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Manufactured Home Energy Audit (MHEA) Users Manual (Version 7)

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Foreword

What is the Manufactured Home Energy Audit

The Manufactured Home Energy Audit (MHEA) is a software tool that predicts manufactured home energy consumption and recommends weatherization retrofit measures. It was developed to assist local weatherization agencies working with the U.S. Department of Energy (DOE) Weatherization Assistance Program. Whether new or experienced, employed within or outside the Weatherization Assistance Program, all users can benefit from incorporating MHEA into their manufactured home weatherization programs. DOE anticipates that the state weatherization assistance programs that incorporate MHEA into their programs will find significant growth in the energy and cost savings achieved from manufactured home weatherization.

The easy-to-use MHEA uses a relatively standard Windows graphical interface for entering simple inputs and provides understandable, usable results. The user enters information about the manufactured home construction, heating equipment, cooling equipment appliances, and weather site. MHEA then calculates annual energy consumption using a simplified building energy analysis technique. Weatherization retrofit measures are evaluated based on the predicted energy savings after installation of the measure, the measure cost, and the measure life. Finally, MHEA recommends retrofit measures that are energy and cost effective for the particular home being evaluated.

MHEA evaluates each manufactured home individually and takes into account local weather conditions, retrofit measure costs, and fuel costs. The recommended package of weatherization retrofit measures is tailored to the home being evaluated. More traditional techniques apply the same package of retrofit measures to all manufactured homes, often the same set of measures that are installed into site-built homes. Effective manufactured home weatherization can be achieved only by installing measures developed specifically for manufactured homes. The unique manufactured home construction characteristics require that each of these measures is evaluated separately in order to devise a package of measures that will result in high energy and dollar savings.

MHEA stands apart from other building energy analysis tools in many ways. Calculations incorporated into the computer code specifically address manufactured home heating and cooling load trends. The retrofit measures evaluated by MHEA are all applicable to manufactured homes. Help messages describe common manufactured home weatherization practices as well as provide hints on how to install retrofit measures. These and other features help make MHEA easy to use when evaluating energy consumption and the effects of weatherization retrofit measures for manufactured homes.

Foreword

The National Renewable Energy Laboratory originally developed MHEA for the U.S. Department of Energy Weatherization Assistance Program. Conversion to a Windows-based program with additional modifications has been performed by the Oak Ridge National Laboratory. Many energy consumption and economic calculations resemble those found in the Computerized Instrumented Residential Audit written by Lawrence Berkeley National Laboratory and the National Energy Audit written by Oak Ridge National Laboratory. The calculations are similar in structure but have been altered to more accurately represent a manufactured home's unique energy use characteristics. Most importantly, MHEA helps meet the DOE Weatherization Assistance Program goals to increase client comfort and use federal dollars wisely.

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How to Use This Manual

How you use this manual will depend on your experience with computers and energy auditing. MHEA is a user-friendly program. Energy auditors who are experienced computer users may only occasionally refer to this manual. Less-experienced auditors and new computer users should read at least the first four chapters to avoid frustration when entering their first audits.

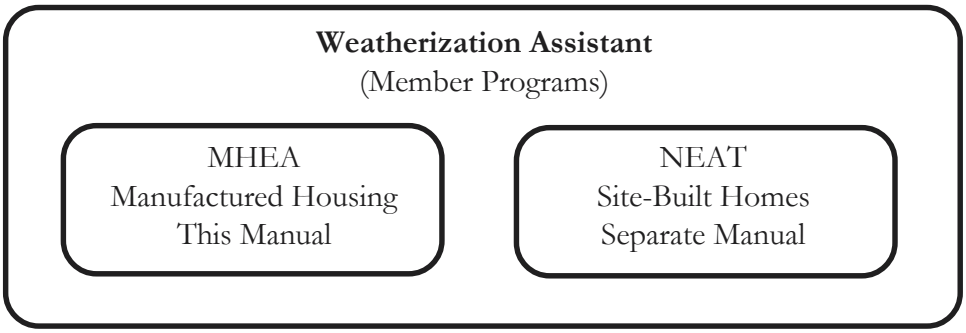
- Chapter One, *An Overview of MHEA*, tells what MHEA is and how it works.
- Chapter Two, *Installing and Starting MHEA*, shows how to install and start MHEA and have the program install an icon on your desktop.
- Chapter Three, *Basic MHEA Tasks*, describes the functions accessible from the toolbar on the Building Characterization and Analysis Window. This toolbar directs most of the basic functions of MHEA related to entire jobs: creating, selecting, executing, and viewing results.
- Chapter Four, *Navigating the Graphic User Interface*, provides explicit instructions on moving around and entering data into MHEA.
- Chapter Five, *MHEA Definitions*, gives detailed definitions of three basic terms used in MHEA: home descriptions, job identifiers, and component codes.
- Chapter Six, *The MHEA Home Description*, explains MHEA's different home description screens and the data entries required of each.
- Chapter Seven, *MHEA Reports*, talks about the reports that MHEA produces from the data you enter.
- Chapter Eight, *Customizing a MHEA Audit*, tells how to adjust MHEA to local conditions (price of fuel, weather conditions, material and labor costs, and other parameters).
- Chapter Nine, *Preferences*, allow you to further tailor your program to your needs by altering range check and default values used within the program and specifying what report sections will be generated.
- Chapter Ten, *MHEA Energy Conservation Measures*, talks about technical considerations of conservation measures considered by MHEA.
- The Glossary defines all technical terms used in this manual.

Chapter 1

MHEA, an acronym for the Manufactured Home Energy Audit, is a program for personal computers that was designed for use by local agencies in the DOE Weatherization Assistance Program. It can assist these agencies select energy conservation measures for manufactured (mobile), single-family homes that meet government criteria for cost-effectiveness.

This manual has been written to describe the operation of MHEA Version 7. This version of MHEA is being distributed with the National Energy Audit (NEAT) in a package of programs referred to as the "Weatherization Assistant." NEAT performs a similar task to that of MHEA except for site-built homes.

Installation of the Weatherization Assistant, described in Chapter 2 of this manual, *Installing and Starting MHEA*, will provide you with both of these programs, MHEA and NEAT, having graphical user interfaces (GUI) consistent with current Windows™ conventions. The remainder of this manual describes the operation of MHEA only. A separate companion manual, also included in the Weatherization Assistant package, describes the NEAT program.



The GUI interface helps speed up data entry by use of a mouse and provides alternate formats to enter and view the data, a traditional Windows™ form approach and the tabular datasheet format, which displays more information on each screen.

1.1 Hardware Requirements

MHEA is written in the programming language "C" with an interface which uses Microsoft's Access. MHEA requires no software associated with either C or Access. The program needs only a Windows operating system (Windows 95, 98, NT4.0, 2000, or XP), which normally comes with the purchase of a computer.

MHEA runs on any IBM-compatible computer having 32 mega-bytes (MB) of free random-access memory (RAM). Installation of both MHEA and NEAT requires approximately 15 mega-bytes (MB) of available hard disk space. Your graphics card and monitor should be able to produce a display with a minimum resolution of 800 × 600 pixels in order to allow windows to be seen without scrolling. All files necessary to run both MHEA and NEAT are stored on a single CD, including weather files for 216 cities in the continental United States. (These files can be accessed from the General Information screen to select the city nearest the audited residence.)

MHEA uses your existing Windows printer setup to both print and view results. Therefore, whether you have a physical printer present or not, you must have a default printer selected from your Windows/Start/Settings/Printers menu in order to view the reports. Note that some printer definitions (e.g., generic text printers) may not produce acceptable formatted displays when viewing reports. Output produced by the program is stored in the audit database and displayed in rich-text format from within the program. In addition, the program provides a standard ASCII formatted file of the output for the most recent run, which is readable by any word processor or text editor and can be viewed in DOS.

Version 7 of MHEA utilizes a commercially produced database software, Microsoft Access, to store the information you provide and the results of running the program. Previous versions of MHEA and NEAT used separate files to store audit inputs and resulting reports. Now, instead of files, this information is stored in "records" of relational database tables. When you enter a new job (or audit), you are really just creating a new record in the 'Job' table in the database. All of the jobs you have entered are available simply by requesting to view different records of this database. Users of other software products based on Microsoft Access may be familiar with the concept of tables, records, and forms.

1.2 The MHEA-Assisted Energy Audit

MHEA is a method for selecting energy conservation measures for manufactured homes. A complete weatherization program includes many steps in addition to selecting these measures. These steps, and some of their relationships to MHEA, may include:

1. Selecting eligible homes and determining the expenditure limit for each.
2. Visiting each home to collect information. Inspecting and measuring various have components. Interviewing clients. Noting health and safety problems. Making sketches. And, possibly, performing general repairs to the house. (MHEA has

certain data requirements, but local agencies' programs may collect additional information.)

3. Conducting air leakage repairs. MHEA can use blower door measurements, but these measurements are not required. MHEA will calculate the weatherization energy savings and Savings-to-Investment Ratio (SIR) for infiltration reduction work that has been performed, if data from blower door tests and cost of the work are provided.
4. Installing cost-effective low-cost and no-cost conservation measures (such as replacing furnace filters or servicing evaporative coolers). These measures, which must be approved by the DOE, often can be installed as quickly as they can be analyzed and are not evaluated within MHEA.
5. Inspecting and diagnosing heating and cooling equipment. Combustion tests measure the steady-state efficiency of heating systems. If such tests are available, MHEA will use them to more accurately estimate savings from equipment replacement or tune-up. If testing is not available, MHEA's default values will estimate efficiency.
6. Choosing measures based on the home description data. MHEA will generate a report of cost-effective energy conservation measures for both the building envelope and heating/cooling equipment as well as some appliances.
7. Obtaining energy consumption data from the customers' utilities. MHEA can use these data to adjust savings estimates for various energy conservation measures.
8. Installing measures following state-of-the-art procedures.
9. Performing an on-site quality assurance inspection of installed energy conservation measures.
10. Educating customers about what they can do to minimize energy consumption.

1.3 What MHEA Does

MHEA uses engineering calculations to compute the savings of individual energy conservation measures. MHEA requires a description of each home and its energy-related systems. You may take data input forms to the building site and record information by hand, or you may enter information directly into a portable computer.

You enter data onto computer screens that store information about the characteristics of the home and its mechanical systems. Screens contain fields into which you enter values or characters, drop-down boxes from which you select one of several prescribed responses, or buttons you turn on or off using your computer's mouse.

MHEA uses this data to rank individual energy conservation measures and also evaluates the interaction between conservation measures. For example, since insulation reduces the amount of energy used for heating, it also reduces the energy savings from a furnace replacement.

MHEA follows nine steps to select the most cost-effective energy conservation measures for a particular single-family manufactured home:

1. MHEA guides the auditor through the process of entering data from the house.
2. MHEA computes heat loss, heat gain, and energy required to keep the house at a specific thermostat set point.
3. MHEA reviews possible conservation measures and checks their applicability to the home described by the auditor.
4. MHEA calculates savings for each applicable conservation measure and computes the discounted savings-to-investment-ratio (SIR). The SIR tells you how many times a conservation measure will repay the initial investment during its lifetime.
5. MHEA ranks the energy conservation measures in order of their SIR.
6. Beginning with the highest SIR, MHEA applies each conservation measure to the home and then re-computes a new SIR for the remaining measures, taking into account savings gained by preceding measures.
7. MHEA again ranks the conservation measures
8. MHEA prepares an essential materials list.
9. MHEA adjusts measure savings based on actual consumption data from the utility company, if the user desires.

MHEA calculates heat loss and gain on a monthly basis, using ten-year average weather data for the selected city. MHEA then evaluates all conservation measures by how much they reduce the flow of heat through the envelope and by how much they after the house's "balance point" (the outdoor temperature above which no heating is needed or below which no cooling is needed).

MHEA estimates heating and cooling efficiency based on information you enter. MHEA also accepts values determined from combustion efficiency measurements.

The amount of solar energy absorbed by a home varies according to area and orientation of its walls, windows, and doors. To help MHEA consider this effect, you need to enter the orientation of the home and which nearest cardinal direction windows and doors face.

MHEA also accounts for the typical amount of heat generated inside a house by people and their refrigerator, water heater, other appliances and lights.

Since conservation measures typically remain after occupants move, MHEA assumes a house is maintained at average conditions, regardless of specific occupants. This follows the intent of government and utility programs that finance energy conservation savings to be realized for up to 20 years.

MHEA reports the cost-effectiveness of conservation measures both individually and cumulatively to fit varying budgets and guidelines of different weatherization programs.

If you follow MHEA, money spent on residential energy conservation will be an economical investment according to the Weatherization Assistance Program rules.

Chapter 2

MHEA is being distributed as part of a package of energy auditing tools collectively known as the "Weatherization Assistant." The following instructions will install all of these tools onto your computer. They assume you have an IBM-compatible computer with at least 15 MB of available hard disk space. Installation only adds a new directory tree to your hard drive at a location you specify.

Programs in the Weatherization Assistant will execute on a variety of platforms, including Windows 95, 98, 2000, NT4.0, and XP. The following instructions will cover all platforms with only minor modifications. Windows 2000 users must have that platform's Service Pack 2 installed. This update to your operating system is available over Microsoft's web site. See the "install.txt" file on the distribution disk for any further guidance not available at the time of this manual's printing.

Remember:

- Keyboard characters this manual wants you to type are printed in bold. Example: **INSTALL.**
- Command keys you are to press, such as **Enter**, have brackets **[ ]** around them. Example: **[Enter]**.

2.1 Program Installation

The procedure used to install the Weatherization Assistant onto a computer uses the standard Windows process for the platform you are using and an installation program common to most software. A summary is given below. More details can be found in your Windows manual.

Turning on your computer places you in the Windows desktop. If you have not just turned on your computer, you should close any applications currently open. From the desktop, double click on the following icons: My Computer, Control Panel, then Add/ Remove Programs. Place the Weatherization Assistant program disk into your computer's CD ROM drive. For Windows 2000, click on Add New Programs then on CD or Floppy. Otherwise, click on the Install button, then Next. Windows should find the "X:\setup.exe" file and place this text in the input window. The "X" stands for the drive letter assigned to your CD ROM. Press [Enter] or click on the Finish button to begin installation.

The installation procedure will present you with the license agreement. Read the agreement and click your mouse on the "I Agree" button if you agree with its contents. Otherwise, click on Cancel to abort the installation process. If you choose to proceed, you will be presented with the "Welcome" screen giving you a further opportunity to either go to the "Next" screen or "Cancel" the process.

The next screen in the installation process allows you to change the location on your computer to which the program files will be copied, the "Destination Directory." Note that this screen will also display the "Free Disk Space" available on the drive selected as well as the expected remaining "Free Disk Space After Installation." The default location is c:\Program Files\Weatherization Assistant xxx, where "xxx" stands for the version number being installed. If this is satisfactory, choose Next. Otherwise click on the "Browse" button and select the preferred location from the drives (bottom) and folders (middle) sub-windows presented. The destination field at the top of this window will change in response to your selections. You may also modify the entry in this destination field directly to make your selection. If your entry does not correspond to an existing location, you will later be asked if you wish to have the location created. If it corresponds to an existing installation of the program, you will be ask to confirm installation into this existing directory. Click on OK to accept your location specification or Cancel if you wish to return to using the default or previously accepted location. When you are satisfied with the selection as displayed in the box containing the Browse button (which will be the default location if you have not selected to Browse to a new location), click on the Next button to continue.

The next screen summarizes the version being installed, the date of installation, and your choice of the destination directory. If the summary is correct, choose Next to continue the installation. Otherwise, choose Back to return to the previous screen to modify your selections or Cancel to exit the installation process without having installed the program.

If your selection of destination directory does not exist on your computer, a screen will appear notifying you of this situation. You must click the OK button to confirm receipt of this notification. You will next see a window with a bar which meters the progress of installing the necessary files. Concluding this process, you will be presented with the "Installation Completed" notice from which you are given the choice of finishing the installation with or without viewing the "User Notes." If you choose to view these notes, they will be presented in a Notepad window. It may be helpful to select the File, Print menu item in this window to print the notes for future reference. It may contain notes available at the time of release of the program but not contained in this manual. After installation, this file will be available from the Weatherization Assistant

destination directory you have selected (e.g., c:\Program Files\Weatherization Assistant xxx). Exit the notes when you have finished by selecting File/Exit or clicking on the Windows close window box [X] in the note pad window. The installation is now complete. Close any other windows associated with the install procedure and return to your normal desktop.

The above described installation process will automatically place the Weatherization Assistant icon on your desktop.

2.2 Starting MHEA

Click on the Weatherization Assistant icon displayed on your desktop to start the program. If during installation you chose to install the Weatherization Assistant into a location on your computer other than the default location (c:/Program Files/ Weatherization Assistant xxx), the first time you open the program, it will tell you that it must connect to the back-end database. Click on the OK to continue. You will then be asked to confirm that the linking was successful.

Also during this first session of program execution, you will be asked to enter your agency information. This information will be associated with each execution of the program and identify your agency's ownership of the jobs (both MHEA and NEAT) within the database. The fields designating your agency name and state, user's name (first and last), and telephone number are required entries. Only one agency name should be used per database and this name will have to be selected during each home description input on the General Information Screen. The personal name you use for this latter entry may be that of the agency director, the data entry individual, or whomever your agency or state directs. Note that there is a separate entry on the General Information form of each home in which to enter the auditor's name. The Phone Number entry is formatted to accept area code and seven local digits. Be careful if you use your mouse to access this field that you do not position yourself somewhere in the middle of this formatted field when initiating entry. The other fields are optional and may be filled in according to local policy. Once completed successfully, click on the Windows close box in the upper right corner of the window. You will not be asked for this information again, unless you request to change it.

Subsequent initiations of the Weatherization Assistant will now briefly display an introductory banner indicating that the Weatherization Assistant has been developed for the Department of Energy and giving a version number and release date. This will be followed by the main menu screen for the Weatherization Assistant from which you may select which program, MHEA or NEAT, you wish to execute. Click on which ever box lies next to your selection. From this screen, you may also edit your Agency Information

or exit the program. Note, single clicks of the mouse are all that is required to make selections from this main menu form. Inadvertent double clicks may take you down two levels in the menu hierarchy.

2.3 The Data Link Feature

As discussed in Chapter 1, *An Overview of MHEA*, Version 7 of the Weatherization Assistant stores information you provide and the results of running the program for each job in a record of a database. Thus, if you have performed MHEA audits on twenty homes, your database would have twenty job records.

These records are stored in a database file on your computer named "WAB1.mdb," by default. Each user of the program will have a similar file on their computer. If you wish to view someone else's database of jobs, you may do this using the Data Link feature. Have the agency whose jobs you wish to view send you a copy of their WAB1.mdb file. After receiving it, rename it to have a different name than your file, retaining the "mdb" extension (e.g., WAB2.mdb). Copy the renamed file into your Weatherization Assistant subdirectory (under c:\Program Files\Weatherization Assistant xxx, if you chose to load MHEA into the default location on your computer).

The next time you start the Weatherization Assistant program, you may select this database by selecting the Data Link option from the Weatherization Assistant main menu. Choose the Browse button then locate the database file (WAB2.mdb in the above example) you wish to view from the files displayed in the look-up table and click the mouse on it. Choose "Link" to have MHEA make these jobs available to you, as were your jobs previously. A window should appear indicating that the link was successful.

The next time you select an existing job (see Section 3.2, *Selecting an Existing Home Description*), the jobs you may choose from will be those from the database to which you just linked. Also, if you create a new job, its information will be stored in this same database.

To access your own jobs again, repeat the process above using the Data Link feature, but choose your original database, WAB1.mdb.

If you regularly access a substantial number of databases, you may create a listing of them to ease selection. Use the Edit button on the Data Link screen to access an input screen which allows you to record a database name and location for each database you regularly access. Type in a name of your choosing under "Name." Any characters in this name you enclose in parentheses will be displayed over the logo on the Weatherization Assistant main menu screen to remind you of the database you are currently accessing. Next enter the full path and filename of the database file (e.g., c:\Program Files\Weatherization Assistant\WAB2.mdb) associated with your name. A quick way to

obtain this path and filename is to use the Browse button, as described above, to locate the database of interest and transfer its name and path into the "New Location" field. Then you can highlight this path and location, use [Cntl-C] to copy it, position yourself at the "Location" field under the "Edit" button, and finally use [Cntl-V] to paste the path and filename into this field (see Section 4.9, *Copying and Pasting a Record or Field*).

Having done this for all databases you wish to access, the "Select Database" window in the main Data Link form will display the names of the available databases. Selecting any one of them from this window will automatically transfer its location to the "New Location" field and allow you to link to it by selecting the "Link" button.

You may wish to have more than one database of jobs of your own, for example, to separate jobs from different program years. This can be done using the Windows Explorer or My Computer features on your computer to copy a data base file and then rename it, retaining the "mdb" extension. If you do this just after installing the program, both data base files will be empty (except for the Default Job and Example homes which are sent with the program). You can then use one of the files to begin the current program year's jobs, retaining the other for future use in perhaps the following program year. You may copy a data base file as many times as you like as long as each has a different name and the same "mdb" extension.

If you would like to apply the above principle but have already used the original data base file to record jobs, you can still copy the file, then relatively quickly delete all except the Default and possibly the Example jobs by using the Data Sheet view from the General Information Screens of both MHEA and NEAT (see Section 4.8, *Data Sheet and Form Views of Records*). This will supply you with an empty data base file from which to start a subsequent set of runs. Please recall that each data base file contains both MHEA and NEAT jobs.

You may also create a new data base file using the export feature within the Weatherization Assistant program (see Section 2.4, *Importing and Exporting Jobs, below*).

2.4 Importing and Exporting Jobs

The Weatherization Assistant also provides you with the capability of importing jobs from one database into the database you are currently accessing (linked to). You may also export any number of jobs from your database to another data base file, possibly for attaching to an e-mail or placing onto a diskette and sending in the mail.

To import jobs from another data base into your own, choose the Data Link feature from the Weatherization Assistant Main Menu, then select Import/Export. This will present you with a screen from which you can "Transfer between databases." On the left of this screen you will see a list of jobs in the data base you are currently accessing

(linked to). The data base path and file name will be displayed in the "Local Database Path" box at the top of this half of the screen. The listing will be either MHEA or NEAT jobs, depending on your selection of "Display Jobs for" at the bottom left of the screen.

To import jobs (add to this list) from another database, first locate the other data base file from the standard Windows browse window which will open when you click your mouse on the "—" browse button at the top right of the screen. Once located, you may either double click on the file or single click then select the Save button. Data base files recently used for importing jobs can be selected from the combo-box to the left of the browse button. Note that there are two types of Weatherization Assistant data bases from which you may select: the standard "mdb" file (make sure it is a Weatherization Assistant data base file) and a "zipped" WA "wdz" data base file. The zipped files are created when you or someone else chooses to export jobs. The standard WA data base ("mdb") files are relatively large (about 1.5 Mbytes). However, when jobs are exported, they can be automatically "zipped" to reduce there size, allowing you to place them on a floppy or send them attached to an e-mail (see below).

The right half of the "Transfer between databases" screen, "External Database Path," will now contain the jobs in the data base from which you are going to import jobs, either NEAT or MHEA, depending on your choice indicated in the "Display Jobs for" check boxes. Jobs from any previous Version 7 Weatherization Assistant database may be imported and automatically updated to your current more recent version. Note the display under the "Version" title indicates the version of the database whose jobs are being displayed. Select the jobs to be imported by clicking on rows containing their information in the job listing on the right of the screen, and using the other standard Windows item selection procedures. For example, you can select multiple jobs lying adjacent to each other by clicking on the first or last, then holding down the [Shift] key while using the [Up Arrow] or [Down Arrow] keys to select others. Holding down the [Cntl] key while clicking on jobs will allow you to select multiple jobs which are not next to each other. To assist in the selection process, you may sort the listings by any of the four identifying data fields listed in the "Sort by" check box grouping at the bottom of the window.

Once you have completed the selection, click on the left pointing arrow which lies between the two halves of the screen. The jobs will be copied over into the data base file you are currently using. The next time you use the "Find" controls in the Building Characterization and Analysis Window (see Section 3.2, *Selecting an Existing Home Description*) you will see those jobs imported available.

Exporting is somewhat a reverse process to that described above. You can export any set of jobs in the data base you are currently linked to and place them in either another existing data base or have a new data base created just for the jobs you wish to export. Note, however, if exporting to an existing data base, it must have been formed using the same version of the Weatherization Assistant. No "backward" compatibility has been provided.

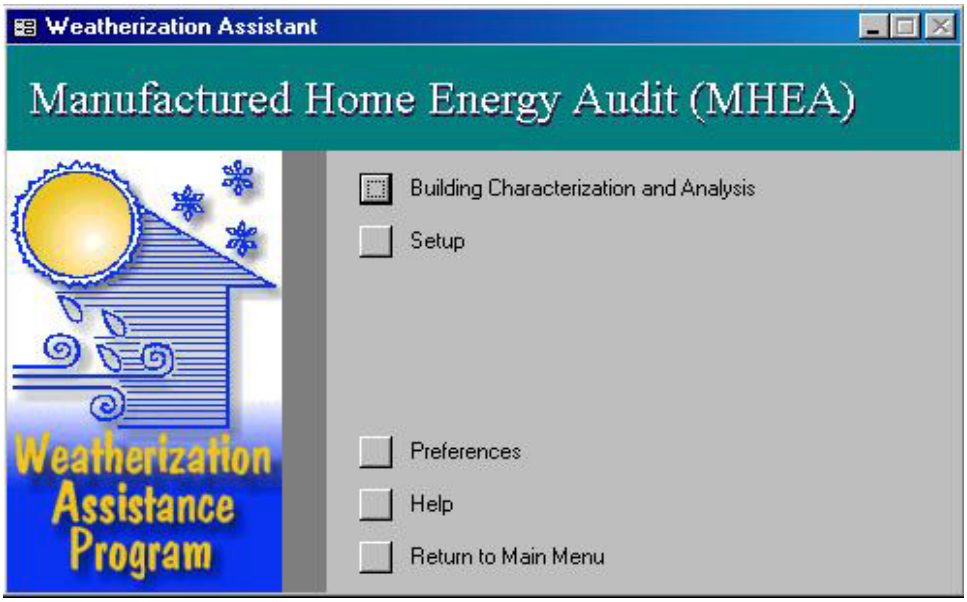
To export jobs, choose the Data Link feature from the Weatherization Assistant Main Menu, then select Import/Export. If you will be exporting jobs to an existing data base, choose the data base in the same manner you chose a data base for importing, as described above. Otherwise, use the browse feature to simply specify a location on your computer where you wish a new data base to be created and enter the name of this new data base in the "File name" field at the bottom of the browse window. You may choose to create a standard "mdb" data base file or a zipped "wdz" file using the "Save as type:" combo box at the bottom of the form. However, to obtain a zipped "wdz" file, you must both specify this type of file in the "Save as type:" combo box and manually provide the ".wdz" extension in the "File name:" field. The "wdz" files are compressed to about one tenth the size of the standard file. They are also automatically encrypted to allow safe transport of confidential client information over public media. Next, click on the Save button to indicate your selection is complete.

You will be returned to the "Transfer between databases" screen having the two side-by-side job listings. Choose the jobs you wish to export from those listed on the left of the screen. Multiple job selections may be accomplished as described above in the discussion on importing jobs. When your job selection is complete, click on the right pointing arrow to complete the export procedure. The process may be repeated to export additional jobs, until all the desired jobs have been exported to the specified data base. You may use the e-mail button (letter icon) at the bottom left of the screen to initiate sending the data base file as an attachment to an e-mail. The file name will automatically be entered into the "File to Attach" field. You will need to enter the e-mail address of the recipient and any Subject and Text you wish to include in the mailing. Then click on the Send button to send your e-mail. Note, you will have had to initiate connection to your internet provider at some time prior to sending the e-mail.

NOTES:

Chapter 3

Choosing the "Manufactured Home Energy Audit" from the Weatherization Assistant main menu displays the MHEA introductory screen. From here, you have the option to choose one of three primary activities, which, combined, encompass all the tasks available in MHEA. Through the "Building Characterization and Analysis" selection, homes are described, recommended energy efficiency measures are determined, and reports are requested and printed. The "Setup" selection permits you to customize MHEA to reflect your specific local climate, fuel cost, material and labor costs, and other parameters (see Chapter 8, *Customizing a MHEA Audit*). The "Preferences" allow you to further choose features in the program to meet your personal needs (see Chapter 9, *Preferences*).



MHEA Introductory screen

This chapter will discuss the main tasks available under the "Building Characterization and Analysis" selection that affect entire home descriptions, including (1) finding and retrieving previous home descriptions to modify or re-execute, (2) initiating a new home description, (3) copying home descriptions, (4) executing the program to produce recommendations, and (5) viewing and printing reports. Detailed discussion of the information required to describe a home to MHEA, also supplied under the "Building Characterization and Analysis" selection, is contained in Chapter 6, *The MHEA Home Description*.

Note, the words "Job" and "Home description" are used interchangeably in the discussions of this chapter. The former often for the sake of brevity. Strictly speaking, however, the term "Job" would apply not only to the home description but also to all the setup parameters and reports associated with having run the analysis of the home.

3.1 The Building Characterization and Analysis Window

Selecting "Building Characterization and Analysis" from the MHEA menu window automatically initiates the data input segment of the program. A new window, the "Building Characterization and Analysis Window," will open. In the Title Bar at the top of this window you will see "MHEA," identifying the program currently accessed, and the words "Job" and "Client." To the right of each of these words will be entries surrounded by caret symbols, "<" and ">." Within the carets will be the Job Identifier and Client Name of the home description MHEA currently has access to. You will supply these names for jobs as you enter them into the program.

Top portion of the Building Characterization and Analysis Window

Just below the Title Bar in this window, you will see a Tool Bar containing buttons and fields which will allow you to perform operations on entire home descriptions. These operations will be discussed in this chapter. The remainder of the window is dedicated to entering the details of individual home descriptions, as described in Chapter 6.

3.2 Selecting an Existing Home Description

In the Building Characterization and Analysis Window below the word "Find" in the tool bar, there are two controls which allow you to search for an existing job, either by Job Identifier or Client. These are data that would have been entered earlier as you described a specific job. Examples are "Sample" and "Doe, John," respectively, as can be viewed on the Title Bar of this screen when first opened. These controls can be used in two different ways to locate an existing job. First, you can begin typing the Job Identifier or Client Name of the job you are looking for into the appropriate field. As soon as the characters you type match those of one of your existing jobs, the remainder of the

name will automatically appear in the field. You can then press [Enter] to accept and move to that job.

Alternately, you may click the mouse on the downward pointing arrow to the right of either the Job or Client fields to display an entire list of existing jobs in alphabetical order by Job Identifier or Client Name, respectively. Position the mouse over one of these selections and double click the mouse to select that job (or single click then press the [Enter] key). You will be positioned to that job.

A second set of controls on the screen's tool bar, below the word "Navigate," allows you to step through the existing jobs which currently lie in your database. The control has an entry field between two sets of arrow controls arranged horizontally. The number in the field is the number of the job currently accessed, as determined by an alphabetical ordering of jobs according to the parameter you have selected in the Data Sheet view of the General Information Screen (see last paragraph in Section 4.8, *Data Sheet and Form Views of Records*). Note that this number assignment changes as jobs are added to your data base and will not be in any anticipated order until you re-order them as indicated in Section 4.8. Thus, the number may be of use only in giving you a relative indication of the position of the currently accessed job in your entire list of jobs.

Clicking on the button to the left of this field, containing an arrow pointing to a line, will position you to the first job in your database. Using the adjacent button, with a left pointing arrow, will access the next lower numbered job. The buttons to the right of the job number field perform similar operations but taking you to the next higher numbered job or to the last job in your database.

You may also enter a number in the field, then press the [Enter] key to be positioned at a job having that number. As already mentioned, the use of these "Navigate" controls to locate a job is not as convenient as the "Find" controls since the Job Number with which they work is not uniquely associated with a job.

3.3 Creating a New Home Description

There are three different ways you can begin a new home description (or job):

1. Open an entirely blank job record. The data entry forms will have no entries made in them and you will have to supply all required entries individually.

   To begin a new job in this manner, click your mouse on the arrow pointing to an asterisk (*) positioned under the word "New" in the tool bar. You will be presented with a blank General Information form except for the "Date" field, which will contain the current date. You will have to fill out the required data on this form before progressing to other forms. This same blank job record would also be

created by entering a Job Number in the Navigate field which was larger than the number of jobs you currently have.

2. Open a job containing previously defined default entries.

   MHEA provides you with, and allows you to alter, a "Default" home description or job record (see Section 4.11, *The Default Record*). By selecting the blank page button under the word "New" on the tool bar, MHEA opens a new home description with the same entries as the Default job. The only difference will be that the Job Identifier will be "New" [<current date and time>]. This entire entry will be selected (highlighted) immediately after choosing to create a new job from the default. It is expected that you will next type in the Job Identifier you wish to assign this new job. From there, you modify the new job to reflect the characteristics of the actual home.

3. The third way to initiate a new job is to copy any other existing job and make modifications to it, saving both the original job and its modified copy.

   To do this, use one of the methods described in Section 3.2, *Selecting an Existing Home Description*, to select an existing job, the job you want copied to create the new job. Then, select the tool bar button showing two cascading pages with writing on them, located under the word "New." You will be positioned at a new job which is a copy of the existing job except that its Job Identifier will be that of the original job followed by the current time in parentheses [e.g., "(16:03:50)"]. This Job Identifier will be highlighted, indicating the expectation that you will enter a new Job Identifier for this job. You are then free to make any modifications necessary to describe this new home.

When you request that an existing job be copied, MHEA will examine the job to see if there is billing data associated with it. If there is, MHEA will ask "Do you want to copy utility bill records as well." If you are copying the existing job in order to modify it to describe an entirely different house, you would likely not want the utility billing data copied, since it would not be applicable to a different house. However, if you are performing parameter studies for a given house to see what the affect is of different assumptions, having the billing data carried over in your copy would be beneficial.

3.4 Running MHEA and Viewing the Reports

After entering new home description data or revising the data from a previously described home, select the exclamation mark (!) button on the tool bar under the title

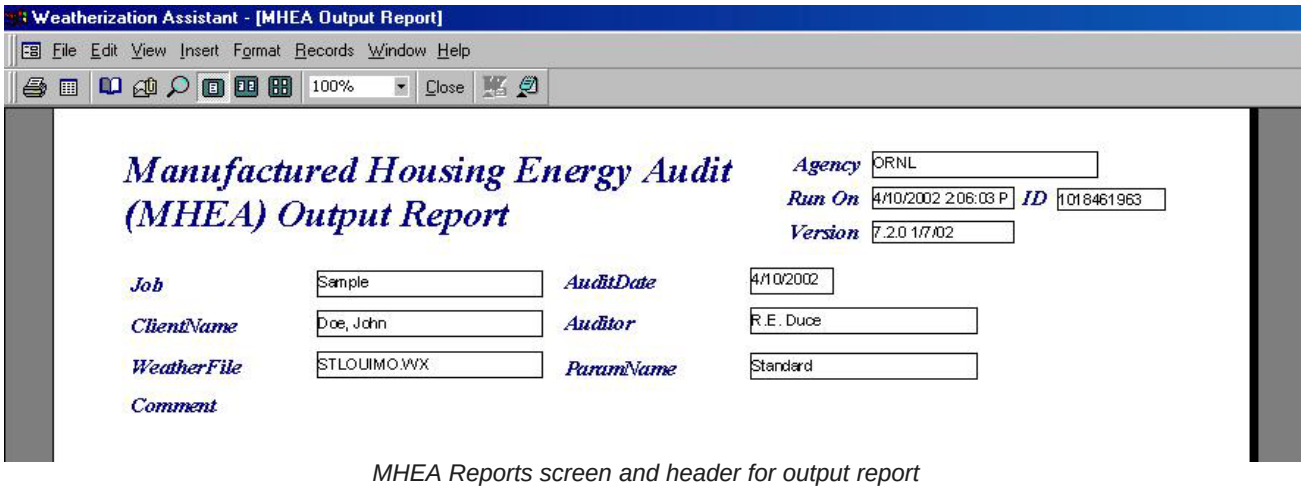
"Run." MHEA will perform the calculations necessary to provide recommendations for the home's weatherization. Note, you name the job (provide the "Job Identifier") as part of entering the home description data. Also, MHEA saves your information each time you leave a specific building component record (or input screen) as well as when you select the Run (exclamation mark) button. Thus, both of these tasks are automatically performed and activating the Run button will immediately execute the job.

Having requested execution, MHEA examines your input to see that all necessary information is available. Though MHEA performs a check on each form's content every time you exit a form, it doesn't know until you request execution whether an entire form with required information has been visited. If such is the case, a warning box will identify the form which contains the required data and ask you to visit it. MHEA requires that the General Information, Duct and Infiltration, and all envelope forms (other than those for additions) be visited. Also, you must indicate the presence of some equipment by visiting either the Heating System or Air Conditioning forms.

Provided all necessary data is available, activating the Run button will change the mouse pointer to an hour glass while the calculations are being performed. You will also see the word "Calculating" in the status bar at the bottom of the window. Wait for the operations to be completed before attempting further interaction with MHEA.

Depending on your settings in Preferences (see Section 9.1, *General, Preferences*), MHEA will either present you with the Output Report for the job you just ran, or return you to the Building Characterization and Analysis Window. If the latter occurs, you will be able to tell that the execution is complete by the mouse pointer changing back into its standard form and the word "Calculating" disappearing from the status bar. The "Last Run On" field will also be updated with the current time stamp.

If you are not presented with the Output Report after execution and wish to view it, select the right-most magnifying glass button under the word "Report" on the Building



MHEA Reports screen and header for output report

Characterization and Analysis Window toolbar. The Output Report will be displayed in two page format with text that may be too small to read. However, the titles of the sections should be readable and by clicking your mouse on any location within the report, you will produce a magnified view of that portion of the report.

Note the requirement that a default printer be defined for your computer in order to view any of MHEA's reports (see Section 1.1, *Hardware Requirements*).

There is no MHEA generated tool bar associated with the Output Report window. However, standard Access toolbars still exist at the top of the program window. Among these are buttons allowing you to display varying numbers of output pages in the report. They appear below the menu bar and each look like a single dark screen with light colored pages in it. A single page in the button's screen indicates viewing one page at a time, two pages side by side allows you to view two pages at one time, and the button with four small pages in the button allows you to choose the display from six additional predefined layouts. Depending on the resolution you have chosen for your graphics, many of these displays will not have large enough text to read. In this same Access toolbar is a magnifying glass which zooms in on whatever display you have chosen. You may be better able to read the output if you magnify it, but scrolling will most likely be necessary to see all of the display.

Also on this same Access toolbar for the Output Report is a printer button, normally at the extreme left of the toolbar. If you have a printer assigned to your computer through your Windows setup, clicking the mouse on this button will send a copy of the report to your printer. You may also press the [Ctrl-P] key combination to display the Windows Print screen and print your output from there. This screen allows you to choose which of the pages are to be printed. If you have not defined any printers to the Windows operating system, pressing the print button will result in an error message.

One other Access toolbar button on the Output Report window may be of interest. On the extreme right of the toolbar is the "Output to Notepad" button. Selecting this will export the Output Report to a pure ASCII text file and display it in Notepad. From there, it may be saved to any location on your computer with any file name you wish. It may also be edited as any other text file would be.

