. The *Start Copying Files* screen shows the installation settings. Then press **Next** to go to the next screen.

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

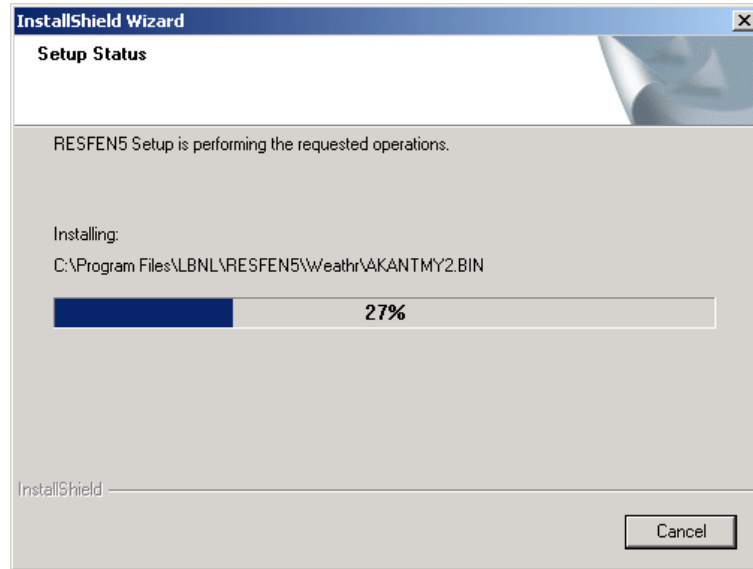


Figure 3-10. Setup will decompress and copy the program files into the specified destination directory.

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.

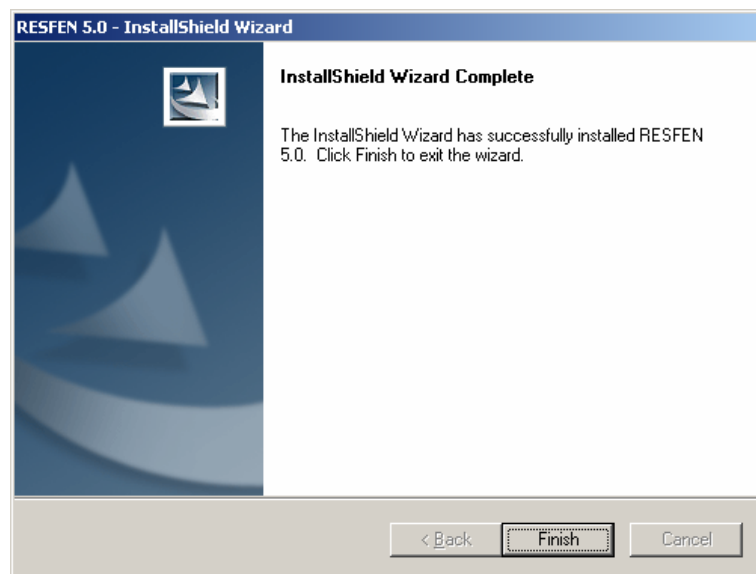


Figure 3-11. The **InstallShield Wizard Complete** screen will display when the installation is finished. Press the **Finish** button to finalize the installation.

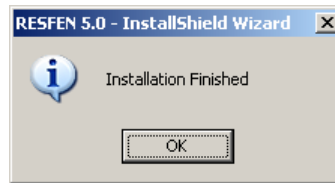


Figure 3-12. The *Installation Finished* screen will display when the installation is finished. Click on the **OK** button to finalize the installation.

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

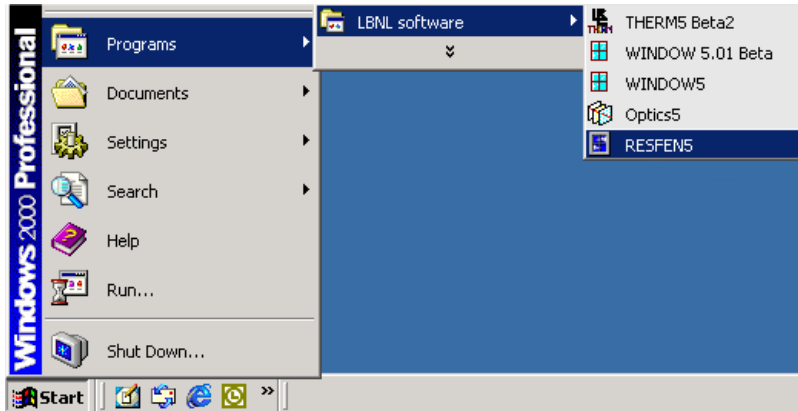


Figure 3-13. Program icon to run RESFEN.

### 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:

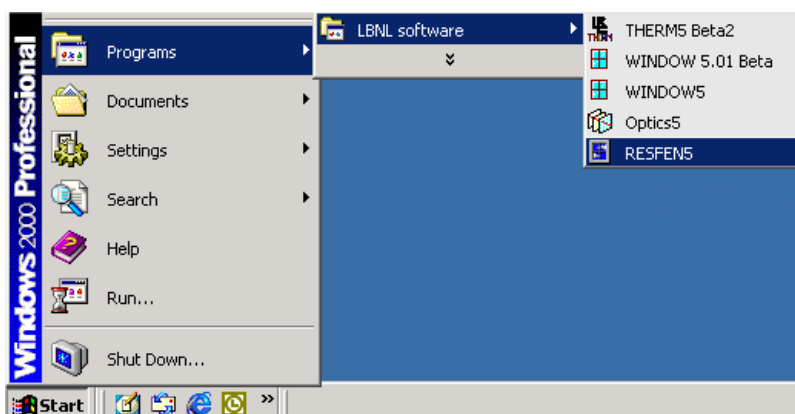


Figure 3-14. Click on Start / Programs / LBNL Software / RESFEN 3.1

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

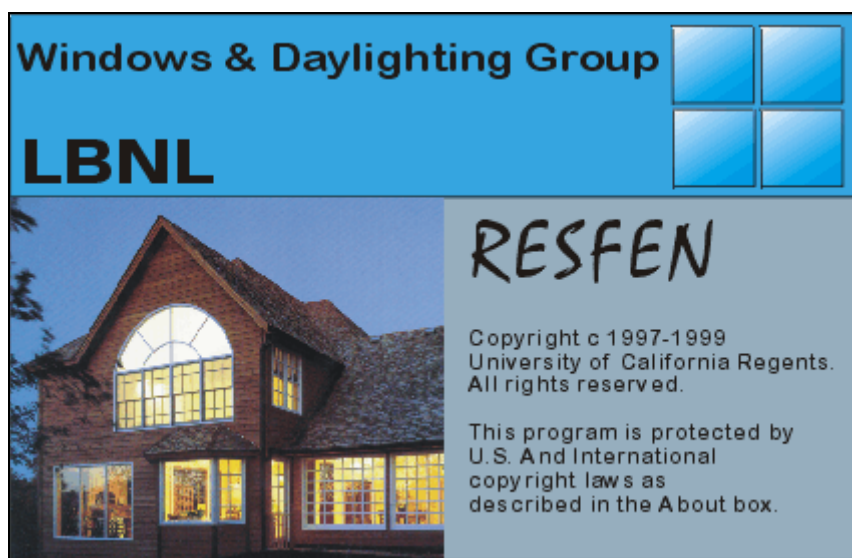


Figure 3-15. RESFEN Splash Screen

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

The screenshot shows the main interface of the RESFEN software. The window title is "Resfen - House Library (C:\Program Files\LBNL\RESFENS\resfen5.mdb)". The interface is divided into several sections:

- House Data:** Includes fields for ID#, Name (1 - Madison - Double Cle), Location (WI Madison), House Type (1-Story Existing Frame), HVAC System Type (Gas Furnace / AC), Floor Area (2000 ft<sup>2</sup>), Envelope Package (Exist03 (WV1)), Foundation Type (Basement), Electric Cost (Wisconsin, 0.085 \$/kWh), Gas Cost (Wisconsin, 0.928 \$/Therm), and Description (Example #1 - Case A).
- Window Data:** A table listing window types and their properties.
 

Window Type	Area (ft <sup>2</sup> )	U-factor (Btu/h-ft <sup>2</sup> -F)	SHGC	Air Leakage (cfm/ft <sup>2</sup> )	Solar Gain Reduction
North: 311: W/V 2 Clear	60	0.49	0.56	0.3	Typical
East: 311: W/V 2 Clear	40	0.49	0.56	0.3	Typical
South: 311: W/V 2 Clear	100	0.49	0.56	0.3	Typical
West: 311: W/V 2 Clear	40	0.49	0.56	0.3	Typical
Skylight: User defined	0	0	0	0	None

 Below the table, there is a checkbox for "East, South and West windows are the same type as North" (checked) and a summary: "Total Window Area 240 ft<sup>2</sup> 12.0% of floor area".
- Whole House:** A summary table of energy calculations.
 

	Heating	Cooling	Total (source)
Annual Energy Totals	160.5 MBtu	427 kWh	164.9 MBtu
Annual Energy per ft <sup>2</sup>	80.3 kBtu/ft <sup>2</sup>	0.21 kWh/ft <sup>2</sup>	82.4 kBtu/ft <sup>2</sup>
Peak	84.0 kBtu/hr	2.94 kW	
Cost	\$ 1489.62	\$ 36.28	\$ 1525.90

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**:

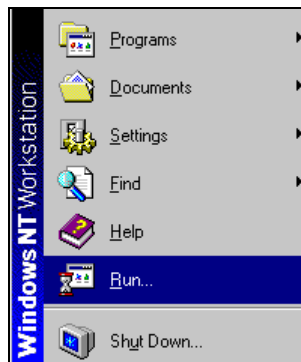


Figure 3-17. Pick **Run** from the Start toolbar.

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.

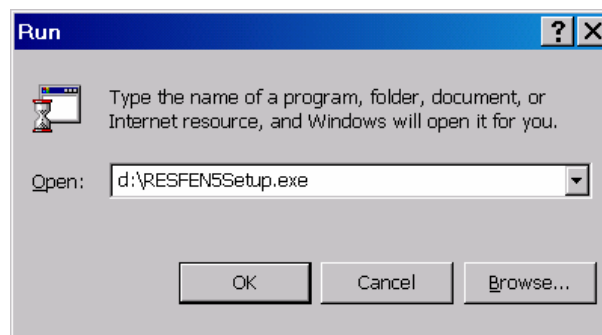


Figure 3-18. Type <drive letter>: RESFEN5Setup.exe and press **OK**.

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.

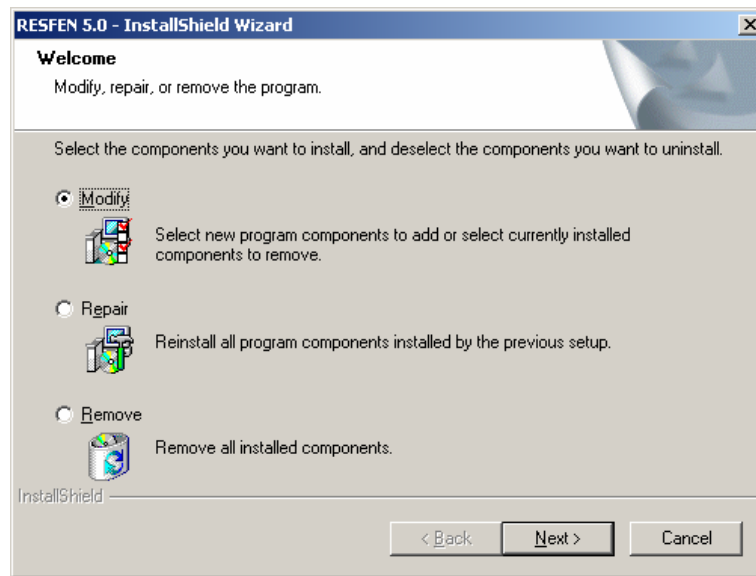


Figure 3-19. Once RESFEN has been installed, running the installation program again will produce this screen. Click on Modify to add program components, such as more weather files.

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.

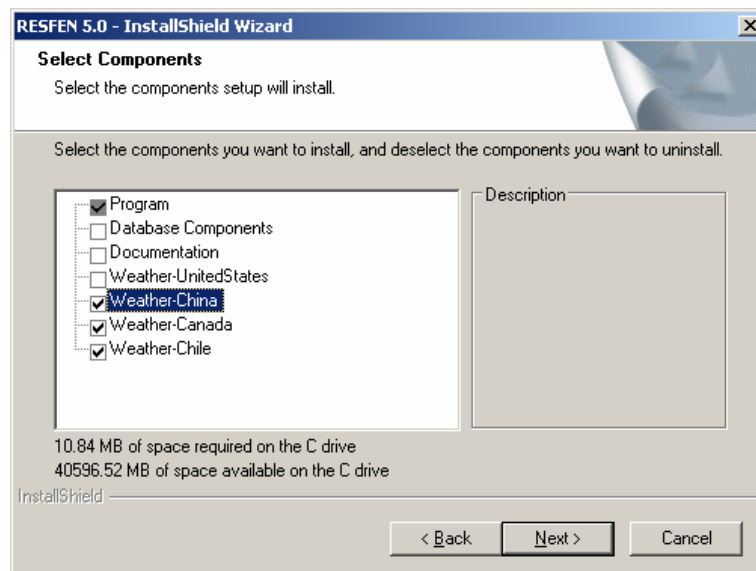


Figure 3-20. Once RESFEN has been installed, running the installation program again will produce this screen. Click on Modify to add program components, such as more weather files.

### 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

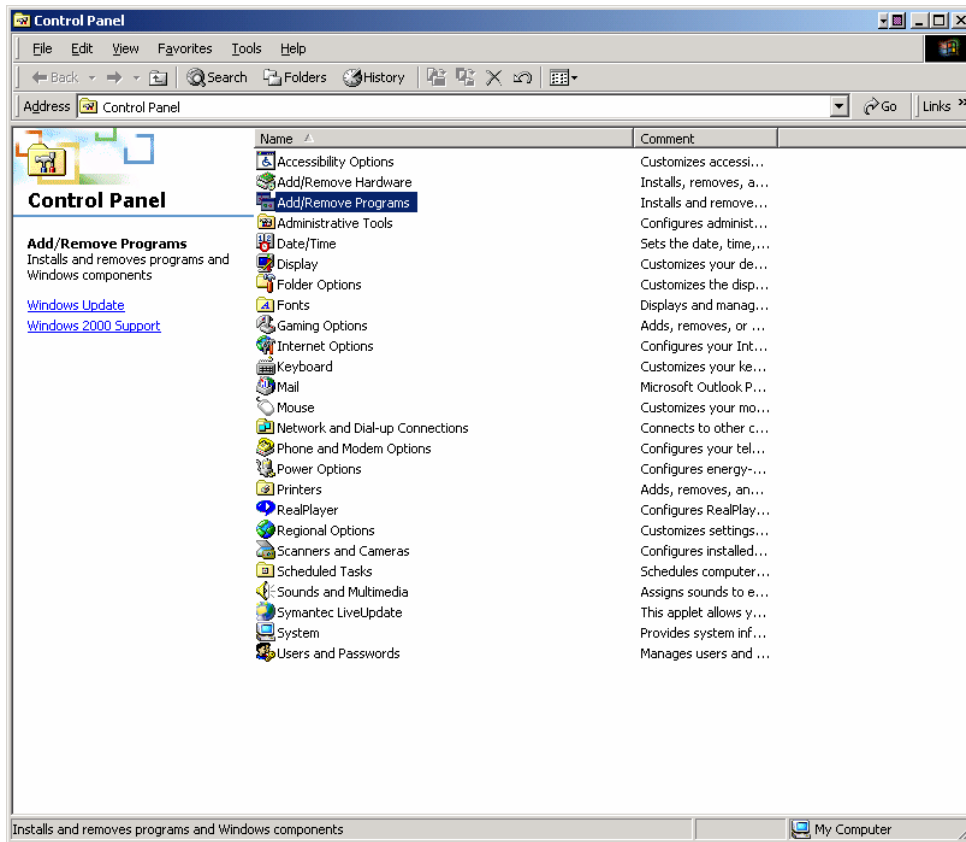


Figure 3-21. Go to the Control Panel (Start/Settings/Control Panel) and click on Add/Remove Programs.

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

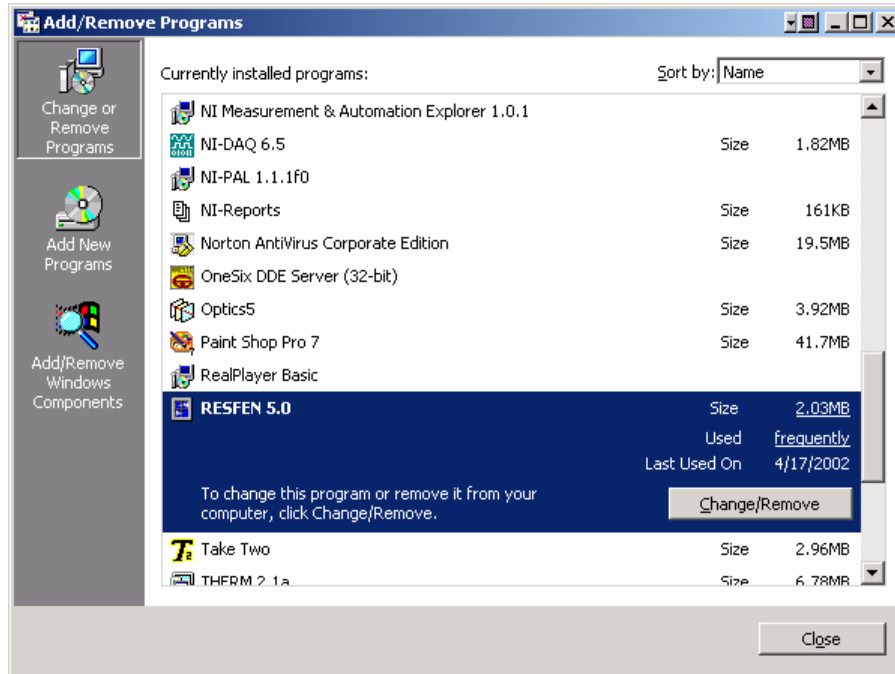


Figure 3-22. Select RESFEN5 from the list of currently installed programs.

3. The InstallShield Wizard appears.

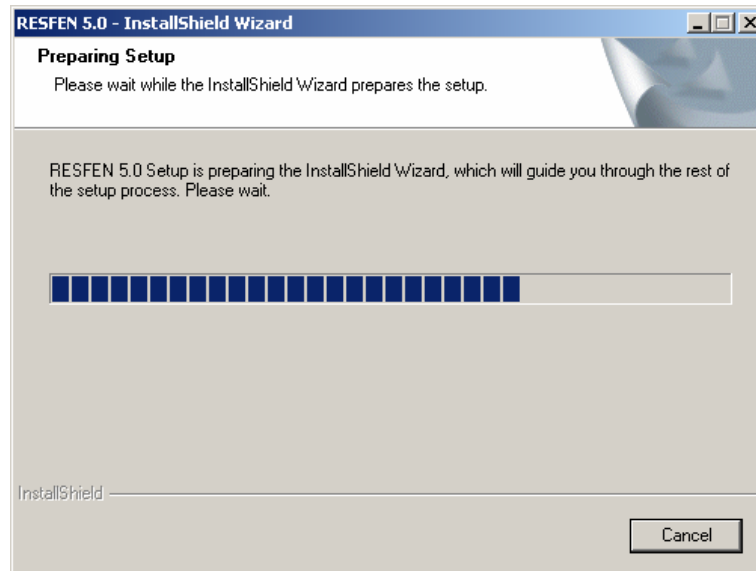


Figure 3-23. The InstallShield Wizard appears.

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

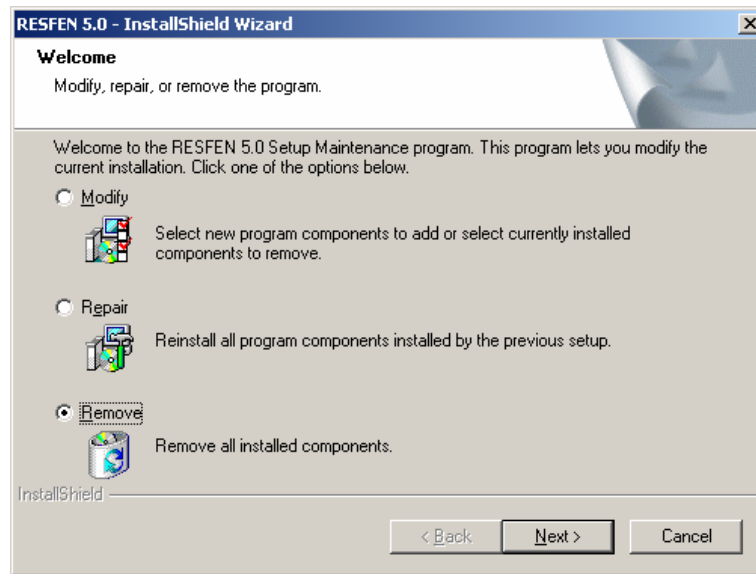


Figure 3-24. The InstallShield Wizard appears.

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.

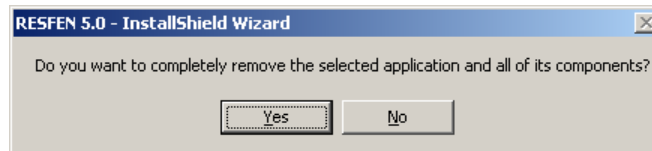


Figure 3-25. Click OK to continue with the uninstall process.

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

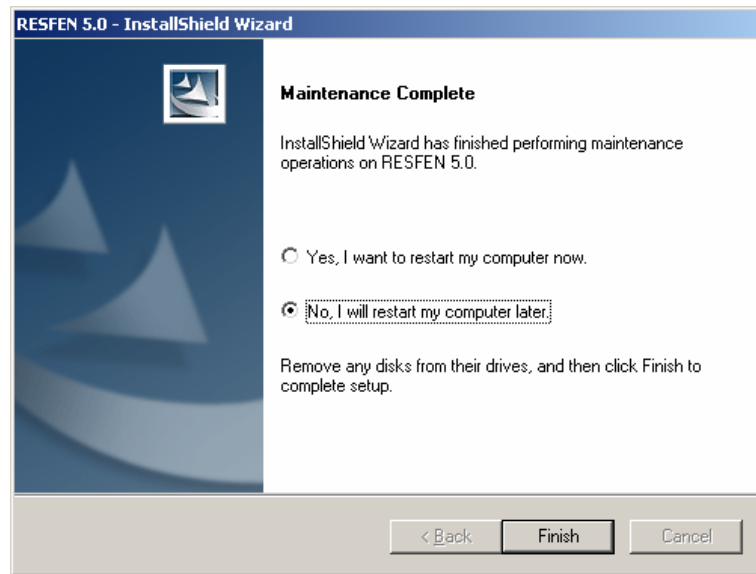


Figure 3-26. You can choose to restart your computer later. You may not always see this screen when uninstalling the program.

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

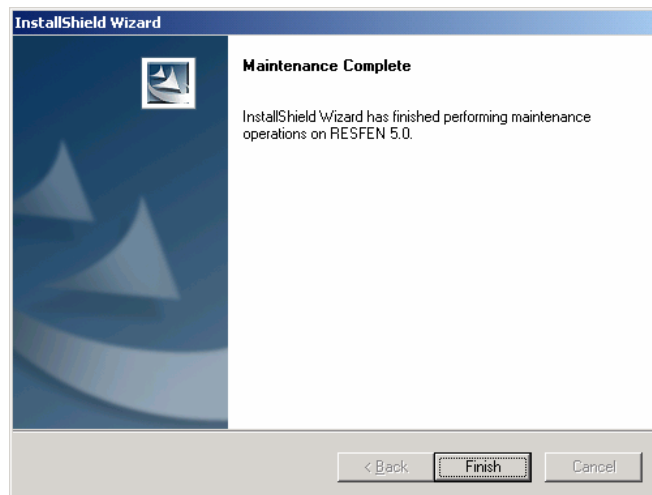


Figure 3-27. Click **Finish** to complete the uninstall process.

### **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](mailto: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