The Output Report may be closed using the standard Windows Close button at the upper right of the window. Note, all or parts of other windows may be displayed at the same time as the Output Report window. Be sure the close button you select is associated with the window you actually wish to close. After closing the Output Report window, the program will return you to the Building Characterization and Analysis Window.

For a description of contents of the Output Report, see Chapter 7, *MHEA Reports*.

From the Building Characterization and Analysis Window, you may also choose to display a Job Input Summary Report. Select the left-most magnifying glass button under the word "Report." You will be shown a report of all the home description data in a tabular format. This may or may not be of use, depending on your needs. The intent is to provide a summary report of all of the inputs that define the audit job. The same Access toolbar options described for the Output Report are also available for this Input Summary Report.

NOTES:

Chapter 4

Version 7 of MHEA uses the graphic user interface (GUI) provided by Microsoft's Access 97. MHEA uses all the standard Access forms, controls, and the concept of records contained in this software. Thus, if you are familiar with Access, you are probably already proficient with the mechanics of entering data into MHEA. Otherwise, the following chapter will supply you with the basics needed for this task.

4.1 Forms and Records

Data entry in MHEA uses forms, each form containing information to describe a specific topic or component, such as general information, the walls, or the ceiling. The term "record" refers to the information contained on a specific form. Often the terms "record" and "form" may be used interchangeably, keeping this somewhat subtle difference in definition in mind. While on the Building Characterization and Analysis window, left click your mouse on the tab corresponding to the type of component you wish to describe (see Section 3.1, *The Building Characterization and Analysis Window*). Appendix C, *Data Input and Sample Forms*, gives examples of component input forms for each type and Chapter 6, *The MHEA Home Description*, describes the information needed to fill in the forms.

The Windows and Doors forms allow entry of up to 18 different window and 18 door types. You may describe as many as 9 lighting systems (under the Base Loads tab) and 10 Itemized Costs. Each description of a particular component, created by filling in a form for that component type, creates a record of information in the MHEA database. Multiple forms for each of these component types are provided to enter their records of information. As many as three forms of a given component type may be visible at one time. Several means are provided to move from one form to another within the same component type:

- Pressing the [PgUp] and [PgDn] keys will move you to the next or previous screen of records. For example, each MHEA windows screen contains three window forms. PgDn takes you to an entirely new screen of window forms. Thus windows 1–3 are first displayed, forms for windows 4–7 will be displayed after entering the PgDn key.
- When more than one record of data for a particular component type are visible at the same time, left clicking any data entry item, or "control," will automatically move your cursor to that record and control. Since not all records of a given type may be

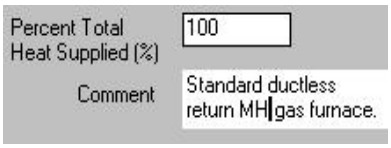
visible at one time, you may use the vertical scroll bar to the right of the forms to locate additional records.

- Left click your mouse in the vertical record selection bar to the left of the record of the particular component you wish to describe. You may again use the vertical scroll bar to view additional records. Note, an asterisk (*) appears in the bar to the left of the first record available for describing a new component. If you had started from a completely blank home description and were just beginning to describe components of a particular component type, this asterisk would appear beside the first record. Use this method to select an entire record of data for the purposes of copying the information (see Section 4.9, *Copying and Pasting a Record or Field*).
- You may use the record positioning control bar at the bottom of the screen form. The number in the window indicates the number of the record you are presently addressing. Click on the right or left arrows in the control bar to move to the next or previous record. Click on the arrows pointing to vertical lines to go to either the first or last record of the component type. If you wish to move to a blank record to enter a new component description, click on the right arrow pointing to an asterisk.

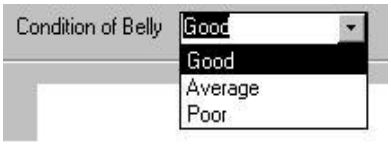
The Ducts and Infiltration form can request different data, depending on responses already provided on the form (see Section 6.10, *Ducts and Infiltration* for more details). Thus, it is good policy to provide data from the top down to avoid being asked for information that is not needed. It is also a good idea to review the list of candidate energy conservation measures selected in the parameter set because a number of controls on forms, especially under the Base Loads tab, are dependent on the list of candidate measures considered (see Section 8.6, *Selecting Candidate Conservation Measures*).

Data for a record are loaded into your computer's temporary memory (not on disk) when you start filling in data on a blank form or modify data on an existing form. You will notice that the icon in the record selection bar on the left of the form changes from a solid triangle (indicating selection) to a pencil (indicating editing). When you exit that form or try to navigate to a new record, the record you were working on gets saved to the database file in your computer's permanent memory, the "disk." There are a number of range and completeness checks as well as relational integrity checks performed by Access when the record is being saved to disk. This is why you can get warning and error messages when you try to leave a form or navigate to a new record.

4.2 Entering Data into MHEA



Two fields, the second accessed in insert mode



A combo-box control in overwrite mode

The forms contain three types of controls which accept input from the user: the field, the combo box, and the check box.

Fields allow you to type in entries from the keyboard and are not restricted to any pre-selected set of responses. However, they often must satisfy certain conditions to be acceptable. For example, a field expecting a number cannot contain an alphabetic character.

Combo-boxes look like fields except that they have a square with a downward pointing arrow to the right of the field. Entries into these controls may be restricted to one of several prescribed responses. The selection may be made in several ways:

- Left click the mouse on the box with the arrow, then click on the desired response from the drop-down list which will appear.
- Having navigated to the control, press the [Cntl-Down Arrow] key combination to display the drop-down list, use the [Up Arrow] and [Down Arrow] keys to highlight the desired response, then press [Enter] or [Tab] to make the selection.
- Or, whenever the entire field is selected (in reverse video), you may begin to type in one of the acceptable responses. As soon as the characters you type uniquely match one of the acceptable responses, the remainder of the field will be automatically filled in. Then press [Enter] or [Tab] to complete the selection.

Most combo boxes are restricted to the list of predefined entries and you must make a selection from that list. The exceptions are the combo boxes for the Existing Refrigerator and Water Heater Manufacturer and Model, which do not restrict the entry to an item in the list. In these cases, the combo box can behave as a regular text entry field. However, you will obtain the data from the data base of refrigerators and water heaters only if your entry matches one that is in the data base (see also Sections 6.11.1, *Base Loads—Refrigerator* and 6.11.2, *Base Loads—Water Heating*).

In all of the cases above, navigating to a new control completes the selection. You will not be allowed to exit a combo-box control unless an acceptable response has been provided, or you press the [Esc] key to back out of your changes.

When the characters in a field or combo-box are highlighted (displayed in reverse video), the control is said to be in 'overwrite' mode. Any characters that are highlighted

in a control will be replaced by keystrokes you enter. Any number of characters can be highlighted by left clicking the mouse while dragging it across those you wish highlighted. To switch to 'insert' mode, position the mouse pointer to a location within the field and left click. This will allow you to insert characters between existing ones.

While in insert mode within a field, the [Left Arrow], [Right Arrow], [Home], [End], [Backspace], and [Delete] keys retain their traditional functions of positioning the cursor within the field. Single character highlighting (replacing only individual characters) can be obtained by pressing the [Insert] key on your keyboard.

Two check boxes, the first selected

The check box is a small white box in which a check mark may or may not be visible. If a check is visible, it implies a yes response to the question associated with the box. You may change the response in a check box either by left clicking the mouse on the box or pressing the [Space] key whenever the box has been selected (indicated by a dotted rectangle around the control name).

4.3 Navigating Between Controls

You can use either the mouse or keyboard to navigate around the controls on forms. Typically you will use a mixture of the methods. The mouse is most intuitive for navigating between forms, menus, and tabs, but you may find the keyboard [Tab] or other keys to be quite handy as well, especially during lots of data entry where constantly moving between the mouse and keyboard can be tedious. Experiment and see what methods are most comfortable for you.

1. You can point and click the left mouse button on the field or combo box you want to edit or the check box you want to select. Accessing a field or combo box in this manner will automatically put you into "insert" mode within the control, a vertical line indicating where the next keyboard character will be inserted.

2. You can use the [Tab] and [Shift-Tab] keys to cycle through the controls in forward or reverse order, respectively. These keys will place you in overwrite mode within a field or combo-box, highlighting its entire contents. In most cases, the [Enter] key will act in the same manner as the [Tab] key. One exception is when positioned in a comment field. Here, the [Enter] key is reserved for moving the cursor to a new line within the comment.

3. The [Up Arrow] and [Down Arrow] keys will work the same as the [Shift-Tab] and [Tab] keys unless you are (1) in the insert mode within a field, during which the keys will be inoperative, or (2) positioned on one of the tabs at the top of a multi-tab

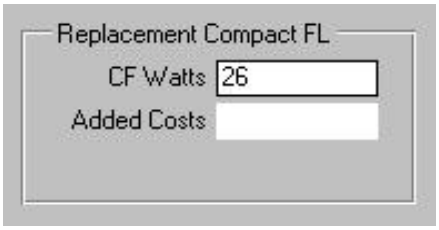
form (indicated by a dotted rectangle around the form name) in which case the [Up Arrow] key will cycle between the two rows of tabs, changing the form displayed. Note, while positioned on the tabs, the [Left Arrow] and [Right Arrow] keys will move you to other tabs within the row.

4.4 The Escape Key

The Esc key is a useful way to back out of your changes. It is similar to an "Undo" command. If you have made changes to a field but have not yet left the field, pressing the [Esc] key restores the value that was in the field prior to your change. Two consecutive [Esc] keys will back out of all changes you have made to all the controls on a form since entering it. Note, once leaving a form and navigating to another, the changes in the former are saved and cannot be reversed. Thus, if you have doubts whether many changes you will make to a home description are desired, you might make a copy of the entire home description prior to initiating the changes (see Section 3.3, *Creating an New Home Description*).

4.5 Required Versus Optional Fields

Required fields have a single solid border. If you try to exit a form with a required field blank, you will be reminded to complete all fields and the cursor will be positioned to the first missing field. If you decide NOT to save the record, you can use the [Esc] key to cancel your changes.



Two fields, the first required, the second optional

Fields without the solid line border are not necessary for MHEA to execute, although, if entered, may contain data which will affect MHEA's recommendations. Other such entries are for informational purposes only and are not used by MHEA in its computations and need not be entered. You may use them as you see fit.

4.6 Field Defaults

Most numerical fields have a user adjustable default value. This field default value is displayed in the lower left portion of the screen in the status bar when you enter a field. If you leave the field blank, the default value is applied. This allows you to quickly press the [Tab] or [Enter] key to cycle around the field controls on a form to apply the field defaults. This is different than the

Status bar showing range checks and default value

Default Record which is a way to apply defaults to an entire audit job (see Section 4.11, *The Default Record*).

You can edit the field default values on the Range Check and Default Value tab on the Preferences main menu form (see Section 9.2, *Range Check and Default Values*).

4.7 Field Range Checking

Numerical fields have range checks applied as soon as you exit the field. There are two ranges that are checked. The Acceptable range determines which number values will be acceptable to the analysis engine. All numeric entries must fall within the acceptable range. When you enter a number outside the field's acceptable range, you get an error message and are forced to change the data in that field. Remember that you can use the [ESC] key to back out of field and record changes.

The Reasonable range can be overridden or changed by the user. The minimum and maximum values are displayed in the status bar in the lower left corner of the screen when you enter the field. When you enter a value outside the reasonable range, you get a warning message that you can override. Be sure to check the accuracy of the value you entered if you choose to override. Use the Range Check and Default Values tab on the Preferences main menu form to alter reasonable ranges for individual fields (see Section 9.2, *Range Check and Default Values*).

4.8 Data Sheet and Form Views of Records

One of the useful features of the MSAccess User Interface is the ability to display different views of your records. You can select the view that best suits your needs. You can edit the data from any view displayed. There are two basic views supported.

- Standard Form View: The Form View is the most common view, allowing you to see and edit all of the information for a particular record. The controls on the form may be arranged or grouped in ways which will contribute to your understanding of the information requested.
- Datasheet View: In the Datasheet View, ALL of the records of a given component type are displayed in a spreadsheet format. All fields for a given item of requested information from all records of a given component type are in the same column in the spreadsheet. In the datasheet view, you can see all records, but typically, the number of fields is too wide to fit on one screen, so you must scroll horizontally to view all of the fields. The Datasheet View is available for only those component types having multiple records: Windows, Doors, Lighting, and Itemized Costs.

It is often helpful to temporarily switch from form view to datasheet view to see all of your records for a given component type. To switch from form view to datasheet view, right click in the form away from any control. Depending on where on the form you right click, either a rectangular "Subform Datasheet" popup window or a View/ Filter menu will appear. Left click on the rectangular window or on the Datasheet View selection on the menu. The view will change to the datasheet view.

To change back to form view, right click again in the form. The same window or menu will appear. Either left click on the rectangular window or, if displayed, choose the Form View in the menu.

Some additional features of the datasheet view may prove to be helpful. The datasheet view allows you to easily change all the entries in a given control. For example, if you wished to change Glazing Type from Single to Double on all windows in the home, you would simply travel down the Glazing Type column in the Datasheet View, changing each type as you go. (Note, the automatic fill-in feature may help you make this change quickly. For this example, you need only enter a "d" in each field, pressing the down arrow after each entry to make the changes. Or, instead of entering the "d," you could use the [Ctl-'] (control-apostrophe) key combination that copies the contents of the same field from the previous record, which, in the datasheet view, is the field immediately above.)

Datasheet views are also handy for sorting and filtering the list of records shown. You can temporarily change the column ordering and width of columns, freeze the position of certain columns, sort in ascending and descending order, and filter for certain entries. Selecting multiple columns in the data sheet (clicking and dragging in the column header) allows the sorting to operate on multiple key fields. The width of the columns can be adjusted by dragging the column header borders. The ordering of columns can be changed by highlighting a column(s) then clicking and dragging the column to a new position. All column width and position settings affect only the current datasheet view. When you close the form, the original column widths and order will be restored.

If you change to datasheet view from the General Information form, you will see a datasheet displaying this form's data for all of your audit jobs. This can be very useful in locating a particular home description. By left clicking on any one of the column headers in the table, then clicking on sort buttons in the tool bar ["AZ" or "ZA"], you can display your jobs in the order prescribed by the contents of the column. Thus, you can arrange the listing of your jobs in alphabetical or chronological order by Client Name, Job Identifier, Audit Date, etc. Left clicking on any data field for a particular job, then switching back to form view will present you with all of the input forms for that

job. Entire jobs may be deleted using the datasheet view of the General Information screen by selecting the jobs you wish to delete, then pressing the [Del] key (see Section 4.10, *Deleting a Record*).

4.9 Copying and Pasting a Record or Field

MSAccess provides a means for copying records and fields. Before you can copy a field or record, however, you must first understand how records and fields are selected. To select a record, press the record selection bar on the left side of the form. When the bar is highlighted, the record is selected. To select a field, click and drag the mouse over the contents of the field or [Tab] to the field. Either way, the contents of the field will become highlighted and selected. If the field has only one word in it, you can simply double click on the field to highlight and select it.

To copy the contents of the record or field, press the [Ctrl-C] key combination after having selected it. To paste the copied record or field into another location, select the new record or field and press [Ctrl-V]. Instead of using the [Ctrl-C] and [Ctrl-V] key combinations, you may instead use either the copy and paste icons on Access's toolbar or the Copy and Paste menu items under Edit on Access's menu, positioned at the top of your Weatherization Assistant window. If you are pasting an entire record, make sure you have selected an entire new record using the record selection bar before pressing [Ctrl-V]. Also, it makes little sense to copy a field to a field of a different data item.

You can also use the [Ctrl-'] (control-apostrophe) key combination when you are in a field to copy the contents of the same field from the previous record. This is particularly useful in the datasheet view when you just want to make a copy of the field directly above the current field in the same datasheet column.

4.10 Deleting a Record

To delete a record, first highlight the record using the record selection bar, then either press the [Del] key or select the Edit, Delete Record menu item on Access's menu. Highlighting the record selection bar on the General Information screen selects the entire job. Caution: if you delete a Job, you automatically delete all of the records (walls, windows, etc.) that are associated with that Job. Access will prompt you to make sure you really intend to delete the records.

MHEA will not allow you to delete a Parameter Set record that is referenced by existing jobs. If you try, you will get the error, "The record cannot be deleted or changed because table 'tblNJob' included related records." You must first change all the

Parameter Set references, making sure the Parameter Set you want to delete is NOT reference by any audit Job records before you attempt to delete the Parameter Set.

To delete multiple records, including whole jobs, first switch to datasheet view. Use the sorting features of the datasheet view to make those records you wish to delete appear together. Select multiple records by moving the cursor to the record selectors on the left side of the datasheet. The cursor will change to a right arrow. Then click and drag the mouse across the record selectors until the records you want to delete are highlighted. Now press the Delete key. Access will ask you if "you are sure you want to delete these records."

4.11 The Default Record

When you use the New Default MHEA Job button, you create a new job by creating a copy of the Job with the Job Identifier 'DEFAULT" (see Section 3.3, *Creating a New Home Description*). This Default Job is already in your database when the software is first installed. You can navigate to this default record using the Find controls and make whatever changes are appropriate to your area, such as the weather file selection. You can use this Default Job to specify the most common insulation types, construction details, or other common inputs that you find yourself making in your audit inputs. MHEA will not allow you to change the Job Identifier for the default job, or the New Default Job button would no longer work. The program will also not allow you to delete this job.

4.12 Entry Errors

Following an entry or when you have selected the run button, the database may detect an error in the input. Although the entire error message may not be completely understood, it will normally contain a reference to a "table" followed by the program's name for the entry in question. This name will lie in single quotes and begin with "tbl" followed by a name which can be recognized as a specific entry. For example, 'tblAgency' refers to the Agency input field on the General Information form. In such instances, locate the entry and examine its contents for conformity with the requirements given in this manual.

4.13 Getting Help

You can get help by pressing the [F1] key anywhere in MHEA. If you press [F1] having selected a specific data item (field, combo-box, or, check box), you will see help

material specific to that item. If tabs or buttons are selected when you press the [F1] key, you will see the "MHEA Main Form" help topic.

The title of the help material is always shown at the top left of the help screen. Tabs are also available which allow you to "Print" the material in the displayed help topic and, if you have searched multiple topics, go "Back" to previous topics.

Every help screen also contains a "Contents" tab at the upper left corner. To view a listing of all topics available in Help, click on the Contents tab. From here, you can choose topics by browsing through the expandable Contents tree (double clicking on a topic in the tree will reveal any sub-topics associated with it) or use the Find feature to search for a particular topic. Type a word in the field supplied and the program will search for all occurrences of that word in the help material.

Hypertext items are the highlighted help text you see in a different color. If you move the mouse cursor to the highlighted word(s) and press the left mouse key, you will see more information on that topic or word.

You can leave the help form and return to MHEA at any time by pressing the [Esc] key, clicking on the close button [X] in the upper right corner, or choosing File, Exit on the help menu bar.

Chapter 5

5.1 Home Descriptions

The term "home description" will be used within this manual to designate all the data supplied to MHEA in describing a particular home. The home description is tailored to single-family, manufactured homes. The term "job" can often be used interchangeably with "home description," although the former would apply not only to the home description but also to all the setup parameters and reports associated with having run the analysis of the home.

A home is described to MHEA by entering characteristics of the home into the computer on separate forms (see Appendix C, *Data Input and Sample Forms*). These forms are accessed from tabs on the Building Characterization and Analysis window of the program. Each titled tab, when selected, displays a screen permitting entry of information about one of the following building components: General Information; Walls, Windows, Doors, Ceiling, Floor, Air Conditioning, Heating Systems, Ducts and Infiltration, Base Loads, Itemized Additional Costs and User-Defined Measures, and Utility Bills. The Walls, Windows, Doors, Ceiling, and Floor screens are repeated under the main "Addition" tab to permit description of the building components of an addition to the manufactured home. Also, the "Base Loads" tab is subdivided into Refrigerator, Water Heater, and Lighting tabs.

For MHEA to process a job, you must enter all essential data on the General Information Screen and all envelope forms (other than those for additions). Either the Heating Systems or Air Conditioning form need also be visited. Finally, a measured Post Infiltration Reduction/Target Whole House Leakage (CFM at a given Pa) must be entered on the Ducts & Infiltration screen. Note that these are the only two entries required on this form if Evaluate Duct Sealing is not selected.

5.2 Job Identifiers

The Job Identifier is an important data item. It is supplied by the user on the General Information form. It uniquely identifies the home description to MHEA and the user. Future reference to a particular home description will use this identifier, as when using the Find feature to locate a previously entered job.

A commonly used Job Identifier is the job number assigned by an agency to a particular audit. Other examples are combinations of the audit date, occupant or landlord's

name, etc., even though there are other fields on the General Information form to input these data items individually. Common home descriptions could be saved using Job Identifiers such as "Double Wide," "Single," "With Addition," etc. Any characters, including spaces, may be used to construct the Job Identifier, but it must be unique from any other Job Identifier in your database.

5.3 Component Codes

Component codes are abbreviated names, which identify specific house components. In MHEA, the only component types requiring codes are windows, doors, and lights. They must be unique for each component of the same type for the same job. They can contain up to four letters or numbers which are not case-sensitive in determining their uniqueness. Default entries are available. They will appear in the status bar at the bottom of the Weatherization Assistant window. However, you are encouraged to enter codes of your own choosing which may help remind you of the particular building components they refer to.

Whenever an input form is exited, the component code you supplied will be checked to insure its uniqueness. If it is not, a warning box will be displayed stating, "The changes you requested to the table were not successful because they would create duplicate values in the index, primary key, or relationship," then asking you to correct the situation. For example, if the copy and paste functions had been used to copy a Window, you would need to change the Code on the duplicated window so that it no longer was the same as the Code of the original window from which it had been copied.

Codes can link windows and doors you identify on a floor plan (drawn as an aid to auditing and data entry) with those entered into MHEA. They may also help identify actions needed for specific windows or doors. By creating a separate record for a component and attaching a comment to that record, you will obtain a listing in your output report of that and other comments linked to the specific component codes. Thus, you may specify that a particular window or door needs replaced or receive other individualized attention.

Chapter 6

The home description contains all of the information needed to describe a particular manufactured home to MHEA. Entry of this data is divided into component types, such as walls, windows, ceilings, etc. Similarly, this chapter is divided into subsections, one for each component type, each describing the data required to characterize a member of that component type.

Blank copies of the screens which you will see when entering data into MHEA are included in Appendix C, *Data Input and Sample Forms*. For Windows and Doors, both the Data Sheet and Form views are shown (see Section 4.8, *Data Sheet and Form Views of Records*). Copies of these pages could be used by the auditor in collecting data while in the field.

Entries are mandatory unless followed by the word "optional" in the descriptions which follow. Range check values (see Section 4.7, *Field Range Checking*) and default values (see Section 4.6, *Field Defaults*) associated with the entries are not listed here because you may adjust them to meet your own needs (see Section 9.2 *Range Check and Default Values*).

"Acceptable values" give ranges of numerical entries outside of which a value will not be accepted. Unless otherwise listed, these ranges may be assumed to be all positive values.

6.1 General Information

The following are descriptions of entries for the General Information screen:

Client Name, Address, City, State, Zip Code, and Auditor—These are comment fields for general reference information. The entries are not used by MHEA except to be displayed at the top of the output reports. (Optional)

Audit Date—Enter the date of the audit. Most formats which can be recognized as a date will be accepted and converted to a date in the format mm/dd/yyyy. Although the entry is mandatory, it is used only at the top of output reports. (Default—current date)

Job Identifier—Identifies this job (audit) to you and the computer (see Section 5.2, *Job Identifiers*). A maximum of 30 keyboard characters, including spaces, may be entered. The entry must be unique from all other Job Identifiers in your data base of homes.

Length (feet)—Enter the length of the home in feet. Manufactured home lengths are typically in the range of 40 feet to 80 feet. The home length is the length of the living

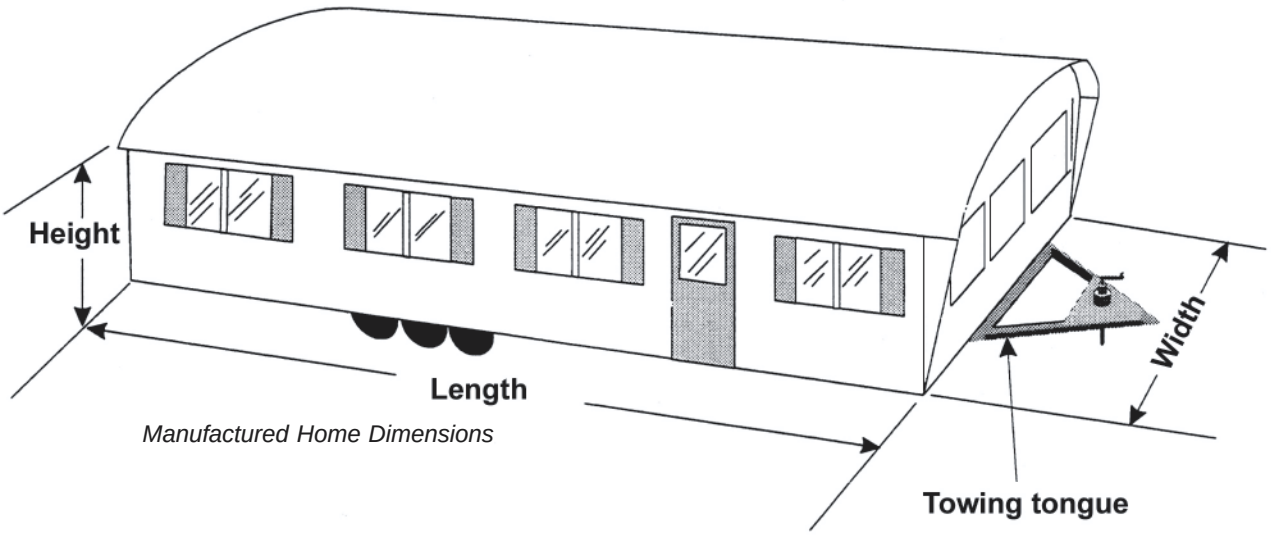
space. Do not include the length of the towing tongue that extends out from one end of the manufactured home.

Width (feet)—Enter the width of the home in feet. Manufactured home widths are typically in the range of 12 feet to 30 feet.

Height (feet)—Enter in feet the interior wall height of the home as measured from the floor to the ceiling in the interior of the home. Measurements should be taken along an exterior wall of the home. The interior height of manufactured homes is typically 7 feet.

Occasionally, a manufactured home will have a change in ceiling height or floor level. If there is a cathedral ceiling, enter the interior wall height at the low section of the cathedral ceiling as though the ceiling was flat. MHEA will calculate the additional wall area resulting from the cathedral ceiling based on information provided on the "Roof/ Ceiling" screen (see Section 6.5, *Ceiling*). If there is a step in the floor level and there is not a corresponding step in the flat-ceiling height, enter the average interior wall height for the home. Also, enter the average interior wall height if the flat ceiling has a step height change but not a corresponding change in the floor level.

Occupants—On average during the year, enter the greatest number of people who occupy the house at any given time (e.g., during dinner).



Manufactured Home Dimensions

Wind Shielding—Select the option that best describes how well the manufactured home is shielded from the wind: Well Shielded, Normal Shielding, or Exposed. A correction factor is included in the infiltration calculation for the relative amount of external wind shielding. A well-shielded home may be surrounded by thick vegetation, in a small valley that seldom experiences windy conditions, or closely surrounded by

other homes and buildings. A normally shielded home may be one that is found in a typical manufactured home housing park where there are surrounding homes and some surrounding vegetation. An exposed home has no surrounding vegetation or buildings to protect it from the wind.

Home Leakiness—Select the option which best describes the air leakiness of the home prior to your weatherization work. Leakage rates in CFM at 50 Pa associated with these selections may be set in the Key Parameters of Setup (see Section 8.7.4, *Altering Key Parameters—Heat* Transfer). These values will be used as the pre-infiltration reduction rates if none are entered in the Ducts and Infiltration form.

Outdoor Water Heater Closet—Indicate whether or not the water heater is housed in an unconditioned closet with an exterior access. If an outdoor closet exists, the calculations will not include it in the conditioned portion of the home. The wall, floor, and ceiling areas of the home are adjusted to account for a "30 × 30" inch water heater closet.

Agency Name—The only acceptable entry is the Weatherization Agency Name you provided in the Agency Information. The name will be available in the drop-down list associated with this field.

Weather File—Select the weather to be used by the program for the analysis. The associated drop-down list contains all 216 weather cities available to MHEA. They are listed in alphabetical order, first by state, then by city. The selection will be retained for any future executions of the program for that job.

Parameter Set—Select the set of parameters (material and fuel costs, candidate measures, key parameters, etc.) you wish to use during the execution of the job. MHEA allows multiple sets to be defined. Double clicking the mouse within this field will take you to the Key Parameter Setup segment of the program where these parameters can be altered (see Section 8.1, *Creating Your Own Parameter Sets*).

Include Billing Adjustments?—If checked and if pre-retrofit billing data has been entered, MHEA will adjust the savings estimates of measures to reflect this billed usage.

Last Run On—Gives the date and time the open job was last run. The field cannot be altered during input.

Comment—Enter any general comments regarding the job as a whole. Comment fields for individual component descriptions will also be available.

The Job ID # in the lower left corner of the form is a number internally generated by Microsoft Access and need not be of concern to you.

6.2 Walls

Wall Stud Size—The wall stud is the wood framing between the interior and exterior manufactured home walls. Manufactured homes are typically constructed using standard

wood framing. MHEA needs this information to calculate the wall R-value and the volume of the wall section.

> *NOTE:* The nominal dimensions (those dimensions you measure with your tape measure) are less than the standard dimensions listed. For example, a 2 inch × 4 inch board will actually have the dimensions of 1-3/4 inch × 3-1/2 inch. The options listed in MHEA are the standard dimensions used by the U.S. lumber industry.

Orientation of Long Wall—Select the cardinal direction one of the long walls of the home faces. MHEA will see North as the same as South and East the same as West, but you might adopt a convention such as entering the orientation of the long wall considered the "front" of the home. The home orientation is needed to calculate solar loads on the home.

Wall Ventilation—A manufactured home wall may be intentionally or unintentionally ventilated. A ventilated wall has a space for air to flow between the exterior and interior wall materials. One technique to determine if a wall is ventilated is to check if the wall insulation is dirty inside the wall cavity. Pull up slightly on the lower end of an exterior wall panel to check for dirty insulation. If a wall is ventilated, the insulation will be dirty. Intentionally ventilated walls will have noticeable rounded or squared channels in the skin open at the bottom through which air can travel. MHEA degrades the wall R-value for ventilated walls.

Uninsulatable Area (feet^2)—Enter the wall area not accessible for insulating. This area should be in addition to framing (assumed 15% of gross wall area) and an additional 15% general reduction factor for imperfect coverage, both already assumed by MHEA.

For example, use this entry to exclude wall area that lies between an attached unconditioned shed and the home, which you will not be able to insulate. Note that wall area associated with a conditioned addition to the home (described under the Addition tab) is automatically excluded. (Optional)

Additional Cost—Enter any added costs not normally associated with insulating the walls of the home and which are, therefore, not accounted for in your Material Costs of Setup (see Section 8.3, *Material Costs*). Note that this cost is in dollars for the entire wall insulation job, not per square foot of wall or bag of insulation used. (Optional)

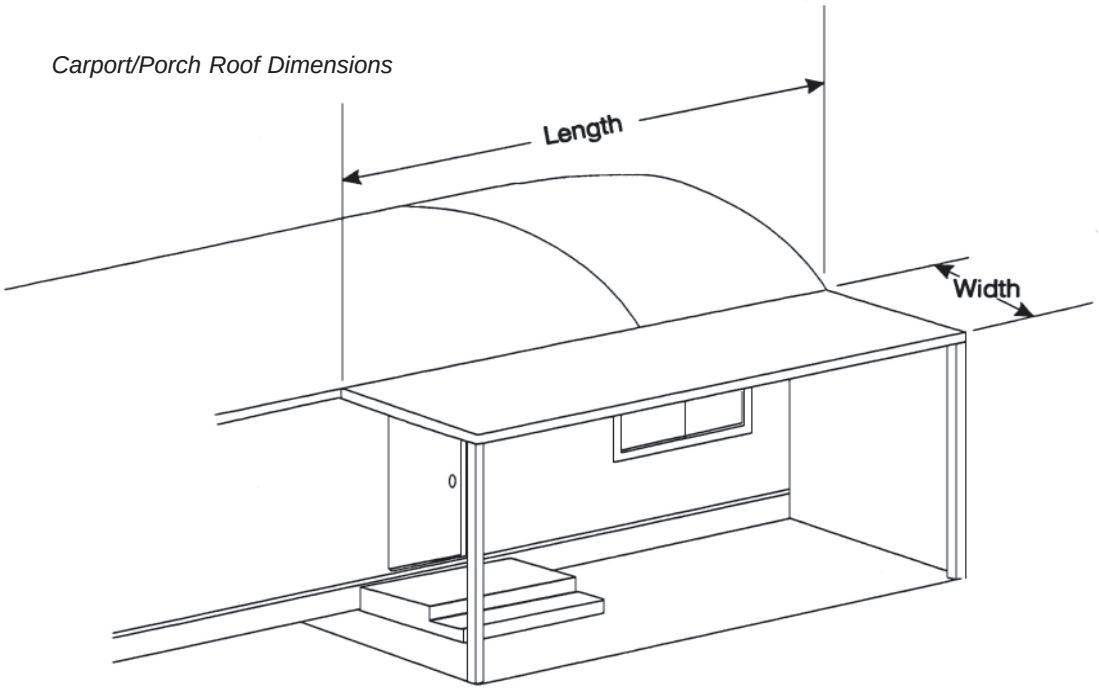
Insulation Type/Thickness—Enter the amount of existing insulation in inches. By entering a value greater than 0 inches, you are implying that the insulation exists. If you enter a thickness of 0 inches, MHEA assumes that insulation of that type does not exist.

Batt/blanket insulation is fibrous insulation formed into very long pads of various thickness. Loose-fill insulation is typically fibers, made either of glass or cellulose, blown into the wall section. Foam core insulation may also exist in the wall section. This type of insulation is a rigid foam typically 1/4 inch thick found either between the wall studs and the interior wall or the wall studs and the exterior wall. MHEA uses the existing insulation thickness to calculate the wall R-value and to calculate the volume in the wall section that is available for additional insulation

You may view and, if necessary, adjust the R-value MHEA assigns to all insulation types from within the Key Parameters tab of MHEA's Setup. Refer to Section 8.7.3, *Altering Key Parameters—Insulation*, for more information.

Carport/Porch Roof—A carport/porch roof is a shelter that has no walls and extends out from one wall of the manufactured home. Often, the home occupant will park a car under this shelter or use it to shade an outdoor sitting area. Indicate the length (in feet) and width (in feet) of this carport/porch roof. The carport/porch description can also be used to describe extensive shading of a wall due to trees or shrubs. Enter pseudo-dimensions sufficient to represent the desired degree of shading. Also indicate the orientation of the manufactured home wall to which the carport/porch is attached and shades. The roof length is the dimension parallel to the manufactured home. If no carport/porch roof exists, then enter a length and width of zero feet. Because a carport/porch roof shades one manufactured home wall, the size and orientation are needed in

Carport/Porch Roof Dimensions



the home solar gains calculations. MHEA allows description of only one carport or porch. If there is more than one attached to the home, describe the one that provides the most shading to the walls. Thus, if you had to choose, you would not enter the porch on the north face of the home.

Comment—Make any comments regarding the manufactured home walls that you want to appear on the MHEA audit report. (Optional)

6.3 Windows

The Window form contains information needed to describe different window types. Each form describes a specific type with given dimensions, shading, and construction. Windows of the same type, size, and shading can be entered on a single record regardless of their orientation. Indicate in the Number Facing fields how many windows of this type face each of the cardinal directions.

A total of twenty four window descriptions may be entered. As many as three can be displayed at one time on a screen.

Window data are presented in the following order:

Window Code—The Window Code allows you to identify the specific window type in the MHEA reports (see Section 5.3, *Component Codes*). MHEA will provide default entries of the form "WD#," where the # is the next higher consecutive integer above the number of window types already described.

Window Type—The window description is the type of window found in the manufactured home.

Jalousie windows are constructed of several horizontal panes (about 6 inches wide) that all open at the same angle when a crank near the bottom of the window is turned. Jalousie windows are always single pane. Often, very large gaps between the glass panes exit resulting in high infiltration rates through the window.

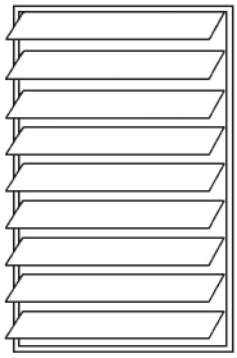
Awning windows are hinged at the top or side of the window so that when opened (usually by turning a crank), the glass angles out from the home exterior. The glass either angles down or to the side, depending on where the window is hinged to the home.

Slider windows usually have two panes of glass and either one or both panes slide past the other when the window is opened. Both horizontal and vertical slider windows are found in manufactured homes.

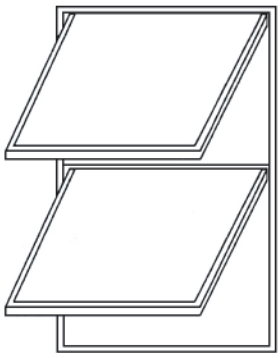
Fixed windows are sealed in the window frame and cannot be opened.

Door windows are sealed in the window frame of a door and cannot be opened.

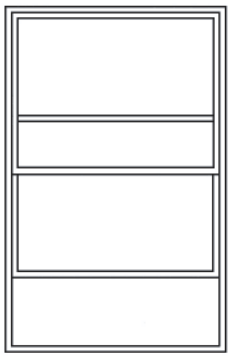
Sliding Glass Doors are large windows that extend from the floor to the ceiling. You may wish to use this selection to also describe picture windows, if they exist, even



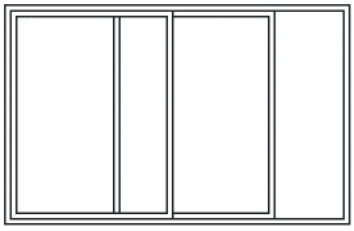
Jalousie



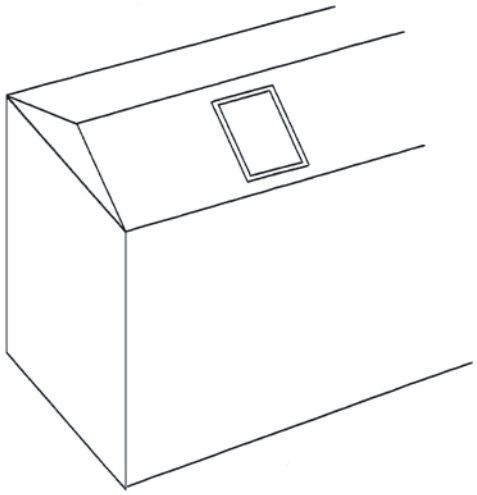
Awning



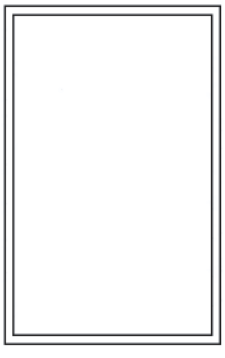
Vertical Slider



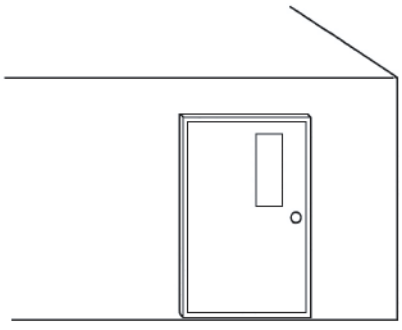
Horizontal Slider



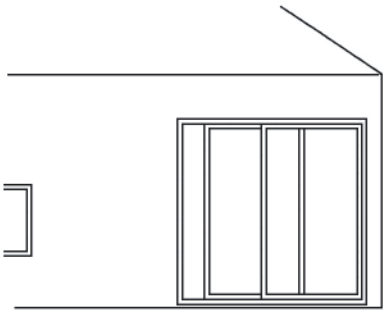
Skylight



Fixed



Door



Sliding Glass Door

Typical Manufactured Home Window Types

though they are fixed and cannot be opened. MHEA will not consider replacement of windows in this category.

Skylights are glass or plastic windows in the ceiling.

Glazing Type—Window glazing is the type and number of glass or plastic panes that make up a window.

Single-glazed windows have one plate of glass in the window frame.

Double-glazed windows have two plates of glass in the window frame.

Single-glazed windows with a glass storm have a single pane of window glass with a second (usually removable) single pane of glass installed at one inch or so from the window pane. MHEA assumes that the storm window (second, removable pane) is installed on the interior side of the window.

Double-glazed windows with a glass storm are two panes of window glass with an additional (usually removable) single pane of glass installed at one inch or so from the window pane. MHEA assumes that the storm window (second, removable pane) is installed on the interior side of the window.

Single-glazed windows with a plastic storm have a single pane of window glass with a second (usually removable) single pane or sheet of plastic installed at one inch or so from the window pane. MHEA assumes that the storm window (second, removable pane) is installed on the interior side of the window. Plastic storm window panes are rigid plastic panes held in a plastic, metal, or vinyl frame. Plastic storm window sheets are flexible plastic sheets held onto the window either with magnets around the outer edge of the plastic sheets or by a frame securely attached to the window frame.

Double-glazed windows with a plastic storm are two panes of window glass with an additional (usually removable) single pane or sheet of plastic installed one inch or so from the glass window panes. MHEA assumes that the storm window (third, removable pane) is installed on the interior side of the window. Plastic storm window panes are rigid plastic panes held in a plastic, metal, or vinyl frame. Plastic storm window sheets are flexible plastic sheets held onto the window either with magnets around the outer edge of the plastic sheets or by a frame securely attached to the window frame.

> *NOTE:* If the existing storm window is on the exterior side of the window, the window should be considered as not having a storm window. Typical manufactured home construction includes very leaky windows. The main benefit of storm windows is to prevent outside air from entering the home around the window frame. Storm windows installed on the exterior side of the window usually do not prevent air from leaking around a manufactured home window frame.

Interior Shading—Interior shading affects the amount of heat that is gained or lost through a window by reducing the solar loads on the home as well as slightly altering the window insulating value (U-value). Interior shading devices are interior window coverings that prevent sunlight from entering the manufactured home. Drapes are heavy curtains that hang in loose folds over the window. Blinds or shades are lightweight window coverings that hang flat over the window. Venetian blinds, mini-shades, and roller shades are in this category. Select drapes with shades if the occupant has both drapes and blinds/shades on the window. If there is no interior window shading, select None.

Exterior Shading—Exterior shading devices are methods of shading a window from the outside of the home. The solar load on the home is reduced because of exterior shading devices. Low-E film is a reflective film applied to the exterior surface of glass window panes by the window manufacturer. A sun screen is a mesh screen that is installed or hung on the exterior side of a window. An awning is a device that is mounted above a window and extends out from the exterior of the home. It is usually constructed of aluminum, fiberglass, or fabric. A carport/porch roof is a shelter that has no walls and extends out from one wall of the manufactured home. Often, the home occupant will park a car under this shelter or use it to shade an outdoor sitting area. Indicate which of these exterior shading devices exist. If there is no exterior window shading, select None.

Average Size—Enter in inches the length and height of the windows you are describing.

Number of Windows Facing Each Orientation—Indicate the number of exterior windows for each window description that face the orientations shown on the form. Do not enter information about windows on the portion of a wall shared with an addition. MHEA assumes all window descriptions are exposed to the outside. The portion of a wall shared with an addition is not exposed to the outside. If you describe a window on such a wall, MHEA will incorrectly include the window in the solar gains and wall R-value calculations.

Comment—Enter comments about windows that you want to appear on the MHEA report. (Optional)

6.4 Doors

Describe door types, sizes, and orientation on the Door input forms. MHEA subtracts door area from the wall area and figures heat loss from the wall and door separately.

A total of 18 door descriptions may be entered. Two or less may be displayed at one time on a screen.

Door data are presented in the following order:

Door Code—The Door Code allows you to identify the specific door in the MHEA reports. MHEA will provide default entries of the form "DR#," where the # is the next higher consecutive integer above the number of doors already described (see Section 5.3, *Component Codes*).

Door Type—Indicate the type of door the description identifies as found in the manufactured home.

Wood, hollow-core doors are constructed of two lightweight panels of wood.

Wood, solid-core doors are constructed of a solid piece of wood.

Standard manufactured home doors are constructed of a metal, vinyl, or fiberglass skin with a solid insulating core (such as polyurethane). Most manufactured home doors are this type.

Storm Door Present?—A storm door is a lightweight door installed outside of the manufactured home door. It is usually constructed of aluminum with a large portion of the door holding a screen, glass, or plastic window. Storm doors have very little impact on the energy consumption of a manufactured home other than to improve the insulating value (R-value) of the manufactured home door slightly. Indicate whether or not a storm door exists.

Replacement Door Required?—Indicate whether the existing door is in such poor condition that it must be replaced. Note that if this is indicated, MHEA will consider the replacement mandatory and recommend it whether the SIR is greater than the minimum acceptable value. Thus, it may have to be considered a repair item.

Average Size—Enter in inches the length and height of the doors you are describing.

Number of Doors Facing Each Orientation—Indicate the number of exterior doors for each door description that face the orientations shown on the form. Do not enter information about doors on the portion of a wall shared with an addition. MHEA assumes all door descriptions are exposed to the outside. The portion of a wall shared with an addition is not exposed to the outside. If you describe a door on such a wall, MHEA will incorrectly include the door in the solar gains and wall R-value calculations.

Comment—Enter comments about doors that you wish to appear on the MHEA audit report. (Optional)

6.5 Ceiling

Enter information describing the roof/ceiling section of the manufactured home.

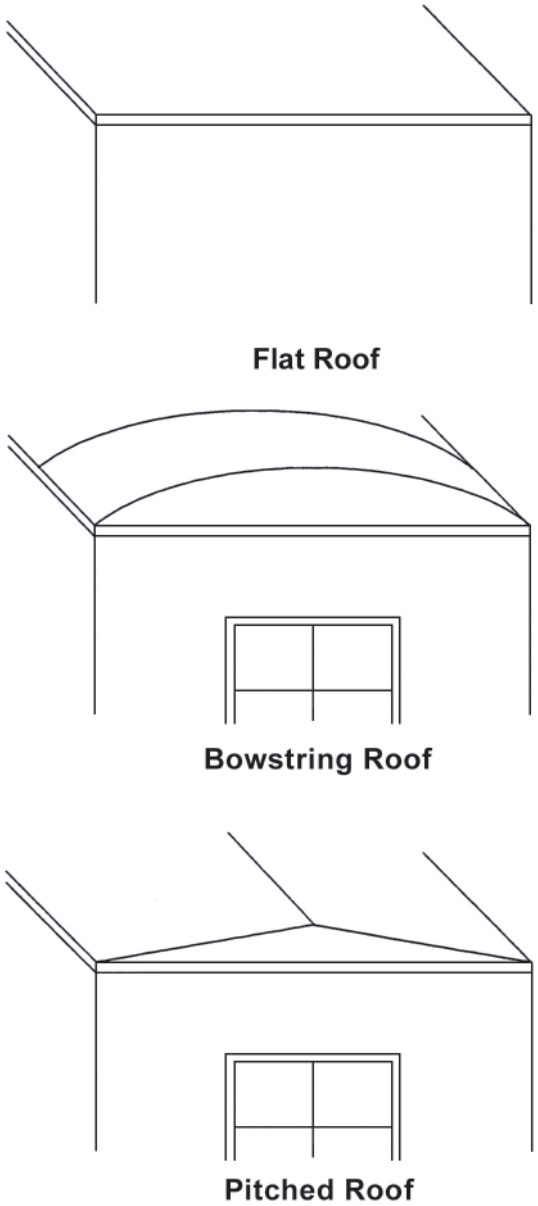
Roof Type—Based on the roof type you indicate, MHEA can calculate the volume of the roof/ceiling section.

Flat roofs have an interior surface (interior ceiling) and an exterior surface (exterior roof) attached directly to either side of the wood framing, similar to wall construction. MHEA assumes the ceiling and roof are separated by 2 inch × 6 inch framing.

Bowstring roofs have a lightweight exterior roofing material (usually aluminum) that is stretched over the roof frame structure. The roof has a slight curve with the highest point in the middle of the home width. MHEA uses the home width and the height of the roof you specify to calculate the volume of a bowstring roof section.

Pitched roofs are sloped to a higher peak point. When viewing the home width from the outdoors, the roof line creates a triangle. Pitched roofs are also often shingled, unlike flat and bowstring roofs. MHEA uses the width of the home and a height of added insulation you provide to calculate the volume of added insulation for the roof insulation measures.

> *NOTE:* In some cases, there will be a second roof constructed over the original manufactured home roof. Enter construction information describing the original manufactured home roof since it is under this roof that insulation may be added. Enter the roof color of the second exterior roof.



Typical Manufactured Home Roof Configuration

Roof Color—The reflectance of the roof affects how solar energy impacts the heating and cooling loads of the home. A White or Reflective roof appears white or shiny metallic, is clean, and has little or no discoloration due to weathering. The majority of roofs will be classified as Normal. Roofs completely shaded by trees in the summer should be designated as "White or Reflective" regardless of their finish.

Height of Roof—For Bowstring roofs, enter the maximum height in inches of the roof above the ceiling, disregarding any existing insulation. This assists MHEA in determining the available space for additional insulation. This field is not provided if a flat or pitched roof is selected.

Insulation Type Thickness—Enter the depth of existing batt/blanket, loose fill, and rigid insulation in inches, present at the center of the roof/ceiling section. By entering a value greater than 0 inch, you are implying that the insulation exists. If you enter a thickness of 0 inch or leave the field blank, MHEA assumes that insulation of that type does not exist.

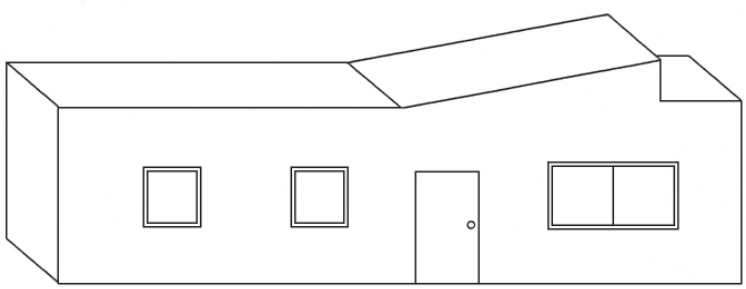
Batt/blanket insulation is fibrous insulation formed into very long pads of various thickness. Loose-fill insulation is typically fibers of either glass or cellulose that are blown into the roof/ceiling section of the home. Rigid insulation is a foam insulation typically a few inches thick found either directly under the roofing material or directly above the ceiling surface. MHEA uses the existing insulation thickness to calculate the roof/ceiling section R-value and to calculate the volume in the roof/ceiling section that is available for additional insulation. You may view and, if necessary, adjust the R-value MHEA assigns to all insulation types from within the Key Parameters tab in Setup. Refer to Section 8.7.3, *Altering Key Parameters—Insulation*, for more information.

> *NOTE:* If you feel that the insulation in the roof/ceiling section has been compressed, you may estimate and enter an uncompressed thickness, even if that thickness is greater than the value you entered for the height of the roof.

Pitched Roof Added Insul. (in.)—For the Pitched Roof Type, enter the number of inches of insulation you wish to consider adding to the existing insulation (if any) at the peak. The pitch of the roof may be such that filling the roof cavity would not be cost-effective in your climate, whereas a lesser level would. Local standard practice or experience with the predictions of MHEA will help establish the most appropriate levels to use. MHEA will not consider adding more than 12 inches. Entering a 0 will prevent roof insulation measures from being considered.

Additional Cost—Enter any added costs not normally associated with insulating the ceiling of the home and which are, therefore, not accounted for in your Material Costs of Setup (see Section 8.3, *Material Costs*). Note that this cost is in dollars for the entire ceiling insulation job, not per square foot of ceiling or bag of insulation used. (Optional)

Percent Cathedral Ceiling—Enter the approximate percent of floor area that lies beneath any portion of the manufactured home having a cathedral ceiling (a sloped ceiling where the roof and ceiling planes are parallel). For example, if a cathedral ceiling is above the living room and the living room



Manufactured Home Cathedral Ceiling with Stepwall

floor area is about one third the total home floor area, the percent cathedral ceiling is about 33%.

Step Wall Orientation—Some manufactured home ceilings slope up to the top of a short wall. This short wall then steps vertically down to the average home height. This configuration is knows as a cathedral ceiling with a step wall. Enter the orientation that the step wall faces if one exists. If the cathedral configuration does not create a step wall, choose the No Step Wall entry. This field will be accessible only if the Percent Cathedral Ceiling is greater than 0 and the roof type is flat or pitched.

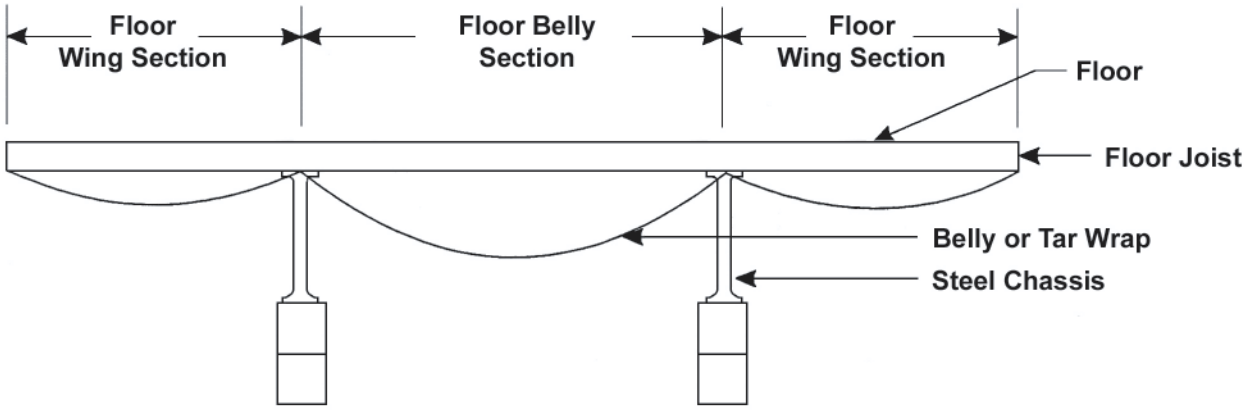
Comment—Enter comments about the roof/ceiling section that you want to appear on the MHEA audit report. (Optional)

6.6 Floor

The Floor input screen contains information about the manufactured home floor/belly section. The screen is divided into four sections. These sections are general floor information, floor wing description, floor belly (center) description, and comments.

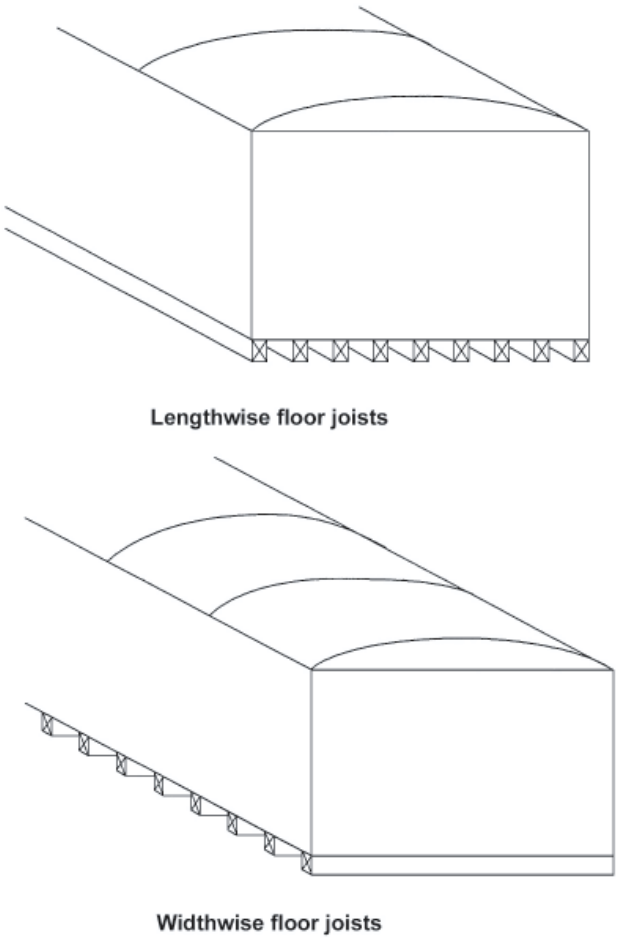
Floor Joist Direction—The floor joist is the wood framing that supports the interior floor. Enter the direction the floor joists are installed. Lengthwise floor joists are installed parallel to the long dimension (length) of the home. Width wise floor joists are installed parallel to the short dimension (width) of the home. The floor joist direction is needed to calculate more accurately the volume of the belly section and the insulating value (R-value) of the floor. The direction also indicates where a central air supply duct is located (between the joists or below the joists).

Batt/Blanket Direction—Indicate if batt/blanket insulation exists and, if it does exist, the direction in which it is installed. Batt/blanket insulation that has been installed lengthwise is parallel to the long dimension (length) of the home. Insulation that has been installed width wise is parallel to the short dimension (width) of the home. The



Section of a Typical Manufactured Home Floor

insulation direction is needed to calculate more accurately the R-value of existing batt/blanket insulation that is attached to the flooring or floor joist. Select the option indicating whether batt/blanket insulation exists and, if so, which direction it is installed.



Lengthwise and Widthwise Floor Joists

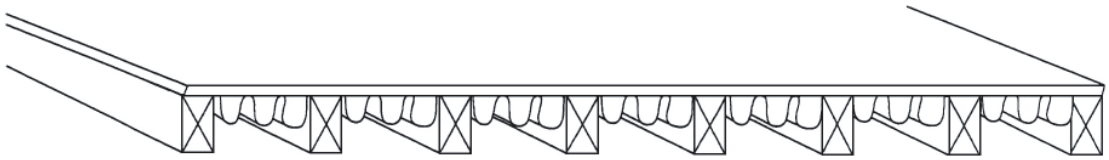
Is There a Skirt?—Check the box to indicate that a skirt exists around the exterior of the home. Research has shown that skirting only protects the manufactured home belly from exposure to the wind. If skirting exists, MHEA adjusts the exterior R-value of the floor/belly section to account for the absence of wind when its total R-value is calculated.

Floor Joist Size—The floor joist is the wood framing that supports the interior floor. Manufactured homes are typically constructed using standard wood framing. Sometimes, the floor joist size is different in the wing section than in the belly (center) section. Indicate the dimensions of the floor joists in both the wing and belly sections. MHEA needs this information to calculate the floor R-value and the volume of the floor/belly section.

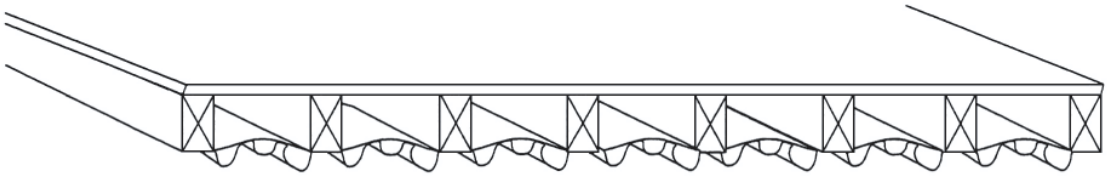
Batt/Blanket Insulation Location—Indicate where the batt/blanket insulation is located in the wing and belly sections. If the batt/blanket insulation is attached to the underside of the flooring, then select Attached to Flooring. If the insulation is attached to the underside of the floor joists, select Attached to Joist. Insulation in the belly section that is draped below the underside of the floor joists (attached only around the perimeter of the belly section) is described as Draped Below Floor Joist. Enter the batt/blanket insulation location for both the wing and belly sections separately.

If you indicated that no batt/blanket insulation exists in the Batt/Blanket Direction field, MHEA will not permit you to enter a batt/blanket insulation location.

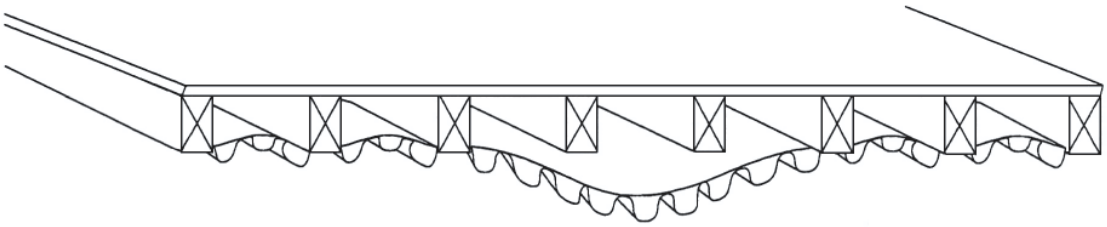
Insulation Type/Thickness—Enter the amount of existing batt\blanket and loose-fill insulation in inches. By entering a value greater than 0 inches, you are implying that the insulation exists. If you enter a thickness of 0 inches, MHEA assumes that insulation of



Insulation Attached to Flooring



Insulation Attached to Floor Joists



Insulation Draped Below Floor Joist
(Belly Section Only)

Batt/Blanket Insulation Location

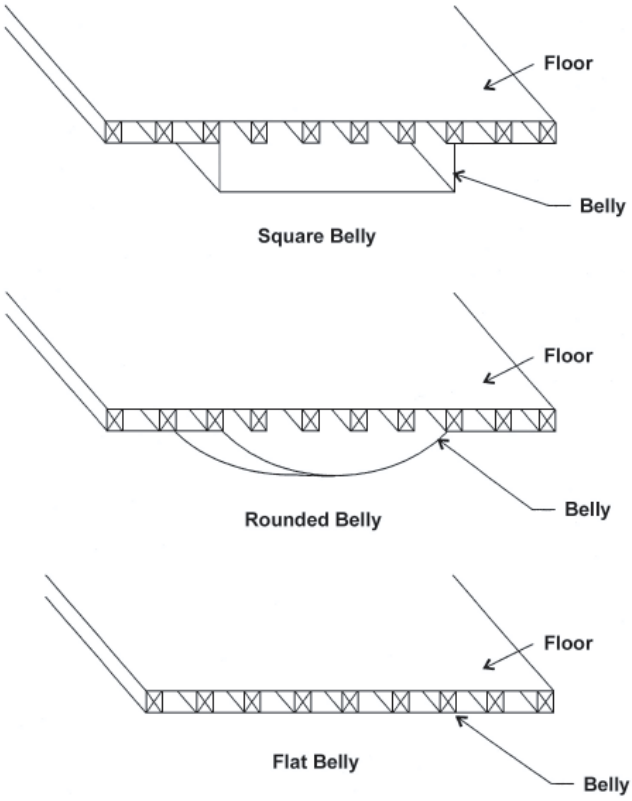
that type does not exist. Occasionally, the insulation existing in the wing section is different than that located in the belly section. Enter the amount of existing insulation for both sections.

Batt/blanket insulation is fibrous insulation formed into very long pads of various thickness. Loose-fill insulation is typically fibers of either glass or cellulose blown into the floor section of the home. MHEA uses the existing insulation thickness to calculate the floor/belly R-value and to calculate the volume in the floor/belly section that is available for additional insulation.

You may view and, if necessary, adjust the R-value MHEA assigns to all insulation types from within the Key Parameters tab of Setup. Refer to Section 8.7.3, *Altering Key Parameters—Insulation,* for more information.

Belly Cavity Configuration—Enter the configuration of the belly center cavity. Manufactured home belly cavities are described as being square, rounded, or flat. The belly cavity is the deep section that runs the length of the home and usually houses the

main supply air duct. A square cavity configuration has vertical sides and a horizontal base. (Usually, the main iron support beams act as the vertical sides.) For a rounded belly cavity configuration, the belly wrap is draped in the middle portion of the home. Usually, the wrap is draped between the main iron support beams of the home. A flat belly cavity configuration is one in which there is no center belly section lower than the belly wing section. This type of belly is often found on homes where the main air supply duct is located between lengthwise floor joists or where the main supply air duct is located in the roof section.



Typical Manufactured Home Belly Configurations

Condition of Belly—From your observation, enter the condition of the existing belly wrap. A belly wrap in good condition does not have any tears, holes, or other openings and is tightly attached around its entire perimeter. An average belly wrap condition has some small tears, holes, or other openings in the belly wrap or may not be well attached at its perimeter. A belly wrap with large tears, holes, or other openings or which is not well attached at its perimeter is in poor condition. MHEA needs the belly wrap condition to calculate the effectiveness of existing insulation in the floor/belly section. It will also alter the effectiveness of sealing any ducts lying within the belly. If the belly is in other than Good condition and you anticipate having to insulate the belly, you may wish to include as "Additional Cost" the cost of repairing the belly. Or, you may include this cost as an "Itemized Cost" and not associate it with the belly insulation measures.

Maximum Depth of Belly Cavity (inches)—Enter the maximum depth of the belly (in inches) as measured from the underside of the flooring to the lowest part of the belly. MHEA uses this input to calculate the volume of the floor/belly section to determine how much insulation can be added as a floor/belly retrofit measure.

Comment—Enter comments about the floor or belly that you want to appear in the MHEA audit report. (Optional)

6.7 Additions

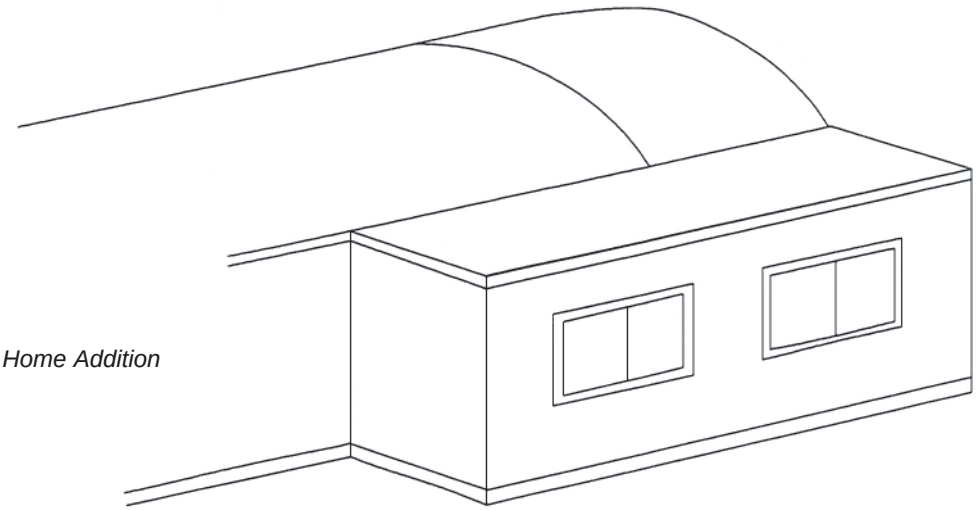
Additions are defined as any add-on structure that is conditioned by the manufactured home heating and cooling systems. Additions cannot be separated from the manufactured home (for example, by closing the door to an entrance vestibule). Additions that are part of the living space must be included in the energy calculations of the home. If the addition can and usually is separated from the manufactured home, it should not be included when evaluating weatherization retrofit measures for the manufactured home.

You may access the Addition description forms in any order to enter information about the addition. You do not necessarily need to start with the form whose tab is displayed first and move sequentially across the tabs. However, it is recommended that you complete the forms in a logical order so that you do not overlook any components of the addition. If there is no addition, you do not need to access the addition forms.

Much of the information on the addition forms is the same as that requested on the analogous building component associated with the manufactured home proper. For completeness, all addition input fields will be described in the following sections. However, those which are unique to the additions or which significantly differ from their analogous manufactured home data will have their topic headings italicized.

6.7.1 Addition—Walls

Wall Stud Size—The wall stud is the wood framing that is between the interior and exterior addition walls. Additions are typically constructed using standard wood framing. MHEA needs this information to calculate the wall R-value and the volume of the wall section.



Typical Manufactured Home Addition

> *NOTE:* The nominal dimensions (those dimensions you measure with your tape measure) are less than the standard dimensions listed. For example, a 2 inch × 4 inch board will actually have the dimensions of 1-3/4 inch × 3-1/2 inch. The options listed in MHEA are the standard dimensions used by the U.S. lumber industry.

Addition Orientation—The addition orientation is the same orientation (direction the wall faces) as the manufactured home wall to which the addition is attached. Indicate this orientation by selecting north, south, east, or west in the Addition Orientation field. The addition is assumed to be rectangular based on the floor dimensions entered on the "Addition Floor" input screen. The addition orientation is needed to calculate solar loads on the addition.

Wall Ventilation—An addition wall may be intentionally or unintentionally ventilated. A ventilated wall has a space for air to flow between the exterior and interior wall materials. The wall insulation is dirty inside ventilated walls. Pull up slightly on the lower end of an exterior wall panel to check for dirty insulation. If a wall is ventilated, the wall R-value is degraded. MHEA incorporates a correction factor to account for this degradation. Intentionally ventilated walls will have noticeable rounded or squared channels in the skin open at the bottom through which air can travel.

Additional Cost—Enter any added costs not normally associated with insulating the walls of the home and which are, therefore, not accounted for in your Material Costs of Setup (see Section 8.3, *Material Costs*). Added costs could be associated with a difference in construction between the addition walls than for walls in the manufactured home proper. Note that this cost is in dollars for the entire wall insulation job, not per square foot of wall or bag of insulation used. (Optional)

Insulation Type Thickness—Enter the amount of existing insulation in inches. By entering a value greater than 0 inch, you are implying that the insulation exists. If you enter a thickness of 0 inch, MHEA assumes that insulation of that type does not exist.

Batt/blanket insulation is fibrous insulation formed into very long pads of various thickness. Loose-fill insulation is typically fibers, made either of glass or cellulose, blown into the wall section of the addition. Foam core insulation may also exist in the wall section. This type of insulation is a rigid foam typically 1/4 inch thick found either between the wall studs and the interior wall or the wall studs and the exterior wall. MHEA uses the existing insulation thickness to calculate the wall R-value and to calculate the volume in the wall section that is available for additional insulation.

> *NOTE:* You may view and, if necessary, adjust the R-value MHEA assigns to all insulation types from within the Key Parameters tab of Setup. Refer to Section 8.7, *Altering Key Parameters*, for more information.

Wall Configuration—Select the approximate wall configuration. The ceiling slopes down from the interior wall (wall shared with the manufactured home) to the opposite exterior wall if the maximum wall height is at the interior wall. The maximum wall height is the center of the addition if, from the interior of the addition, the ceiling peaks along the center of the addition and slopes down towards the exterior walls that are perpendicular to the manufactured home. Finally, an addition with a flat ceiling has walls that are all the same height. MHEA will only accept a flat ceiling wall configuration if the minimum and maximum wall heights are the same.

Interior Wall Height—Enter the height in feet of the addition walls. Because additions are usually constructed by the occupant, they are often uniquely designed. If the walls are of varying height, enter the maximum and minimum wall heights. If the walls are all the same height, enter the same value in both the maximum and minimum height fields.

Comment—Enter comments about the addition walls that you want to appear in the MHEA audit report. (Optional)

6.7.2 Addition—Windows

The Addition Window form contains information needed to describe different window types. Each form describes a specific type with given dimensions, shading, and construction. Windows of the same type, size, and shading can be entered on a single record regardless of their orientation. Indicate in the Number Facing fields how many windows having the description face each of the cardinal directions.

A total of twenty four addition window descriptions may be entered.

Window data are presented in the following order:

Window Code—The Window Code allows you to identify the specific window type in the MHEA reports (see Section 5.3, Component Codes). MHEA will provide default entries of the form "AWD#," where the # is the next higher consecutive integer above the number of addition window types already described.

Window Type—The window description is the type of window found in the addition.

Jalousie windows are constructed of several horizontal panes (about 6 inches wide) that all open at the same angle when a crank near the bottom of the window is turned. Jalousie windows are always single pane. Often, very large gaps between the glass panes exit resulting in high infiltration rates through the window.

Awning windows are hinged at the top or side of the window so that when opened (usually by turning a crank), the glass angles out from the home exterior. The glass either angles down or to the side, depending on where the window is hinged to the addition exterior.

Slider windows usually have two panes of glass and either one or both panes slide past the other when the window is opened. Both horizontal and vertical slider windows may be found in manufactured home additions.

Fixed windows are sealed in the window frame and cannot be opened.

Door windows are sealed in the window frame of a door and cannot be opened.

Sliding Glass Doors are large windows that extend from the floor to the ceiling. You may wish to use this selection to also describe picture windows, if they exist, even though they are fixed and cannot be opened. MHEA will not consider replacement of windows in this category.

Skylights are glass or plastic windows in the ceiling of the addition.

Glazing Type—Window glazing is the type and number of glass or plastic panes that make up a window.

Single-glazed windows have one plate of glass in the window frame.

Double-glazed windows have two plates of glass in the window frame.

Single-glazed windows with a glass storm window have a single pane of window glass with a second (usually removable) single pane of glass installed one inch or so from the primary window pane.

Double-glazed windows with a glass storm window are two panes of window glass with an additional (usually removable) single pane of glass installed one inch or so from the primary window panes.

Single-glazed windows with a plastic storm window have a single pane of window glass with a second (usually removable) single pane or sheet of plastic installed one inch or so from the glass window pane. Plastic storm window panes are rigid plastic panes held in a plastic, metal, or vinyl frame. Plastic storm window sheets are flexible plastic sheets held onto the window either with magnets around the outer edge of the plastic sheets or by a frame securely attached to the window frame.

Double-glazed windows with a plastic storm window are two panes of window glass with an additional (usually removable) single pane or sheet of plastic installed one inch or so from the glass window panes. Plastic storm window panes are rigid plastic panes held in a plastic, metal, or vinyl frame. Plastic storm window sheets are flexible plastic sheets held onto the window either with magnets around the outer edge of the plastic sheets or by a frame securely attached to the window frame.

Interior Shading—Interior shading affects the amount of heat that is gained or lost through a window by reducing the solar loads on the home as well as slightly altering the window insulating value (U-value). Interior shading devices are interior window coverings that prevent sunlight from entering the addition. Drapes are heavy curtains that hang in loose folds over the window. Blinds or shades are lightweight window coverings that

hang flat over the window. Venetian blinds, mini-shades, and roller shades are in this category. Select drapes with shades if the occupant has both drapes and blinds/shades on the window. If there is no interior window shading, select None.

Exterior Shading—Exterior shading devices are methods of shading a window from the outside of the addition. The solar load on the addition is reduced because of exterior shading devices. Low-E film is a reflective film applied to the exterior surface of glass window panes by the window manufacturer. A sun screen is a mesh screen that is installed or hung on the exterior side of a window. An awning is a device that is mounted above a window and extends out from the exterior of the home. It is usually constructed of aluminum, fiberglass, or fabric. A carport/porch roof is a shelter that has no walls and extends out from one wall of the addition. Often, the home occupant will park a car under this shelter or use it to shade an outdoor sitting area. Indicate which of these exterior shading devices exist. If there is no exterior window shading, select None.

Average Window Size—Enter in inches the length and height of the windows you are describing.

Number of Windows Facing Each Orientation—Indicate the number of windows for each window description that face the orientations shown on the form. Do not enter information about windows on the portion of a wall shared with the manufactured home proper. MHEA assumes all window descriptions are exposed to the outside.

Comment—Enter comments about windows that you want to appear on the MHEA report. (Optional)

6.7.3 Addition—Doors

Describe addition door types, sizes, and orientation on the Addition Door input forms. MHEA subtracts door area from the wall area and figures heat loss from the wall and door separately.

A total of 18 door descriptions may be entered.

Door data are presented in the following order:

Door Code—The Door Code allows you to identify the specific door in the MHEA reports. MHEA will provide default entries of the form "DR#," where the # is the next higher consecutive integer above the number of doors already described (see Section 5.3, *Component Codes*).

Door Type—Indicate the type of door the description identifies as found in the addition.

Wood, hollow-core doors are constructed of two lightweight panels of wood.

Wood, solid-core doors are constructed of a solid piece of wood.

Insulated metal doors are constructed of a metal, vinyl, or fiberglass skin with a solid insulating core (such as polyurethane).

Storm Door Present?—A storm door is a lightweight door installed outside of the addition door. It is usually constructed of aluminum with a large portion of the door holding a screen, glass, or plastic window. Storm doors have very little impact on the energy consumption of a manufactured home other than to improve the insulating value (R-value) of the manufactured home door slightly. Indicate whether or not a storm door exists.

Replacement Door Required?—Indicate whether the existing door is in such poor condition that it must be replaced. Note that if this is indicated, MHEA will consider the replacement mandatory and recommend it whether the SIR is greater than the minimum acceptable value. Thus, it may have to be considered a repair item.

Average Door Size—Enter in inches the length and height of the doors you are describing.

Number of Doors Facing Each Orientation—Indicate the number of exterior doors for each door description that face the orientations shown on the form. Do not enter information about doors on the portion of a wall shared with the manufactured home proper. MHEA assumes all door descriptions are exposed to the outside. The portion of a wall shared with the manufactured home is not exposed to the outside.

Comment—Enter comments about addition doors that you wish to appear on the MHEA audit report. (Optional)

6.7.4 Addition—Ceiling

Enter information describing the roof/ceiling section of the addition on the Addition Ceiling form.

Joist Size—The roof/ceiling joist is the wood framing that supports the interior ceiling and the exterior roof. Additions are typically constructed using standard wood framing. Indicate the dimensions of the roof/ceiling joists. MHEA needs this information to calculate the roof/ceiling R-value and the volume of the addition roof/ceiling section.

> *WARNING:* The nominal dimensions (those dimensions you measure with your tape measure) are less than the standard dimensions listed. For example, a 2 inch × 4 inch board will actually have the dimensions of 1-3/4 inch × 3-1/2 inch The options listed in MHEA are the standard dimensions used by the U.S. lumber industry.