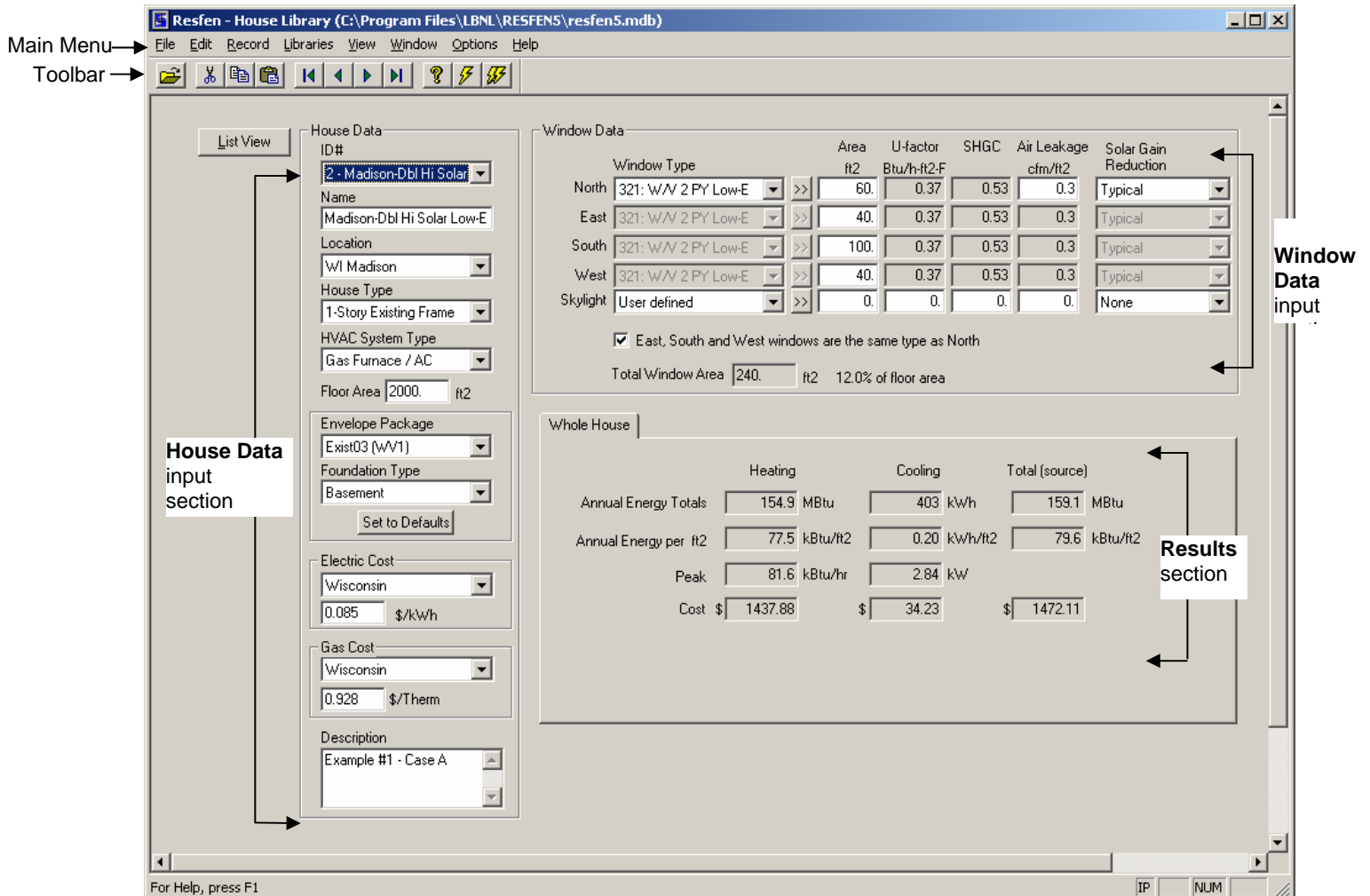


Figure 4-1. Components of the RESFEN House Library Screen

## 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.

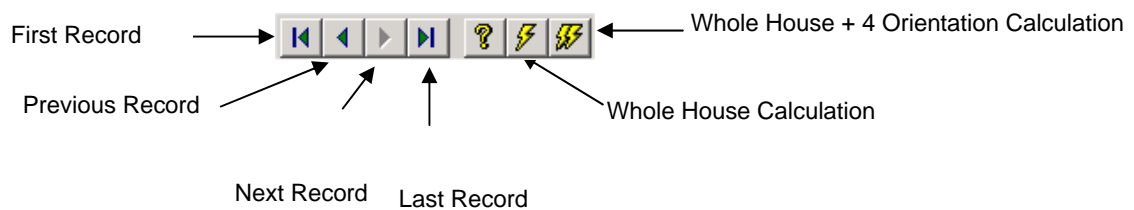


Figure 4-2. Toolbar

## 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.rs" 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.

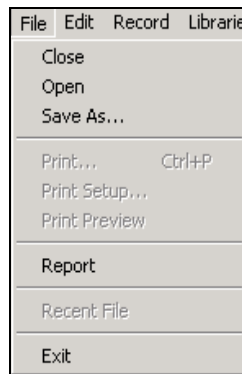


Figure 4-3. The File menu

Close

Close the RESFEN program. Equivalent to Exit.

Open

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

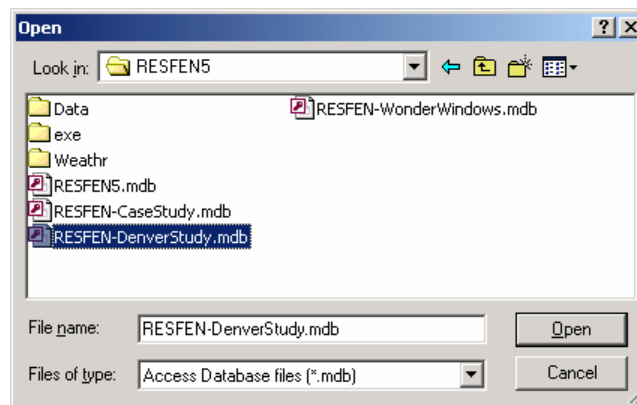


Figure 4-4. The File Open dialog box.

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.

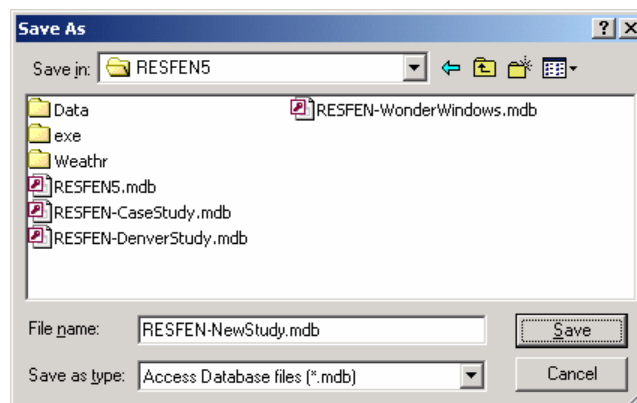


Figure 4-5. Use the Save As feature to save the database under a different name for future use.

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.

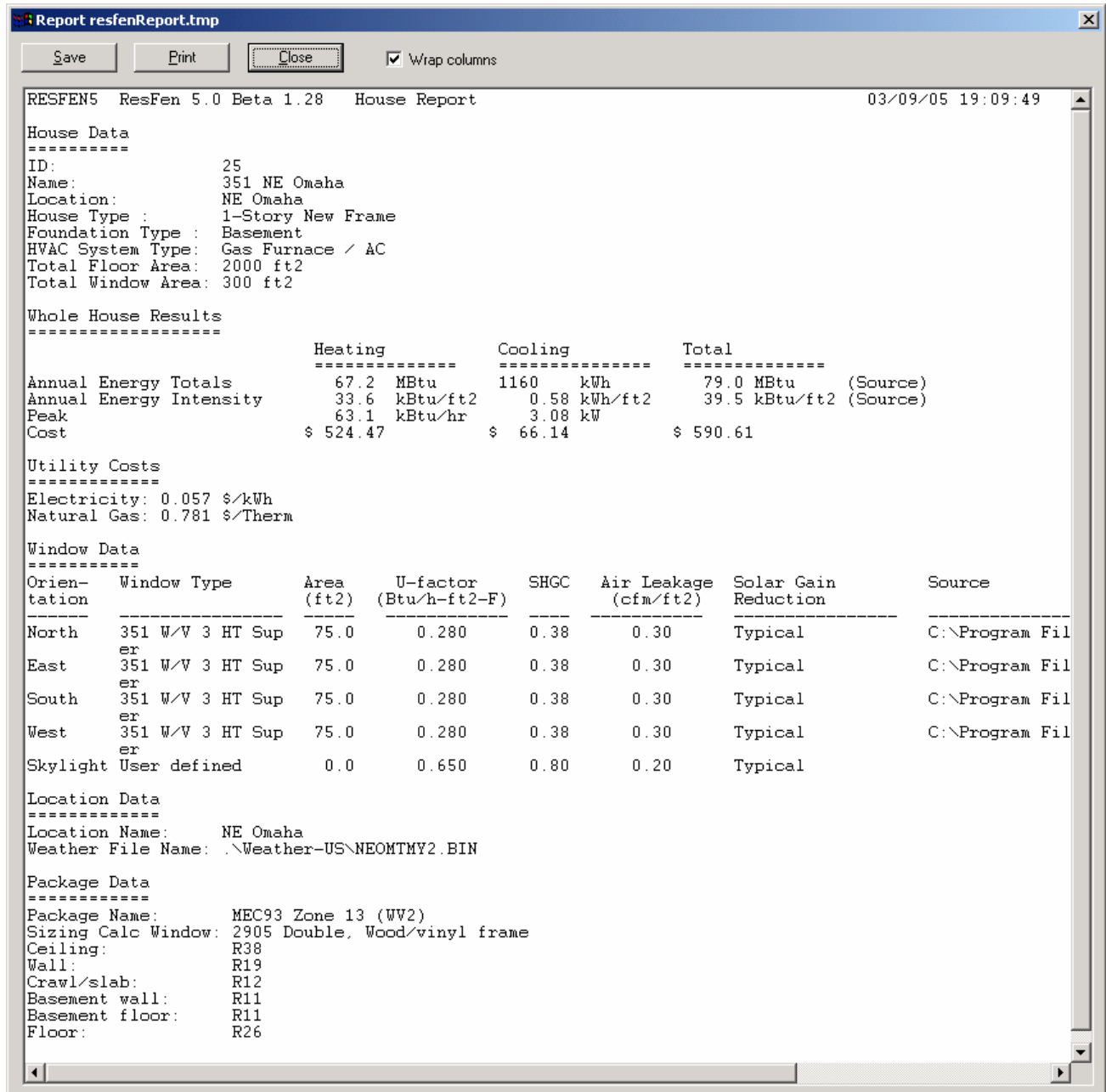


Figure 4-6. The **Report** dialog box.

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.

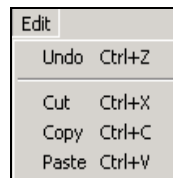


Figure 4-7. The **Record** menu

#### 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.

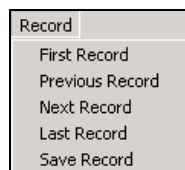


Figure 4-8. The **Record** menu

#### 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.

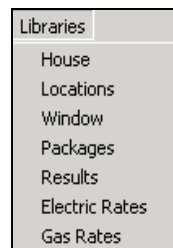


Figure 4-9. The **Libraries** menu

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

- |                  |  |
|------------------|--|
| <i>House</i>     | 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.  |
| <i>Locations</i> | 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. |
| <i>Window</i>    | 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.  |
| <i>Packages</i>  | 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.                          |

<i>Results</i>	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.
<i>Electric Rates</i>	The Electric Rates Library contains a list of electric rates which can be selected from in the Location Library.
<i>Gas Rates</i>	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.

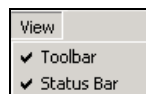


Figure 4-10. The *View* menu

#### 4.4.6. Options

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

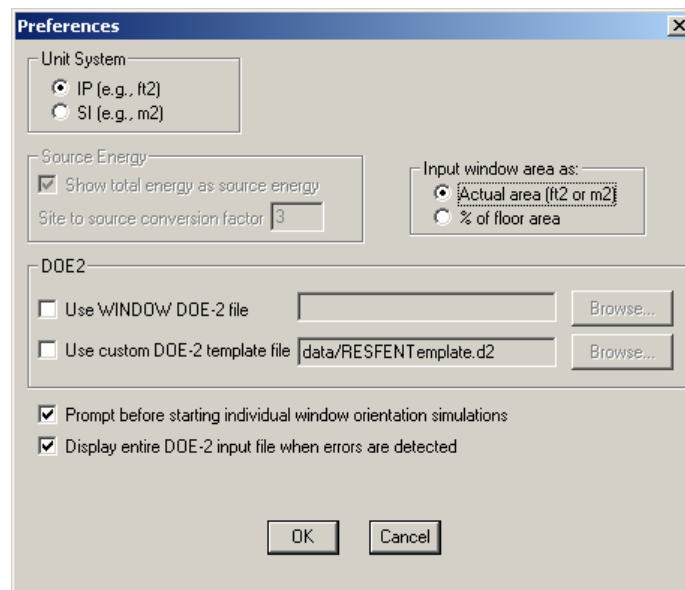


Figure 4-11. The *Options* menu

<i>Unit System</i>	The system of units, from the choice of either: <ul style="list-style-type: none"> <li>▪ IP: Inch pounds</li> <li>▪ SI: International units</li> </ul>
<i>Input Window Area as</i>	<ul style="list-style-type: none"> <li>▪ Area (sf): this option allows input of the window as actual area. <b>Units:</b> square feet (IP); square meters (SI).</li> <li>▪ % of floor area: <i>Currently inactive.</i> (This option allows input of the window area based on the floor area.)</li> </ul>

**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.

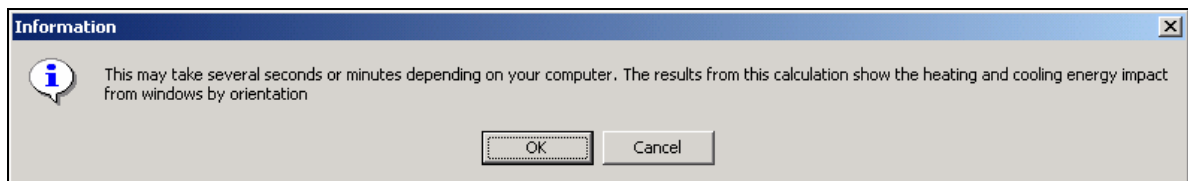


Figure 4-12. Message displayed before the House + 4 Orientations run begins.

*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.

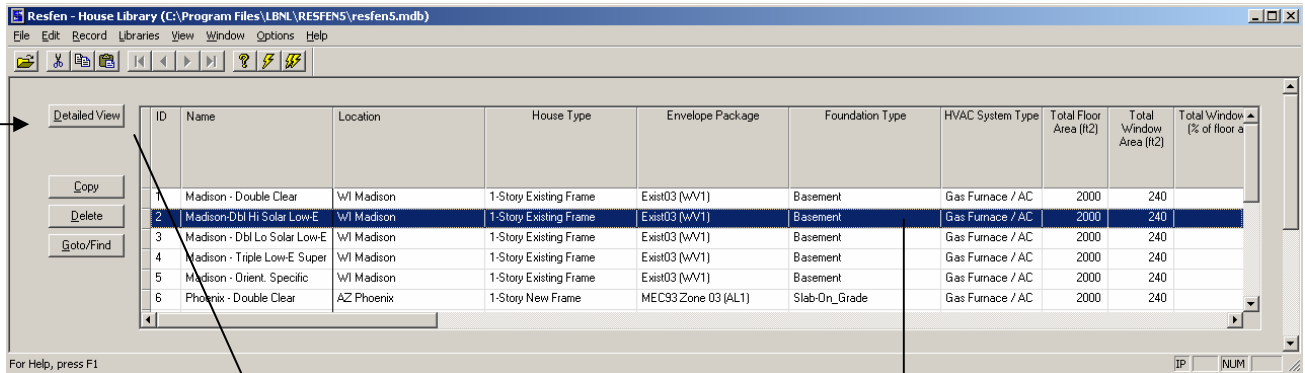
### 4.5. Libraries in General

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.

The List View of the House Library



Click on the List button to see the List View of the library

Click on the Detailed View button to see the Detail View of the selected record, where the values can be edited.

The Detailed View of the House Library for the selected record, ID #2.