Roof Color—The color of the roof affects how solar energy impacts the heating and cooling loads of the addition. A light/reflective roof appears white or light gray and a dark roof is black, dark brown, or other dark color.

Additional Cost—Enter any added costs not normally associated with insulating the ceiling of the home and which are, therefore, not accounted for in your Material Costs of Setup (see Section 8.3, *Material Costs*). Added costs could be associated with a difference in construction between the addition ceiling and the ceiling in the manufactured home proper. Note that this cost is in dollars for the entire ceiling insulation job, not per square foot of ceiling or bag of insulation used. (Optional)

Insulation Type Thickness—Enter the amount of existing batt/blanket, loose-fill, and rigid insulation in inches. By entering a value greater than 0 inch, you are implying that the insulation exists. If you enter a thickness of 0 inch or leave the field blank, MHEA assumes that insulation of that type does not exist. (Optional)

Batt/blanket insulation is fibrous insulation formed into very long pads of various thickness. Loose-fill insulation is typically fibers of either glass or cellulose blown into the roof/ceiling section of the addition. Rigid insulation is a foam insulation typically a few inches thick found either directly under the roofing material or directly above the ceiling surface. MHEA uses the existing insulation thickness to calculate the roof/ceiling R-value and to calculate the volume in the roof/ceiling section that is available for additional insulation. (Optional)

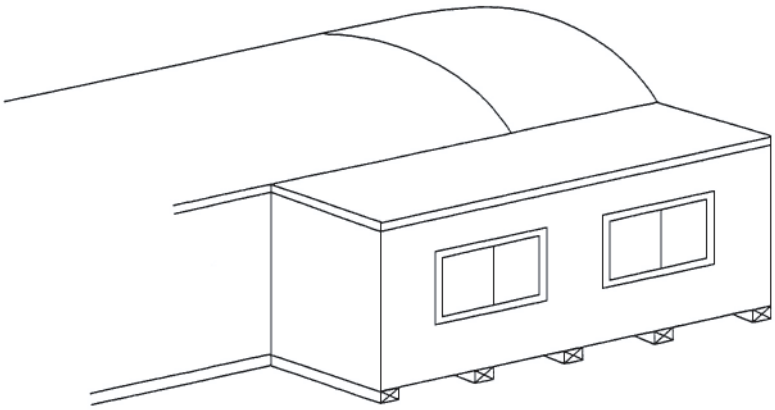
> *NOTE:* You may view and, if necessary, adjust the R-value per inch MHEA assigns to all insulation types from within the Key Parameters tab in Setup. Refer to Section 8.7.3, *Altering Key Parameters—Insulation*, for more information.

Comment—Enter comments about the addition roof/ceiling section that you want to appear on the MHEA audit report. (Optional)

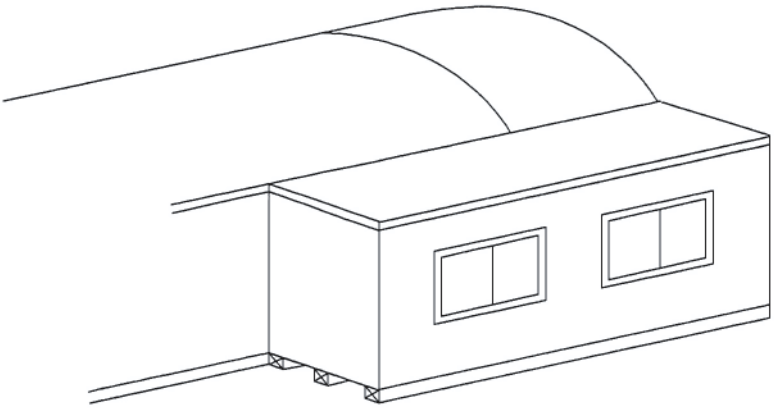
6.7.5 Addition—Floor

Enter information describing the floor section of the addition on this form. You will notice that the Addition Floor form is very similar to the Floor form for the manufacture home proper (see Section 6.6, *Floor*) except that the Addition Floor form does not assume that separate wing and belly sections exist.

Floor Joist Direction—The floor joist is the wood framing that supports the interior floor. Enter the direction the floor joists are installed. Lengthwise floor joists are installed parallel to the long dimension (length) of the addition. Widthwise floor joists are installed parallel to the short dimension (width) of the addition. The floor joist direction



Widthwise Addition Floor Joists



Lengthwise Addition Floor Joists

Manufactured Home Addition Floor Joist Direction

is needed to calculate more accurately the volume of the addition floor section and the R-value of the floor.

Floor Joist Size—The floor joist is the wood framing that supports the interior floor. Additions are typically constructed using standard wood framing. Indicate the dimensions of the floor joists. MHEA needs this information to calculate the floor R-value and the volume addition floor section.

> *NOTE:* The nominal dimensions (those dimensions you measure with your tape measure) are less than the standard dimensions listed. For example,

a 2 inch × 4 inch board will actually have the dimensions of 1-3/4 inch × 3-1/2 inch. The options listed in MHEA are the standard dimensions used by the U.S. lumber industry.

Batt/Blanket Direction—Indicate if batt/blanket insulation exists and if it does exist, the direction in which it is installed. Batt/blanket insulation that has been installed lengthwise is parallel to the long dimension (length) of the addition. Insulation that has been installed widthwise is parallel to the short dimension (width) of the addition. The insulation direction is needed to calculate more accurately the R-value of existing batt/blanket insulation that is attached to the flooring or floor joist. Select the option indicating where the batt/blanket insulation exists and, if it exists, which direction it is installed.

Batt/Blanket Insulation Location—Indicate where the batt\blanket insulation is located in the addition floor. If the batt/blanket insulation is attached to the underside of the flooring, select Attached to Flooring. If the insulation is attached to the underside of the floor joists, select Attached to Floor Joist.

NOTE: If you indicated that no batt/blanket insulation exists in the Batt/Blanket Direction field, MHEA will not permit you to enter a batt/blanket insulation location.

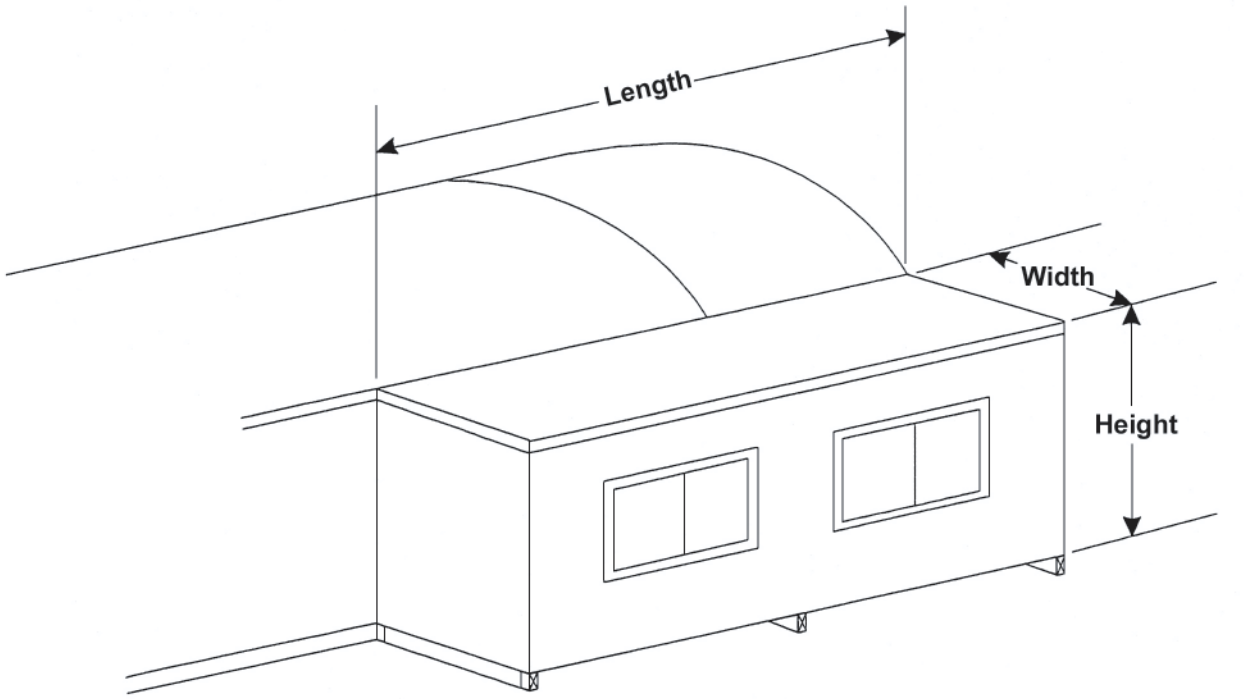
Depth Available for Added Insulation—Enter in inches the depth of space available for added insulation in the addition floor section. This information is needed when MHEA calculates retrofit measures to be installed in the addition.

Insulation Type/Thickness—Enter in inches the amount of existing batt/blanket and loose-fill insulation. By entering a value greater than 0 inch, you are implying that the insulation exists. If you enter a thickness of 0 inch or leave the field blank, MHEA assumes that insulation of that type does not exist.

Batt/blanket insulation is fibrous insulation formed into very long pads of various thickness. Loose-fill insulation is typically fibers of either glass or cellulose blown into the floor section of the addition. MHEA uses the existing insulation thickness to calculate the floor R-value.

NOTE: You may view and, if necessary, adjust the R-value MHEA assigns to all insulation types from within the Key Parameters tab in Setup. Refer to Section 8.7.3, *Altering Key Parameters—Insulation*, for more information.

Skirt?—Check the Skirt checkbox if a skirt exists around the exterior of the addition. Research has shown that skirting only protects the addition floor from exposure to the wind. If skirting exists, MHEA adjusts the exterior air R-value to account for the absence of wind when the total R-value of the floor section is calculated.



Manufactured home Addition Dimensions

Floor Dimensions—Enter the dimensions of the addition floor. The floor length is the dimension parallel to the wall shared with the manufactured home and the floor width is the dimension perpendicular to the wall shared with the manufactured home.

> *NOTE:* In order for MHEA to recognize that there is an addition, you must enter floor dimensions. If you complete other addition description forms but do not enter floor dimensions, MHEA will assume that an addition does not exist.

Comment—Enter comments about the addition floor that you want to appear in the MHEA audit report. (Optional)

6.8 Air Conditioning

Describe the equipment used to cool the manufactured home on the Air Conditioning form. Some manufactured homes have more than one cooling system. Usually, a second air conditioner is added by the occupants because the primary system is unable to satisfactorily cool the home. Describe the primary air-conditioner on the Primary sub-form under Air Conditioning and the secondary system on the Secondary sub-form. Normally the primary system would be that air-conditioner which delivers the majority of the cooling or which cools the larger part of the manufactured home. Note that the

two forms are nearly identical. If the occupant does not have an air-conditioning system in the manufactured home, do not access the Air Conditioning tab, leaving the form blank or enter None in the AC Unit Type field.

> *NOTE:* Enter information on the Primary Air Conditioning form to describe the cooling system that will become the primary system after weatherizing the manufactured home. In some cases, this primary system may supply only a small portion of the needed cooling before weatherization has been completed.
>
> *NOTE:* You must describe either a heating system or an air conditioner. MHEA will not execute without some equipment described.

Cooling Equipment Type—Indicate the home cooling equipment type. If the occupant does not have an air-conditioning system in the manufactured home, select None.

Evaporative coolers usually are a rectangular box mounted on the roof of the home. Air is cooled when it is pulled through wetted pads before being blown into the home from one central supply air location. There is no ductwork with evaporative coolers. If Evaporative Cooler is chosen as the AC Unit Type, the only other field on the Air Conditioning form which will be presented is the Comment field.

Central air conditioners have a cooling coil often located inside the home (with the central furnace unit) and a condenser found outdoors near the home. Central air-conditioning systems distribute cool air through ducts, usually the same ducts through which heated air is supplied to the home.

Room air conditioners are either installed in a window or mounted through an exterior wall. This type of air conditioner is designed to cool only one room or a portion of the home. There is no ductwork with room air conditioners.

Heat Pumps provide both heating and cooling to the manufactured home. Like a central air conditioner, they usually have a cooling coil and air handler located inside the home and a condenser found outdoors near the home. Conditioned air is usually distributed through ducts.

Capacity (kBtu/h)—Read the energy input from the nameplate attached to the cooling equipment. No capacity input is allowed if the cooling equipment is an evaporative cooler or if no cooling equipment exists.

> *WARNING:* If MHEA determines that the capacity of the equipment is insufficient to meet the home's load, the annual energy consumption predicted by the program for the house will be reduced, also reducing the savings which might be predicted for individual measures.

Efficiency—Enter the equipment-rated efficiency from the nameplate attached to the cooling equipment. If an efficiency rating is not included on the nameplate, look up the efficiency in a cooling equipment blue book or other literature that includes typical values for various cooling equipment types and ages. Entries for COP, EER, and SEER are permitted. COP values will normally fall between 1.5 and 4, while EER and SEER values may range from 5 to 14. See Efficiency Units for additional information.

Efficiency Units—Select the unit of efficiency entered in the Equipment Efficiency field: COP, EER, or SEER. EER ratings are commonly found on window/room air-conditioners while the SEER ratings are more common on central systems. MHEA assumes that COP and EER values are instantaneous or steady state efficiencies, while the SEER is a seasonal efficiency.

Duct Location—Select the location of the main supply air duct for the cooling system. Usually, manufactured homes will have a single duct that runs along the center of the home or two ducts, each running along the length of the home, connected by a cross duct. The main supply duct will be located under the floor or above the ceiling. In some cases, there will not be an existing main supply air duct.

Duct Insulation Location—Select the location of the main cooling supply air duct insulation. Insulation may be located only on the top of the duct, only on the bottom of the duct, or wrapped completely around the duct. Ductboard is a rigid insulation used to either insulate ducts or to create a plenum that is used as a duct. Indicated that the insulation is around the duct if ductboard is used. (Entry available only if Duct Location is other than None.)

Percent Cooled (%)—Enter the approximate percent of home floor area cooled by the room air conditioner. For example, if a room air conditioner cools the living room and the living room floor area is about one-third the total home floor area, the approximate home area cooled by the room air conditioner is 33%.

Comment—Enter comments about the air conditioning system that you want to appear in the MHEA audit report. (Optional)

6.9 Heating Systems

Describe the equipment used to heat the manufactured home on the heating equipment description forms. Some homes have more than one heating system. The occupants may add a second heating system because the primary system is unable to satisfactorily heat the home. Describe the primary heating system on the Primary sub-form under Heating Systems and the secondary system on the Secondary sub-form.

NOTE: Normally the primary system will be that heating system which supplies the majority of heat to the manufactured home and to which MHEA will consider installing energy efficiency measures. However, in some circumstances, this may be the case only after weatherizing. Enter information on the Primary Heating System form describing the existing heating system that will be the primary heating system after weatherizing the manufactured home. In some cases, this existing primary system may supply only a small portion of the needed heat before weatherization has been completed.

WARNING: If the existing furnace condition is such that products of combustion are allowed to enter the home, the situation is a health and safety issue that must be resolved before weatherization retrofit measures are installed into the home. After weatherizing, it is recommended to again test for combustion products in the living space.

6.9.1 Primary Heating System

The Primary Heating System data are presented in the following order:

Equipment Type—Indicate the home heating equipment type. If the occupant does not have a heating system in the manufactured home, enter None as the heating equipment type.

NOTE: You must describe either a heating system or an air conditioner. MHEA will not execute without some equipment described.

Furnace systems use ducts in the belly or ceiling to deliver heated supply air to the various rooms of the manufactured home. They may or may not have additional ducts supplying return air from the home to the furnace to be heated. Combustion-type Furnaces (natural gas, oil, and propane) direct the hot combustion gases resulting from burning the fuel through a heat exchanger to heat cooler indoor air. These furnaces have a burner, sometimes an air duct to bring combustion air from the outside into the furnace closet, and an exhaust duct (flue) to release combustion gases to the outdoors. Electric Furnaces heat air by pulling air over electric resistance heating panels. This furnace type differs from combustion-type furnaces in that there are no burners or ducts for combustion air supply or exhaust. Coal and wood burning Furnaces are not standard to manufactured homes. Because someone other than the manufacturer installed this furnace into the manufactured home, many types of coal and wood burning furnaces

may exist. The furnace should be installed so that adequate combustion air is brought in from the outdoors and the products of combustion are completely removed from the living space. It is recommended that you conduct tests to ensure that combustion gases are not in the living space.

Heat Pumps provide both heating and cooling to the manufactured home. Air-to-air heat pumps are most commonly found in manufactured homes. These usually have a heating/cooling coil and air handler located inside the home and an evaporator/condenser found outdoors near the home. Conditioned air is usually distributed through ducts. Electricity powers heat pumps so there are no burners or ducts for combustion air or exhaust. When operating in the heating mode, these heat pumps extract heat from outdoor air in order to heat the indoor air.

Space Heaters deliver heated air directly to the space in which they exist, having no supply or return ducts. They are made in various sizes (capacities) capable of heating only a small room to larger wall mounted units which can often heat a substantial portion of the manufactured home. Combustion-type space heaters (natural gas, oil, propane, kerosene, coal, and wood) should have exhaust ducts (vents) to release the combustion gases to the outdoors. Unvented combustion-type space heaters can be dangerous to the occupants. Most weatherization programs will either replace these units or choose not to weatherize the home. Sometimes non-conventional means of heating a home will be considered a space heater, for example, the kitchen stove. Wood-burning pot-belly stoves would also be considered space heaters as would fireplaces.

Fuel Type—Select the fuel type associated with the primary heating system, whether it be a furnace or space heater. Heat pumps are automatically considered electric.

Capacity (kBtu/h)—Enter the rated input capacity (usually found on the equipment nameplate) for natural gas, electric, propane, oil, and kerosene furnaces and space heaters. Enter the rated output capacity for heat pumps. Capacity input for coal and wood systems is not required.

> WARNING: If MHEA determines that the capacity of the equipment is insufficient to meet the home's load, the annual energy consumption predicted by the program for the house will be reduced, also reducing the savings which might be predicted for individual measures.

Efficiency—Enter the heating efficiency of the primary heating system in the Efficiency Units selected. The heating efficiency is the fraction of heat supplied to the living space by the equipment after fuel is consumed to produce the heat. The efficiency entered should be for the heating equipment only and not take into account the air supply system. The value entered may be either a percent or a pure number depending on the units selected. See Efficiency Units for additional information.

NOTE: An electric furnace or unvented space heater is 100% efficient as long as it is located in the living space of the manufactured home. If an electric furnace is located in a closet with an exterior access, the heating efficiency should be derated by as much as 10%, depending on how easily the closet communicates with the outside.

Efficiency Units—Select the unit of efficiency entered in the Equipment Efficiency field: Steady State, AFUE, COP, or HSPF. COP and HSPF are used in rating heat pump equipment while AFUE and Steady State entries apply to fossil fuel or electric resistance heating. AFUE and HSPF are treated as annual average efficiencies, while Steady State and COP are instantaneous measures of efficiency. Steady State and AFUE entries are expressed as percentages typically ranging from 50% to 100% (for electric resistance heating). COP entries are pure numbers with typical values between 1.5 and 4.0. HSPF values are also pure numbers with typical values between 5.0 and 10.0.

Duct Location—Select the location of the main supply air duct for the heating system. Usually, manufactured homes will have a single duct that runs along the center of the home or two ducts, each running along the length of the home and connected by a cross-over duct. The main supply duct will be located under the floor or above the ceiling. In some cases, there will not be an existing main supply air duct. If the existing supply air duct has been disconnected from the central heating system and there are no plans to reconnect it, then indicate by selecting None that there is no existing main supply air duct.

Duct Insulation Location—Enter the location of insulation, if any, associated with the main supply air duct. Insulation may be located only on the top of the duct, only on the bottom of the duct, or wrapped completely around the duct. Ductboard is a rigid insulation used to either insulate ducts or to create a plenum that is used as a duct. Indicate that the insulation is around the duct if ductboard is used.

Percent of Total Heat Supplied (%)—If there are two heating systems in the home, estimate the amount of heat supplied by the primary heating system. Enter this value as a percent of the total heat supplied by both the primary and secondary heating systems. MHEA assumes that the primary system supplies 100% of the required heat unless you indicate otherwise. If you attempt to access the secondary heating equipment form having entered 100% for the Percent of Total Heat Supplied, MHEA will warn you and ignore any information you enter on this form.

Comment—Enter any comments regarding the primary heating system that you want to appear on the MHEA output report. (Optional)

6.9.2 Secondary Heating System

Once you have fully described the primary system, you may describe a secondary system if (1) the primary system does not provide 100 percent of the heat and (2) another heating system exists, such as a space heater. Click the tab labeled "Secondary" to access the Secondary Heating Equipment description form. Secondary equipment may be used by the occupant to supply heat that cannot be supplied by the primary heating system. Inputs present on the Secondary Heating Equipment form are identical to analogous entries on the Primary Heating Equipment form. Required entries include Equipment Type, Fuel Type, Capacity, and Efficiency . An optional Comment field also exists. Note that MHEA will use the information provided on the Secondary Heating Equipment screen only if the primary heating equipment supplies less than 100% of the required heat.

6.9.3 Replacement Heating System

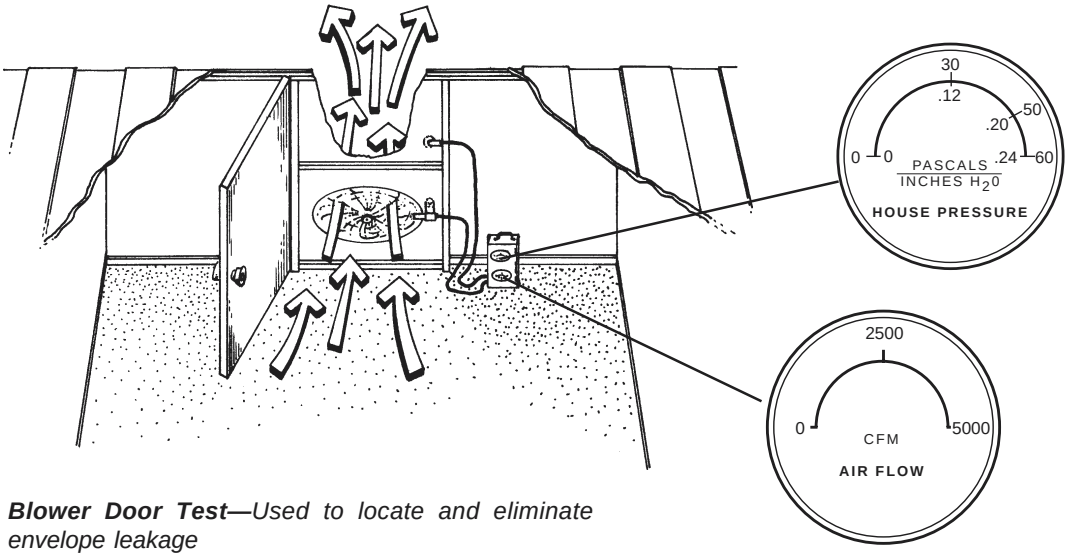
Click the tab labeled "Replacement" to access the Replacement Heating Equipment description form. A form similar to the Primary Heating Equipment form will appear. Use this form to specify the equipment you want MHEA to evaluate as the replacement unit for a possible retrofit measure. If replacing the heating equipment is mandatory, check the "Replacement Required" check box. Also, check the box next to "Include Replacement Costs in Home Retrofit" to indicate that the costs associated with a mandatory replacement of the heating equipment are to be included with the home retrofit costs.

6.10 Ducts and Infiltration

MHEA provides means to evaluate the effectiveness of duct sealing and infiltration reduction work. Note, however, it does not direct this work since air leakage reductions from specific weatherization activities cannot be predicted accurately with calculations. It assumes that available procedures of locating and repairing air leaks are being used.

What information you provide MHEA regarding ducts and infiltration will depend on what measurements you are accustomed to taking during an audit.

Blower doors depressurize (or pressurize) a house to some pressure differential (measured in Pascal, Pa) with respect to the outside. They can then measure the cubic feet per minute (CFM) of air passing through leaks in the house at that pressure differential. Since the pressure differential is greater than under normal circumstances, the air leaks are exaggerated above what they would be normally, allowing easier detection.



Blower Door Test—*Used to locate and eliminate envelope leakage*

A duct blower works in a similar manner as the blower door, except that it pressurizes only the ducts with respect to the remainder of the house and outdoors. Similarly, it will provide the CFM of air leaking from the ducts at this pressure differential.

Seven different modes of data input relating to ducts and air infiltration are available. The first three below assume that no duct leakage measurements are available. For all of these cases, leave the Evaluate Duct Sealing check box, located on the Ducts and Infiltration form, unchecked. The remaining modes will evaluate your duct sealing efforts.

Regardless of which of the seven modes you use, each has a Comment field into which you may enter any information regarding ducts and infiltration you want to appear in the MHEA audit report. The entry, however, is optional.

> *NOTE:* Duct sealing will be evaluated only for a forced-air furnace, heatpump, or forced-air furnace and air-conditioner combination. MHEA will not use any duct leakage data unless you have indicated these equipment types.

1. No duct or infiltration measurements available

If you wish to run MHEA without duct and infiltration measurement data (either because your program doesn't make these measurements or because measurements are not available at the time you run MHEA), you can do so by accessing the Ducts and Infiltration form, leaving the Evaluate Duct Sealing check box unchecked, then supplying entries for the only two required fields on the form:

Post Infiltration Reduction/Target Whole House Leakage (CFM)—If your audit procedure has established a target post-retrofit CFM leakage rate, enter it here. Otherwise, use the default value of 2500 CFM, unless you have a better estimate of what the final leakage rate will be. (Default—2500 CFM)

Post Infiltration Reduction/Target, Pressure Differential (PA)—Enter either the pressure differential on which your target leakage rate or estimate is based or accept the default of 50 PA, corresponding to the default leakage. (Default—50 Pa)

These settings will allow MHEA to make logical recommendations for the other measures it considers while not addressing the infiltration or duct leakage. A post-retrofit air leakage is required rather than a pre-retrofit value, because MHEA assumes some air leakage reduction is likely to occur, particularly if the initial reading is significantly higher than the default or target level. Estimates of savings for other measures will be more accurate if they are based on the air leakage characteristics of the house after this reduction is accomplished, rather than at its pre-retrofit level.

2. Only pre-infiltration reduction air leakage readings are available.

If your audit procedure regularly takes pre-infiltration reduction blower-door readings but has no post-reduction values at the time MHEA is run, you may enter these readings in the Pre Infiltration Reduction, Whole House Leakage and Pressure Differential fields. However, you must still enter either target or estimated values in the required Post-Infiltration Reduction/Target fields. MHEA will store these readings for you but will not compute any savings or SIR for infiltration reduction work unless an Infiltration Reduction Cost is also entered (see Mode 3 below). If no infiltration reduction work is deemed necessary for the house, enter the pre-retrofit rate into the post-retrofit fields since, in this case, both pre- and post-retrofit levels will be the same and the post-retrofit levels are required for MHEA to run.

If post-retrofit air leakage rate readings become available at some future time, the house description could be recalled, the readings entered, and an appended report printed. However, this may not be worth the time, especially if a target value you chose is near the final reading obtained.

3. Pre- and post-infiltration reduction air leakage readings are available but no duct readings.

Enter data in all fields available on the Whole House Infiltration Reduction with Blower Door form. The Evaluate Duct Sealing check box remains unchecked.

Pre-Infiltration Reduction, Whole House Leakage (CFM) and Pressure Differential (Pa)—These entries are from blower door measurements of air leakage before sealing. The CFM reading is normally taken at a pressure differential of 50 Pa, if such can be

reached. Pre-retrofit entries are optional but, if provided, used to estimate savings from air sealing. Pre-retrofit entries will not affect savings computed for other measures. (Air leakage rate default—2500 cfm; pressure differential default—50 Pa) (Optional)

Post-Infiltration Reduction/Target Whole House Leakage (CFM) and Pressure Differential (Pa)—These entries are from blower door measurements after air sealing. The CFM reading is normally taken at a pressure differential of 50 Pa, if such can be reached. If the only air leakage information available is in air changes-per-hour (ACH) at natural conditions, an approximate conversion to CFM at 50 Pascal (CFM50) may be obtained as follows: CFM50 = ACH × House volume ÷ 3. (Air leakage rate default—2500 cfm; pressure differential default—50 Pa)

Infiltration Reduction Cost ($)—Enter the cost in dollars spent to reduce air infiltration from the pre-retrofit to the post-retrofit level. If a cost is entered together with the above entries of pre- and post-infiltration reduction blower-door data, energy savings and an SIR for the air-leakage reduction will be computed and reported (see Section 7.2, *Annual Energy and Cost Savings*). (Optional)

The remaining modes of data entry for the Ducts and Infiltration forms provide means of estimating the cost-effectiveness of duct sealing as well as infiltration reduction. MHEA provides input fields to accommodate four common duct leakage measurement techniques: Pre/Post Whole House Blower Door Measurements, Blower Door Subtraction, Duct Blower Pressure Tests, and Pressure Pan Measurements. To access the forms needed, check the Evaluate Duct Sealing check box on the Ducts and Infiltration form. You will then be presented with the Duct Leakage Method drop-down list. From this list, choose one of the four duct leakage measurement techniques. Once you have made your selection, the form's input fields will be altered to accommodate that particular method.

Each of the data input modes associated with the four measurement techniques requires duct operating pressure inputs. Since they are common to all four modes, they will be described once here. The readings are taken during normal conditions with the air handler fan on. A small hole (afterwards repaired) can be drilled in the supply plenum near the air handler in which to insert a pressure probe. It is recommended that a digital gauge be used to then measure the pressure inside of plenum with respect to the room or part of the house in which the duct is located. The data entry fields for this data lie under the Duct Operating Pressures title on each of the forms. The duct operating pressures required are:

Pre Duct Sealing Supply (Pa)—Enter the supply duct-house pressure difference before implementing any duct-sealing measures.

Post Duct Sealing Supply (Pa)—Enter the supply duct-house pressure difference after implementing any duct-sealing measures.

MHEA assumes there is no return duct in the home.

The additional entries necessary for each of the four input modes will be discussed separately below. They are arranged in order of complexity, the simplest first. Unfortunately, the simplest tends to also be the least accurate.

4. Pre/Post Whole House Blower Door Measurements

This technique of estimating duct leakage uses whole house blower door leakage measurements before and after duct sealing to estimate the duct leakage reduction accomplished. To provide this method in MHEA, some assumption had to be made with regard to the order in which duct sealing and infiltration reduction work was performed. MHEA assumes that the duct sealing is accomplished first, followed, at some point, by the infiltration reduction.

The entries required are from readings you would normally take to estimate the whole house air leakage rate. These readings are simply taken before any duct leakage or infiltration reduction work has been performed, after duct sealing is accomplished but before infiltration reduction work occurs, then a third time after both duct and infiltration reduction work has been performed. Note, for all readings, the vents and registers of the distribution system should remain open, thus making the ducts as much a part of the conditioned space as possible.

The entries required are described separately below:

Pre-Infiltration Reduction, Whole House Leakage (CFM) and Pressure Differential (Pa)—Same as in Mode 3 above, but no longer optional.

Post Duct Sealing, Whole House Leakage (CFM) and Pressure Differential (Pa)—These entries are from blower door measurements of whole house air leakage after duct sealing efforts, but before air infiltration reduction work occurs. (Air leakage rate default—2500 cfm; pressure differential default—50 Pa)

Post-Infiltration Reduction, Whole House Leakage (CFM) and Pressure Differential (Pa)—Same as in Mode 3 above, but assumed to be from readings taken after both duct sealing and infiltration reduction efforts have been accomplished.

Duct Sealing Cost—Enter the cost in dollars spent to reduce the duct leakage from the Pre Infiltration Reduction (and, therefore, the pre duct sealing) to the Post Duct Sealing level.

Infiltration Reduction Cost—Enter the cost in dollars spent to reduce the air infiltration from the Post Duct Sealing (and, therefore, the pre infiltration reduction) to the Post Infiltration Reduction level.

5. Blower Door Subtraction

This method uses the same readings as the Whole House Blower Door technique but adds analogous readings, both before and after duct sealing, during which the distribution system has been sealed off from the rest of the house. Use cardboard, plastic, tape, etc., to temporarily cover and seal all registers and grills on both the supply and return (if it exists). This essentially allows subtraction of the house-only leakage from the duct plus house leakage to isolate the leakiness of the ducts. One additional reading is required to help compensate for duct leakage to the conditioned space—the duct-house pressure differential with the ducts and registers sealed and the house pressurized (or depressurized) to the same degree as for the other CFM readings (normally 50 Pa).

> *NOTE:* It is normally recommended that this technique not be used if the measured duct-house pressure differential is less than 20 Pa, indicating that the duct system is very well connected to the house interior. This is commonly true in homes which use building cavities for a significant part of the duct work.

The data entry items for this input mode are as follows:

Pre-Infiltration Reduction, Whole House Leakage (CFM) and Pressure Differential (Pa) (with registers/grills open)—Same as in Mode 3 above, but no longer optional.

Pre-Infiltration Reduction, Whole House Leakage (CFM) and Pressure Differential (Pa) (with registers/grills sealed)—Same as immediately above except with registers and grills sealed.

Pre-Infiltration Reduction, Duct/House Pressure Differential (Pa) (with registers/grills sealed)—Enter the measured pressure differential between the duct system and the house with the house pressurized (or depressurized) to the same degree as for the CFM readings immediately above (normally 50 Pa). This measurement can be taken at the supply plenum or at a supply register by punching a small hole through the masking tape or other material used to temporarily seal the grills, and inserting a pressure tap or hose connected to a differential pressure gauge.

Post Duct Sealing, Whole House Leakage (CFM) and Pressure Differential (Pa) (with registers/grills open)—Same as in Mode 4 above. Measured after duct sealing efforts, but before air infiltration reduction work.

Post-Duct Sealing, Whole House Leakage (CFM) and Pressure Differential (Pa) (with registers/grills sealed)—Same as immediately above except with registers and grills sealed.

Post-Duct Sealing, Duct House Pressure Differential (Pa) (with registers/grills sealed)—Same as Pre-Infiltration Reduction Duct/Hour Pressure Differential above, but measured after duct sealing efforts, but before air infiltration reduction work is performed.

Post-Infiltration Reduction, Whole House Leakage (CFM) and Pressure Differential (Pa) (with registers/grills open)—Same as in Mode 4 above.

Duct Sealing Cost—Enter the cost in dollars spent to reduce the duct leakage from the Pre Infiltration Reduction (and, therefore, the pre duct sealing) to the Post Duct Sealing level, as for Mode 4 above.

Infiltration Reduction Cost—Enter the cost in dollars spent to reduce the air infiltration from the Post Duct Sealing (and, therefore, the pre infiltration reduction) to the Post Infiltration Reduction level, as for Mode 4 above.

The Duct Operating Pressure entries are described in the introductory material to Mode 4.

6. Duct Blower Pressure Tests

This method involves use of both a duct blower and a blower door. A duct blower pressurizes the duct system which is sealed off (by taping the registers and grills) from the remainder of the house. The measured CFM through the duct blower is then equal to the total air leakage from the ducts to both the outside and interior of the house. To obtain leakage to only the outside, the blower door is used to pressurize the entire house to the same pressure, with respect to the outside, as the ducts. With no pressure differential between the house and the ducts, any leakage recorded by the duct blower must then be to the outside. The leakage will be at whatever pressure differential is established by the duct blower between the duct and outside (typically 25 PA).

Duct Blower—*Used to measure duct leakage.* (Courtesy of The Energy Conservatory)

This technique of determining duct leakage is more accurate than the other means, but also the most time-consuming. It requires both a duct blower and a blower door.

The data entry items for this input mode are as follows. Each of the items is determined and entered twice, once before permanent duct sealing occurs (Pre), and again afterwards (Post).

Pre/Post Duct Sealing Total Fan Flow (CFM) and Duct Pressure (Pa)—Enter the CFM measured through the duct blower with the duct pressurized with respect to the outside. For these measurements, the registers and grills are temporarily sealed off (taped) from the remainder of the house and there should be no induced pressure differential between the house and outside.

Pre/Post Duct Sealing Outside Fan Flow (CFM) and Duct Pressure (Pa)—Enter the CFM measured through the duct blower with the house at the same pressure difference with respect to the outside as the ducts. While the duct blower is used to pressurize the duct system, a blower door will be used to pressurize the house. For these measurements, the registers and grills are temporarily sealed off (taped) from the remainder of the house.

House Pressure (Pa) Outside—Enter the pressure differential between the house and the outside as created by the blower door. Note, for accurate determination of the duct leakage, this pressure differential should be the same as, or as close as possible to, the pressure differential between the ducts and outside.

The Duct Operating Pressures entries are described in the introductory material to Mode 4. The remainder of the entries on this form relate to the infiltration reduction efforts and are the same as given in Mode 3 above.

7. Pressure Pan Measurements

A correspondence has been found to exist between the sum of pressure pan measurements from all of the supply registers in a manufactured home and the duct leakage to the outside. To take the pressure pan measurements, use a blower door to depressurize the house to 50 Pascal. Then, with a pressure pan attached to a digital manometer, measure the pressure differential at each supply register with respect to the home. No pressure difference indicates that the supply duct leading to the register is at the same pressure as the house and that little or no leaks to the outside exist in that branch of the ducts. The sum of these measurements from all supply registers is an indication of the total leakage of the ducts to the outside.

This method of estimating duct leakage is normally appropriate only for manufactured homes.

Pre/Post Duct Sealing Sum of Pressure Pan Readings (Pa)—Enter the sum of the pressure differentials between the supply duct registers and the house with the house depressurized to 50 Pa with respect to the outside.

The Duct Operating Pressures entries are described in the introductory material to Mode 4. The remainder of the entries on this form relate to the infiltration reduction efforts and are the same as given in Mode 3 above.

6.11 Base Loads

The term "base loads," as used in this manual, refers to energy consumption from equipment or appliances whose usage is not as directly affected by climatic conditions as are those of the heating and cooling equipment. In MHEA, the three base load energy usages considered for reduction by weatherization are from the refrigerator, water heater, and lights.

The data requirements described below are displayed by MHEA only if the associated candidate measure is selected from Setup's Candidate Measures form (see Section 8.6, *Selecting Candidate Conservation Measures*).

6.11.1 Base Loads—Refrigerator

MHEA includes a refrigerator replacement measure (see Section 10.27, *Refrigerator Replacement*). In order to evaluate the potential savings obtained from replacing an existing refrigerator with a newer, more efficient unit, MHEA needs to know an estimate of the existing and new refrigerators' annual energy use, in kWh/year. This data can be obtained in either of three ways:

1. The Association of Home Appliance Manufacturers (AHAM) has accumulated the results of efficiency tests for many manufacturers' models of refrigerators. The data base containing their data has been incorporated into MHEA. Thus, if you are able to locate the manufacturer and model in the look-up table provided, the required annual consumption will be entered for you.
2. Refrigerators are sold with labels that list the estimated annual energy consumption in kWh/year. If such an energy guide label is available for either the existing or new units (more likely for the latter), it can be used as the source for this required input to MHEA.
3. Small meters exist which are capable of relatively easily monitoring the electricity consumption of a refrigerator. If you use one of these meters, MHEA asks for the kWh consumed by the refrigerator during the monitoring period, the number of minutes monitored, the type of defrost mode, and whether the refrigerator operated in an automatic defrost cycle during the monitoring period.

The data input is grouped into data items relevant to the three input modes described above. There is some overlap, however. The data entry descriptions for the existing unit are given below:

Manufacturer—Enter the existing refrigerator's manufacturer's name. You may use this field to either enter a manufacturer of your own choosing or to search the look-up

tables for a matching entry. This entry is optional unless you are using the data look-up tables to identify the unit.

Model—Enter the existing refrigerator's model number. You may use this field to either enter a model number of your own choosing or to search the look-up tables for a matching entry. This entry is optional unless you are using the data look-up tables to identify the unit.

Height, Width, Depth, Size—Enter the dimensions of the existing unit, in inches, and the size in cubic feet. These entries are always optional. However, if entered for both the existing and replacement units, MHEA will compare the entries and produce a warning if the entries indicate a possible size problem related to the replacement. If you used the look-up tables to identify the existing unit and dimensions are available from the tables, these dimensions will be entered automatically. (Optional)

kWh/Year—Enter the electricity consumption in kWh/year listed on the energy guide label for the existing unit, if one exists. If you have used the look-up tables to identify the existing unit, this value will be entered automatically. The entry is not required if you are using metered consumption data.

Age—Select one of the categories describing the age of the existing unit: Less than 5 years; 5 to 10 years; 10 to 15 years; or More than 15 years. If you used the look-up tables to identify the existing unit and the data is available from the tables, this data will be entered automatically. Note, however, the age from the tables will be based on the first year the model was sold. If you know that the existing model is newer than that indicated from the tables, change the entry. The existing refrigerator's age is used to increase the labeled annual consumption, assuming performance degrades somewhat with time. The entry is not required if you are using metered consumption data.

Metering Minutes—If you are using metered consumption data, enter the number of minutes you metered the existing refrigerator. Metering should be performed for at least 180 minutes (3 hours). You should attempt to prevent refrigerator door openings during the metering period. This entry is not required if the kWh/year field has been used to provide the consumption data.

Meter Reading—Enter the metered consumption in kWh for the period specified by the Metering Minutes. This entry is not required if the kWh/year field has been used to provide the consumption data.

Manual Defrost—Is the existing unit manual defrost? This entry is required for metered consumption only.

Includes Defrost Cycle—Check the Includes Defrost Cycle check box if the metered consumption entered above included a defrost cycle. This can be determined if either the consumption or refrigerator interior temperature is being monitored by the presence

of a peak in either of these parameters extending several times higher than the surrounding peaks. Unpredictable recommendations for the refrigerator replacement measure may occur if the metering time is two hours or less and the period included a defrost cycle. If you are unsure whether the period included a defrost cycle, it may be best to assume that it did not or repeat the measurement.

Consumption data is also necessary for the replacement refrigerator. This data will be provided either from the energy guide label on the replacement unit, or from values of pre-selected replacement units in your library of replacement refrigerators. This library is defined by you in the Setup portion of MHEA (see Section 8.8, *Replacement Refrigerators*). Data for the replacement refrigerator is entered on the right side of the form and include the following:

Pre-Defined Replacement—Use this drop-down box to select a replacement unit from your library of refrigerators. If this field is used, the entry must match a unit listed in your library. (Optional)

Manufacturer—Enter the manufacturer of the replacement refrigerator. If your selection of a replacement has been made from your library of replacement refrigerators, this data will be entered automatically. (Optional)

Model—Enter the model number of the replacement refrigerator. If your selection of a replacement has been made from your library of replacement refrigerators, this data will be entered automatically. (Optional)

kWh/Year—Enter the annual electricity consumption in kWh/year for the replacement refrigerator. This value may be obtained from the energy guide label of the replacement unit. Otherwise, if your selection of a replacement has been made from your library of replacement refrigerators, this data will be entered automatically.

Material and Other Costs—Enter the purchase (material) price of the replacement refrigerator and any other installation or disposal costs associated with the refrigerator replacement. If your selection of a replacement has been made from your library of replacement refrigerators and a cost was recorded there, that cost will be automatically entered into the Material Cost field. However, any Other costs must be entered on a case-by-case basis. Any costs incurred in disposing of the old existing refrigerator must be included in the Other cost field if these costs have not been included in the Material Cost field.

Height, Width, Depth, Size—Enter the dimensions of the replacement unit, in inches, and the size in cubic feet. These entries are always optional. However, if entered for both the existing and replacement units, MHEA will compare the entries and produce a warning if the entries indicate a possible size problem related to the replacement. If you choose your replacement from your library of replacement refrigerators and dimensions are available in the library entry, these dimensions will be entered automatically. (Optional)

Comment—Enter comments about the refrigerator replacement you may want to appear in the MHEA audit report. (Optional)

6.11.2 Base Loads—Water Heating

MHEA evaluates several water heating measures: water heater replacement, tank insulation, pipe insulation, and low-flow showerheads. The water heater data required by MHEA depends on which of these measures you have chosen to evaluate in your program (see Section 8.6, *Selecting Candidate Conservation Measures*). The data are presented in the following order on the Base Loads, Water Heater form:

Manufacturer—Enter the existing water heater's manufacturer name. You may use this field to either enter a manufacturer of your own choosing or to search the look-up tables for a matching entry. However, if you are evaluating replacing the existing unit, you must locate the manufacturer and model of the unit in the data base in order for MHEA to have the efficiency data necessary to evaluate the replacement. Otherwise, this entry is optional.

Model—Enter the existing water heater's model number. As for the manufacturer, you may use this field to either enter a model of your own choosing or to search the look-up tables for a matching entry. However, if you are evaluating replacing the existing unit, you must locate the manufacturer and model of the unit in the data base in order for MHEA to have the efficiency data necessary to evaluate the replacement. Otherwise, this entry is optional.

Fuel—Select the fuel used by the existing water heater from the three choices: Natural Gas, Electric, or Propane. The entry is required for all water heater measures. If the manufacture and model have been successfully chosen from the data base, this field will be entered automatically.

Water Heater Location—Select one of two locations for the water heater: Heated Space (space that utilizes a thermostat to control its temperature) or Unheated Space (space not heated by a mechanical system).

Gallons—Enter the rated tank capacity in gallons for the water heater. If you have located the manufacturer and model of the unit in the data base this entry will be automatically entered. If the capacities have been entered for both the existing and replacement units and their values differ by more than 20%, MHEA will display a warning. This entry is required only if evaluating the water heater placement measure.

Rated Input—The rated input is the rate at which the water heater consumes energy while operating. This entry is required only if water heater replacement is to be considered and will be automatically entered if the existing unit is located in the data base of water heaters.

Input Units—Select the units associated with the above value of Rated Input, either KBtu or KW.

Insulation Type—Select one of two insulation types used in the existing water heater: Fiberglass or Polyurethane. Often an access plate can be removed to view the insulation and determine its type and thickness. This entry is required only for evaluating the tank insulation measure.

Insulation Thickness—Enter the thickness, in inches, of insulation in the existing unit. If an insulating wrap already exists, include its thickness as well. Often an access plate can be removed to view the insulation and determine its type and thickness. This entry is required only for evaluating the tank insulation measure.

Existing Tank R-Value—If the Existing Insulation Type and Thickness (described above) are not entered, an alternative option to enter an existing tank insulation R-value is made available. This R-value might be listed on the water heater's name plate or from the unit's specification sheet.

Supply Pipe Insulation—Check the Supply Pipe Insulation check box to indicate that pipe insulation exists on at least the first five feet of supply pipe exiting the water heater. This entry is required only for pipe insulation measure.

Number of Shower Heads—Enter the number of showerheads used in the house for which replacement with low-flow models needs to be evaluated. This entry is required only for evaluating the low-flow showerhead measure.

Minutes of Shower Use Per Day—Enter the total minutes per day the showerheads are in use. Combine the times for each showerhead being considered for replacement. This entry is required only for evaluating the low-flow showerhead measure.

Average GPM for Shower Heads—Enter the average flow rate in gallons per minute of all showerheads being considered for replacement. You can determine this easily using a container of known volume and a stop watch. This entry is required only for evaluating the low-flow showerhead measure.

Comment—Enter any comments associated with the water heating you want displayed on the output reports.

If the water heater replacement measure is to be evaluated, MHEA also needs information on the replacement unit to be installed. However, this information will be automatically entered as you select the specific unit from your water heater replacement library, as defined in the Setup portion of MHEA (see Section 8.9, *Replacement Water Heaters*). Thus, the specific data entry fields under the replacement unit are ghosted, indicating that you do not enter the data yourself. These fields have the same description as given above for the existing unit, but now apply to the replacement unit. The only fields available for entry include the following.

Pre-Defined Replacements—Use this drop-down box to select a replacement unit from your library of replacement water heaters. The entry must match a unit listed in your library.

Material and Other Costs—Enter the purchase (material) price of the replacement water heater and any other installation or disposal costs associated with the replacement. If your library entry included a material cost, that cost will be automatically entered into the Material Cost field. Any costs incurred in disposing of the old existing water heater must be included in the Other cost field if these costs have not been included in the Material Cost field. In addition, if the replacement required changing the fuel type used by the unit, any costs associated with this fuel switching must also be included in the Other Costs field.

Two additional ghosted fields exist in the Replacement information grouping, the "energy factors" for both the existing and replacement units. These data are measures of the efficiencies of the units. The data is entered automatically for you from the database used to define the existing and replacement water heaters. The higher the energy factor, the more efficient the unit is in providing hot water. An additional efficiency parameter, the "recovery efficiency" is also required for both units in order to evaluate the water heater measure. These values are also taken from the database of units, though not displayed to you.

6.11.3 Base Loads—Lighting

Data describing the existing lighting in the house is entered on the Lighting form. If your program does not consider replacing existing incandescent lamps with compact fluorescent ones, you can ignore this form. The form is used only to describe the light bulbs you intend to consider for this replacement measure. If the Lighting Retrofits measure has been turned off in the Candidate Measures form of Setup, this form will not be accessible.

Entries on this screen are a follows:

Light Code—The Light Code allows you to identify the specific Light description in the MHEA reports. MHEA will provide default entries of the form "LT#," where the # is the next higher consecutive integer above the number of lights already described.

Room—Enter the room in which the lights being described are located. The eight choices are: Kitchen, Living Room, Rec Room, Dining, Bedroom, Bathroom, Utility, and Other. The entry is for the auditor's use in locating the lights for possible later retrofit. (Optional)

Location—Describe the location of the lighting fixtures within the room using one of the following selections: Ceiling, Floor, Table, and Wall. This entry is for the auditor's use only in locating the lights for later retrofit. (Optional)

Lamp Type—Indicate the type of the existing incandescent lamp: Standard or Flood (reflective or spot). The default for the replacement compact fluorescent's wattage is determined by this entry and the existing lamp wattage. Also, the materials report will indicate that the replacement is to be either standard or flood, depending on your entry here.

Quantity (of existing incandescent lamps)—Enter the number of lamps having the description given by this record and which are candidates for replacement with compact fluorescents. The entry is required with no default.

Watts (of existing incandescent lamps)—Enter the wattage of the existing incandescent lamp which is to be replaced. Standard incandescent lamp wattages are 25, 40, 50, 60, 75, 90, 100, and 150. The value is required and used in computing the savings resulting from its replacement with a fluorescent lamp. The default for the replacement compact fluorescent's wattage is determined by this entry and the lamp type. (Default—100)

Hours/Day—Enter the average number of hours per day the lamp is normally on. The value must be 24 or less. Your response to this entry has a considerable effect on the savings associated with replacing the lamp. You should target this measure to lamps with substantial on-times usually more than two to three hours per day.

Replacement CF Watts—Enter the wattage of the compact fluorescent which is to replace the existing lamp. Common replacements given in the table below are used as the default for this field. They depend on your entry for existing lamp wattage and type.

The lighting measure will use the standard replacement wattage closest to your entry.

Added Costs—Enter any added cost, in dollars per lamp, not normally associated with installation of a compact fluorescent and not included in the standard material

Existing Incandescent (Watts)	Replacement Fluorescent (Watts)	Existing Incandescent (Watts)	Replacement Fluorescent (Watts)	Existing Incandescent (Watts)	Replacement Fluorescent (Watts)
Standard					
25 40 50	5 7 8	60 75 90	13 18 25	100 150	26 38
Flood					
50	11	75	15	100	18

costs provided in Setup. Replacing a fixture's harp to allow the CFL to fit, or other size modification, are examples. (Default—0) (Optional)

Comment—Enter any comments relevant to the lamps described or retrofits to be installed, such as the reason for any added cost recorded or physical restrictions. (Optional)

6.12 Itemized Additional Costs and User Defined Measures

Costs not associated with specific energy conservation measures, yet incurred during weatherization, may be entered on this form. Examples might be travel, administrative costs, or health and safety repairs. If you know the approximate annual MBtu savings for a weatherization activity not addressed by the standard MHEA measures, this screen may also be used to define a new measure associated with the savings. After you define the "user-defined" measure, MHEA will treat it the same as it does all other measures.

For user-defined measures, no fields, except Material and Comment, are optional. For added costs, only Description, Cost, Material, and Include in SIR controls are relevant. See Appendix C, *Data Input and Sample Forms*, for sample screens. Data entries are presented in the following order:

Description—Enter a brief description of the added cost or user-defined measure. This description will be entered in the Recommended Measure column of the reports.

Cost—Enter the dollar cost of the item being described.

Material—Enter a brief description of the major material needed to implement the itemized additional cost or the user-defined measure. The description entered will appear on MHEA's Material Report. (Optional)

Include in SIR?—Do you wish this cost to be included in the cumulative SIR on the reports? If this check box is selected, an itemized cost will appear at the top of the recommended measure list and will be included in the cumulative cost and SIR for the job. If you choose not to include that cost in the SIR, the costs are placed at the end of the measure list allowing you to obtain a cumulative cost and SIR which do not include the effects of this itemized cost.

You must select Include in SIR if the record you are entering is to describe a user-defined measure.

Annual Energy Savings—For user-defined measures, enter an estimate of the annual energy savings associated with the measure in millions of Btu (MBtu). You may need to use standard conversion factors to arrive at savings in MBtu. The entry will be used in the computation of the measure's SIR. This field may be hidden if MHEA determines that it is not needed.

Life-time—Enter the lifetime, in years, of the measure/materials associated with the user-defined measure. Industry standards have been established for many materials.

DOE requires the maximum to be 20 years. This field will be hidden if MHEA determines that it is not needed.

Fuel Saved—Select one of seven choices for the type of fuel saved by the user-defined measure: Natural gas, Oil, Electric, Propane, Wood, Coal, and Kerosene. This field will be hidden if MHEA determines that it is not needed.

Comment—Enter any comments you want displayed on the output reports. (Optional)

6.13 Utility Bills

Although optional, utility billing data you enter into MHEA for the homes you weatherize can be a valuable source of information. MHEA allows you to compare its consumption predictions with pre-retrofit billing data (see Section 7.7, *Heating and Cooling Energy Comparisons*). Then, if you desire, it will adjust the measure recommendations and savings to reflect this actual consumption.

Post-weatherization billing data may also be input to MHEA and stored with the other data for a house. Computer software exists which can use both pre- and post-weatherization billing data to derive actual energy savings estimates, possibly useful in program evaluations.

MHEA permits entry of four sets of utility bills: pre- and post-retrofit heating and cooling energy usage. If you wish to enter billing data, ask the client for up to 12 months of utility bills. If the client has discarded these bills, he or she may request consumption records from the local utility. Or, the client may sign a release which grants you authority to directly obtain the data.

MHEA cannot separate heating and cooling consumptions from a single billing history when the same fuel is used for both conditioning components. Thus, an electrically heated house with air-conditioning or a house with a heatpump cannot use MHEA's billing data features unless you can successfully divide the electric bills into their heating and cooling components before entering the data into MHEA.

MHEA's billing data features work best with metered fuels, such as natural gas and electric. In fact, the billing data entry screens were designed for these two fuels. Use with other fuels will likely require units conversions. Bulk fuels, such as propane or fuel oil, which are delivered in bulk and stored in tanks at the house, are less appropriate. Unless deliveries are relatively frequent and approximately the same amount of fuel remains in the tank at the time of each delivery, use of billing data for these fuels can lead to substantial inaccuracy. The following discussions will assume electric or natural gas heat.

Billing periods entered into MHEA must be consecutive. They may extend from one year into the next, but must span one year or less. Thus, no two periods can include any

of the same days of the year in two years. The number of periods entered must be 12 or less. Examples of entries are (1) twelve consecutive monthly readings, (2) one annual consumption, or (3) any number of periods, 12 or less, spanning less than an a years time.

Each of the four sets of entries has the following data requirements:

Type—Select either Heating or Cooling as the major purpose for which the fuel entered is used. The fuel may also supply non-heating or cooling end uses, such as cooking or water heating. However, you will have to enter an estimate of this "Base Load" in a subsequent field.

Period—Select whether the data being entered pertains to a Pre-Retrofit or Post-Retrofit period. Only pre-retrofit data will be used for measure savings adjustments.

Units—Select either Therms or kWh depending on the fuel source and season for which data is to be entered. Normally cooling data will be in kilowatt-hours of electricity and heating data in either therms or kilowatt-hours. The utility may document natural gas consumption in therms, mcf (thousand cubic feet), or ccf (hundred cubic feet). Mcf and ccf can be converted to therms by multiplying by a value obtained from the local gas utility. Because heat content of natural gas varies according to composition, ask the utility for the number of therms contained in a mcf or ccf delivered to homes in the area. This value (in therms-per-ccf) should be entered in the Key Parameters (see Section 8.7.4, *Altering Key Parameters—Heat Transfer*). Most natural gas contains approximately ten therms per mcf and one therm per ccf of natural gas. Other fuels may require additional conversion, such as gallons of propane or oil. However, note the warning above regarding recording bulk fuel consumption.

Days in First Period—Enter the number of days included in the first billing period. Subsequent periods are assumed to be contiguous, thus allowing MHEA to determine their lengths.

Base Temperature—The Utility Bills Data Entry screens provide an option for entering heating degree days (HDDs) and cooling degree days (CDDs) for natural gas and electricity billing data, respectively. The degree-day information will not affect any adjustments to the measure savings. It simply allows you to compare degree-days used by MHEA with those from the actual billing periods. Heating and cooling degree days are available from local utilities, state energy offices or the U.S. Department of Commerce National Weather Service, Asheville, NC.

If degree-day information is to be entered, MHEA requires base temperatures for these HDD or CDD values. Assume a base temperature of 65°F for HDDs and 78°F for CDDs, unless a different base temperature is listed on the utility bill.

Base Load—Enter an estimate of the average base load consumption per month in the units chosen in "Units" above. The period consumptions entered likely result from not only heating or cooling, but also from use of appliances, such as stoves, water heaters, or refrigerators. MHEA needs to separate this "base load" consumption from the heating and cooling consumption. This entry is an estimate of this base load consumption for an average 30-day month.

To determine the base load for the heating fuel yourself, select a month when the heating equipment did not operate, most likely during summer. This month should be one of normal household occupancy—no long term visitors or household vacations. Determine the heating fuel consumption for that month, in the units selected in the "Units" field.

To determine cooling base load, select a month with no electric heating or air conditioning consumption, most likely during fall or spring. The number of kilowatt-hours consumed is the base load.

MHEA will adjust this value to correspond to each of the billing periods, regardless of their duration. You may wish to leave this field blank until after entering the actual billing data for the periods. MHEA will then compute a default value for the base load that reflects the period data entered. If the billing information you enter is not sufficient for MHEA to determine a reasonable default base load, the default value will be displayed as "99999."

Comment—Enter any comments regarding this particular set of billing data you wish to be displayed in the MHEA output reports. (Optional)

The above data is entered once per set of billing data. The following data are required for each billing period within a set. They appear on the right side of the input screen in a tabular format. The data need not be entered row by row, but, instead, could be entered column by column. Thus, if the meter is read on the 15th of every month, you may wish to travel down the month column first, entering 1, 2, 3, 4, etc., then moving to the Day column entering 15 in each entry, using the down arrow to travel to the next field after each entry.

Month—Enter the number of the month in which the meter reading (not the billing date) corresponding to the billing period was taken (e.g., January—1, February—2, etc.).

Day—Enter the day of month on which the meter reading corresponding to the billing period was taken.

Usage—Enter the consumption during the billing period. The units are those selected in the "Units" field to the left.

Degree Days—Enter the number of heating or cooling degree-days (depending on the "Type" selected) corresponding to the period. (Optional)

NOTES:

Chapter 7

Following input of the home description, as described in Chapter 6, and running the program, MHEA provides you with a variety of input and output reports. Section 3.4, *Running MHEA and Viewing the Reports*, discusses executing the program and accessing these reports. This chapter describes the content of the various reports.

Which report sections are available depends on your settings in the Report Sections in Preferences, as described in 9.3, *Report Sections*. Whichever reports are displayed, they will be prefaced by an introductory section identifying at least the Job and Client Name, Audit Date, and Auditor.

All of the report sections will be summarized below. If information described here is of interest to you and you do not see it in the reports generated, go to Preferences and make sure the appropriate report sections are selected.

Examples of the reports are provided in Appendix A, *Audit Example*.

Recall that the reports can be printed using the printer button at the extreme left of the Access toolbar at the top of the report or by entering the [Ctrl-P] key combination while viewing the report.

7.1 Input Summary Report

The Input Summary Report reflects your entire home description in a tabular format similar to what you see during input using the Datasheet View (Section 4.8, *Data Sheet and Form Views of Records*). Following the General Information, each component type is individually described with its own header line printed in large, bold, and italicized letters. If no entries were made for a specific component type or if the specific component type's input summary has been turned off in Preferences, no reference to that type will be made in the input summary.

The remaining report sections are part of the Output Summary Report. Thy also may be turned on or off in the Report Sections in Preferences.

7.2 Annual Energy and Cost Savings

This report section lists the individual measure recommendations generated by MHEA that reflect the input you provided. Each recommended measure is identified by its name, as given in Candidate Measures of Setup (see Section 8.6, *Selecting Candidate*

Conservation Measures), and, if applicable, by the component codes of those components to which the measure is to be applied (see Section 5.3, *Component Codes*). For example, one recommendation might be to install compact fluorescent lamps in fixtures "LT1" and "LT2" or to replace door "DR1." Additional information is appended to some recommended measure names. This information is enclosed in square brackets, "[ ]." For example, a lighting retrofit will display what room the auditor indicated the lights were in and how many lights met that particular description, "[Dining][5]."

Appearing first in the list will be those measures assumed to be cost justified outside of MHEA (infiltration or duct sealing), then measures declared mandatory (such as the replacement of an unsafe furnace).

Following these items, measures will be listed in order of cost-effectiveness (SIR), after all interactions with other measures have been considered. Only measures with SIR greater than the cut-off value selected in Key Parameters of Setup will be displayed.

For each measure recommended, the annual energy and dollar savings associated with the measure is given. These savings parameters will be divided into three categories, Heating, Cooling, and Base Load, for each measure. The heating energy savings is always given in MBtu (million Btu), while the cooling and base load savings will be in kWh. A total energy savings in MBtu is given in the last column of this report section. This entry may not be of use since it converts cooling and base load savings from kWh to MBtu in order to add to the heating savings.

7.3 Energy Saving Measure Economics

The Energy Saving Measure Economics report section gives individual and cumulative economic parameters for the recommended measures. The measure name and any applicable component codes are given in the first two columns, as for the Annual Energy and Cost Savings section described above. Then, for each measure, the following is listed:

- Total dollar savings per year;
- Dollar cost to install the measure;
- Savings-to-Investment Ratio (SIR) for each recommended energy conservation measure (computed over the measure's lifetime);
- Cumulative cost of recommended measures;
- Cumulative savings of recommended measures; and
- Cumulative SIR of recommended measures.

Costs entered as Itemized Additional Costs are displayed in this report section with "[item]" appended to the item description. These costs are not assigned a savings value

or SIR, because no energy savings is associated with them. If, on the Itemized Additional Cost screen, you indicated that a cost should not be included in the SIR, it will be listed at the end of the recommended measure list, allowing you to obtain a cumulative cost and SIR which do not include the effects of this itemized cost. If, on the other hand, you have requested that a cost be included in the SIR, it will be listed at the top of the measure list and its value added to both the cumulative cost and SIR.

User-defined measures are reported in exactly the same manner as standard MHEA measures.

MHEA cannot report the success of infiltration reduction unless an actual or estimated cost for the work has been entered on the Ducts and Infiltration input screen. If a cost has been entered, but no Pre-Infiltration Reduction Whole House Blower Door Leakage rate is entered on this same screen, the program will use a rate corresponding to your selection for Home Leakiness on the General Information Screen to estimate a savings to report.

Duct sealing will be considered and results reported only if the Evaluate Duct Sealing check box has been checked and sufficient data has been supplied (see Section 6.12, *Ducts and Infiltration*).

7.4 Materials

This report section lists the major materials and their quantities necessary to install the recommended measures reported in the Energy Saving Measure Economics report section. Please note that minor materials, such as fasteners and other hardware, are not listed. Any materials associated with user defined items (see Section 6.12, *Itemized Additional Costs and User Defined Measures*) will also be listed in this report section.

7.5 Pre/Post Retrofit Energy Consumption

MHEA provides estimates of annual energy consumption for both heating and cooling, before and after installing the recommended measures. Units for the consumption estimates are always MBtu (million Btu) for heating and kWh for cooling.

Also provided are pre- and post-retrofit estimates of the base load consumption from whatever appliances and equipment you may have described during input (refrigerator, water heater, and lights).

7.6 Billing Data Adjusted Results

Pre-retrofit utility billing data you enter into MHEA (see Section 6.13, *Utility Bills*) allows MHEA to show you a comparison of its energy consumption predictions and

this billing data (see Section 7.7, *Heating and Cooling Energy Comparisons*). Then, if you desire, it will adjust the measure recommendations and savings to reflect the data

Results in three of the above reports (Annual Energy and Cost Savings, Energy Saving Measure Economics, and the Materials) are altered whenever you enter billing data and request that the results be adjusted accordingly (using the Include Billing Adjustment check box on the General Information form). Thus, if so requested, MHEA will print these same three reports except with adjusted values. You may choose to print both the unadjusted and the adjusted reports, or, to avoid confusion, only the adjusted if you have made the decision to weatherize according to billing adjusted recommendations.

Note, however, MHEA was designed to make its recommendations based on average weather and occupancy characteristics rather than the specific life styles of the occupants. If adjustment is requested, the recommendations will then be specific to the life styles of the occupants during the period in which the billing data were gathered.

7.7 Heating and Cooling Energy Consumption Comparisons

The Heating and Cooling Energy Consumption Comparison reports allow you to see a comparison of the MHEA predicted consumptions and the billed consumptions. These reports are available only if the corresponding heating and/or cooling billing data have been previously entered.

The predicted values are based on the same assumptions used in estimating measure savings and the home description you have entered. They correspond to the same time intervals for which the billing data were taken, allowing a one-to-one comparison. They will be displayed side-by-side with actual values taken from the billing data. If you have entered the values, MHEA will use the pre-retrofit air leakage data from your blower-door tests in computing the predicted consumptions. Otherwise, MHEA will use a rate corresponding to your selection for Home Leakiness on the General Information Screen.

Also displayed side-by side will be the heating or cooling degree-days used by MHEA in its computations as well as those you entered with the billing data (if available). Both will be based on the base temperature you indicated during entry of the billing data. Comparison of predicted and actual consumptions and degree-day totals should assist you in determining whether to use MHEA adjusted measure savings based on the billing data entered. Percent differences of the totals of these two quantities are displayed to further aid in the decision.

Note, MHEA was designed to make its recommendations based on average weather and occupancy characteristics rather than the specific life styles of the occupants. Thus, it should not be expected to reproduce the billing data with great accuracy.

7.8 Equipment Sizing

The size of a home's heating equipment should correspond to the peak heat loss of the house, normally expressed in thousand of Btus per hour (kBtu/h). MHEA estimates this size both before and after weatherization using the home description information you provide and formulas taken with permission from tables published by the Air Conditioning Contractors of America (ACCA) in their Seventh Edition (1986) of Manual J, Load Calculation for Residential Winter and Summer Air Conditioning.

However, you should verify MHEA's estimates with the results of the actual Manual J procedure for types of building components common in your area before regularly using them to guide the purchase of new replacement equipment. The sizing estimate calculated by MHEA is different from a complete Manual J calculation procedure in several ways: (1) the range of building components available in MHEA is not as extensive as the range available in Manual J, which could result in differences; (2) MHEA performs the estimate on the building as a whole, whereas Manual J may be applied by zones or even room by room; and (3) generic duct-loss factors are used in MHEA, whereas Manual J estimates a specific unique duct loss factor for each zone.

The Manual J Component Contributions report in MHEA's Output Summary will list each building component's contribution to the total design heat loss. You can compare these individual component contributions with standard Manual J calculations for an indication of variations between the two sizing procedures.

MHEA converts the total building heat loss to a required heating system output by multiplying the former by a duct-loss factor. Although MHEA's duct loss-factors are based on those published in Manual J, they can not be as specific as those used in the accepted procedure. In addition, the standard Manual J technique recommends computing the building heat loss zone-by-zone, assigning a specific heat-loss factor for the duct supplying heat to each zone (refer to Manual J). MHEA factors range from 0.0 to 0.20 depending on the winter design temperature and whether or not the ducts are insulated.

These duct-loss factors may be inappropriate for hot water or steam boilers which may have lower or higher heat loss through their pipes than forced-air systems have through ducts. You may be able to assign a more accurate duct-loss (or "pipe loss") factor based upon your examination of a home after weatherization. For example, a

hydronic heating system with insulated pipes or a forced-air system with insulated ducts may merit a lower "duct-loss" factor. A steam system with uninsulated pipes may merit a higher "duct-loss" factor. You can estimate the heating system output required by multiplying this factor by the building heat loss reported on the Sizing report.

7.9 Special Notes and Comments

The Special Notes section of MHEA's Output Summary is devoted to notes generated internally by MHEA as it executes. They should be reviewed to see if any may alter your retrofit decisions.

The Comments section contains all comments you may have entered during the home description input. Each is associated with a component type and, if applicable, the specific component code you chose for the component.

NOTES:

Chapter 8

MHEA computes energy savings and selects conservation measures using other data in addition to the home description, such as fuel and material costs. These and other parameters should be customized to produce audit results tailored to your location. By changing the parameters, you can reflect specific local conditions. You can create up to 10 sets of parameters to choose from at any time.

8.1 Creating Your Own Parameter Sets

MHEA is distributed with a set of standard parameters. Although some of the standard values for these parameters may be appropriate for your location, others must be altered before your MHEA audits can accurately reflect conditions in your area.

This chapter will describe the various parameters you can adjust with MHEA's Setup. However, before you do this, it is suggested that you copy the standard parameter set and make modifications to the values in this copy, thus preserving the original standard set for future reference.

This is easily done by selecting Setup on MHEA's introductory screen. You will automatically be presented with the Parameter Set form. If you have never created any additional parameter sets beyond the standard parameter set, you will see reference to this "Standard" set in the Parameter Set Name field. To make a copy of this set for future modification, click on the tool bar button showing two cascading pages with writing on them, located under the word "New" at the top of the form. This will create a copy of the standard set. You will see the Parameter Set Name change to "Standard (copy)." Change this name to what ever you desire, likely reflecting your agency name and/or location to which this parameter set will apply. Note, however, all parameter set names must be unique. Similarly, change the Description to your satisfaction. The creation date will automatically change to the current date. You may also enter any comments applicable to this parameter set you may wish preserved.

Now that you have your own parameter set, you can make any of the changes in parameters described in this chapter while still being able to refer back to the original parameter set if you so desire.

You may also create additional parameter sets of your own by applying the same procedure. Note, you do not always need to use the standard parameter set as the starting point for a new set. If the new set you wish to create more closely resembles a set other than the standard one, simply choose the existing set from those available

under the Find control on the Parameter Set toolbar. Then use the copy button to create a copy of this set from which to make your changes.

Multiple parameter sets may be useful if you have different contractors in your agency area who have different costs or possibly different fuel suppliers with significantly different fuel prices.

8.2 Changing Parameters

The remainder of this chapter will be devoted to describing the changes you can make in parameters included in the parameter set. They are grouped by categories corresponding to forms available through tabs on the Parameter Set screen. The categories are:

Material Costs	Key Parameters
Fuel Costs	Replacement Refrigerators
Fuel Escalation	Replacement Water Heaters
Candidate Measures	

8.3 Material Costs

The Material Costs forms contain cost information for all retrofit measures evaluated by MHEA. You may revise the estimated Life of the measure and the Material, Labor, and Extra Costs for each measure. There are more retrofit measures than can be displayed on one screen. Therefore, they have been divided into groups, and each group is displayed on a separate form. Access the category of materials you desire by clicking on the tab corresponding to that group.

The columns within each Material Costs form are the same. The "Material Name" column displays a short phrase describing each measure that MHEA can evaluate. You cannot alter this text.

The Life is the expected length of time a measure is effective before wear, weather, or other damage usually occurs and the measure must be replaced. The life times in the standard set of parameters reflect industry standards, and will likely be sufficient for your use. However, if you have documented cause to alter them, you may do so from this form. The Weatherization Program has prescribed a maximum 20-year life for materials when used to compute savings-to-investment ratios (SIRs). Therefore, you cannot enter values for measure life more than 20 years or less than 0 years. Enter values in whole numbers. For example, if a retrofit measure has an expected life of 5-1/2 years, enter either 5 or 6 years. Life times are in years except for the Compact Fluorescent materials, for which they are in thousands of hours burn time.

The unit of measurement for each measure is listed in the Units column. You cannot revise these abbreviations. Abbreviations used are "EA" for Each, "SF" for Square Foot, "BAG" for bag (of insulation), and "UI" for United Inch.

The "BAG" unit refers to a bag of loose insulation with the weight you designate in the Insulation Section of Key Parameters (see Section 8.7.3, *Altering Key Parameters—Insulation*). Unless altered, the bag weights in the Standard Parameter Set are 25 pounds for both loose fiberglass and loose cellulose. MHEA then uses installed densities of insulation in lb/ft^3 to determine the coverage from each bag. The installed are also available for you to alter in the Key Parameters section. Unless altered, the values to the Standard Parameter Set are 1.5 lb/ft^3 for loose fiberglass and 3.0 lb/ft^3 for loose cellulose. The volume of insulation at these densities required to install each measure depends on the geometry of the implementation and available depths or heights you give during input of the home description.

The united inch ("UI") unit is a measure of replacement window size. It is equivalent to the length plus the width of the window. For example, if the size of a window is 24 in. × 36 in., its equivalent dimension is 60 UI.

The Material Cost column contains estimated costs to purchase the materials for a retrofit measure. To revise this information, enter the new cost in dollars and cents per unit measurement, as given in the corresponding Units entry. For example, if a retrofit has a unit measurement of square feet ("SF"), the cost entered should be equivalent to $XX.XX/sq ft.

The cost of labor to install the retrofit measure is shown in the Labor Cost column. To revise this information, enter the new cost in dollars and cents per unit measurement, as given in the corresponding Units entry. For example, if a retrofit has a unit measurement of square feet, the cost entered should be equivalent to $XX.XX/sq ft.

When computing a total retrofit cost, MHEA adds the material and labor costs per unit of measurement. The differentiation between material and labor costs is lost thereafter. Thus, if you only have a total per unit cost for a retrofit, not divided into material and labor, you may enter that total cost into either Material or Labor columns, leaving the other at zero.

The far right column on the Material Cost forms contains extra costs for each measure. Extra costs are those other than material and labor costs that are associated with a particular retrofit measure. These costs may include setup or repair costs necessary for the retrofit measure installation (for example, the cost of operating the equipment to blow loose insulation into the floor, wall, or roof sections of the manufactured home). Note that the costs should be entered in dollars and cents per measure, <u>not</u> per "Unit" of measurement. Thus, it is a lumped dollar amount added to the total computed labor

and material installation cost for the measure. Added costs will be applied only to the corresponding retrofit measure during MHEA calculations.

The entries in the Material Cost forms of Setup for Duct Sealing and General Air Sealing are intended to be used as equipment setup costs. Any costs entered here for these two measures will be added to the costs you enter on the Ducts and Infiltration form for the house description.

Do not allow any retrofit to have zero costs entered into all three of its cost fields. This would imply a total zero cost for the retrofit and the program cannot execute under such a condition. If you do not use a particular material, don't zero out its costs. Instead, just leave the costs unchanged and turn off that measure in the Candidate Measures form (see Section 8.6, *Selecting Candidate Conservation Measures*).

8.4 Fuel Costs

The Fuel Costs form contains dollar costs of the listed fuels in common units—mcf (1,000 cubic feet) of natural gas, gallons of #2 oil, kWh of electricity, gallons of propane, cords of wood, tons of coal, and gallons of kerosene. Natural gas quantities may be reported in units of "therms." There are approximately 10 therms of energy produced by each mcf of natural gas. Thus, if your gas costs are reported in $/therms, multiply this cost by 10 to get $/mcf.

Assemble a list of fuel costs in your area and enter these values into this form. Since fuel costs vary widely throughout the United States, the values in the standard parameter set do not likely reflect costs in your location and should be changed. Check the costs of fuels in your area at least once a year and update the costs, if necessary. Fuel costs should be typical—avoid high or low short-term values.

8.5 Fuel Escalation Rates

Each year, the U.S. Department of Commerce prepares and publishes for the U.S. Department of Energy fuel escalation rates to be used by the Weatherization Assistance Program. The Program rules require agencies to update the fuel escalation rates at least every five years. Each release of MHEA will contain the most recent values published. Thus, unless your version of MHEA was released more than five years ago, you should not need to make any changes in these values.

8.6 Selecting Candidate Conservation Measures

This form allows you to prevent MHEA from considering conservation measures which may not be appropriate for your location. For instance, if the weather in your

location suggests that evaporative coolers are cost-effective, but they are not accessible or practical to install, this measure may be turned off. Or, you may lack confidence that occupants will not override the automatic setback thermostat, giving cause for eliminating this measure.

Click on the check boxes adjacent to the measure name to change its status. The presence of a "✓" in the check box indicates the measure is to be considered.

More detailed descriptions of the retrofit measures are contained in Chapter 10, *MHEA Energy Conservation Measures*. Note, decisions regarding regularly preventing measures from being considered by MHEA are usually made with the guidance of State personnel.

8.7 Altering Key Parameters

Key parameters are accessible to give you more flexibility in applying MHEA. If you have more accurate numbers than MHEA's default values, enter them to replace existing values. For example, if you normally purchase 30 pound bags of cellulose insulation, you should change the "Bag size for loose cellulose insulation" from 25 to 30. Caution should be exercised in altering parameters. MHEA attempts to find energy conservation retrofits for houses with "average" occupants. Seldom should effort be made to adjust parameters to coincide with life-styles of individual occupants.

The parameters are sub-divided into six categories for ease in locating a particular entry. Click on the tab which describes the type of parameter you are looking for. The categories are: Economics, Setpoints, Insulation, Heat Transfer, Doors, Windows, and Base Loads.

You may change only the Value fields within the Key Parameter forms. The entries in the Name and Units columns are fixed and may not be altered.

The following are brief descriptions of each parameter included in the Key Parameters, divided by category.