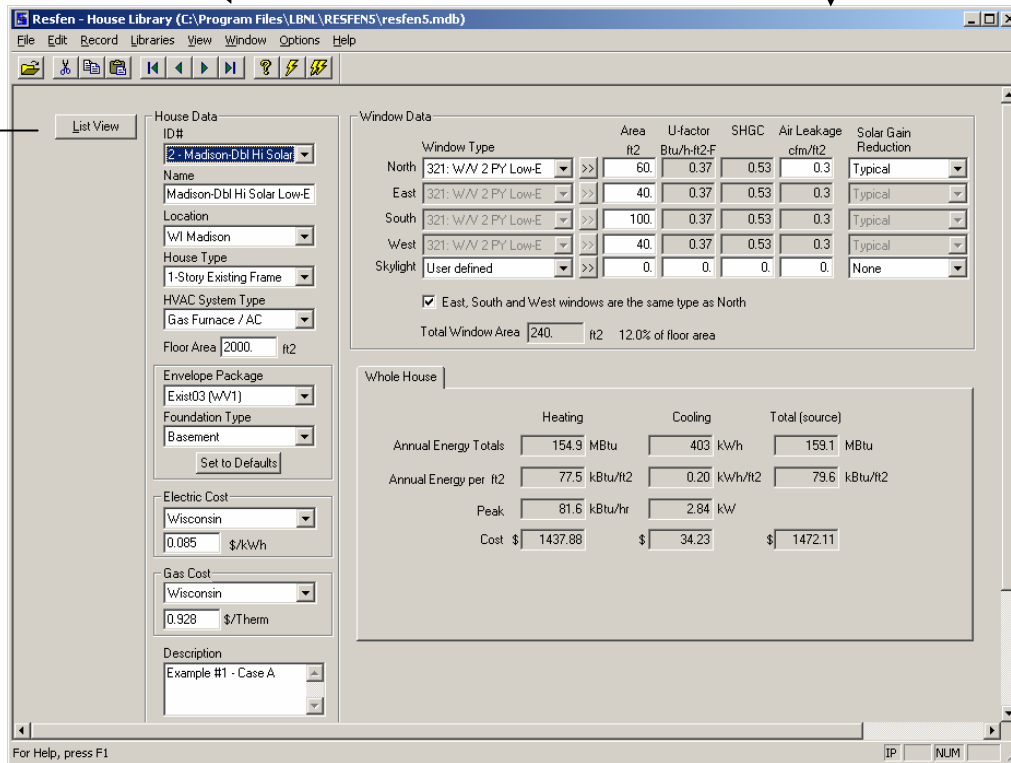


Figure 4-13. Switching between the List View and Detail View in a Library.

### 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.

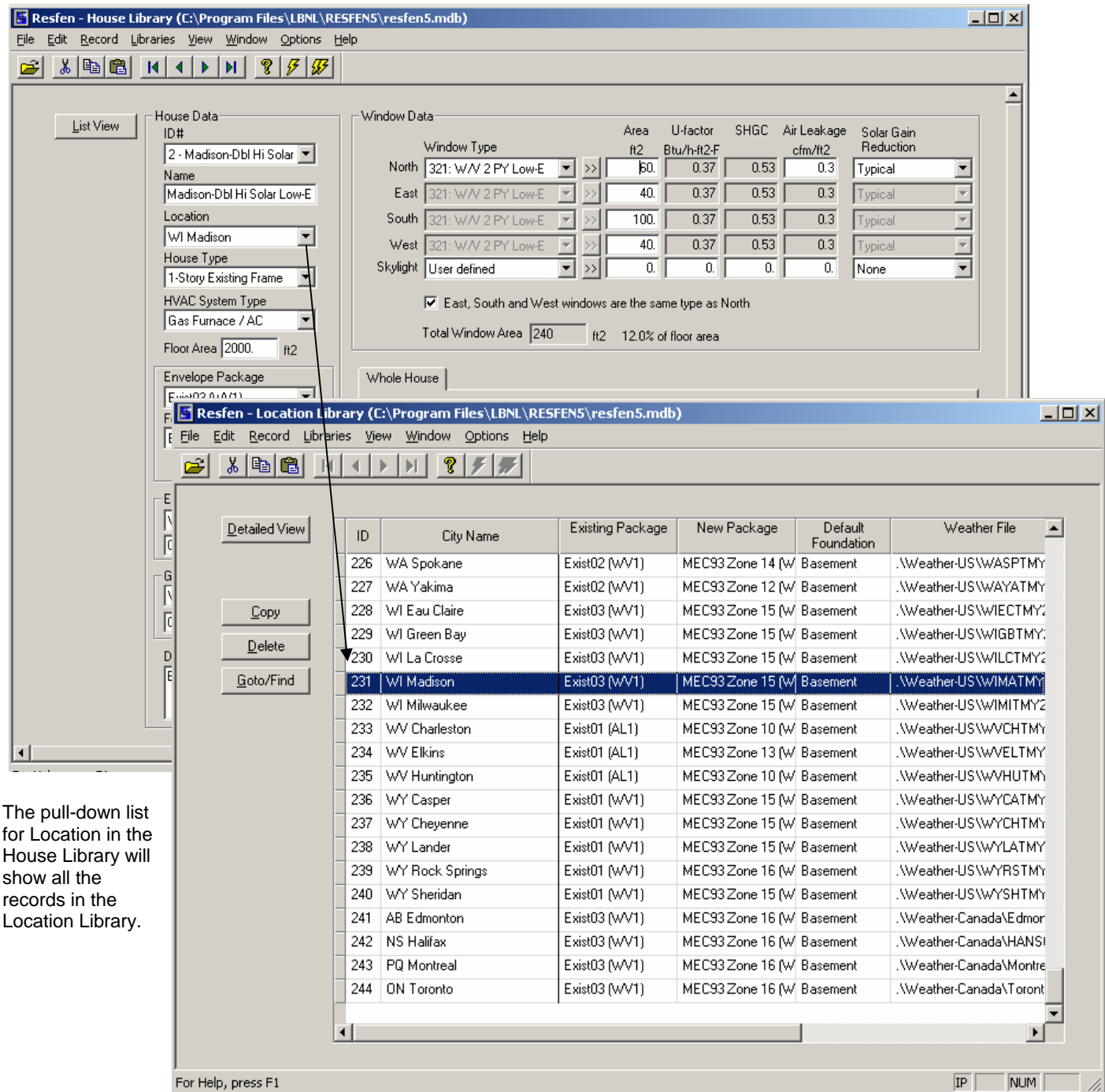






Figure 4-14. Selecting a record from another library.

### 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.

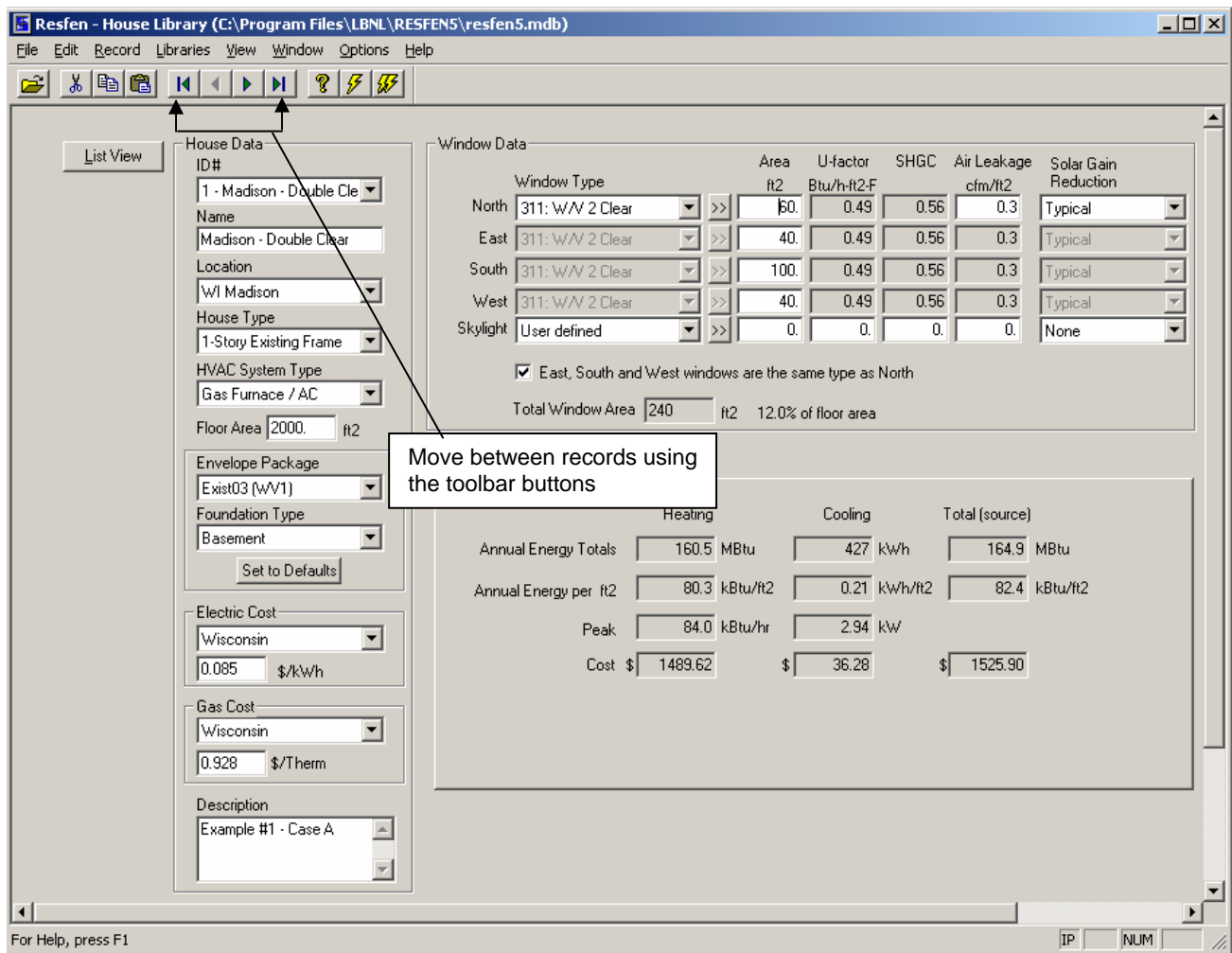


Figure 4-15. Use the Toolbar buttons to move between records.

### 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.

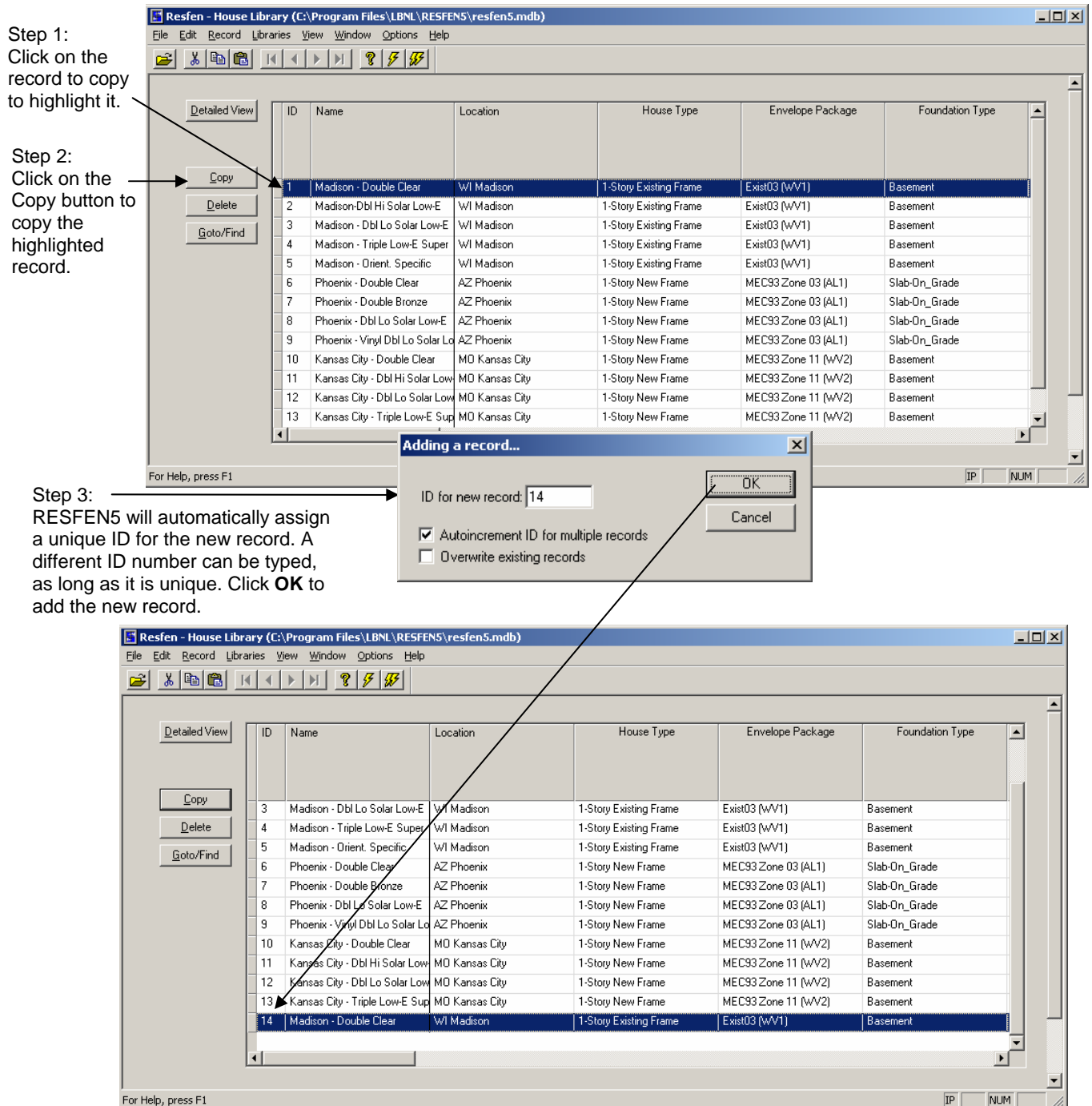
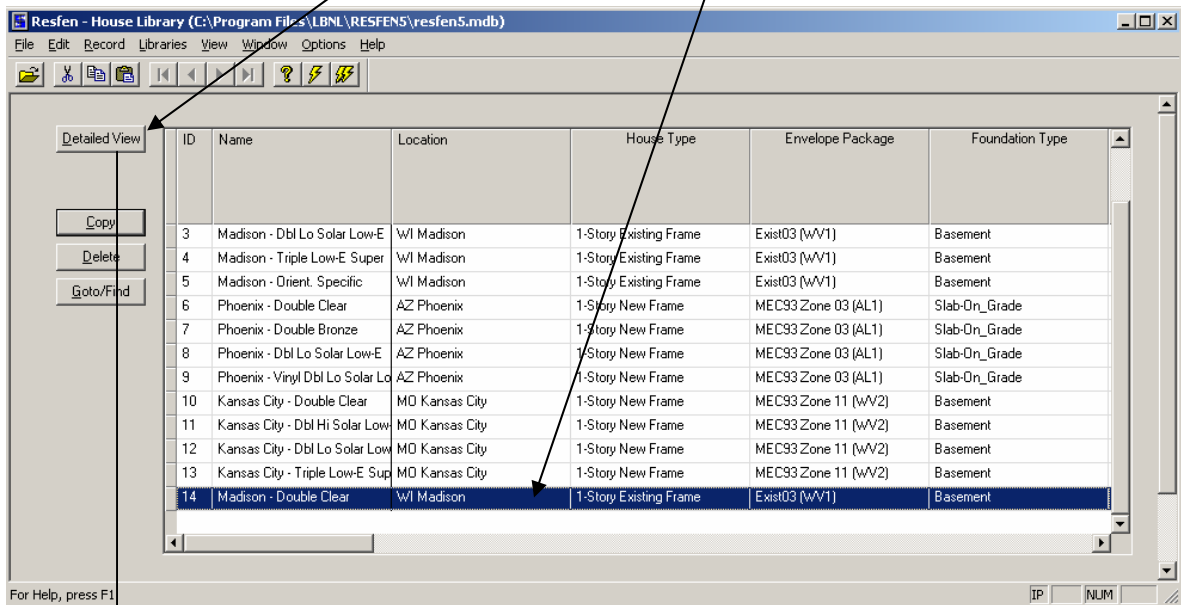