8.7.1 Economics

Real Discount Rate—The real discount rate adjusts the economic calculations for the time-value of money. DOE annually determines the discount rate to be used. An unaltered rate may be used for weatherization economic evaluations for up to 5 years. A higher rate than that determined by DOE may be used if the adjusted rate is within the range of 3% to 10%. For more information, refer to section 440.21 (i) of the DOE rule, titled "Weatherization Assistance Program for Low-Income Persons" approved in March 1993.

Minimum Acceptable SIR—Enter the minimum acceptable SIR value to be used during MHEA economic evaluation. The minimum acceptable SIR value for retrofit measures interactive effect is 1 according to the DOE rule, "Weatherization Assistance Program for Low-Income Persons" approved in March 1993.

Spending Limit for Package of Measures—Enter the maximum amount of money, in dollars, to be spent on a package of measures to retrofit the home. If the costs exceed this value a message will appear in the "Costs" screen found in the Results menu.

8.7.2 Setpoints

Thermostat Setback Amount—MHEA assumes an automatic setback thermostat, if one exists, will allow the nighttime temperature to decrease by the Thermostat Setback Amount, in degrees Fahrenheit, below the normal Heating Nighttime Setpoint.

Length of Day for Thermostat Setback—Enter the number of hours per day that a setback thermostat, if one exists, does not affect the thermostat setpoint. Thus, if the thermostat sets the thermostat setpoint back for eight hours at night, the Length of Day would be 16 hours.

Heating and Cooling Setpoints for Day and Night—Enter thermostat setpoints, in degree Fahrenheit, to be assumed when MHEA estimates the home's consumption. MHEA is designed to make recommendations base on average occupancy. Thus, these setpoint values should not be altered to reflect any unusual life-styles of the occupants, unless possibly those maintained for purposes of health and safety of the occupant and which are expected to persist for a significant time compared to the life of the materials to be installed.

8.7.3 Insulation

Existing Batt/Blanket, Loose, Rigid, Foamcore Insulation R-Value Per Inch—Enter the R-value per inch for the insulation to be used in MHEA energy calculations. This value is used to evaluate the insulating effect of existing insulation described on the input forms as well as the insulating effect of new insulation added during weatherization. Note that rigid insulation is typically found in the roof section and that foamcore insulation is typically found in the wall sections of the manufactured home.

Interior Ceiling R-Value: Summer, Winter—Enter the R-value of the interior ceiling components for the summer and winter seasons. The ceiling components may simply include the ceiling material and the surface resistance of the air. Refer to literature related to approximating R-values of building components for further detail.

Interior Floor R-Value: Summer, Winter—Enter the R-value of the interior floor components for the summer and winter seasons. The floor components may simply

include the flooring material, floor covering, and the surface resistance of the air. Refer to literature related to approximating R-values of building components for further detail.

Interior Wall R-Value: Summer, Winter—Enter the R-value of the interior wall components for the summer and winter seasons. The wall components may simply include the interior wall material and the surface resistance of the air. Refer to literature related to approximating R-values of building components for further detail.

Outside Wall R-Value: Summer, Winter—Enter the R-value of the outside wall components for the summer and winter seasons. The wall components may simply include the exterior wall material and the surface resistance of the air. Refer to literature related to approximating R-values of building components for further detail.

Density of Added Loose Fiberglass and Cellulose Insulation—Enter the anticipated density in lb/cuft of fiberglass and cellulose insulation to be installed. These values are used with the Bag Size entries which follow to determine the number of bags of insulation necessary to perform the associated insulation retrofits.

Bag Size for Loose Fiberglass and Cellulose Insulation—Enter the weight of the bags of fiberglass and cellulose insulation purchased to perform the insulation retrofits. These values are used with the Installed Density entries above to determine the number of bags of insulation necessary to perform the associated insulation retrofits.

8.7.4 Heat Transfer

Free Heat from Interior Sources: Day, Night—Free heat is the heat resulting from activities taking place within the home. MHEA initially assumes a daytime free heat daytime load of 2,400 Btuh from occupant activities that include cooking, hot water use, appliance use, and lighting. The MHEA assumed free heat nighttime heat load is 1,000 Btuh for occupants at rest, miscellaneous appliances that operate continuously (electric clocks, etc.) and lighting.

Duct-Sealing and Duct Insulation Distribution Loss Reduction—The duct distribution loss is the supply air lost to the outside through holes in the duct that does not reenter the living space. The percent reduction in the duct distribution loss because of duct sealing or insulating around the ducts are the Duct Sealing and Duct Insulation Distribution Loss Reduction factors. Insulating around the ducts usually is a result of filling the belly or roof cavity with loose insulation.

Heating System Tune-up Efficiency Improvement—Enter the heating efficiency improvement of the heating equipment expected to result from a system tune-up. The heating efficiency is the fraction of heat supplied to the living space by the equipment after fuel is consumed to produce the heat. The efficiency increase entered should be for the heating equipment only and not take into account the air supply system.

Cooling System Fan Power—Enter the fan power of the cooling system fan. This value is used in the equipment cooling capacity and equipment energy consumption calculations.

Evaporative Cooler Actual Saturating Efficiency—Enter the actual saturating efficiency of the evaporative cooler. Refer to manufacturer's literature or literature describing evaporative cooler operation for actual saturating efficiency values.

Saturating Efficiency for Evaporative Tune-Up—Enter the saturating efficiency after a tune-up has been performed on an evaporative cooler.

Saturating Efficiency for Evaporative Replacement—Enter the saturating efficiency of a replacement evaporative cooler. The manufacturer's literature should help indicate the new evaporative cooler saturating efficiency.

Home Leakiness—Tight, Medium, and Loose—These are the pre-retrofit blower door readings in CFM at 50 Pa pressure differential which are associated with the selection of Home Leakiness on the General Information form (see Section 6.1, *General Information*).

8.7.5 Doors

Door U-Value: Wood with Solid Core, Wood with Hollow Core, Standard Manufactured Home Door—Enter a U-value for each type of door. These values are used to evaluate the insulating effect of the existing doors described on the input screens. Note that MHEA assumes a standard manufactured home door has a solid core and a vinyl or fiberglass skin.

U-Value of Replacement Door—Enter the U-value for a replacement manufactured home door. This value is used to evaluate the insulating effect of the replacement doors.

8.7.6 Windows

Window U-Value: Summer, Winter; Single Pane, Double Pane—Enter the U-value of single and double pane windows with no storm windows for the summer and winter seasons. Refer to manufacturer's literature or literature related to approximating window U-values for further detail.

Window U-Value with Glass Storm: Summer, Winter; Single Pane, Double Pane—Enter the U-value of single and double pane windows with a glass storm for the summer and winter seasons. Refer to manufacturer's literature or literature related to approximating window U-values for further detail.

Window U-Value with Plastic Storm: Summer, Winter; Single Pane, Double Pane—Enter the U-value of single and double pane windows with a plastic storm for the summer and winter seasons. Refer to manufacturer's literature or literature related to approximating window U-values for further detail.

Skylight U-Value: Summer, Winter; Single Pane, Double Pane—Enter the U-value of single and double pane skylights with no storms for the summer and winter seasons. Refer to manufacturer's literature or literature related to approximating skylight U-values for further detail.

Skylight U-Value with Glass Storm: Summer, Winter; Single Pane, Double Pane—Enter the U-value of single and double pane skylights with a glass storm for the summer and winter seasons. Refer to manufacturer's literature or literature related to approximating skylight U-values for further detail.

Skylight U-Value with Plastic Storm: Summer, Winter; Single Pane, Double Pane—Enter the U-value of the skylights with a plastic storm for the summer and winter seasons. Refer to manufacturer's literature or literature related to approximating skylight U-values for further detail.

Window Shading R-Value: Blinds or Shades, Drapes, Drapes and Shades—Enter the R-value of the interior window covering. Refer to manufacturer's literature or literature related to approximating R-values of interior window shading devices for further detail.

Ratio of Awning Depth to Window Height—Enter the ratio of the exterior window awning depth to the height of the window (depth/height). The depth of the awning is the distance the awning extends from the exterior of the manufactured home. This value is used to calculate the shading effect of the awning on the window.

Sun Screen Solar Transmittance Reduction: Summer, Winter—Enter the percent reduction of solar transmittance in the summer and winter due to an exterior window sun screen. The solar transmittance is the fraction of solar energy that travels through the window into the living space of the manufactured home. Refer to manufacturer's literature or literature related to sun screen solar transmittance for further detail.

8.7.7 Base Loads

Low-Flow Shower Head Flow Rate—Enter the flow rate of replacement shower heads used in your program (gal/min).

Water Heater Wrap Added R-Value—Enter the R-value of insulation used to wrap water heaters ($F\text{-}ft^2\text{-}h/Btu$).

Refrigerator Defrost Cycle Energy—Enter the kilowatt-hours you wish the program to use as an estimate of the added refrigerator energy use due to a defrost cycle (kWh).

8.8 Replacement Refrigerators

The Refrigerators form under Setup allows you to create a library of refrigerators from which you select replacements when entering home description base load data for a house. It is anticipated that you would have a relatively small stock of replacement

refrigerators that are available to you and that you have chosen to use in your program. By creating a library of these models, you can quickly select the most appropriate one when entering data for each individual home. You may have models of varying capacities in your library, to allow replacement of the existing unit with one of equal capacity.

You may choose models from the AHAM (Association of Home Appliance Manufacturers) data base of refrigerators by selecting the Manufacturer and Model for the replacement from the drop down lists, as you possibly do in selecting the existing model (see Section 6.11.1, *Refrigerator*). If the specific model does exist in the data base, its annual consumption (in kWh/year) will automatically be entered in the table for you.

Alternatively, you may enter all of the data manually, most likely taking the annual consumption from the energy guide label posted on the refrigerator itself.

However you choose to enter the models for your replacement refrigerators, you will have to manually enter the cost of the refrigerator into your library. The cost column in the form is the material cost of purchasing the refrigerator. Other costs (labor, disposal, etc.) may differ from one house to another and are, therefore, not included in the library input, but are requested during the home description input.

A default life time of 15 years is automatically entered for you. If you have a well established reason to change this value, you may do so on the form.

The Capacity, Height, Width, and Depth fields are optional, as is the case on the building description input form. If entered, however, they will allow you to compare the size of the existing and replacement units to insure a proper fit.

8.9 Replacement Water Heaters

The Water Heaters form under Setup allows you to create a library of replacement water heaters from which you select replacements when entering home description base load data for a home. The process is similar to that used for Refrigerators above. Your library might contain replacement models of varying fuel type (electric or gas) and capacity.

You may choose models from the GAMA (Gas Appliance Manufacturers Association) data base of water heaters by selecting the Manufacturer and Model for the replacement from the drop down lists, as you possibly do in selecting the existing model (see Section 6.11.2, *Water Heating*). If the specific model does exist in the data base, all of its required data will automatically be entered in the table for you.

Alternately, you may enter all of the data manually, most likely from available manufacturer specifications. If you choose to do so, the following information will be required:

Fuel—Select the fuel used by the water heater, either Natural Gas, Electric, or Propane.

Gal.—Enter the rated tank capacity of the water heater in gallons.

Input/Units—Enter the rated input, fuel consumption rate, of the water heater and the units of your numerical value.

EFact—Enter the Energy Factor of the replacement unit. The energy factor is a measure of the overall efficiency with which the unit delivers hot water.

RFact—The Recovery Factor or Recovery Efficiency is a measure of how efficiently energy is transferred to the water when the burner(s) are on.

Both the Energy Factor and the Recovery Efficiency are determined by DOE specified laboratory tests of the units.

Cost—Enter the cost of the replacement unit. If a cost is entered, it will be automatically transferred into the Material Cost field on the Water Heater input form. The cost will likely be the purchase price only. An additional field on the Water Heater input form is available for other costs associated with installation. (Optional)

Life—An industry accepted life time for water heaters of 15 years is already entered for you. Change the value if you have documented evidence supporting the change. Note that DOE will not allow material life times of greater than 20 years.

NOTES

Chapter 9

MHEA allows you to further tailor the program to your needs through preference settings. These settings alter the operation of MHEA and produce debugging reports, allow you to set individual field range checks and default values, and determine which input and output reports will be displayed and printed. You may alter these settings through the Preferences button on the MHEA Introductory screen. Note, only one set of preferences is retained and they apply to all parameter sets you may have defined.

The preference setting categories are General, Range Check and Default Values, and Report Sections.

9.1 General

Three check boxes under General of the Preferences screen are available to you.

The first check box allows automatic display of the chosen output reports after execution. If checked, these reports will be displayed after you have chosen to run the program, using the exclamation mark (!) button, and the execution is complete. If unchecked, no obvious change in the display will be seen following execution. To view the output reports, you will have to request them using the magnifying glass button under the word "Report" on the Building Characterization and Analysis Window (see Section 3.4, *Running MHEA and Viewing the Reports*).

The second check box displayed on the General screen under Preferences allows you to view messages produced by the program during execution. If checked, a text file will be displayed in Notepad following completion of program execution. The file will indicate the program and version number and date followed by the contents of three arguments submitted to MHEA on execution. Below this is the word "MHEA" followed by a number, the return code, in parentheses. Neither the arguments or the return code will mean anything to the user. However, should the program not operate correctly, this information would assist technical support in diagnosing the problem. Under some situations, other messages may be added to the above, which would further aid in solving execution problems.

If you wish to print the contents of this file, use Notepad's File/Print option. Before continuing, you will have to exit Notepad by using the traditional Windows Close Application [X] box in the upper right hand corner of the Notepad window.

The last check box allows detailed debug reports to be created. You personally will not find these reports useful, but they can help technical support personnel discover the reasons for problems you might encounter when running the program. If checked, following your request to execute the program, you will be presented with several informational boxes in which you will have to click on the OK button to continue. You will then see a DOS window open in which a substantial amount of data will be scrolled past your view. Once the scrolling has ended, you will have to press any key in order to continue. The creation of the debug report is complete and MHEA will proceed normally.

9.2 Range Check and Default Values

As discussed in Sections 4.6, *Field Defaults*, and 4.7, *Field Range Checking*, MHEA provides you with default values and range checks for the various numerical input parameters in order to assist you in properly describing a building. Though the values for these defaults and ranges are set for a variety of parameters during installation of the program, you may wish to alter or set additional defaults and checks. This can be done from Preference's Range Check and Default Values form. Here, each parameter is listed by its field name and the form on which it lies. Designated columns allow you to adjust the "Min," "Max," and "Default" values to meet you needs.

If any entry in the table is left blank, no default will be available or no range checking will occur for that particular field. The Range Check and Default Values form must be exited before any changes made during a visit to the form will take effect.

9.3 Report Sections

As described in Chapter 7, *MHEA Results,* MHEA's input and output reports are divided into sections.

In the Report Sections of Preferences, you may turn on or off the display of any sections you do not regularly use. Here, the sections are listed by their name and report name (Input or Output). Check boxes to the right of each listing allow you to select whether a particular section will be displayed whenever you choose to view reports. If the box is checked, the associated report section will be displayed.

NOTES:

Chapter 10

The list of energy conservation measures considered by MHEA may be accessed through the Setup Menu, Select Candidate Measures option (see Section 8.6, *Selecting Candidate Conservation Measures*).

MHEA currently examines 31 energy conservation measures:

1. Duct sealing
2. General air sealing
3. Wall fiberglass batt insulation
4. Wall cellulose loose insulation
5. Wall fiberglass loose insulation
6. Belly cellulose loose insulation
7. Belly fiberglass loose insulation
8. Roof cellulose loose insulation
9. Roof fiberglass loose insulation
10. Skirting
11. White coat roof
12. Replace wood doors
13. Replace wood doors—mandatory
14. Storm doors
15. Window replacement
16. Plastic storm windows
17. Glass storm windows
18. Awnings
19. Shade screens
20. Setback thermostat
21. Heating system replacement
22. Tune heating system
23. Evaporative cooling
24. Tune cooling system
25. Cooling system replacement (DX)
26. Lighting
27. Refrigerator replacement
28. Water heater tank insulation

29. Water heater pipe insulation
30. Low-flow showerheads
31. Water heater replacement

The first fourteen conservation measures are designed to reduce heat loss or gain through walls, floors, ceilings, and ducts. Measures 15 through 19 affect the way windows behave in the house. They can alter the conduction heat loss, solar gain, and infiltration through the windows. Window shading reduces solar gain—a major element of total heat gain. Shading the windows may affect the heating load, because shade blocks some solar heat from the house during the heating season.

Conservation measures 20 through 22 improve heating system efficiency by decreasing heating energy consumed by the house. They do not affect heat loss through the envelope, however.

Conservation measures 23 through 25 improve cooling efficiency during the cooling season. Evaporative coolers and new air conditioners can reduce cooling costs markedly, if properly installed.

Conservation measures 26 through 31 reduce the energy consumption not directly related to the climate. Such measures are referred to as "base load" measures. They can have minor effects on the heating and cooling costs.

All of the envelope measures (3–19) have separate entries in the Candidate Measure section of Setup for their application to the manufactured home proper versus any addition to the home. They will also be listed separately in any reports involving the measures.

Below is a brief description of each of the measures. Recommended methods for installing retrofit measures are given in some cases. Each weatherization agency will have its own methods for installing retrofit measures. Those methods outlined in this appendix are not necessarily the only or best methods for effective weatherization.

10.1 Duct Sealing

It is very common to find leaks in manufactured home supply air ducts. Leaks are typically found where the supply duct connects to the furnace, at the junction between the air delivery plenum and the vertical floor register sleeves, where the vertical duct sleeves penetrate the subfloor/ceiling, and at the end of the supply duct run. These leaks can be found using a flashlight and mirror aimed from a supply register. Another method for finding leaks is to use a pressure pan and blower door. Leak locations can be isolated by successively sealing off sections of the duct with temporary air blocks while observing blower door readings. Openings can be sealed using silicone caulk or mastic.

Large holes can be sealed with rigid foam or a combination of mastic, mesh tape, sheet-metal patches, and screws.

Most manufactured homes return air to the furnace through a grill in the furnace closet door. Some manufactured homes return air either through ducts or through open plenums in the floor or ceiling. Typically, these latter systems are extremely leaky. Return air systems are also unnecessary because of the small volume of manufactured homes. MHEA calculations assume the return air registers in the floor and the return air chase at the furnace are sealed during the duct-sealing procedure. MHEA also assumes that a grill is installed in the furnace closet door and a 1 to 1-1/2 inches clearance between the bottom of the bedroom and bathroom doors and the floor or carpet is added to accommodate return air flow to the furnace as part of this procedure.

Duct leaks have a large effect on home energy consumption, both when the air handler is on and off. When the fan is on, conditioned distribution air leaks out into the underfloor or roof space (depending on where the ducts are located) and then to the outside environment, decreasing the overall efficiency of the heating or cooling system. When the fan is off, extra infiltration leakage paths exist from the underfloor or roof area through the ducts and then through the supply registers into the living space.

10.2 General Air Sealing

Manufactured homes, especially those constructed prior to the 1976 U.S. Department of Housing and Urban Development manufactured home construction standards, are inherently leaky. Leakage locations typically are: water heater closets with exterior access; furnace flue and combustion air duct penetrations through the rodent barrier, floor, and ceiling; evaporative cooler chase penetration through the ceiling; doors and windows that do not seal properly when closed; kitchen vent fans; and damaged rodent barriers.

While sealing an exterior water heater closet, insulation should be installed wherever possible including the common wall, the outside wall, and the door of the closet. Note that the exterior door should be sealed as well. Redirect combustion air from the register in the exterior door to a combustion air duct installed in the floor of the closet that pulls air in from under the belly of the home. Sealing and insulating can be accomplished with 1/8-inch hardboard and silicone or, for the less accessible areas, 6-mil polyethylene sheet or insulating aluminized foil and construction adhesive. Large openings can be stuffed with batt insulation and sealed with an insulating foil membrane. Wrap water pipes to avoid freezing. BE SURE THERE IS ADEQUATE COMBUSTION AIR AVAILABLE FROM THE OUTSIDE IF THE WATER HEATER IS FUELED BY GAS OR OIL.

Penetrations through the ceiling and floor from combustion air ducts, exhaust fans, and waste pipes can be sealed using a silicone caulk. Furnace flue penetrations must be sealed using materials that meet local fire codes, often metal sleeves. Covering the opening in the ceiling with an interior plastic cover may stop evaporative cooler chase leaks. Covers are commercially available or can be constructed in the same manner as interior plastic storms. This type of cover is simple to remove and store during the cooling months when the evaporative cooler is in use. Install a similar cover used for evaporative cooler chases over a room air conditioner (inside the home). Do not cover the portion of the room air conditioner that extends outdoors unless the inside portion is also covered. Also, check that the perimeter of the room air conditioner is sealed tightly.

Inexpensive window repairs include installing ludwig clips to tightly close the panes of jalousie or awning-type windows, replacing the window-operating mechanisms, replacing the panes, repairing or replacing damaged seals at awning and jalousie pane edges with weather stripping, rerouting cables (such as TV or other cables) through the floor or walls (and seal new opening), and sealing cracks between the window trim and the interior wall with silicon acrylic caulk.

Seal leaks around doors by replacing damaged, missing, or degraded weather stripping on door flanges. Repair or adjust latch plates if damaged. Damaged plates prevent tight sealing of the door. Replace the door if there is a damaged door flange. A damaged flange prevents a pressure fit of the weather stripping upon closure. Replace damaged window with rigid insulation sheathed in manufactured home siding.

Ensure that the kitchen vent fans are operating properly and that they are sealed shut when the fan is turned off.

A damaged rodent barrier allows outside air to enter the floor section. When this occurs, any insulation that may exist in the floor section essentially has no effect. All damage to the rodent barrier should be repaired before insulation is added to the belly

10.3 Wall Fiberglass Batt Insulation

This measure adds 3-1/2 inches of fiberglass batt insulation to the walls. It will be evaluated if the insulatable space in the walls is 1 inch or greater. A recommended method of stuffing batt insulation into the wall cavity is listed below.

- Insure interior paneling is tightly fastened to the wall frame.
- Remove bottom two rows of screws from exterior siding and look inside the wall cavity to see where wiring is located.

- Cut vinyl-backed fiberglass batts or unfaced fiberglass insulation batts and flexible plastic sheeting approximately 8 inches longer than the length of the cavity to be stuffed.
- Sandwich the insulation between the vinyl backing/plastic sheeting and a sheet metal insulation "stuffer," fold the insulation (and plastic sheeting) over the top of the stuffer and push the insulation up into the cavity with the vinyl backing/plastic sheeting facing the interior paneling.

10.4 Wall Cellulose Loose Insulation

> **Caution:** Use a fill tube that minimizes buildup of static electricity and discharge it frequently.

This measure fills walls with loose cellulose insulation. It is evaluated if the insulatable space in the walls is 1 inch or greater. Adding loose insulation will increase the R-value of the walls. If the siding is metal, check that the interior paneling is secured, remove the bottom row of exterior siding screws, and use a flexible fill tube to fill each cavity between the interior paneling and the existing insulation starting at the top of the wall and working down. If the exterior siding is wood, then drill a hole in each cavity approximately 1 foot from the bottom of the wall and use a flexible fill tube (8 feet long, 1 to 2 inches in diameter) to fill the cavity, starting at the top of the wall and working down. Be careful not to damage electrical boxes and wire located in the walls while filling the cavities with loose insulation.

10.5 Wall Fiberglass Loose Insulation

> **Caution:** Use a fill tube that minimizes buildup of static electricity and discharge it frequently.

This measure fills walls with loose fiberglass insulation. It is evaluated if the insulatable space in the walls is 1 inch or greater. Adding loose insulation will increase the R-value of the walls. If the siding is metal, check that the interior paneling is secured, remove the bottom row of exterior siding screws, and use a flexible fill tube to fill each cavity between the interior paneling and the existing insulation starting at the top of the wall and working down. If the exterior siding is wood, then drill a hole in each cavity approximately 1 foot from the bottom of the wall and use a flexible fill tube (8 feet long, 1 to 2 inches in diameter) to fill the cavity, starting at the top of the wall and working down. Be careful not to damage electrical boxes and wire located in the walls while filling the cavities with loose insulation.

10.6 Floor Cellulose Loose Insulation

> **Caution:** Use a fill tube that minimizes buildup of static electricity and discharge it frequently.

This measure fills the available space in the wing sections with cellulose loose insulation and adds up to eight inches of cellulose loose insulation to the belly, space permitting. It is important that the wings along the perimeter of the home be filled with insulation to eliminate infiltration air from entering the belly, thus bypassing the insulation. As long as this is done, the belly need not necessarily be filled. The benefit from filling the belly with loose insulation is fourfold: (1) the R-value of the floor section is increased; (2) if the duct is located under the floor, the duct distribution loss is decreased (resulting in an increased furnace delivery efficiency); (3) air leaks are sealed; and (4) the floor of the manufactured home remains warm in the winter, increasing occupant comfort. Be sure to repair holes in the belly, repair openings in the floor, and seal the duct (if located under the floor) before blowing insulation into the belly section. Also, be careful that there is at least 2 inches of insulation under pipes located in the belly section and do not insulate above water pipes. Finally, insulate the belly below the bathtub to help retain heat in the bath water.

Typically, insulation is blown into the belly through holes cut in the belly wrap or through the rim joist. If necessary, reinforce the belly with lath strips and long screws. Reinforcing the belly will also reduce the volume, resulting in fewer bags of insulation needed to fill the belly section.

10.7 Floor Fiberglass Loose Insulation

> **Caution:** Use a fill tube that minimizes buildup of static electricity and discharge it frequently.

This measure fills the available space in the wing sections with fiberglass loose insulation and adds up to eight inches of fiberglass loose insulation to the belly, space permitting. It is important that the wings along the perimeter of the home be filled with insulation to eliminate infiltration air from entering the belly, thus bypassing the insulation. As long as this is done, the belly need not necessarily be filled. The benefit from filling the belly with loose insulation is fourfold: (1) the R-value of the floor section is increased; (2) if the duct is located under the floor, the duct distribution loss is decreased (resulting in an increased furnace delivery efficiency); (3) air leaks are sealed; and (4) the floor of the manufactured home remains warm in the winter, increasing occupant comfort. Be

sure to repair holes in the belly, repair openings in the floor, and seal the duct (if located under the floor) before blowing insulation into the belly section. Also, be careful that there is at least 2 inches of insulation under pipes located in the belly section and do not to insulate above water pipes. Finally, insulate the belly below the bathtub to help retain heat in the bath water.

Typically, insulation is blown into the belly through holes cut in the belly wrap or through the rim joist. If necessary, reinforce the belly with lath strips and long screws. Reinforcing the belly will also reduce the volume, resulting in fewer bags of insulation needed to fill the belly section.

10.8 Roof Cellulose Loose Insulation

> **Caution:** Use a fill tube that minimizes buildup of static electricity and discharge it frequently.

This measure fills the roof with cellulose loose insulation. It is evaluated if the existing insulatable space in the roof section is greater than 2 inches. The benefit from filling the roof with loose insulation is twofold. The R-value of the roof section is increased and, if the duct is located above the ceiling, the duct distribution loss is decreased (resulting in an increased furnace delivery efficiency). Be sure to repair holes in the roof, repair openings in the ceiling, and seal the duct (if located above the ceiling) before blowing insulation into the roof section. If necessary, also reinforce the ceiling of the home with rosettes or wood lath strips and long screws before blowing insulation into the roof section. Typically, insulation is blown into the roof section through holes cut between the roof joists in either the roof or the ceiling, through the edge of the roof, or through the gable ends of the roof.

10.9 Roof Fiberglass Loose Insulation

> **Caution:** Use a fill tube that minimizes buildup of static electricity and discharge it frequently.

This measure fills the roof with fiberglass loose insulation. It is evaluated if the existing insulatable space in the roof section is greater than 2 inches. The benefit from filling the roof with loose insulation is twofold. The R-value of the roof section is increased and if the duct is located above the ceiling, the duct distribution loss is decreased (resulting in an increased furnace delivery efficiency). Be sure to repair holes in the roof, repair openings in the ceiling, and seal the duct (if located above the ceiling)

before blowing insulation into the roof section. If necessary, also reinforce the ceiling of the home with rosettes or wood lath strips and long screws before blowing insulation into the roof section. Typically, insulation is blown into the roof section through holes cut between the roof joists in either the roof or the ceiling, through the edge of the roof, or through the gable ends of the roof.

10.10 Add Skirting

This measure installs exterior skirting. It is evaluated only if no exterior skirting exits. The benefit from installing exterior skirting is to slightly increase the R-value of the floor section. Exterior skirting typically does not significantly decrease the energy consumption of the home.

10.11 White Coat Roof

An elastomeric, low-emissivity roof-coating retrofit measure is applied only to homes with either a bowstring roof or flat roof, dark roof color, and an existing cooling system. The benefit is to decrease the solar load on the roof, which in turn decreases the home cooling load. This retrofit measure is commonly installed in cooling climates.

10.12 Replace Exterior Doors

This retrofit measure is evaluated only if the existing door is not a standard manufactured home door. The benefit assigned to this measure is to increase the R-value through the door. Typically, replacing manufactured home doors does not significantly reduce the overall heating and cooling loads.

10.13 Replace Door (Mandatory)

If a door flange is damaged so that a tight seal around the closed door cannot be made, then the door may need replacing. Or, the door itself may be deteriorated beyond repair. Replacing the door under these circumstances is a judgment made by the auditor. This measure forces the door replacement for the specified door description to be recommended, whether or not it proves to be cost-effective. If it is not cost-effective, the replacement would normally have to be viewed as a repair item. Alternative approaches are to include the door replacement as part of the infiltration reduction or to list it as a repair item on the Itemized Cost form (see Section 6.12, *Itemized Additional Costs and User-Defined Measures*).

10.14 Add Exterior Storm Doors

This retrofit measure is evaluated only if there is not an existing storm door. The effect of adding a storm door is to slightly increase the R-value of the storm door/manufactured home door combination. Storm doors seldom significantly affect the energy consumption of the manufactured home.

10.15 Replace Single-Glaze Windows

The advantage of replacing single-glazed windows with double-glazed windows is evaluated for this retrofit measure. The measure is not applied to sliding glass doors or door windows. The benefit is to decrease the window U-value and to decrease the solar transmittance (which in turn decreases the solar load).

10.16 Add Interior Plastic Film Storm Windows

This retrofit measure is evaluated if storm windows do not exist. The U-value of the storm window/window combination is decreased when this retrofit measure is applied. MHEA assumes that interior plastic film storm windows are used only during the heating-dominated months. Interior plastic storms may either be purchased or can be fabricated using a acrylic window film cut to the size of the window and held in place with magnetic strips or Velcro™.

10.17 Add Interior Glass Storm Windows

This retrofit measure is evaluated if storm windows do not exist. The U-value of the storm window/window combination is decreased when this retrofit measure is applied. MHEA assumes that interior glass storm windows are used only during the heating-dominated months.

10.18 Add Exterior Window Awnings

This retrofit measure is applied to all windows without existing awnings except north-facing windows. The measure increases the shade on the windows, which decreases the solar load.

10.19 Add Exterior Fabric Mesh Window Sun Screen Shades

This retrofit measure is applied to all windows without existing sun shades except north-facing windows. The measure increases the shade on the windows, which decreases the solar load.

10.20 Install Automatic Setback Thermostat

This retrofit measure is evaluated if the difference between the daytime/nighttime setpoint temperatures is less than 5°F and the heating night temperature is greater than 60°F. The retrofit measure is only applied if the heating system is controlled from a central thermostat. The night heating thermostat setpoint is decreased by 5°F with this retrofit measure. If an automatic setback thermostat is installed, it is advised that you instruct the occupant as to how to properly set and operate the thermostat.

10.21 Replace Heating System

This retrofit measure is evaluated if the existing primary heating system is not fueled by coal or wood. The efficiency of the system is increased with a new furnace. Because of the high cost of a new furnace, this retrofit measure is typically not recommended.

10.22 Tune-up Heating System

Caution: Work should only be conducted by qualified personnel.

Tune-up Natural Gas, Oil, Propane, or Kerosene Fueled Heating System—Identifying opportunities for increasing furnace delivery efficiency and safety can be accomplished quickly by trained personnel. For example, comparing the air temperature at the return air intake and the closest heating register 5 minutes after the fan turns on can help determine potential problems. Excessive heat rise may indicate insufficient air flow because of a dirty or faulty blower, a clogged filter, duct blockage, or an oversized fuel jet. A small heat rise may indicate duct leaks, improperly sized blower, dirty filter, needed adjustment or replacement of fan on/off switches, needed adjustment of the thermostat anticipator, and a clogged fuel line or faulty fuel valve.

Servicing a manufactured home furnace should include but is not limited to cleaning out duct blockage and repairing duct leaks (if not already completed as a duct-sealing retrofit measure), cleaning the blower, cleaning the heat exchanger (check for cracks), replacing the filter, replacing or adjusting fan on/off switches, and adjusting the thermostat anticipator. Refer to state weatherization office guidelines for servicing furnaces.

Typical sealed combustion furnaces found in manufactured homes will have a combustion air duct that either supplies combustion air from underneath the furnace through a duct that penetrates the belly and floor or supplies combustion air to the top of the furnace by way of a downdraft air channel fabricated as part of the flue. Check that the combustion air inlets are properly sealed. No other combustion air sources are

needed if the combustion path is sealed properly and if the heat exchanger is in good condition.

For health and safety reasons, it is recommended that basic safety checks for carbon monoxide, spillage, backdrafting, flame color, and cracked heat exchangers be done after any work on a combustion furnace has been completed.

Tune-up electric/heat pump heating system—Identifying opportunities for increasing furnace delivery efficiency and safety can be accomplished quickly by trained personnel. For example, comparing the air temperature at the return air intake and the closest heating register 5 minutes after the fan turns on can help determine potential problems. Excessive heat rise may indicate insufficient air flow because of a dirty or faulty blower, a clogged filter, or duct blockage. A small heat rise may indicate duct leaks, improperly sized blower, dirty filter, needed adjustment or replacement of fan on/off switches, or needed adjustment of the thermostat anticipator.

Servicing a manufactured home electric furnace or heat pump should include but is not limited to cleaning out duct blockage and repairing duct leaks (if not already completed as a duct-sealing retrofit measure), cleaning the blower, replacing the filter, replacing or adjusting fan on/off switches, and adjusting the thermostat anticipator. Refer to state weatherization office guidelines for servicing these types of units.

10.23 Replace DX Cooling System with Evaporative Cooler

This retrofit measure evaluates the benefit of replacing an existing DX cooling system with an evaporative cooler if the existing primary cooling equipment is a central system or a room air conditioner with a COP of less than 3.5. In dry climates, an evaporative cooler can be quite comfortable. Usually, an evaporative cooler consumes only about 25% of the energy consumed by central air conditioners.

10.24 Tune-up Cooling System

This retrofit measure is applied to all central cooling systems. The cooling capacity of the cooling equipment is increased as a result of tuning the system. Evaporative cooler tune-ups may include cleaning the fan blades, scraping scale off the louvers in the cooler cabinet, cleaning the water trough, replacing the motor with a high-efficiency motor, change out pump controls, and add new pads. DX system tune-ups may include cleaning the coils, filters, fan blades, grilles, motors, compressors, and controls as well as adding a few drops of 20 weight electric motor oil to the motor and fan bearings. If the cooling equipment supplies air through the heating-supply duct, check that the damper that prevents heated air from flowing into the cooling equipment during the winter operates properly.

10.25 Replace Cooling System

This retrofit measure is evaluated if the existing primary cooling system is a central air conditioner, heat pump, or room air conditioner. The cooling efficiency of the system is increased with a new air conditioner. Because of the high cost of a new air conditioner, this retrofit measure is typically not recommended.

10.26 Lighting

Replacing existing incandescent interior lighting with compact fluorescent lights is a relatively straight forward way to reduce the electric consumption of a home.

The development of the compact fluorescent bulb has made this retrofit an extremely simple one to accomplish because most compact fluorescent lights are fitted with screw-in bases identical to the incandescent bulbs which allow a quick and easy one-for-one replacement. Compact fluorescent lights should be chosen carefully because physical size and weight can prevent some bulbs from being used in certain fixtures. There is a variety of bulbs available making it possible to find a compact fluorescent replacement for just about any fixture type that currently exists.

One of the main advantages of the compact fluorescent is its extended life, approximately 10,000 hours versus a normal incandescent's life of approximately 750 to 1000 hours. This equates to approximately thirteen incandescents to equal the same life as one compact fluorescent. The considerably longer life of compact fluorescent bulbs coupled with their energy savings helps to offset the substantially higher initial cost of the compact fluorescent versus the normal incandescent bulb.

MHEA computes the savings of using the lower wattage compact fluorescent bulb to replace an existing incandescent bulb. The watt reduction is determined from the user's input of existing and replacement bulb consumption, though default values for replacement wattage give the standard replacement for the existing bulb.

MHEA also accounts for the longer life of the fluorescent bulb over that of the incandescent.

You must enter the cost for various wattage compact fluorescent bulbs in the Material Cost section of Setup.

10.27 Refrigerator Replacement

On average, refrigerators use nine percent of a home's total energy consumption. They can consume as much as 2000 kWh/year to as little as 400 kWh/year, a factor of five! Significant energy efficiency improvements have been made in refrigerator construction. Units manufactured prior to 1990 will most often use substantially more

energy than today's units. MHEA evaluates the cost-effectiveness of replacing an older unit with a more energy efficient model.

The savings associated with refrigerator replacement is computed from the difference in the annual consumptions of the existing and replacement units. Several methods of data collection can be used to determine this information (see Section 6.11.1, *Refrigerator*). Depending on the method used, MHEA makes adjustments for the unit's age, existence of defrost cycles, and door openings.

10.28 Water Heater Tank Insulation

Older water heaters will likely have less insulation surrounding the hot water tank than is economically justified. MHEA evaluates the installation of a water heater wrap to increase this insulation level. The R-value of the added water heater wrap is specified by the user in the Key Parameters section of Setup (see Section 8.7.7, *Altering Key Parameters—Base Loads*). Greater dollar savings will occur from this measure when applied to electric units in unconditioned spaces. Common practice is to also insulate the tops of electric units, but not gas or propane due to potential fire hazards associated with the flue or interference with the draft diverter.

Due to the measure's relatively low cost, it will often be found cost-effective.

10.29 Water Heater Pipe Insulation

MHEA evaluates the savings from insulating the first five feet of both the cold and hot water pipes entering and exiting a water heater. This not only reduces direct conductive heat loss from the hot water pipe, but also loss from convected water in both the hot and cold pipes. The insulation was assumed to be R-1.85, 1/2 inch elastomer foam rubber. The savings estimates are based on first principle heat transfer calculations and compare favorably with published data.

Due to the measures relatively low cost, it will often be found cost-effective.

10.30 Low-Flow Showerheads

Low-flow showerheads are inexpensive, easily installed, energy efficiency measures. MHEA uses your input of the approximate minutes of shower use per day and the gallons per minute discharged from existing showerheads to estimate an energy savings associated with installing low-flow heads. Replacement showerheads are assumed to discharge the number of gallons per minute specified by the user in the Key Parameters section of Setup (see Section 8.7.7, *Altering Key Parameters—Base Loads*). The temperature of water discharged from the replacement showerheads is assumed to be four degrees

Fahrenheit greater than water from the existing showerheads. This is to compensate for the lower output from the replacement heads.