Figure 4-16. Create a new record by copying an existing record in the List View of any library.

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.

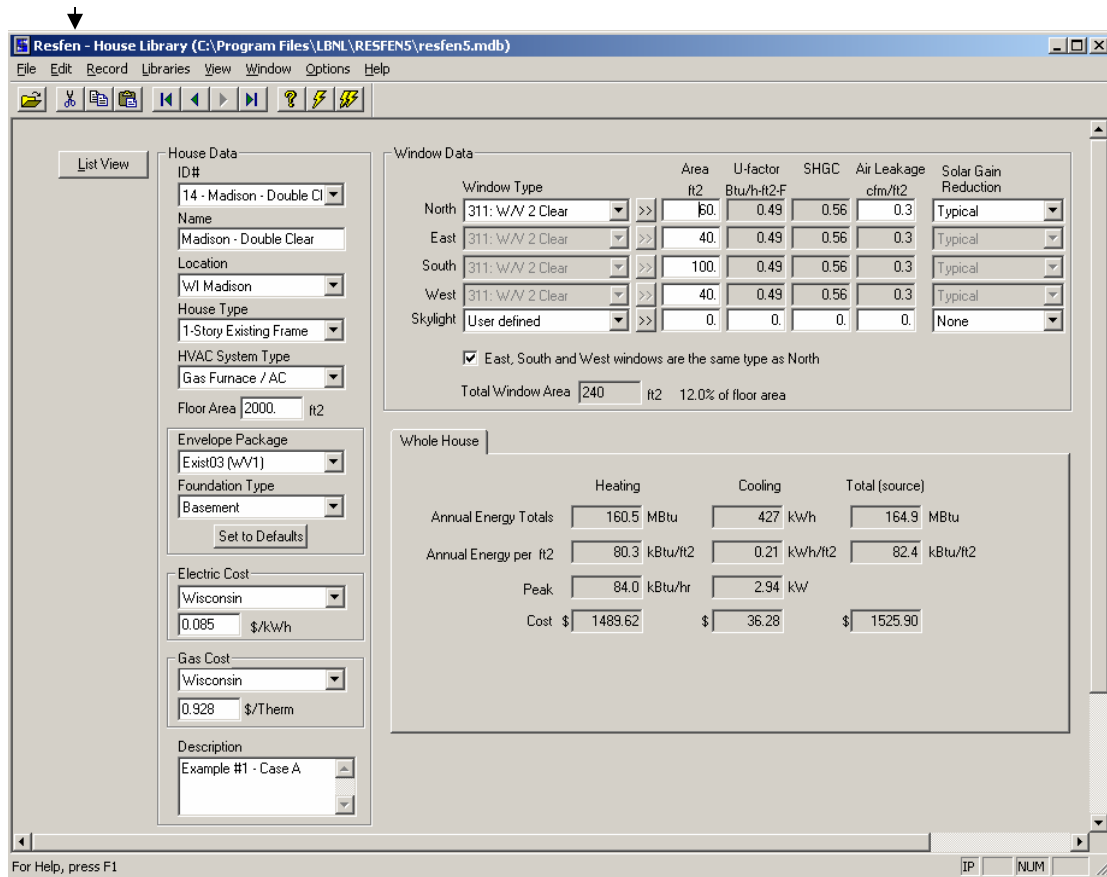


Figure 4-17. Edit the newly created record in the Library Detail View.

## 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.

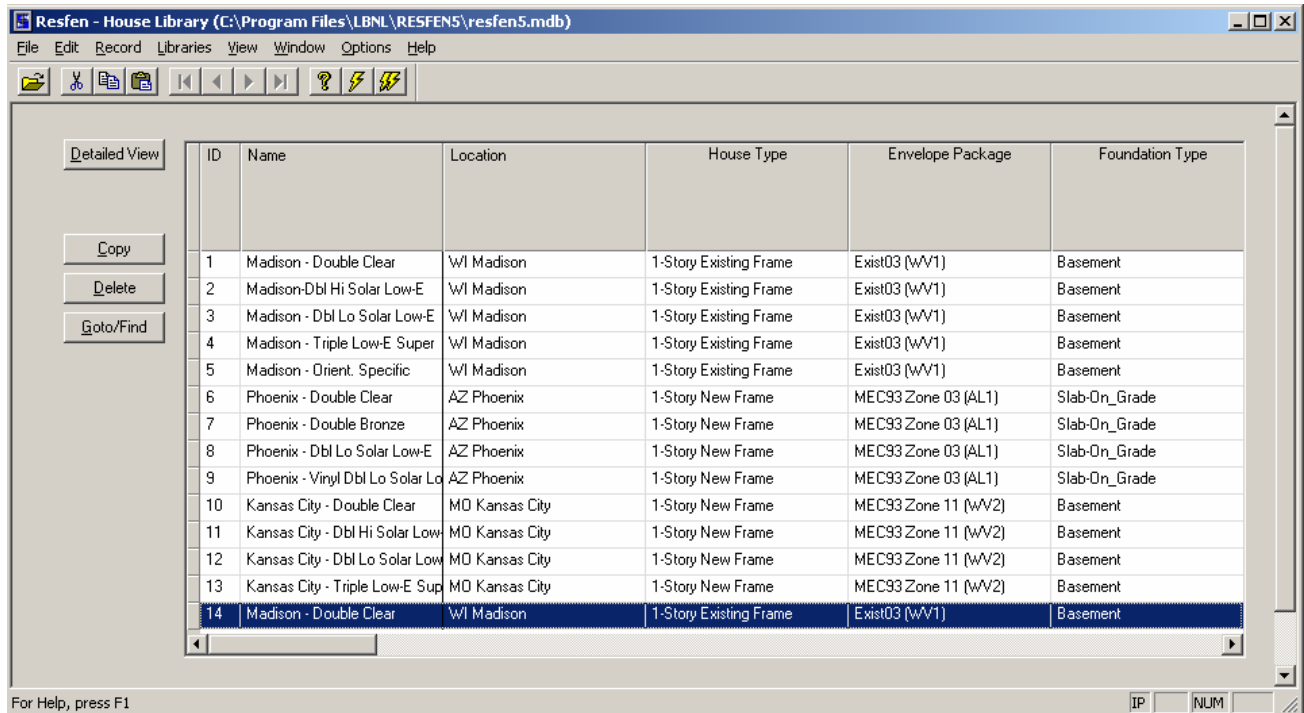


Figure 4-18. The House Library Detail View.

- 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 be 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.

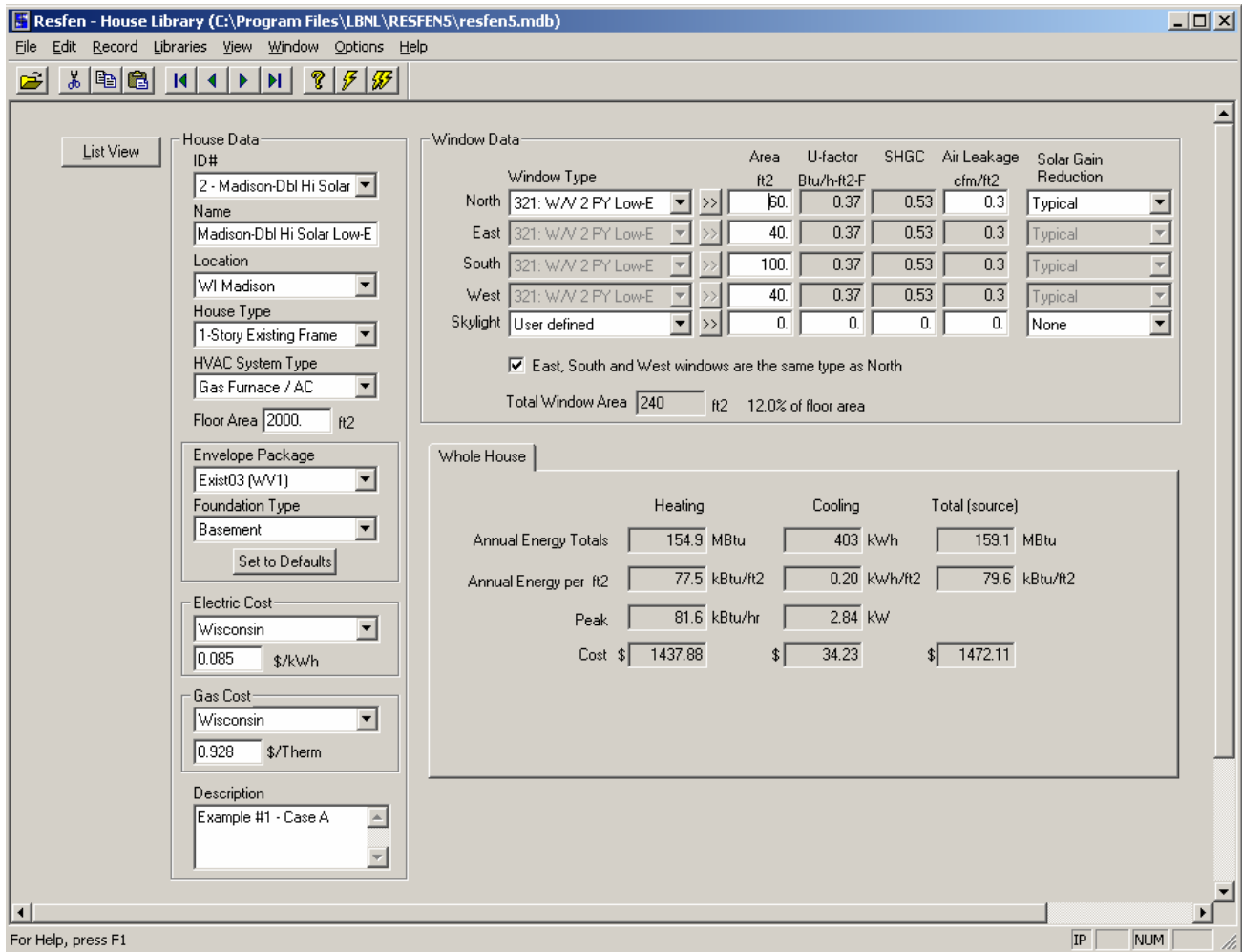


Figure 4-19. The House Library Detail View.