Due to their relative low cost, low-flow showerheads will often be recommended as long as they are not already installed and there is at least average shower use.

10.31 Water Heater Replacement

MHEA will evaluate the cost-effectiveness of replacing an existing water heater with a higher efficiency model. However, over recent years, the efficiency of water heaters has not changed dramatically. Thus, this measure may not prove cost-effective. MHEA allows you to evaluate the effectiveness of fuel switching. However, you must be sure that all costs associated with the switch are included in the Water Heater Replacement measure cost.

The Water Heater savings are computed using equations from the Lawrence Berkeley National Laboratory's Water Heater Analysis Model (WHAM) (Lutz et. al). The derivation requires the water heater characteristics of energy factor, recovery efficiency, and input rating, all available from the GAMA data base referenced by MHEA. Estimates of daily hot water consumption are based on the number of occupants you indicate in the home description data.

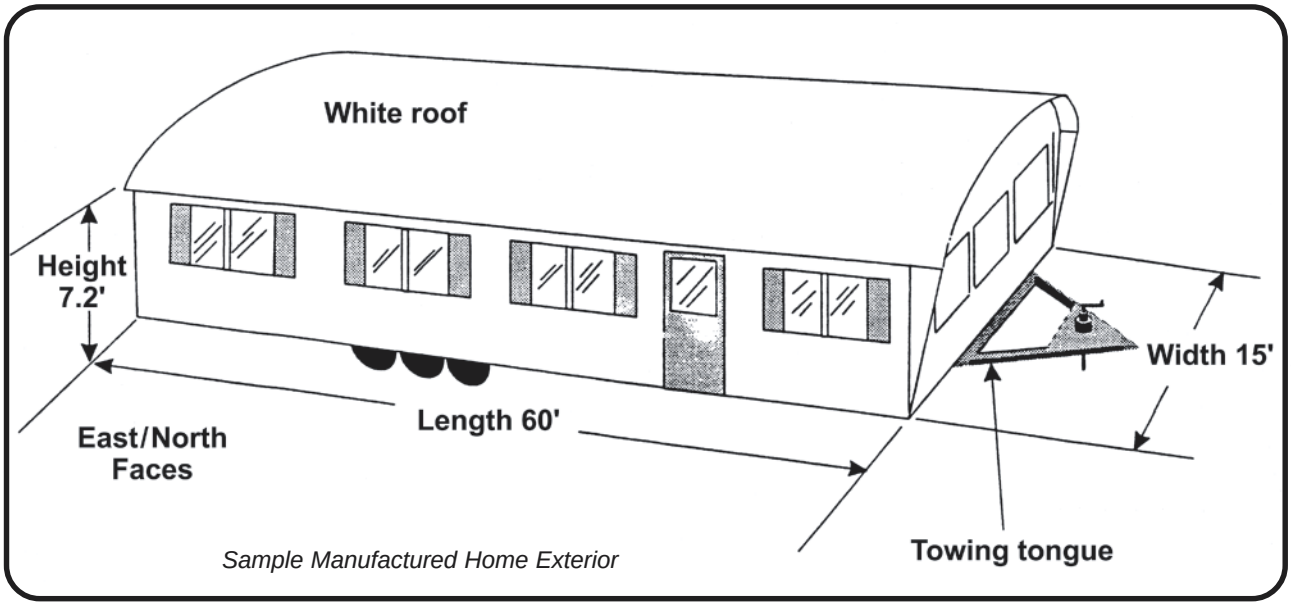
Lutz, J. D., et. Al., "A Simplified Energy Consumption Equation for Water Heaters," LBL-37805, Lawrence Berkeley Laboratory, November 1996.

NOTES:

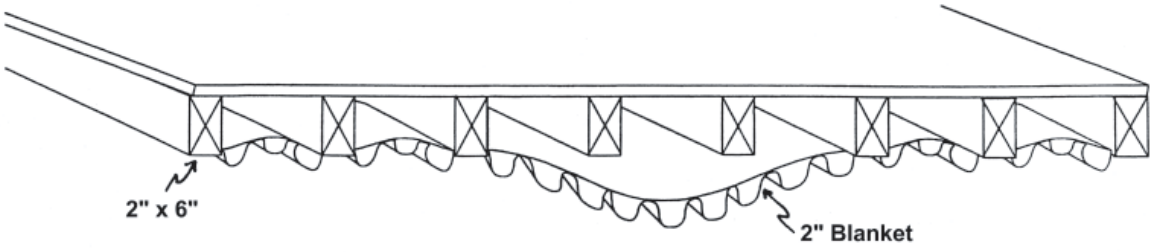
Appendix A

Example House

The following diagrams depict a sample manufactured home. Succeeding pages give completed input forms for a MHEA audit of the home. Note that this sample home does not require all MHEA forms (it does not have an Addition, for example). For a complete set of forms, refer to Appendix C, MHEA Input Forms.

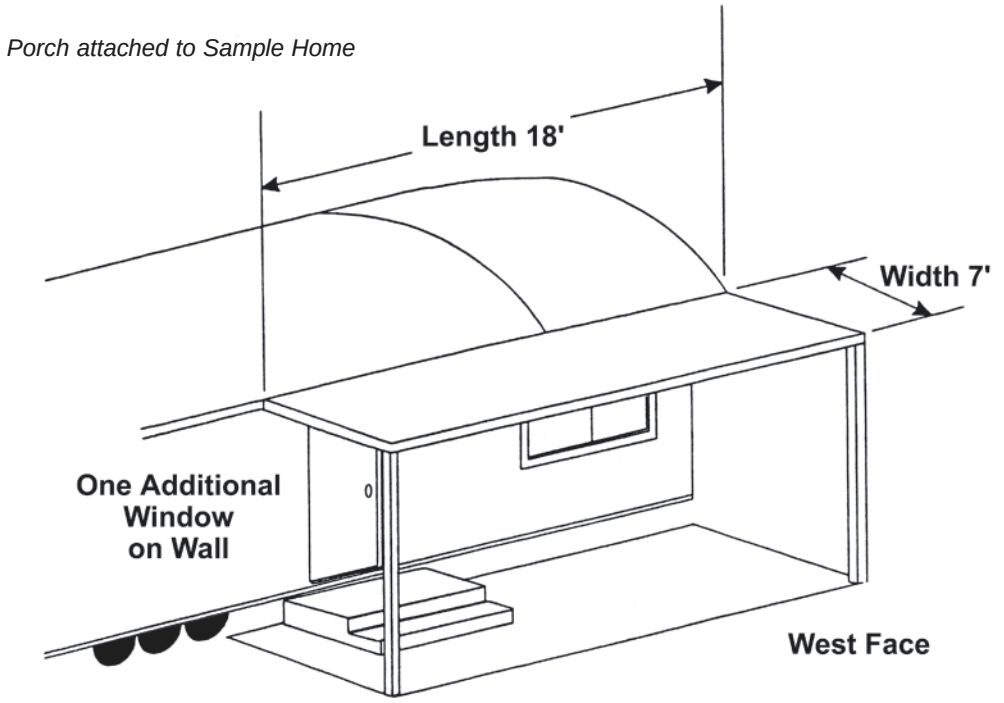


Sample Manufactured Home Exterior



Sample Home Belly

Appendix A — Audit Example



General Info.

Client Information
ClientName: Doe, John
Address: 1234 Any Street
Anytown (City) | US (State) | 12345 (ZipCode)

Audit Information
AuditDate: 8/5/2002
Auditor: R.E. Duce
Job Identifier: SAMPLE

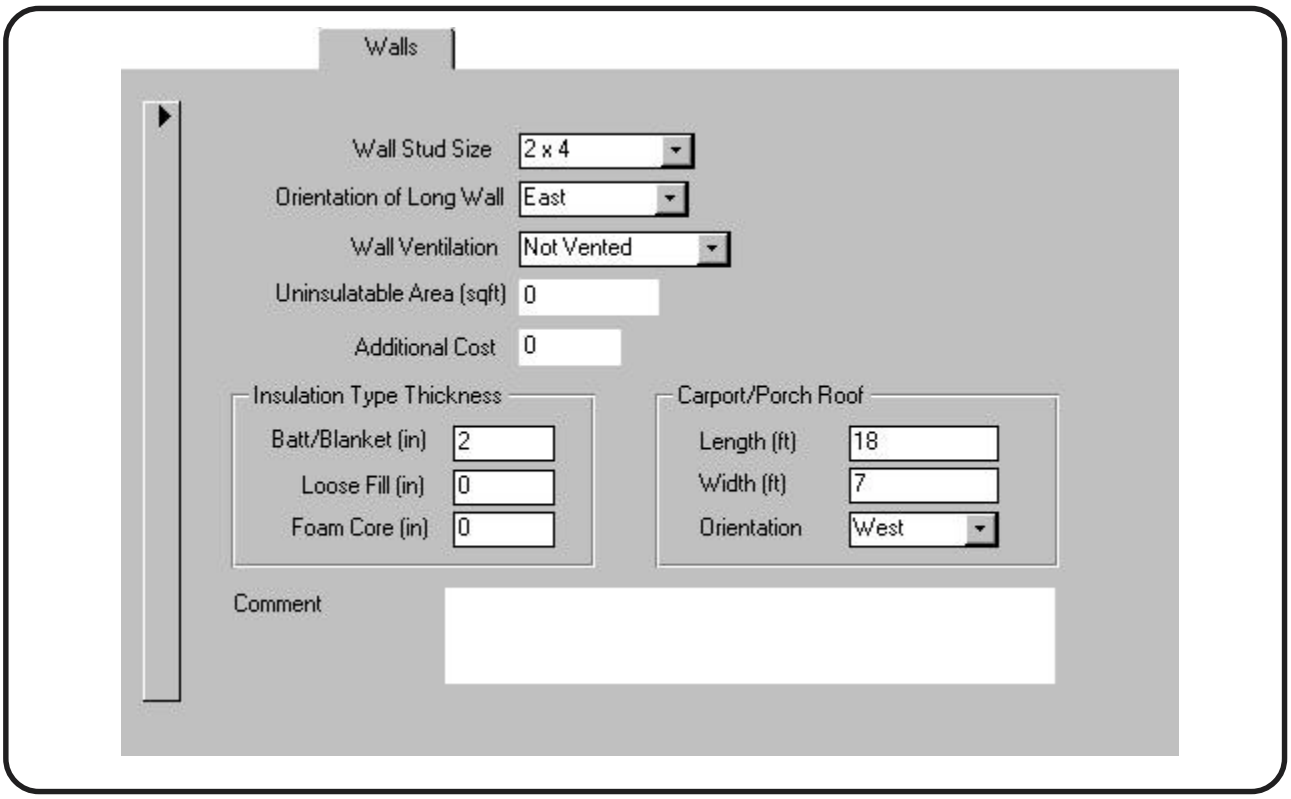
House Data
Length (ft): 60
Width (ft): 15
Height (ft): 7
Occupants: 2
Wind Shielding: Normal Shielding
Home Leakiness: Medium
Outdoor Water Heater Closet?

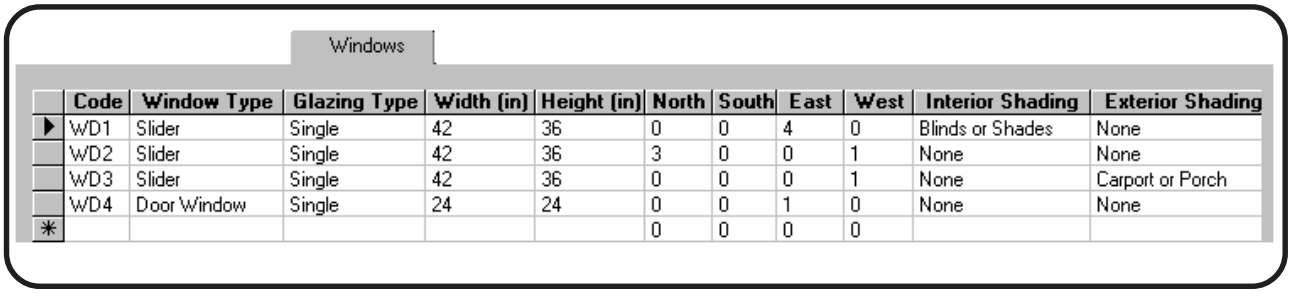
Agency Name: ORNL

Analysis Control
Weather File: SAMPLEUS.WX
Parameter Set: Standard
Include Billing Adjustment?
Last Run On: 9/5/2002 10:51:21 AM

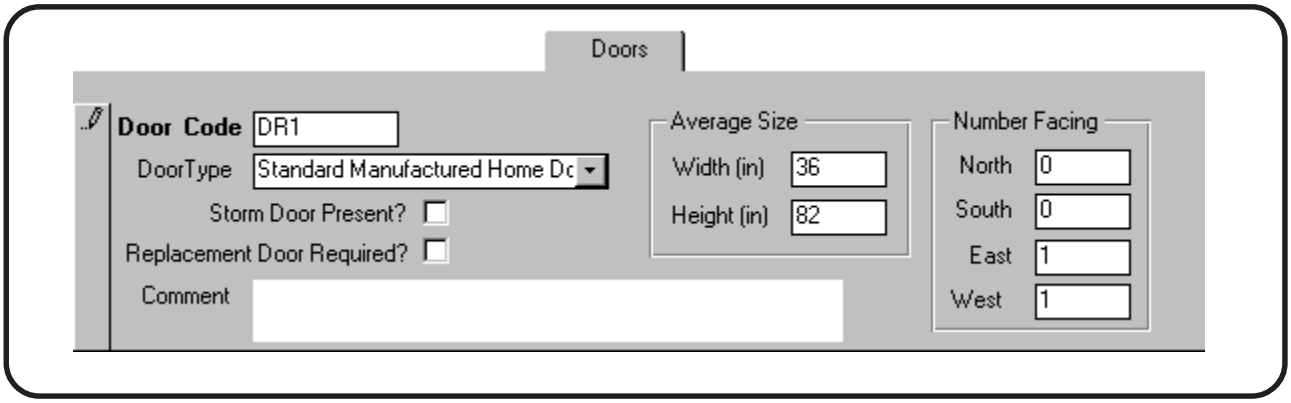
Comment

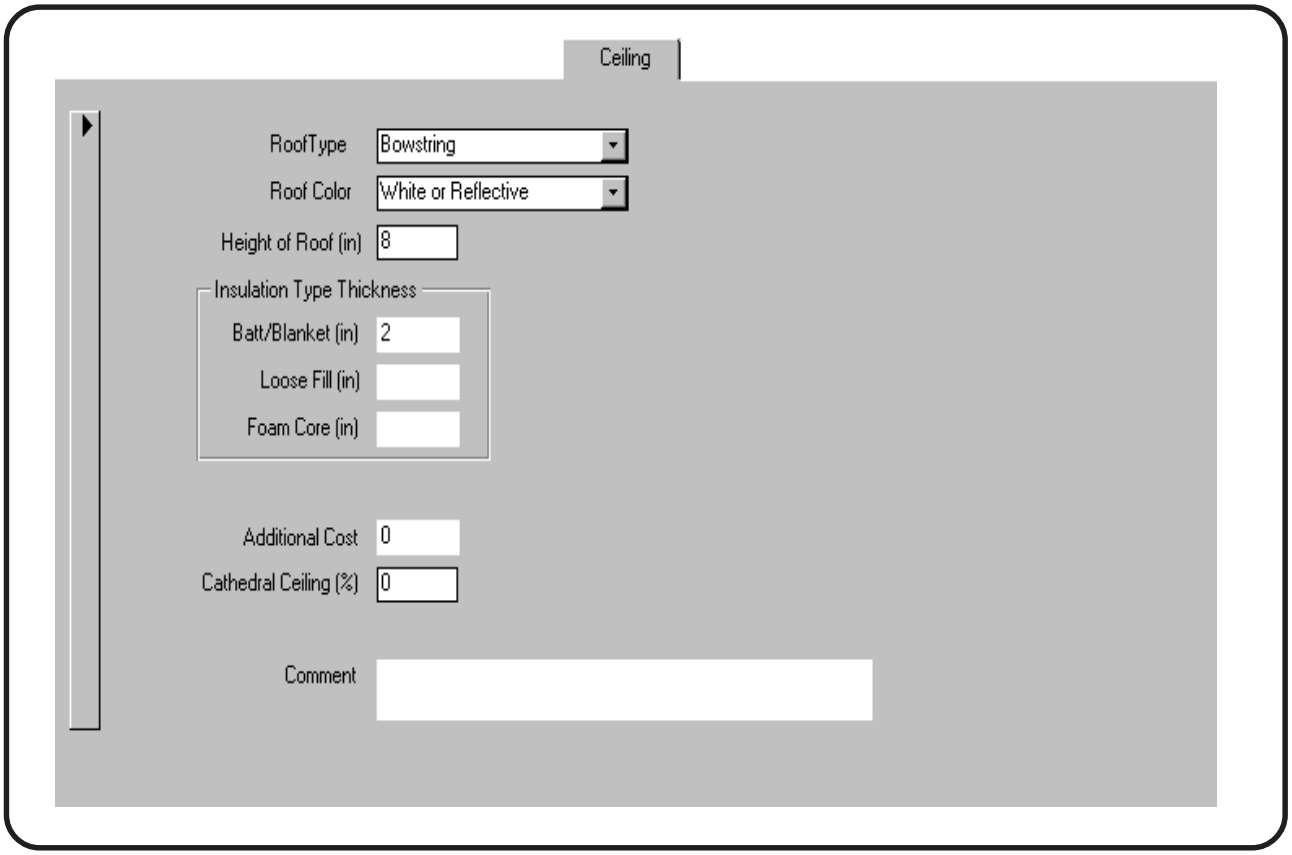
Job ID #: 1009948135

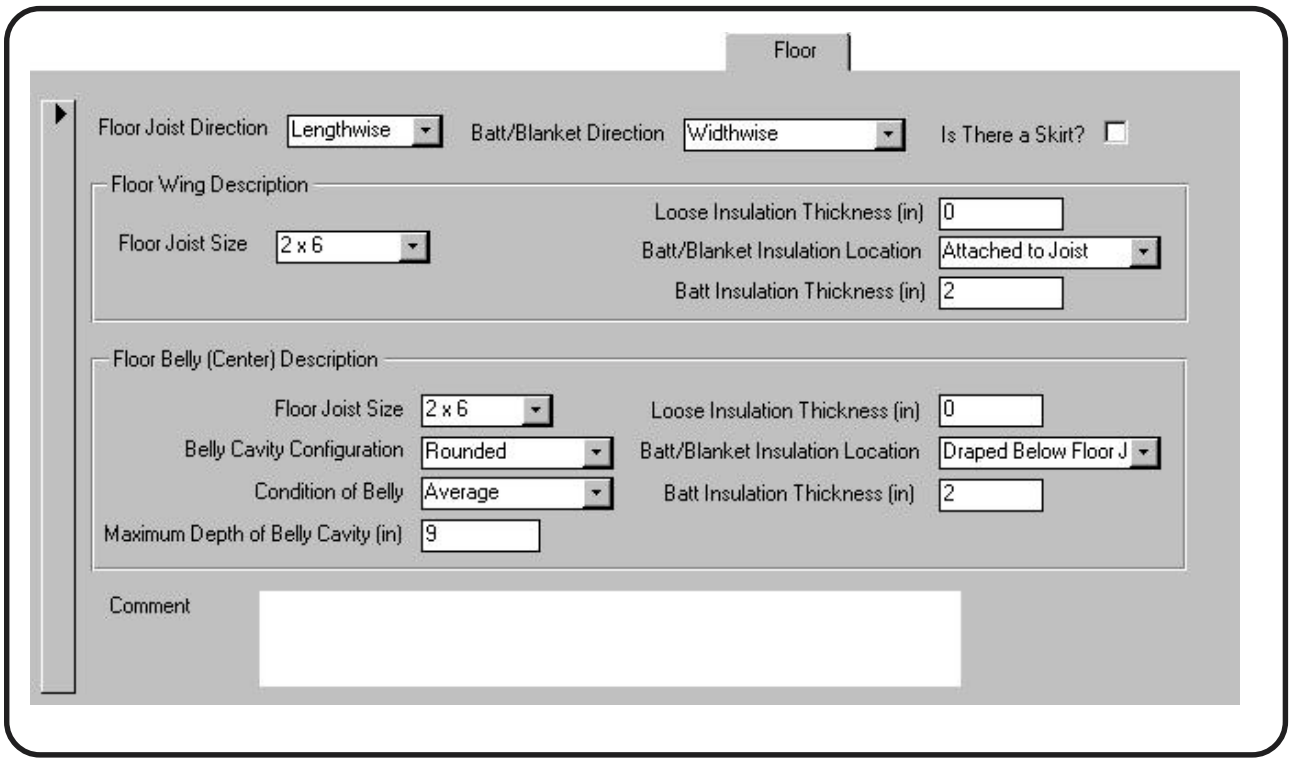


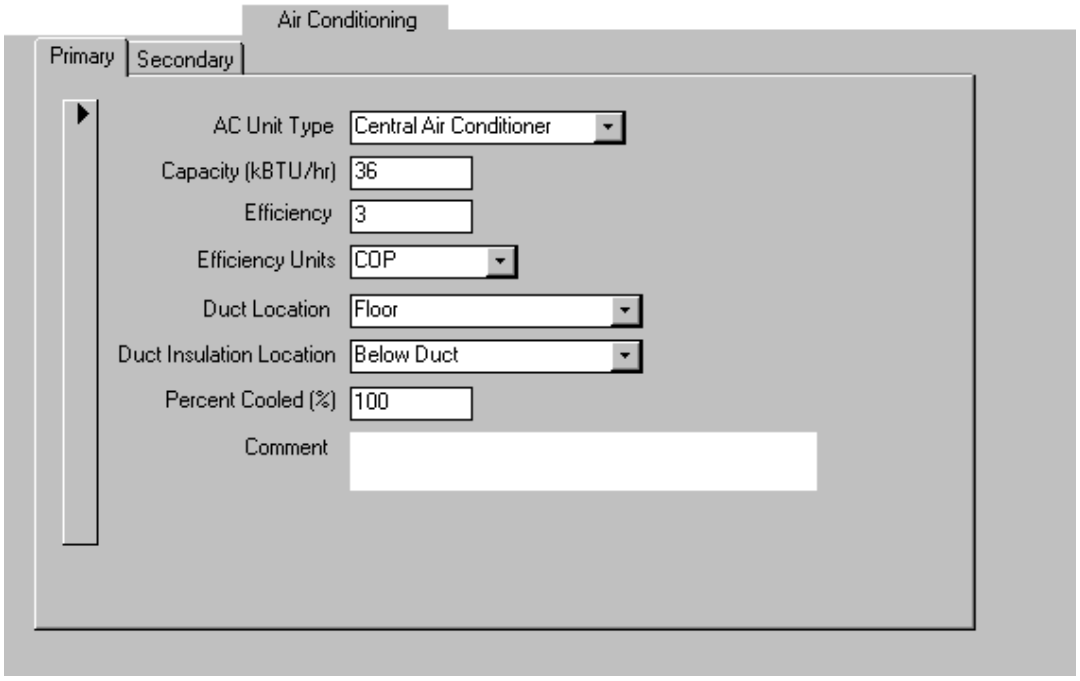


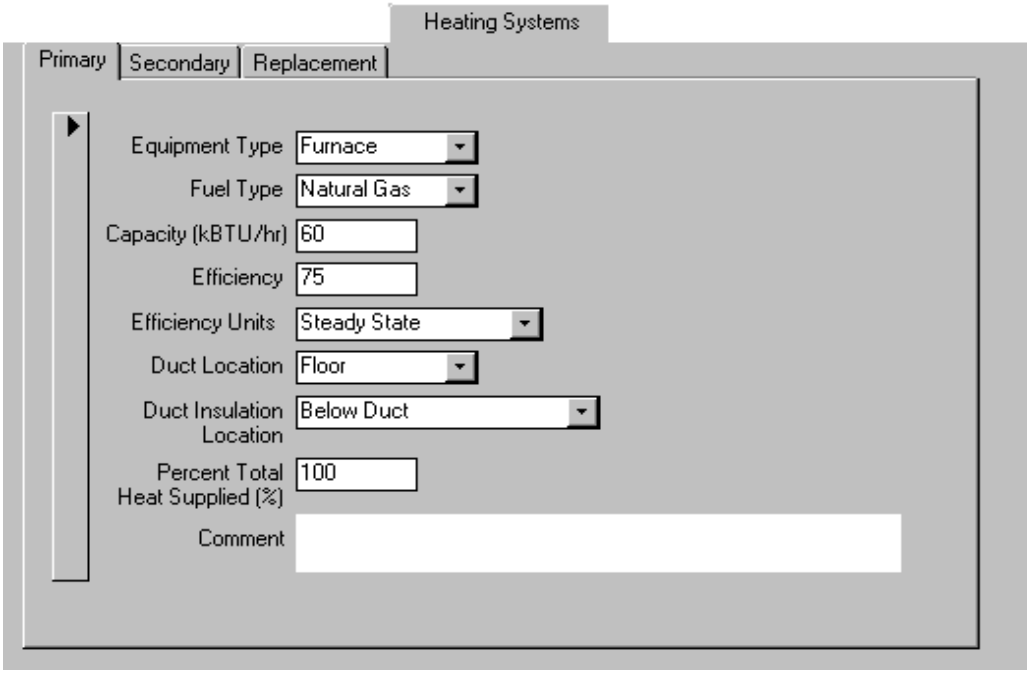
Code	Window Type	Glazing Type	Width (in)	Height (in)	North	South	East	West	Interior Shading	Exterior Shading
WD1	Slider	Single	42	36	0	0	4	0	Blinds or Shades	None
WD2	Slider	Single	42	36	3	0	0	1	None	None
WD3	Slider	Single	42	36	0	0	0	1	None	Carport or Porch
WD4	Door Window	Single	24	24	0	0	1	0	None	None
					0	0	0	0		

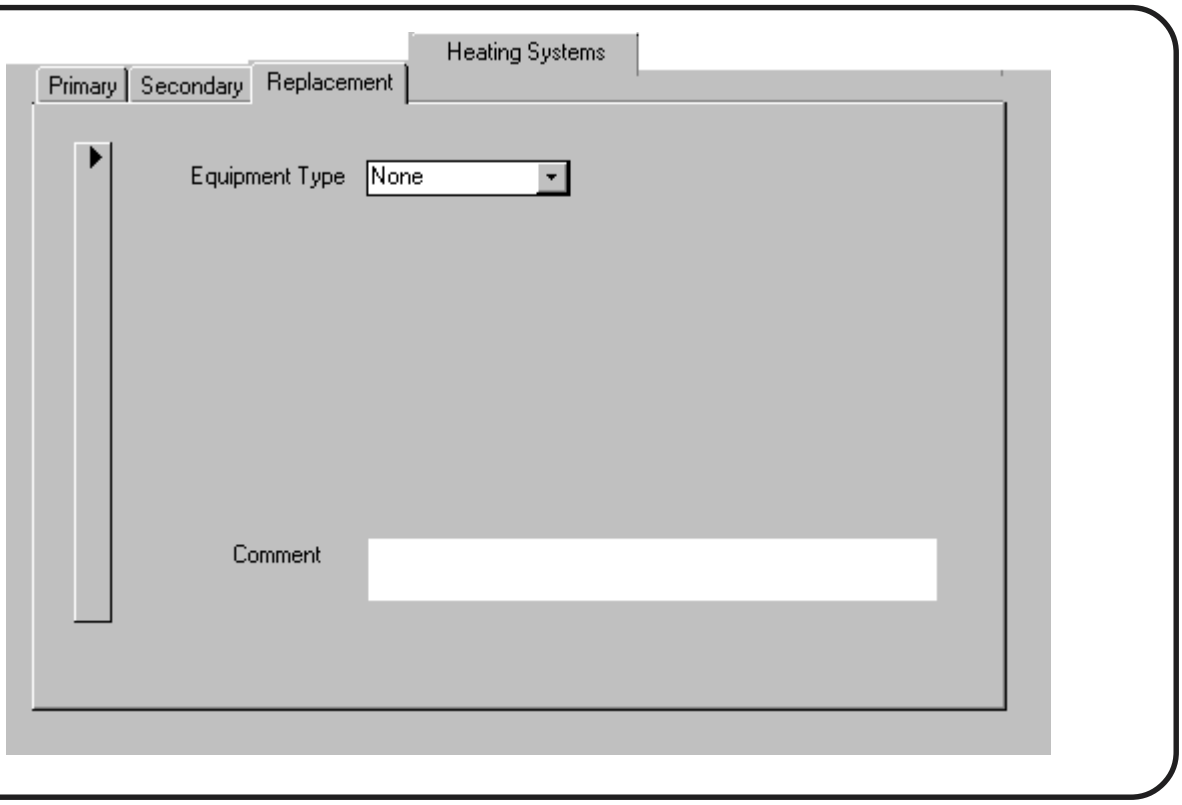


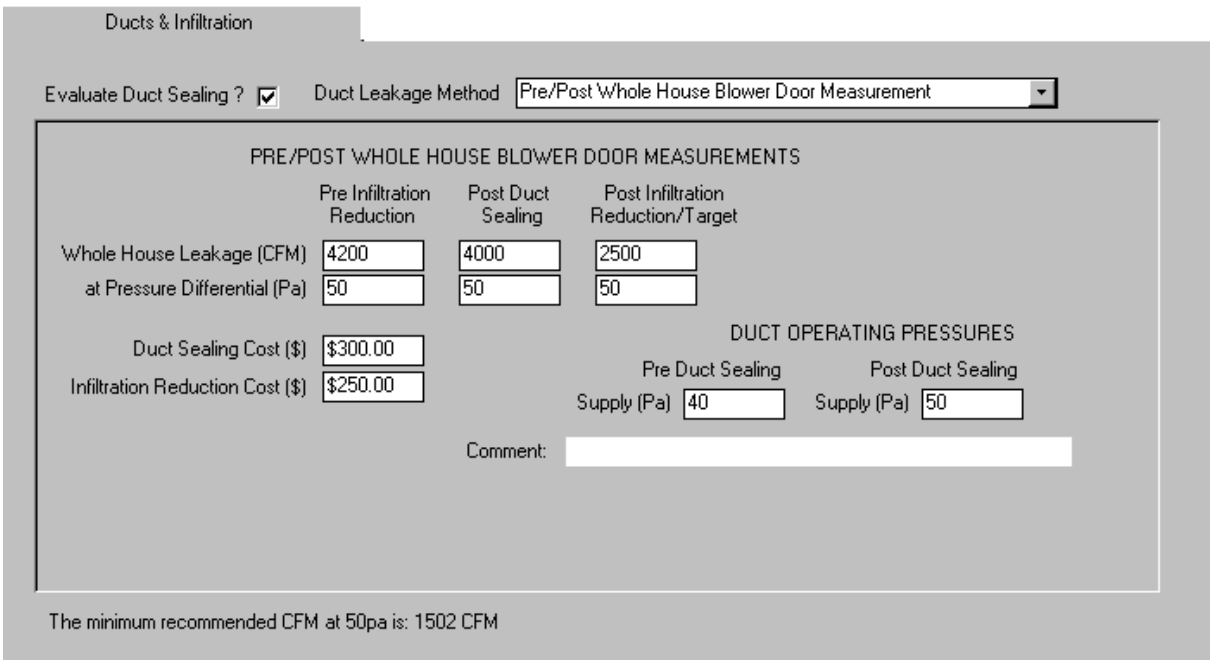

Ceiling
RoofType
Bowstring
Roof Color
White or Reflective
Height of Roof (in)
8
Insulation Type Thickness
Batt/Blanket (in)
2
Loose Fill (in)
Foam Core (in)
Additional Cost
0
Cathedral Ceiling (%)
0
Comment

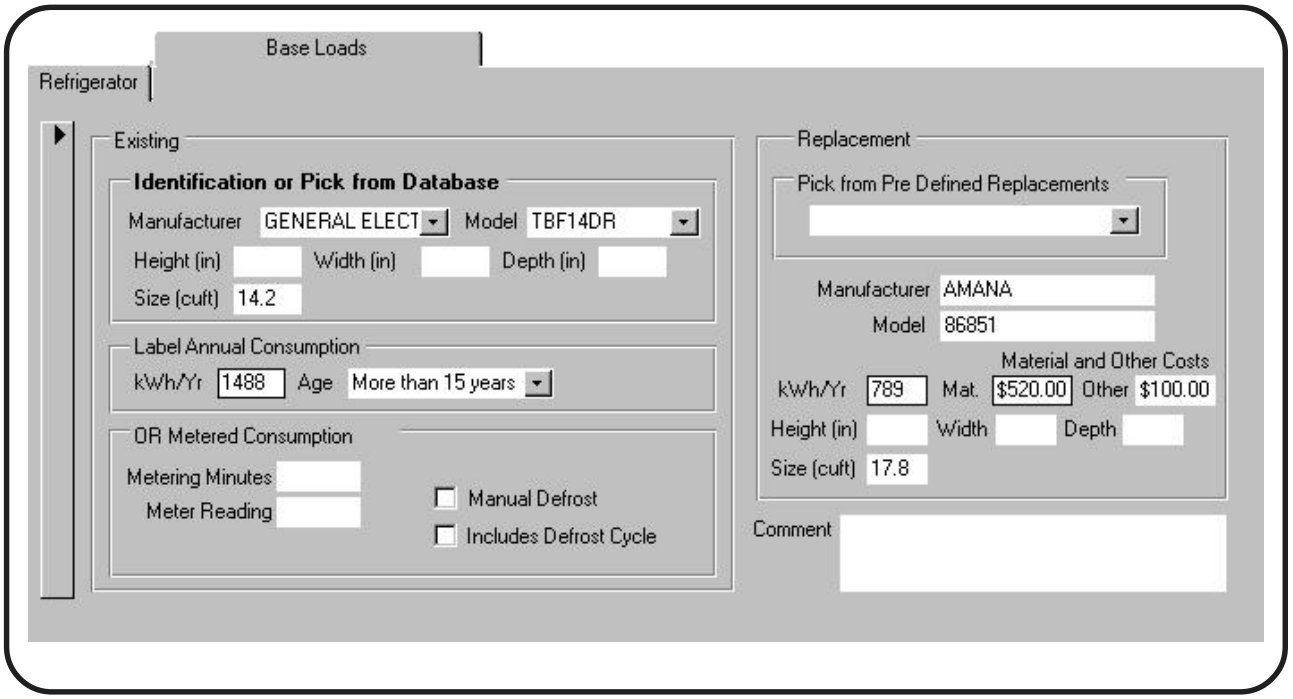

Floor
Floor Joist Direction
Lengthwise
Batt/Blanket Direction
Widthwise
Is There a Skirt?
Floor Wing Description
Floor Joist Size
2 x 6
Loose Insulation Thickness (in)
0
Batt/Blanket Insulation Location
Attached to Joist
Batt Insulation Thickness (in)
2
Floor Belly (Center) Description
Floor Joist Size
2 x 6
Loose Insulation Thickness (in)
0
Belly Cavity Configuration
Rounded
Batt/Blanket Insulation Location
Draped Below Floor J
Condition of Belly
Average
Batt Insulation Thickness (in)
2
Maximum Depth of Belly Cavity (in)
9
Comment

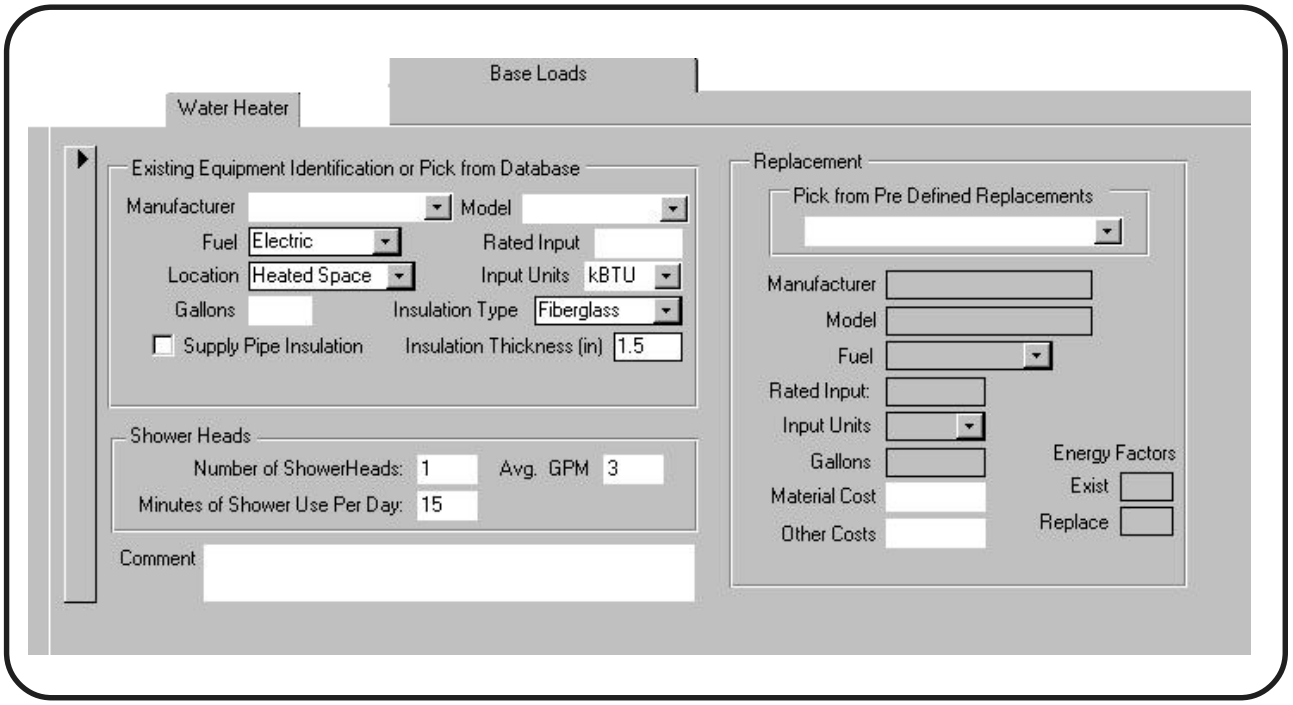

Air Conditioning
Primary
Secondary
AC Unit Type
Central Air Conditioner
Capacity (kBTU/hr)
36
Efficiency
3
Efficiency Units
COP
Duct Location
Floor
Duct Insulation Location
Below Duct
Percent Cooled (%)
100
Comment


Heating Systems
Primary
Secondary
Replacement
Equipment Type
Furnace
Fuel Type
Natural Gas
Capacity (kBTU/hr)
60
Efficiency
75
Efficiency Units
Steady State
Duct Location
Floor
Duct Insulation Location
Below Duct
Percent Total Heat Supplied (%)
100
Comment


Heating Systems
Primary
Secondary
Replacement
Equipment Type
None
Comment


Ducts & Infiltration
Evaluate Duct Sealing ?
Duct Leakage Method
Pre/Post Whole House Blower Door Measurement
PRE/POST WHOLE HOUSE BLOWER DOOR MEASUREMENTS
Pre Infiltration Reduction
Post Duct Sealing
Post Infiltration Reduction/Target
Whole House Leakage (CFM)
4200
4000
2500
at Pressure Differential (Pa)
50
50
50
Duct Sealing Cost ($)
$300.00
Infiltration Reduction Cost ($)
$250.00
DUCT OPERATING PRESSURES
Pre Duct Sealing
Supply (Pa)
40
Post Duct Sealing
Supply (Pa)
50
Comment:
The minimum recommended CFM at 50pa is: 1502 CFM