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

	<ul style="list-style-type: none"> <li>▪ 1-Story New Masonry</li> <li>▪ 1-Story Existing Frame</li> <li>▪ 1-Story Existing Masonry</li> <li>▪ 2-Story New Frame</li> <li>▪ 2-Story New Masonry</li> <li>▪ 2-Story Existing Frame</li> <li>▪ 2-Story Existing Masonry</li> </ul> <p><b>Default:</b> 1-Story New Frame</p>
<i>HVAC System Type</i>	<p>A pull-down list for specifying the house's heating and cooling system. The efficiencies are different for <b>New</b> and <b>Existing Construction</b> (see Section 6.2, "RESFEN Modeling Assumptions" for details).</p> <ul style="list-style-type: none"> <li>▪ Gas Furnace / AC</li> <li>▪ Electric Heat Pump</li> </ul>
<i>Floor Area</i>	<p>The total floor area of the house.</p> <p><b>Units:</b> square feet (ft<sup>2</sup>) (IP); square meters (m<sup>2</sup>)(SI)</p> <p><b>Legal values:</b> 1,000 to 4,000 square feet</p>
<i>Envelope Package</i>	<p>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.</p>
<i>Foundation Type</i>	<p>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.</p> <ul style="list-style-type: none"> <li>▪ Basement</li> <li>▪ Slab-on-Grade</li> <li>▪ Crawlspace</li> </ul> <p><b>Default:</b> dependent on the location selected.</p>
<i>Set to Defaults</i>	<p>Clicking on this button will reset the Envelope Package and the Foundation Type to the values defined in the Location Library.</p>
<i>Electric Cost</i>	<p>There are two input boxes for Electric Cost.</p> <p>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.</p>

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.

	Window Type	Area ft <sup>2</sup>	U-factor Btu/h-ft <sup>2</sup> -F	SHGC	Air Leakage cfm/ft <sup>2</sup>	Solar Gain Reduction
North	321: W/W 2 PY Low-E	60.	0.37	0.53	0.3	Typical
East	321: W/W 2 PY Low-E	40.	0.37	0.53	0.3	Typical
South	321: W/W 2 PY Low-E	100.	0.37	0.53	0.3	Typical
West	321: W/W 2 PY Low-E	40.	0.37	0.53	0.3	Typical
Skylight	User defined	0.	0.	0.	0.	None

East, South and West windows are the same type as North

Total Window Area  ft<sup>2</sup> 12.0% of floor area

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:

Orientation	Window Type	Area (ft <sup>2</sup> )	U-factor (Btu/h-ft <sup>2</sup> -F)	SHGC	Air Leakage (cfm/ft <sup>2</sup> )	Solar Gain Reduction
North	User defined	60.	0.45	0.55	0.3	Typical
East	321: W/W 2 PY Low-E	40.	0.37	0.53	0.3	Typical
South	321: W/W 2 PY Low-E	100.	0.37	0.53	0.3	Typical
West	321: W/W 2 PY Low-E	40.	0.37	0.53	0.3	Typical
Skylight	User defined	0.	0.	0.	0.	None

East, South and West windows are the same type as North

Total Window Area: 240 ft<sup>2</sup> 12.0% of floor area

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 particular 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

ID	Name	Ufactor (W/m <sup>2</sup> -C)	SHGC	Area (m <sup>2</sup> )	Width (mm)	Height (mm)
101	AL 1 Clr	6.580	0.756	0.9	609.60	1498.60
102	AL 1 Bronze	6.578	0.647	0.9	609.60	1498.60
111	AL 2 Clear	4.325	0.675	0.9	609.60	1498.60
112	AL 2 Bronze	4.324	0.562	0.9	609.60	1498.60
113	AL 2 SS Tint	4.324	0.469	0.9	609.60	1498.60
121	AL 2 PY Low-E	3.482	0.635	0.9	609.60	1498.60
131	AL 2 SP Low-E	3.381	0.528	0.9	609.60	1498.60
141	AL 2 SS Low-E	3.321	0.367	0.9	609.60	1498.60
201	ATB 1 Clr	5.703	0.696	0.9	609.60	1498.60

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.

To select a record from the Window Library, click on either the pull-down list or the double arrow

ID	Name	Ufactor Btu/h-ft2-F	SHGC	Area ft2	Width inches	Height inches
301	301 W/V 1 Clr	0.147	0.635	104.3	0.94	2.32
302	302 W/V 1 Bronze	0.147	0.540	104.3	0.94	2.32
311	311 W/V 2 Clear	0.087	0.564	104.3	0.94	2.32
312	312 W/V 2 Bronze	0.087	0.466	104.3	0.94	2.32
313	313 W/V 2 SS Tint	0.087	0.385	104.3	0.94	2.32
321	321 W/V 2 PY Low-E	0.064	0.529	104.3	0.94	2.32
331	331 W/V 2 SP Low-E	0.062	0.436	104.3	0.94	2.32
341	341 W/V 2 SS Low-E	0.060	0.297	104.3	0.94	2.32
351	351 W/V 3 HT Super	0.050	0.382	104.3	0.94	2.32
352	352 W/V 3 SS Super	0.050	0.254	104.3	0.94	2.32
411	411 INS 2 Clear	0.078	0.596	104.3	0.94	2.32

Highlight the desired record from either selection option (both selection options show the same records in the Window Library, but one shows more detail)

The selected entry is displayed in the **Window Type** input field, and the values from the library are automatically used in the **U-factor** and **SHGC** fields. Remember to change the **Cfm** field if necessary because it is not determined by the WINDOW 5 library.

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

<i>Window</i>	<p>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<sup>2</sup> (36/1540).</p> <p><b>Units:</b> square feet (ft<sup>2</sup>)(IP), square meters (m<sup>2</sup>)(SI), or % of floor area (% Flr Area), depending on the settings in the <b>Options</b> menu.</p> <p><b>Legal values:</b> 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.</p>
<i>U-Factor</i>	<p>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.</p> <p><b>Units:</b> Btu/hr-ft<sup>2</sup>-°F (IP), W/m<sup>2</sup>-°C (SI).</p> <p><b>Legal values:</b> between 0.05 and 1.40 Btu/hr-ft<sup>2</sup>-°F at standard NFRC winter conditions.</p>
<i>SHGC</i>	<p>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.</p> <p><b>Legal values:</b> between 0.05 and 0.90.</p>
<i>CFM/Area</i>	<p>The infiltration of the total fenestration product (from ASTM E283 tests or equivalent), which includes the frame as well as the glazing.</p> <p><b>Units:</b> CFM/ft<sup>2</sup>.</p> <p><b>Legal values:</b> between 0.05 and 2.0 CFM/ft<sup>2</sup>.</p>
<i>Solar Gain Reduction</i>	<p>The type of solar gain reduction for the building, from the following list:</p> <ul style="list-style-type: none"> <li>▪ <b>Typical:</b> 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.</li> <li>▪ <b>None:</b> No interior shading, exterior overhangs, or obstructions.</li> <li>▪ <b>Interior:</b> Interior drapes. See Section 6.2, "RESFEN Modeling Assumptions" for specific details.</li> <li>▪ <b>Overhang:</b> two-foot exterior overhang at roof line.</li> <li>▪ <b>Obstruction:</b> Used to model large obstructions, such as neighboring houses or other buildings. See Section 6.2, "RESFEN Modeling Assumptions" for details.</li> <li>▪ <b>Int+Ovh:</b> A combination of the Interior and Overhang options.</li> <li>▪ <b>Ovh + Obs:</b> A combination of the Overhang and Obstruction options.</li> <li>▪ <b>Int + Obs:</b> A combination of the Interior and Obstruction options.</li> <li>▪ <b>All:</b> A combination of the Interior, Overhang, and Obstruction options.</li> </ul>
<i>East, South and West windows are The Same type as North</i>	<p>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.</p>
<i>Total Area Window</i>	<p><i>Feedback only.</i> This box displays the total window area of all the building orientations, including skylights; this total is calculated automatically by the program.</p>

**Units:** square feet (ft<sup>2</sup>) (IP), square meters (m<sup>2</sup>) (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.

The screenshot shows the Resfen software interface. The title bar reads "Resfen - House Library (C:\Program Files\LBNL\RESFEN5\resfen5.mdb)". The menu bar includes File, Edit, Record, Libraries, View, Window, Options, and Help. The toolbar contains icons for file operations and navigation.

The interface is divided into several sections:

- House Data:** Includes fields for ID# (2 - Madison-Dbl Hi Solar), Name (Madison-Dbl Hi Solar Low-E), Location (Wl Madison), House Type (1-Story Existing Frame), HVAC System Type (Gas Furnace / AC), Floor Area (2000 ft<sup>2</sup>), Envelope Package (Exist03 (wV1)), Foundation Type (Basement), Electric Cost (Wisconsin, 0.085 \$/kWh), Gas Cost (Wisconsin, 0.928 \$/Therm), and Description (Example #1 - Case A).
- Window Data:** A table showing window types and their properties.
 



Window Type	Area (ft <sup>2</sup> )	U-factor (Btu/h-ft <sup>2</sup> -F)	SHGC	Air Leakage (cfm/ft <sup>2</sup> )	Solar Gain Reduction
North: 331: W/W 2 SP Low-E	60	0.35	0.44	0.3	Typical
East: 331: W/W 2 SP Low-E	40	0.35	0.44	0.3	Typical
South: 331: W/W 2 SP Low-E	100	0.35	0.44	0.3	Typical
West: 331: W/W 2 SP Low-E	40	0.35	0.44	0.3	Typical
Skylight: User defined	0	0	0	0	None

 Total Window Area: 240 ft<sup>2</sup> (12.0% of floor area).
- Results Section:** Four tabs are visible: "Whole House", "Window Annual Energy", "Window Energy Cost", and "Window Peak Energy". The "Whole House" tab is active, showing the following data:
 

	Heating	Cooling	Total (source)
Annual Energy Totals	164.8 MBtu	311 kWh	168.0 MBtu
Annual Energy per ft <sup>2</sup>	82.4 kBtu/ft <sup>2</sup>	0.16 kWh/ft <sup>2</sup>	84.0 kBtu/ft <sup>2</sup>
Peak	81.1 kBtu/hr	2.67 kW	
Cost \$	1529.21	26.48	1555.69

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<sup>2</sup>
- Total Cost

Whole House				Window Annual Energy	Window Energy Cost	Window Peak Energy
	Heating	Cooling	Total			
Annual Energy Totals	33.11 MBtu	689 kWh	35.5 MBtu			
Annual Energy per ft <sup>2</sup>	16.56 kBtu/ft <sup>2</sup>	0.34 kWh/ft <sup>2</sup>	17.72 kBtu/ft <sup>2</sup>			
Peak	44.07 kBtu/hr	1.82 kW				
Cost	\$ 165.57	\$ 68.90	\$ 234.47			

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 ft<sup>2</sup>

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

	North	East	South	West	Skylight
Cooling ft <sup>2</sup> (kWh/ft <sup>2</sup> )	0.00	0.00	0.00	0.00	0.00
Heating ft <sup>2</sup> (kBtu/ft <sup>2</sup> )	0.00	0.00	0.00	0.00	0.00
Cooling (kWh)	00	00	00	00	00
Heating (MBtu)	0.00	0.00	0.00	0.00	0.00

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

<i>Cooling/ft<sup>2</sup></i>	Cooling energy per unit window area. <b>Units:</b> kWh/ft <sup>2</sup> -year (IP), kWh/m <sup>2</sup> -year (SI).
<i>Heating/ft<sup>2</sup></i>	Heating energy per unit window area. <b>Units:</b> kBtu/ft <sup>2</sup> -year (IP), GJ/m <sup>2</sup> -year (SI) for <b>Gas Furnace</b> ; kWh/ft <sup>2</sup> -year (IP), kWh/m <sup>2</sup> -year (SI), for <b>HeatPump</b> .
<i>Cooling Energy</i>	Cooling energy attributed to windows. <b>Units:</b> kWh/year (IP and SI)
<i>Heating Energy</i>	Heating energy attributed to windows. <b>Units:</b> MBtu/year (IP), GJ/year (SI) for <b>Gas Furnace</b> , or kWh/year (IP and SI) for <b>HeatPump</b> .

### 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**.

<i>Cooling (\$/area)</i>	Cooling energy per unit window area. <b>Units:</b> \$/ft <sup>2</sup> -year (IP), . \$/m <sup>2</sup> (SI)
<i>Heat (\$/area)</i>	Heating energy per unit window area. <b>Units:</b> \$/ft <sup>2</sup> -year (IP), . \$/m <sup>2</sup> (SI)
<i>Cooling (\$)</i>	Cooling energy attributed to windows. <b>Units:</b> \$/year.
<i>Heating (\$)</i>	Heating energy attributed to windows. <b>Units:</b> \$/year.
<i>Total Energy (\$)</i>	Sum of the Cooling and Heating Energy Cost. <b>Units:</b> \$/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<sup>2</sup> (IP).

*Heat Peak/  
Unit Area*

Heating peak per unit window area.  
**Units:** Btu/ ft<sup>2</sup> (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.

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.

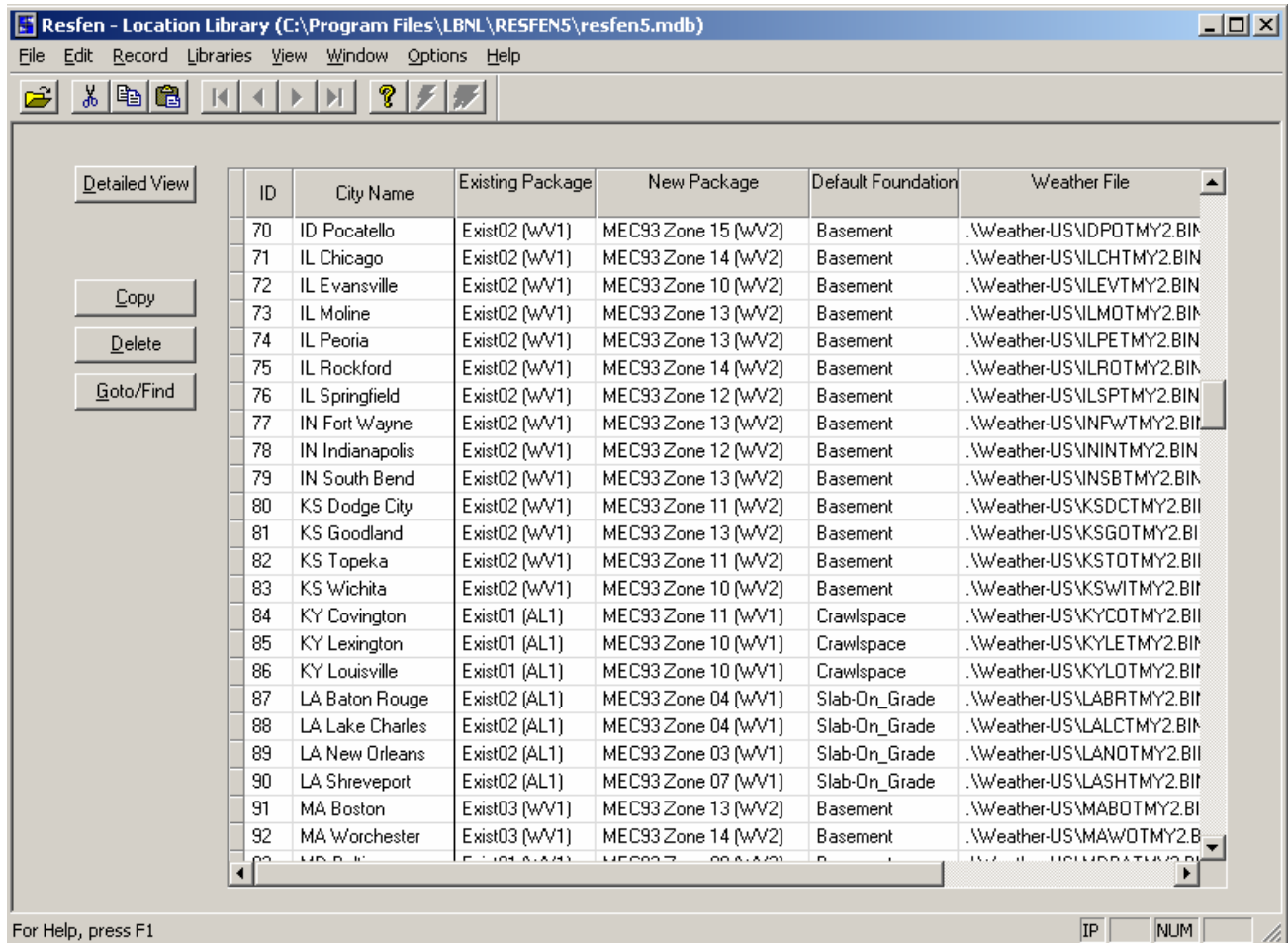


Figure 4-30. The Location Library List View.

- 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 be 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.

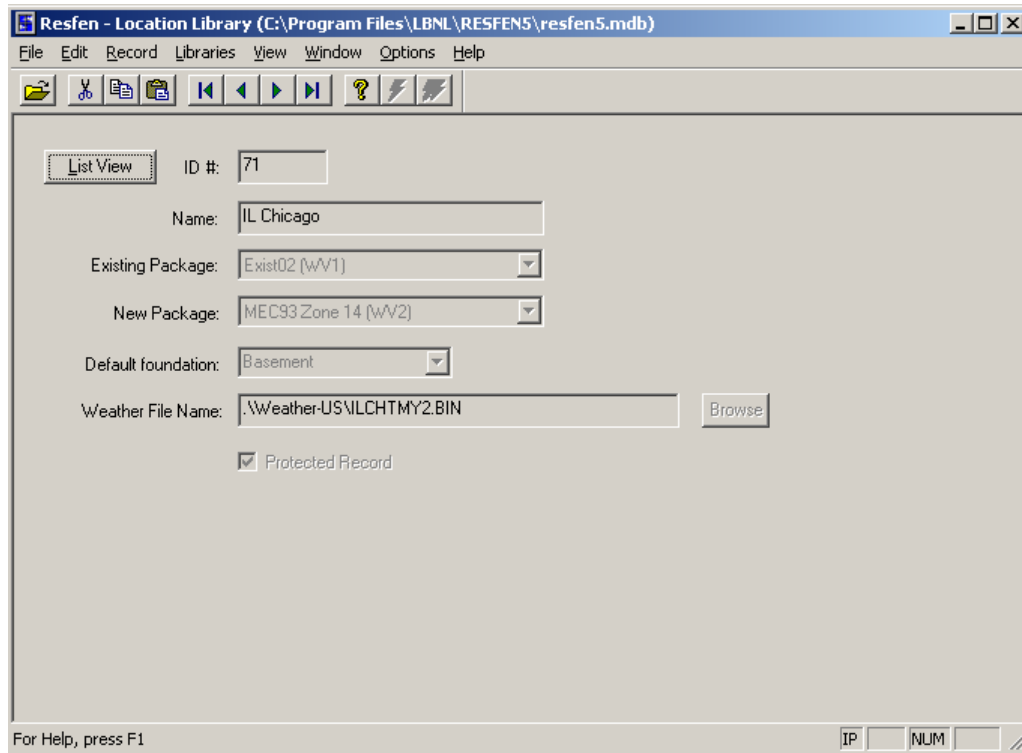


Figure 4-31. The Location Library Detail View.

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.

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<i>New Package</i>	The building envelope insulation package to be used for this location, from the <b>Package Library</b> . This insulation package will be used if “New” is selected in the <b>House Type</b> 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.
<i>Default foundation</i>	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: <ul style="list-style-type: none"><li>▪ Crawlspace</li><li>▪ Slab-On-Grade</li><li>▪ Basement</li></ul>
<i>Weather File Name</i>	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](http://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 Btu/h-ft2-F	SHGC	Area ft2	Width inches	Height inches	Source
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 be 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

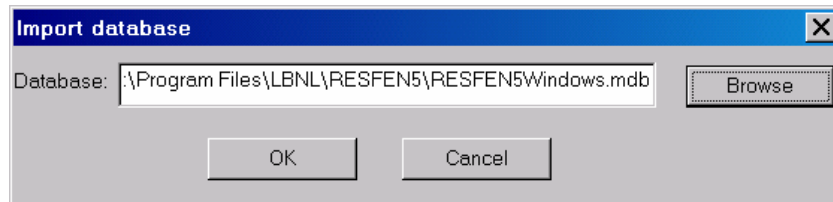


Figure 4-33. Importing a WINDOW5 window database.

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.

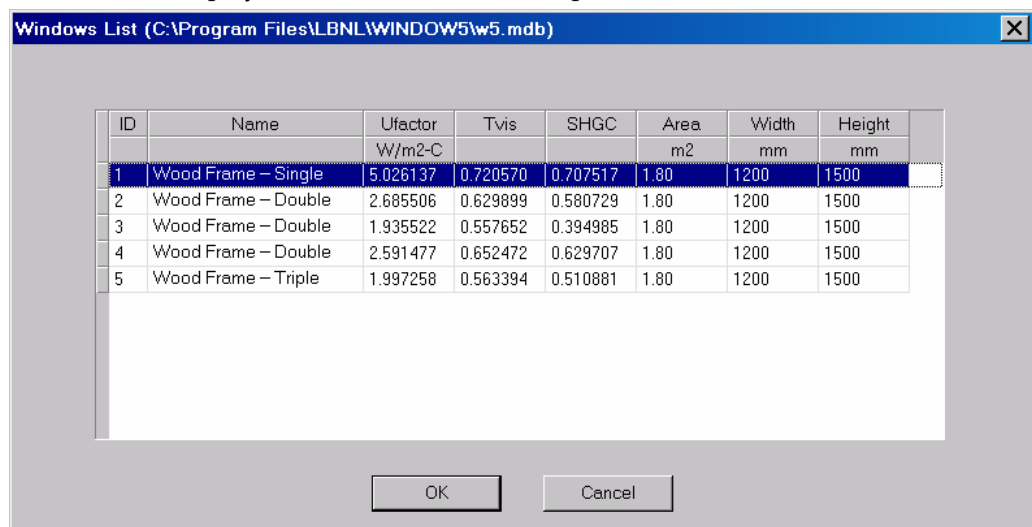
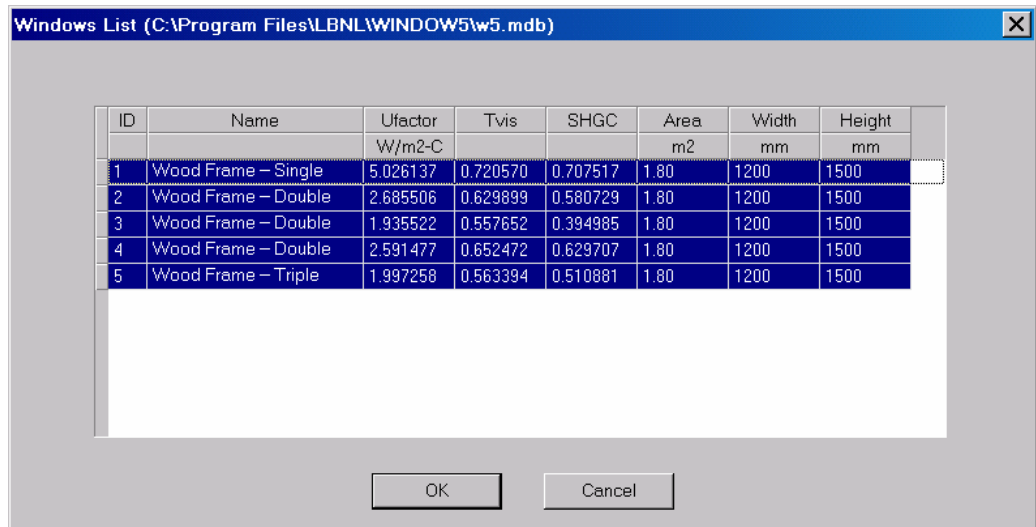


Figure 4-34. Select records from the WINDOW5 window database to be imported into the RESFEN Window Library.

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.



Windows List (C:\Program Files\LBNL\WINDOW5\w5.mdb)

ID	Name	Ufactor W/m2-C	Tvis	SHGC	Area m2	Width mm	Height 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

OK Cancel

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:

<i>ID</i>	The ID of the record, set automatically by the program or by the user when copying an existing record. This ID must be unique.
<i>Name</i>	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.
<i>Type</i>	Unused
<i>Source</i>	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.
<i>Height</i>	For records copied from an existing record: Set automatically to User The height of the window, either from the WINDOW5 database or input by the user. <b>Units:</b> inches (IP)
<i>Width</i>	The width of the window, either from the WINDOW5 database or input by the user. <b>Units:</b> inches (IP)
<i>Area</i>	The area of the window, either from the WINDOW5 database or input by the user. <b>Units:</b> square feet (IP)
<i>Ufactor</i>	The U-factor of the window, either from the WINDOW5 database or input by the user

.	<b>Units:</b> Btu/ft <sup>2</sup> -h-°F (IP)
<i>SHGC</i>	The Solar Heat Gain Coefficient, either from the WINDOW5 database or input by the user.
<i>Protected</i>	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 be 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.

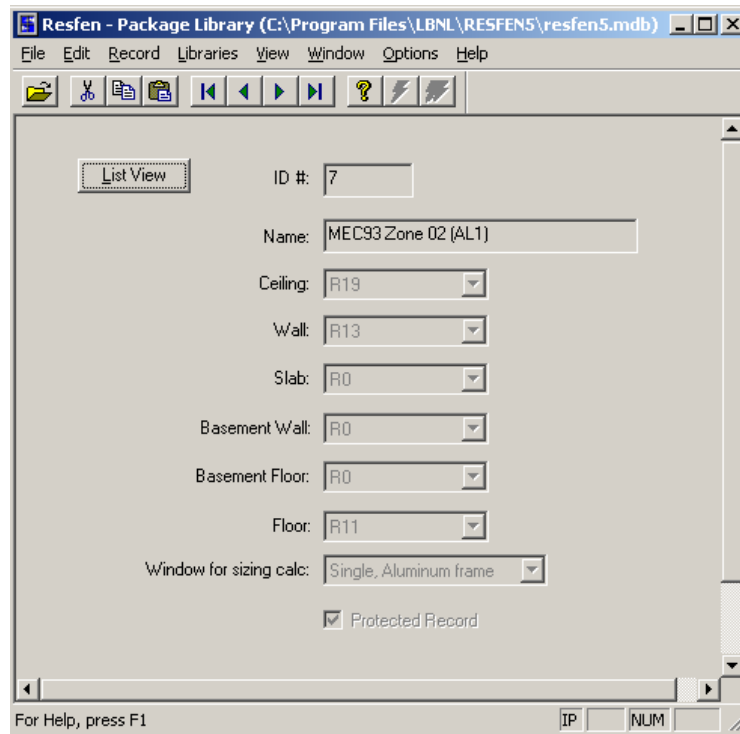


Figure 4-38. The Package Library Detail View.

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

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

<i>Ceiling</i>	The level of ceiling insulation for this package, from the predefined list of the following values: <ul style="list-style-type: none"> <li>▪ R11</li> <li>▪ R19</li> <li>▪ R22</li> <li>▪ R26</li> <li>▪ R30</li> <li>▪ R38</li> <li>▪ R49</li> </ul>
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<i>Wall</i>	<p>The level of wall insulation for this package, from the predefined list of the following values:</p> <ul style="list-style-type: none"><li>▪ R7</li><li>▪ R11</li><li>▪ R13</li><li>▪ R14</li><li>▪ R19</li><li>▪ R21</li><li>▪ R28</li></ul>
<i>Crawl Slab</i>	<p>The level of crawlspace insulation for this package, from the predefined list of the following values:</p> <ul style="list-style-type: none"><li>▪ R0</li><li>▪ R2</li><li>▪ R3</li><li>▪ R4</li><li>▪ R5</li><li>▪ R6</li><li>▪ R12</li></ul>
<i>Basement Wall</i>	<p>The level of basement wall insulation for this package, from the predefined list of the following values:</p> <ul style="list-style-type: none"><li>▪ R0</li><li>▪ R5</li><li>▪ R6</li><li>▪ R7</li><li>▪ R8</li><li>▪ R9</li><li>▪ R11</li><li>▪ R14</li><li>▪ R15</li><li>▪ R19</li><li>▪ R28</li><li>▪ R30</li></ul>
<i>Basement Floor</i>	<p>The level of basement floor insulation for this package, from the predefined list of the following values:</p> <ul style="list-style-type: none"><li>▪ R0</li><li>▪ R5</li><li>▪ R6</li><li>▪ R7</li></ul>

- 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.

The screenshot shows a window titled "Resfen - Result Library (C:\Program Files\LBNL\RESFEN5\resfen5.mdb)". The window contains a "List Name" dropdown menu set to "All". On the left side, there are three buttons: "Detailed View", "Modify List", and "Export". The main area is a table with the following columns: ID, Name, Location, Whole House Cooling, Whole House Heating, Whole House Energy (Source), Whole House Cooling Cost (\$), Whole House Heating Cost (\$), and Whole House Total Cost. The table contains 13 rows of data.

ID	Name	Location	Whole House Cooling	Whole House Heating	Whole House Energy (Source)	Whole House Cooling Cost (\$)	Whole House Heating Cost (\$)	Whole House Total Cost
1	Madison - Double Clear	WI Madison	427 kWh	160.5 MBtu	164.9 MBtu	36.28	1489.61	1525.89
2	Madison-Dbl Hi Solar Low-E	WI Madison	311 kWh	164.8 MBtu	168.0 MBtu	26.48	1529.21	1555.69
3	Madison - Dbl Lo Solar Low-E	WI Madison	209 kWh	162.5 MBtu	164.7 MBtu	17.76	1508.35	1526.11
4	Madison - Triple Low-E Super	WI Madison	287 kWh	148.4 MBtu	151.3 MBtu	24.40	1376.79	1401.19
5	Madison - Orient. Specific	WI Madison	337 kWh	153.5 MBtu	156.9 MBtu	28.65	1424.35	1453.00
6	Phoenix - Double Clear	AZ Phoenix	7369 kWh	5.5 MBtu	80.9 MBtu	545.29	62.56	607.85
7	Phoenix - Double Bronze	AZ Phoenix	6781 kWh	6.1 MBtu	75.6 MBtu	501.81	69.75	571.56
8	Phoenix - Dbl Lo Solar Low-E	AZ Phoenix	5464 kWh	6.3 MBtu	62.2 MBtu	404.33	71.78	476.11
9	Phoenix - Vinyl Dbl Lo Solar Low-E	AZ Phoenix	4528 kWh	6.6 MBtu	53.0 MBtu	335.05	75.29	410.34
10	Kansas City - Double Clear	MO Kansas City	1582 kWh	54.4 MBtu	70.6 MBtu	96.49	516.67	613.16
11	Kansas City - Dbl Hi Solar Low-E	MO Kansas City	1540 kWh	51.0 MBtu	66.8 MBtu	93.94	484.18	578.12
12	Kansas City - Dbl Lo Solar Low-E	MO Kansas City	1133 kWh	56.1 MBtu	67.7 MBtu	69.14	532.75	601.89
13	Kansas City - Triple Low-E Super	MO Kansas City	1326 kWh	47.1 MBtu	60.7 MBtu	80.88	447.30	528.18

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.

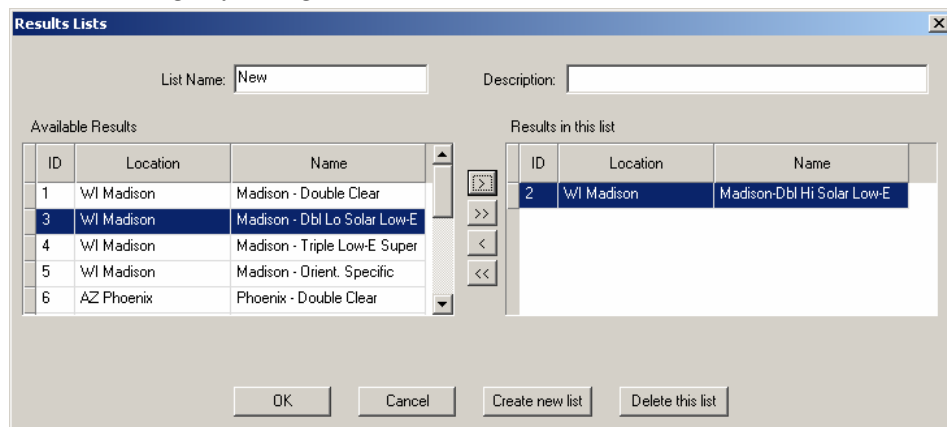


Figure 4-40. The *Modify List* dialog box.

#### *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.

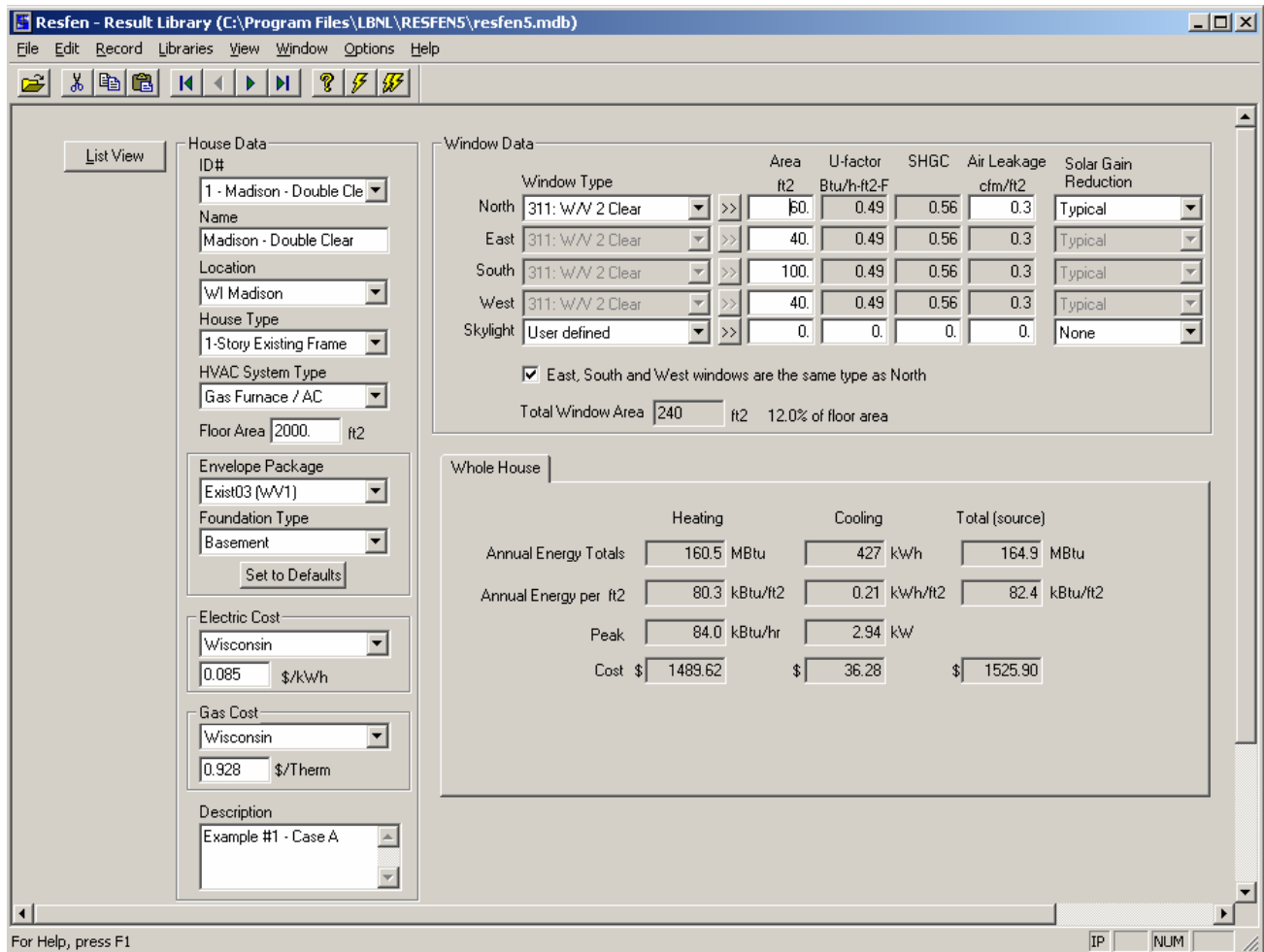


Figure 4-41. The Results Library Detail View.

## 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 be 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.

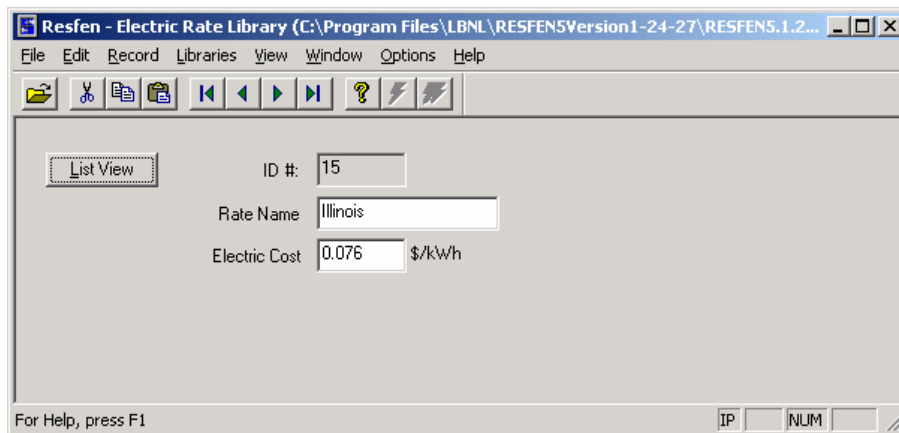


Figure 4-43. The Electric Rate Library Detail View.

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

- |                         |  |
|-------------------------|--|
| <i>ID</i>               | The ID of the record, set automatically by the program or by the user when copying an existing record. This ID must be unique. |
| <i>Rate Name</i>        | Name of electric rate.   |
| <i>Electric Cost</i>    | The electricity rate.<br><b>Units:</b> \$0.00/kWh (IP and SI).<br><b>Legal Values:</b> any number.                             |
| <i>List View Button</i> | 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.

The screenshot shows a window titled "Resfen - Gas Rate Library (C:\Program Files\LBNL\RESFEN5Version1-24-27\RESFEN5.1.27-Final.mdb)". The window has a menu bar (File, Edit, Record, Libraries, View, Window, Options, Help) and a toolbar with icons for file operations and navigation. On the left side, there are buttons for "Detailed View", "Copy", "Delete", and "Goto/Find". The main area contains a table with the following data:

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
23	Michigan	0.726

At the bottom of the window, there is a status bar with the text "For Help, press F1" and some keyboard shortcuts like "IP" and "NUM".

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 be 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.

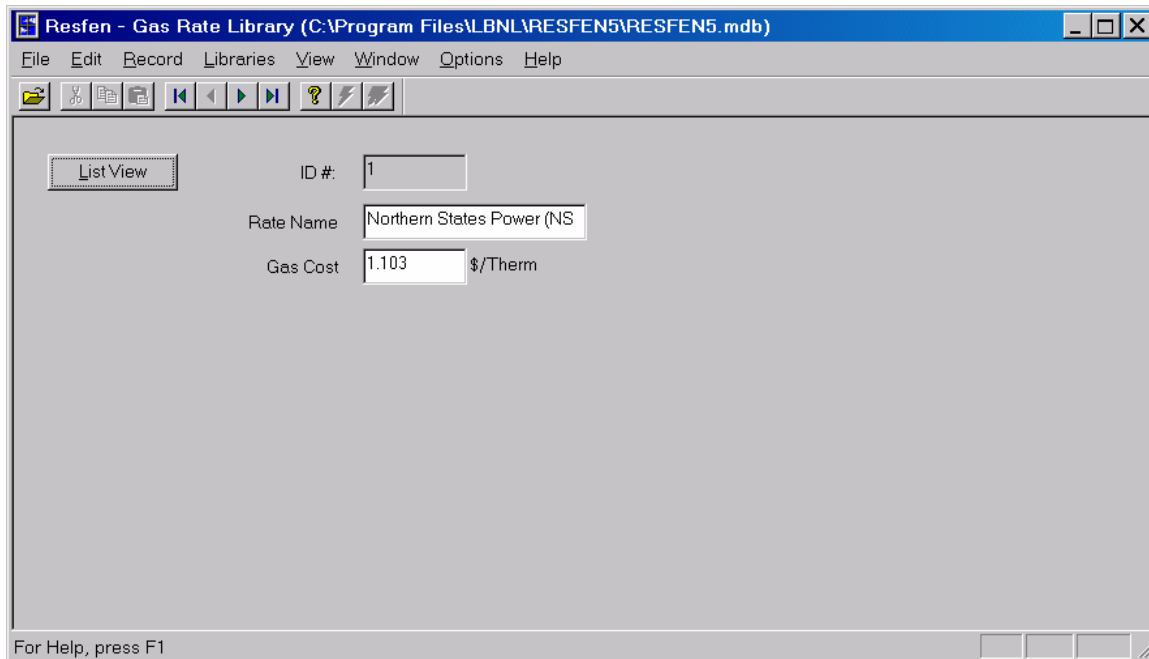


Figure 4-45. The Gas Rate Library Detail View.

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

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To be completed



## 7. ACKNOWLEDGEMENTS

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