Base Loads
Refrigerator
Existing
Identification or Pick from Database
Manufacturer GENERAL ELECT
Model TBF14DR
Height (in)
Width (in)
Depth (in)
Size (cuft) 14.2
Label Annual Consumption
kWh/Yr 1488
Age More than 15 years
OR Metered Consumption
Metering Minutes
Meter Reading
Manual Defrost
Includes Defrost Cycle
Replacement
Pick from Pre Defined Replacements
Manufacturer AMANA
Model 86851
Material and Other Costs
kWh/Yr 789
Mat. $520.00
Other $100.00
Height (in)
Width
Depth
Size (cuft) 17.8
Comment


Base Loads
Water Heater
Existing Equipment Identification or Pick from Database
Manufacturer
Model
Fuel Electric
Rated Input
Location Heated Space
Input Units kBTU
Gallons
Insulation Type Fiberglass
Supply Pipe Insulation
Insulation Thickness (in) 1.5
Shower Heads
Number of ShowerHeads: 1
Avg. GPM 3
Minutes of Shower Use Per Day: 15
Comment
Replacement
Pick from Pre Defined Replacements
Manufacturer
Model
Fuel
Rated Input:
Input Units
Gallons
Material Cost
Other Costs
Energy Factors
Exist
Replace

Appendix A — Audit Example

Base Loads

Lighting

Light Code	Room	Location	Lamp Type	Quant	Watts	Hours/Day	CF Watts	Added Costs
LT1	Kitchen	Ceiling	Standard	4	60	6	13	
LT2	Living Room	Table	Standard	2	150	3	38	
*								

Itemized Costs

Description Door repaired
Cost $20.00 Include in SIR? ☑
Material
Comment
Energy Savings

Description Flue Moved
Cost $30.00 Include in SIR? ☐
Material
Comment
Energy Savings

Description Outlet Gaskets
Cost $10.00 Include in SIR? ☑
Material 15 Outlet Gaskets
Comment
Energy Savings 1.3

Record: 1 of 3

Utility Bills

Type Heating
Period Pre-Retrofit
Units Therms
Days in first period 31
Base Temperature 65
Base Load 20.7
Comment

	#	Month	Day	Usage	Degree Days
▶	1	1	25	295	1044
	2	2	28	256	937
	3	3	27	130	680
	4	4	26	105	272
	5	5	30	90	103
	6	6	30	40	9
	7	7	30	20	0
	8	8	29	20	0
	9	9	28	40	34
	10	10	30	115	223
	11	11	29	130	599
	12	12	30	270	941
*		0	0	0	0

Record: 1 of 12

Utility Bills

Type Cooling
Period Pre-Retrofit
Units kWh
Days in first period 30
Base Temperature 65
Base Load 120
Comment

	#	Month	Day	Usage	Degree Days
▶	1	4	30	180	16
	2	5	31	205	128
	3	6	30	650	306
	4	7	31	845	421
	5	8	31	700	378
	6	9	30	430	240
	7	0	0	0	0
*		0	0	0	0

Record: 1 of 7

Manufactured Housing Energy Audit (MHEA) Output Report

Agency	Enter Agency Name Here		
Run On	8/6/03 9:53:40 AM	RunID	1060188820
Version	7.4.3.2 08/06/03	JobID	1009948135

Job	SAMPLE	AuditDate	8/5/02
ClientName	Doe, John	Auditor	R.E. Duce
WeatherFile	SAMPLEUS.WX	ParamName	Standard
Comment			

Annual Energy and Cost Savings

#	Recommended Measure	Components	Heating (MMBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	BaseLoad (kWh)	BaseLoad ($)	Total (MMBtu)
1	Seal Ducts		12.5	95	230	19	0	0	13.3
2	General Air Sealing		14.3	109	1	0	0	0	14.3
3	DWH Tank Insulation		0.0	0	0	0	453	38	1.5
4	Setback [heating]		10.1	77	0	0	0	0	10.1
5	Low-Flow Showerheads		0.0	0	0	0	223	19	0.8
6	Outlet Gaskets[item]		0.0	0	0	0	0	0	1.3
7	DWH Pipe Insulation		0.0	0	0	0	156	13	0.5
8	Lighting [Living][2]	LT2	0.0	0	0	0	245	20	0.8
9	Lighting [Kitche][4]	LT1	0.0	0	0	0	411	34	1.4
10	Belly Fiberglass Loose		9.4	72	28	2	0	0	9.5
11	Add Shade Screens		-0.4	-3	455	38	0	0	1.1
12	Roof Fiberglass Loose		6.8	52	175	14	0	0	7.4
13	Wall Fiberglass Loose		4.1	31	79	7	0	0	4.3
14	Refrigerator Replacement		0.0	0	0	0	1145	95	3.9
15	Tune Heating System (5%)		3.0	23	0	0	0	0	3.0

Energy Saving Measure Economics

#	Recommended Measure	Components	Measure Savings ($/yr)	Measure Cost ($)	Measure SIR	Cumulative Cost ($)	Cumulative Savings ($/yr)	Cumulative SIR
1	Seal Ducts		115	300	3.2	300	115	3.2
2	General Air Sealing		109	250	6.5	550	224	4.7
3	Door repaired[item]		0	20	0.0	570	224	4.5
4	DWH Tank Insulation		38	25	17.4	595	261	5.1
5	Setback [heating]		77	75	15.3	670	338	6.2
6	Low-Flow Showerheads		19	20	10.7	690	357	6.4
7	Outlet Gaskets[item]		12	10	10.4	700	368	6.4
8	DWH Pipe Insulation		13	15	10.0	715	381	6.5
9	Lighting [Living][2]	LT2	20	30	5.2	745	402	6.4
10	Lighting [Kitche][4]	LT1	34	44	3.2	789	436	6.3
11	Belly Fiberglass Loose		74	385	2.9	1174	510	5.1
12	Add Shade Screens		35	113	2.5	1287	545	4.9
13	Roof Fiberglass Loose		66	430	2.3	1717	611	4.3
14	Wall Fiberglass Loose		38	310	1.8	2027	649	3.9
15	Refrigerator Replacement		95	620	1.8	2647	744	3.4
16	Tune Heating System (5%)		23	85	1.2	2732	767	3.3
17	Flue Moved[item]		0	30	0.0	2762	767	3.3

Materials

Index	Material	Quantity	Units
1	Duct sealing (setup cost)	1	EA
2	General air sealing (setup cost)	1	EA
3	DWH Tank Insulation	1	EA
4	Setback thermostat	1	EA
5	DWH Low-Flow Shower Head	1	EA
6	DWH Pipe Insulation	1	EA
7	Compact Fl. 38 Watt	2	EA
8	Compact Fl. 13 Watt	4	EA
9	Floor fiberglass loose insl	15	BAG
10	Added shade screens	57	SF
11	Roof fiberglass loose insl	16	BAG
12	Wall fiberglass loose insl	8	BAG
13	Refrigerator	1	Ea
14	Heating system tune up	1	EA

Pre/Post Retrofit Energy Consumption

Pre Retrofit			Post Retrofit		
Heating (MMBtu)	Cooling(kWh)	BaseLoad(kWh)	Heating(MMBtu)	Cooling(kWh)	BaseLoad(kWh)
102.5	2520.8	6052.0	42.7	1552.9	3418.2

Annual Energy and Cost Savings (Adjusted)

#	Recommended Measure	Components	Heating (MMBtu)	($)	Cooling (kWh)	($)	BaseLoad (kWh)	($)	Total (MMBtu)
1	Seal Ducts		14.5	111	202	17	0	0	15.2
2	General Air Sealing		16.6	126	1	0	0	0	16.6
3	Setback [heating]		11.7	89	0	0	0	0	11.7
4	DWH Tank Insulation		0.0	0	0	0	453	38	1.5
5	Low-Flow Showerheads		0.0	0	0	0	223	19	0.8
6	Outlet Gaskets[item]		0.0	0	0	0	0	0	1.3
7	DWH Pipe Insulation		0.0	0	0	0	156	13	0.5
8	Lighting [Living][2]	LT2	0.0	0	0	0	245	20	0.8
9	Lighting [Kitche][4]	LT1	0.0	0	0	0	411	34	1.4
10	Belly Fiberglass Loose		10.3	79	26	2	0	0	10.4
11	Roof Fiberglass Loose		7.4	57	155	13	0	0	7.9
12	Add Shade Screens		-0.6	-4	399	33	0	0	0.8
13	Wall Fiberglass Loose		4.7	36	68	6	0	0	5.0
14	Tune Heating System (5%)		4.7	36	0	0	0	0	4.7
15	Refrigerator Replacement		0.0	0	0	0	1145	95	3.9
16	Plastic Storm Windows		7.9	60	-2	0	0	0	7.9

Energy Saving Measure Economics (Adjusted)

#	Recommended Measure	Components	Measure Savings ($/yr)	Measure Cost ($)	Measure SIR	Cost ($)	Cumulative Savings ($/yr)	SIR
1	Seal Ducts		128	300	3.6	300	0	3.6
2	General Air Sealing		127	250	7.6	550	0	5.4

#	Recommended Measure	Components	Measure Savings ($/yr)	Measure Cost ($)	Measure SIR	Cost ($)	Cumulative Savings ($/yr)	Cumulative SIR
3	Door repaired[item]		0	20	0.0	570	0	5.2
4	Setback [heating]		89	75	17.8	645	0	6.7
5	DWH Tank Insulation		38	25	17.4	670	0	7.1
6	Low-Flow Showerheads		19	20	10.7	690	0	7.2
7	Outlet Gaskets[item]		12	10	10.4	700	0	7.2
8	DWH Pipe Insulation		13	15	10.0	715	0	7.3
9	Lighting [Living][2]	LT2	20	30	5.2	745	0	7.2
10	Lighting [Kitche][4]	LT1	34	44	3.2	789	0	7.0
11	Belly Fiberglass Loose		81	385	3.1	1174	0	5.7
12	Roof Fiberglass Loose		69	430	2.4	1604	0	4.8
13	Add Shade Screens		29	113	2.1	1717	0	4.6
14	Wall Fiberglass Loose		42	310	2.0	2027	0	4.2
15	Tune Heating System (5%)		36	85	1.9	2112	0	4.1
16	Refrigerator Replacement		95	620	1.8	2732	0	3.6
17	Plastic Storm Windows		60	246	1.1	2978	0	3.4
18	Flue Moved[item]		0	30	0.0	3008	0	3.4

Materials (Adjusted)

Index	Material	Quantity	Units
1	Duct sealing (setup cost)	1	EA
2	General air sealing (setup cost)	1	EA
3	Setback thermostat	1	EA
4	DWH Tank Insulation	1	EA
5	DWH Low-Flow Shower Head	1	EA
6	DWH Pipe Insulation	1	EA
7	Compact Fl. 38 Watt	2	EA
8	Compact Fl. 13 Watt	4	EA
9	Floor fiberglass loose insl	15	BAG
10	Roof fiberglass loose insl	16	BAG
11	Added shade screens	57	SF
12	Wall fiberglass loose insl	8	BAG
13	Heating system tune up	1	EA
14	Refrigerator	1	Ea
15	Plastic storm windows	99	SF

Heating Energy Consumption Comparison

Month	Day	Days in Period	Consumption		Degree Days	
			Actual	Predicted	Actual	Predicted
1	25	31	274	235	1044	1008
2	28	34	233	245	937	1085
3	27	27	111	129	680	619
4	26	30	84	68	272	363
5	30	34	67	37	103	208
6	30	31	19	2	9	43
7	30	30	0	0	0	4
8	29	30	0	0	0	16
9	28	30	19	0	34	48
10	30	32	93	52	223	283
11	29	30	109	124	599	603
12	30	31	249	190	941	852

Total	370	1258	1082	4842	5132
%Difference		-14.0		6.0	

Cooling Energy Consumption Comparison

Month	Day	Days in Period	Consumption		Degree Days	
			Actual	Predicted	Actual	Predicted
4	30	30	60	0	16	59
5	31	31	81	0	128	92
6	30	30	530	597	306	267
7	31	31	721	885	421	333
8	31	31	576	701	378	286
9	30	30	310	409	240	205
Total		183	2278	2592	1489	1242
%Difference			13.8		-16.6	

Approximate Manual J Component Contributions to Peak Heating Load

Component Type	Pre Retrofit Load (Btu/h)	Post Retrofit Load (BTU/h)
Wall	7325.2	5302.1
Floor	5988.2	2437.0
Roof	6048.8	2816.1
Windows	6698.4	3475.4
Doors	310.1	275.6
Infiltration	15415.3	8502.8
Duct Loss	4178.6	2280.9
Total	45964.7	25089.9

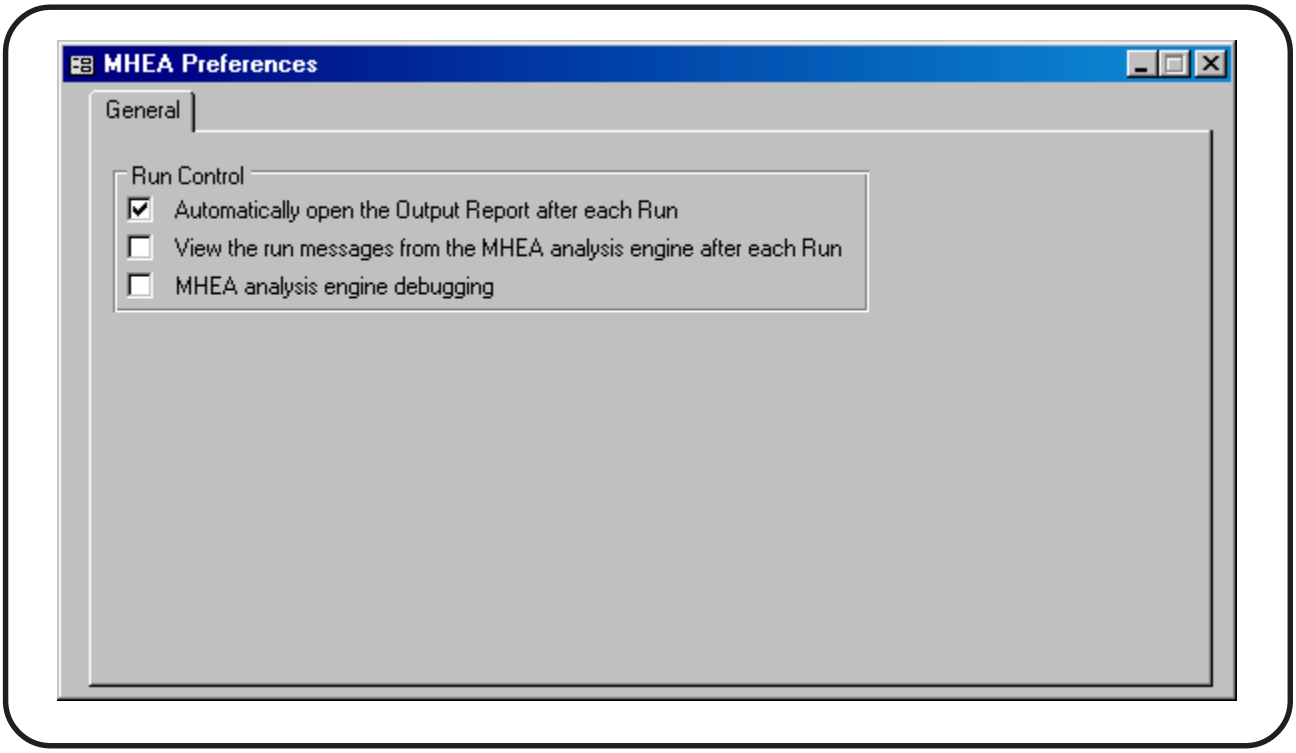
Special Notes

ManualJ sizing based on 70F indoor and 3F outdoor temp
10 Base case duct loss fraction
10 Retrofit case duct loss fraction
Sizing estimate are general guidelines only
Sizing estimate should be review by qualified heating contractor
Cumulative Expenditure Exceeds Limit of 2500 Dollars

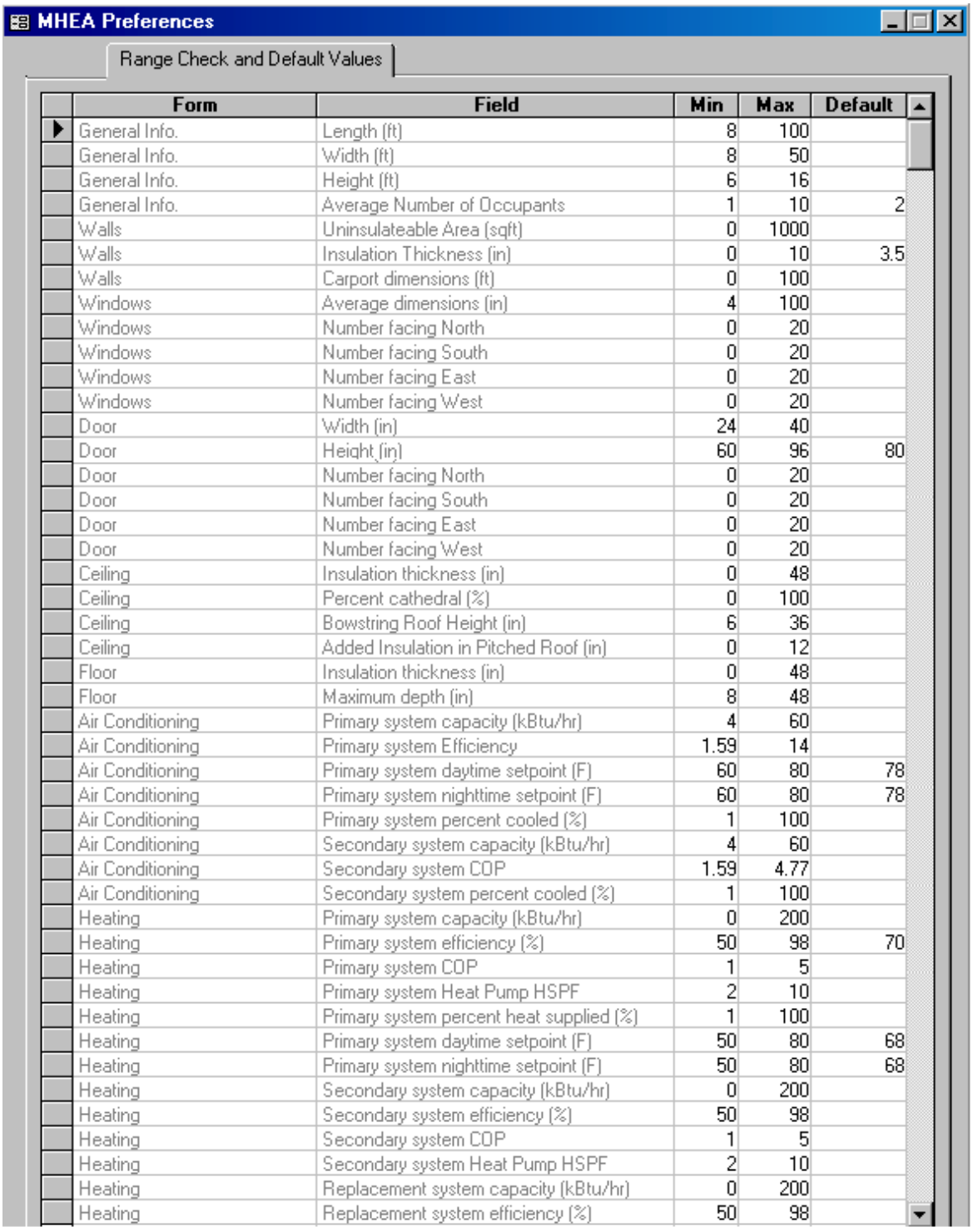
Appendix B

This appendix contains screens from the Preferences and Setup portions of MHEA. They show settings as they are when the program is newly installed. You will have to modify the values and settings to reflect your local conditions and costs.

General Preferences



Range Check and Default Values

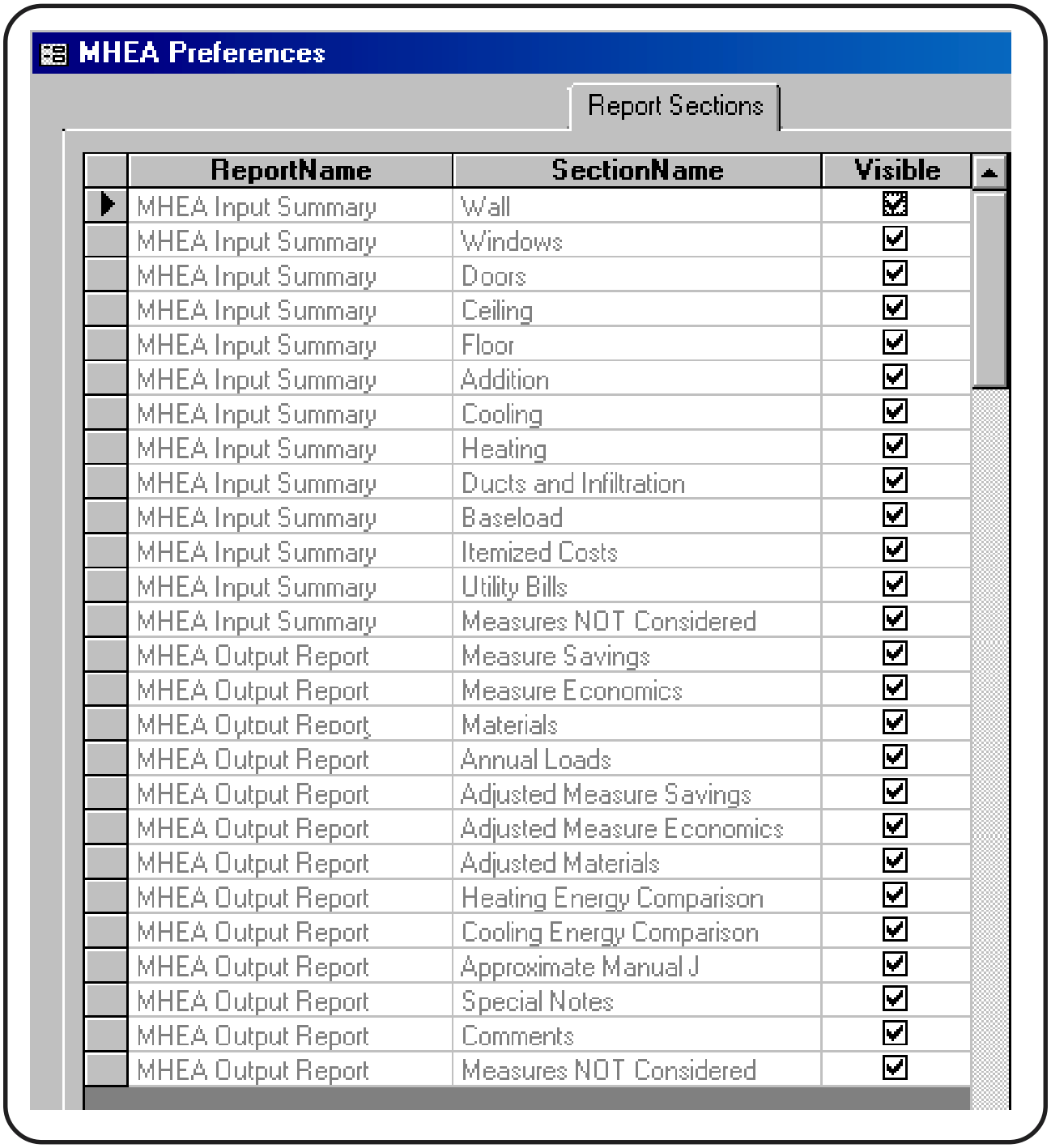


Form	Field	Min	Max	Default
General Info.	Length (ft)	8	100	
General Info.	Width (ft)	8	50	
General Info.	Height (ft)	6	16	
General Info.	Average Number of Occupants	1	10	2
Walls	Uninsulateable Area (sqft)	0	1000	
Walls	Insulation Thickness (in)	0	10	3.5
Walls	Carport dimensions (ft)	0	100	
Windows	Average dimensions (in)	4	100	
Windows	Number facing North	0	20	
Windows	Number facing South	0	20	
Windows	Number facing East	0	20	
Windows	Number facing West	0	20	
Door	Width (in)	24	40	
Door	Height (in)	60	96	80
Door	Number facing North	0	20	
Door	Number facing South	0	20	
Door	Number facing East	0	20	
Door	Number facing West	0	20	
Ceiling	Insulation thickness (in)	0	48	
Ceiling	Percent cathedral (%)	0	100	
Ceiling	Bowstring Roof Height (in)	6	36	
Ceiling	Added Insulation in Pitched Roof (in)	0	12	
Floor	Insulation thickness (in)	0	48	
Floor	Maximum depth (in)	8	48	
Air Conditioning	Primary system capacity (kBtu/hr)	4	60	
Air Conditioning	Primary system Efficiency	1.59	14	
Air Conditioning	Primary system daytime setpoint (F)	60	80	78
Air Conditioning	Primary system nighttime setpoint (F)	60	80	78
Air Conditioning	Primary system percent cooled (%)	1	100	
Air Conditioning	Secondary system capacity (kBtu/hr)	4	60	
Air Conditioning	Secondary system COP	1.59	4.77	
Air Conditioning	Secondary system percent cooled (%)	1	100	
Heating	Primary system capacity (kBtu/hr)	0	200	
Heating	Primary system efficiency (%)	50	98	70
Heating	Primary system COP	1	5	
Heating	Primary system Heat Pump HSPF	2	10	
Heating	Primary system percent heat supplied (%)	1	100	
Heating	Primary system daytime setpoint (F)	50	80	68
Heating	Primary system nighttime setpoint (F)	50	80	68
Heating	Secondary system capacity (kBtu/hr)	0	200	
Heating	Secondary system efficiency (%)	50	98	
Heating	Secondary system COP	1	5	
Heating	Secondary system Heat Pump HSPF	2	10	
Heating	Replacement system capacity (kBtu/hr)	0	200	
Heating	Replacement system efficiency (%)	50	98	

Range Check and Default Values (continued)

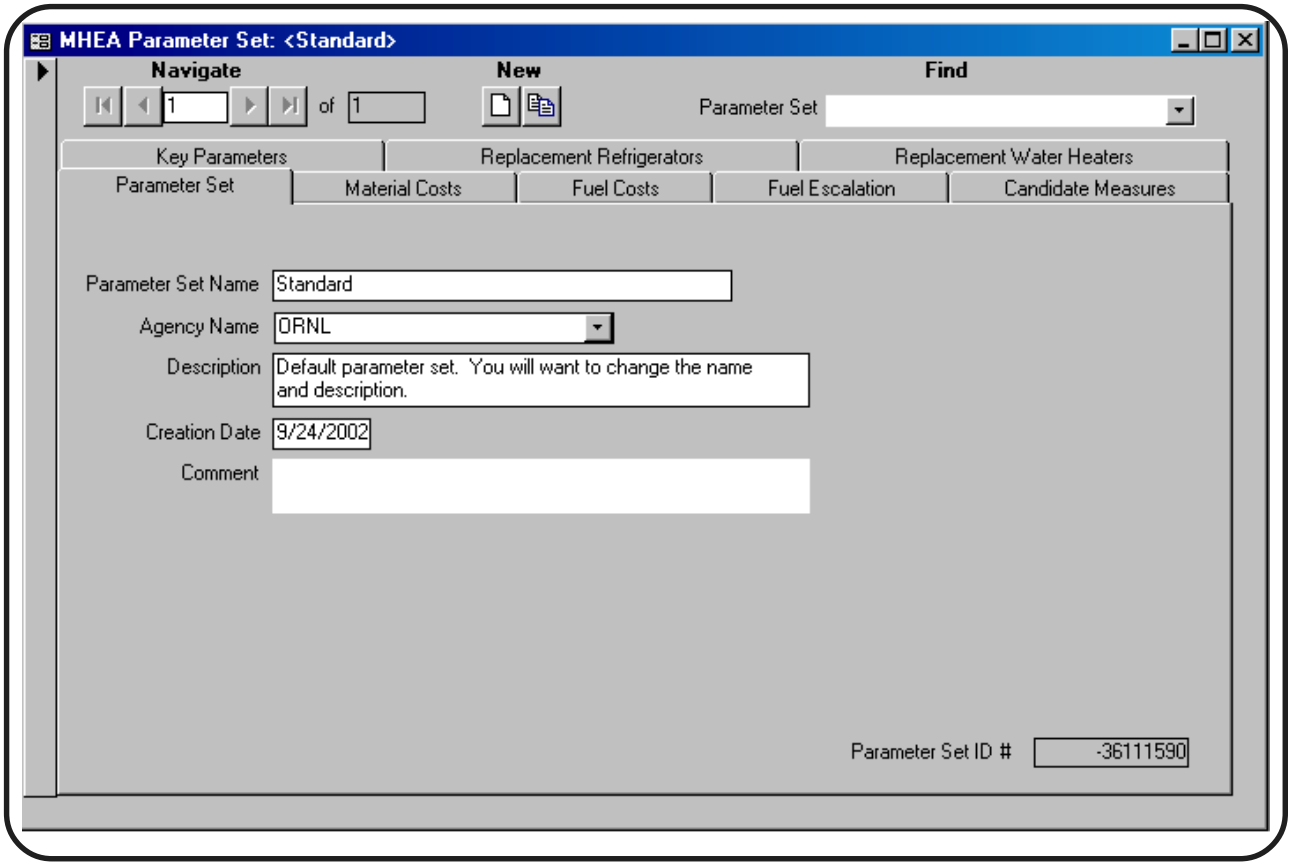
	Heating	Replacement system COP	1.59	5	
	Heating	Replacement system Heat Pump HSPF	2	10	
	Ducts & Infiltration	Whole house blower door CFM (pre sealing)	500	8000	
	Ducts & Infiltration	Whole house blower door CFM (post sealing)	500	8000	2500
	Ducts & Infiltration	Whole house blower door pressure (pa)	10	100	50
	Ducts & Infiltration	Duct blower CFM (pre and post sealing)	100	5000	
	Ducts & Infiltration	Duct blower pressure (pa)	10	100	
	Ducts & Infiltration	Duct operating pressure (pa)	10	100	
	Ducts & Infiltration	Infiltration Reduction Cost ($)	1	1000	
	Ducts & Infiltration	Duct Sealing Cost ($)	0	1000	
	Ducts & Infiltration	Pressure Pan Reading (Pa)	0	100	
	Base Loads, Refrigerator	Number of minutes metered (min)	120	360	
	Base Loads, Refrigerator	kWh meter reading	0.1	2	
	Base Loads, Refrigerator	Refrigerator location temperature (F)	40	100	
	Base Loads, Refrigerator	kWh per Year (New or Existing)	200	2500	
	Base Loads, Refrigerator	Refrigerator Dimension (in)	24	80	
	Base Loads, Refrigerator	Refrigerator Capacity (cuft)	10	27	
	Base Loads, Refrigerator	New Refrigerator Material Cost ($)	100	1000	
	Base Loads, Refrigerator	New Refrigerator Labor and other Cost ($)	0	200	
	Base Loads, Refrigerator	New Refrigerator Life (yrs)	10	20	
	Base Loads, Water Heating	Gallons capacity	20	120	
	Base Loads, Water Heating	Rated Input Power	1	120	
	Base Loads, Water Heating	New Material Cost ($)	50	300	
	Base Loads, Water Heating	Labor and Other Cost ($)	0	200	
	Base Loads, Water Heating	Existing Insulation Thickness	0.5	4	
	Base Loads, Water Heating	R Value of existing insulation from label	2	15	
	Base Loads, Water Heating	Number of Shower Heads	0	4	
	Base Loads, Water Heating	Minutes of Shower Usage Per Day	0	240	
	Base Loads, Water Heating	Average Shower Head GPM	1	5	
	Lighting	Quantity	1	25	
	Lighting	Existing Incandescent Watts	15	250	
	Lighting	Hours/Day	1	24	
	Lighting	Replacement CF Watts	5	50	
	Lighting	Additional Cost	0	100	
	Itemized Costs	Cost ($)	1	2000	
	Itemized Costs	Life (years)	1	20	
	Itemized Costs	Energy Savings (MBTU/yr)	0	100	
	Utility Bills	Base Temperature (F)	0	100	65
	Utility Bills	Monthly Degree Days (DD)	0	3000	
	Utility Bills	Days in Month	1	31	
	Utility Bills	BaseLoad	0	1000	

Report Sections

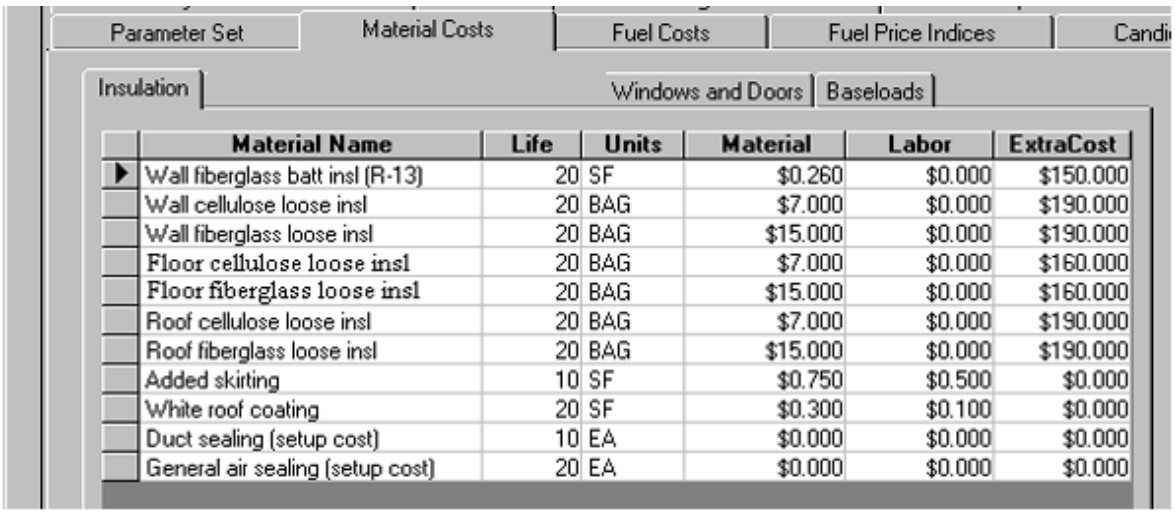


ReportName	SectionName	Visible
MHEA Input Summary	Wall	☑
MHEA Input Summary	Windows	☑
MHEA Input Summary	Doors	☑
MHEA Input Summary	Ceiling	☑
MHEA Input Summary	Floor	☑
MHEA Input Summary	Addition	☑
MHEA Input Summary	Cooling	☑
MHEA Input Summary	Heating	☑
MHEA Input Summary	Ducts and Infiltration	☑
MHEA Input Summary	Baseload	☑
MHEA Input Summary	Itemized Costs	☑
MHEA Input Summary	Utility Bills	☑
MHEA Input Summary	Measures NOT Considered	☑
MHEA Output Report	Measure Savings	☑
MHEA Output Report	Measure Economics	☑
MHEA Output Report	Materials	☑
MHEA Output Report	Annual Loads	☑
MHEA Output Report	Adjusted Measure Savings	☑
MHEA Output Report	Adjusted Measure Economics	☑
MHEA Output Report	Adjusted Materials	☑
MHEA Output Report	Heating Energy Comparison	☑
MHEA Output Report	Cooling Energy Comparison	☑
MHEA Output Report	Approximate Manual J	☑
MHEA Output Report	Special Notes	☑
MHEA Output Report	Comments	☑
MHEA Output Report	Measures NOT Considered	☑

Parameter Set Selection Screen

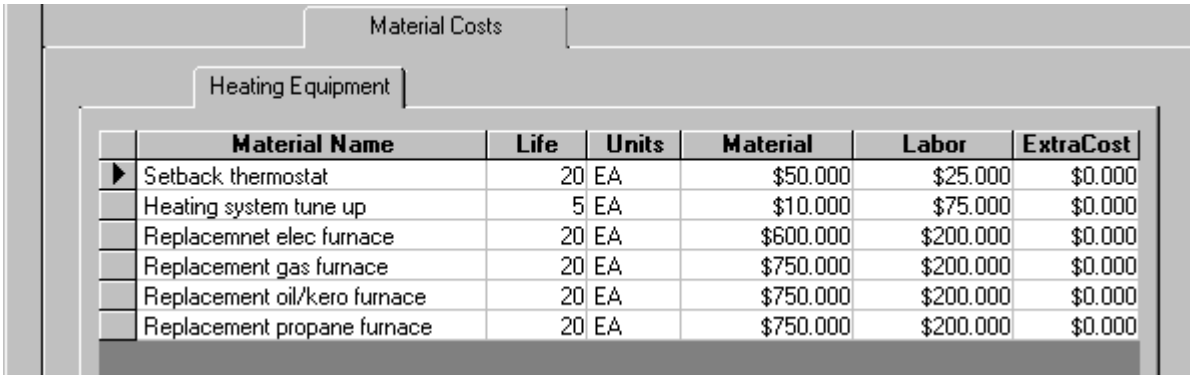


Material Costs—Insulation



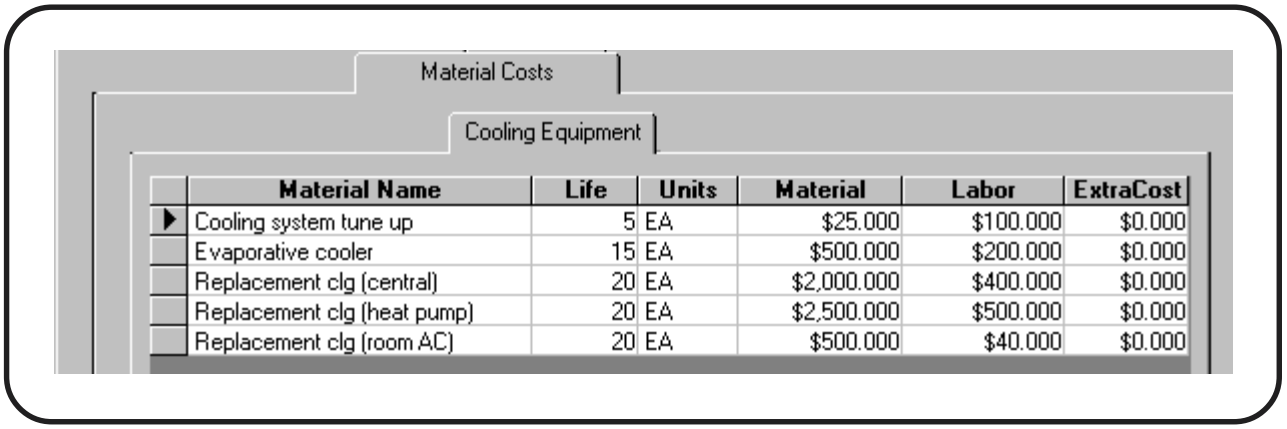
Material Name	Life	Units	Material	Labor	ExtraCost
Wall fiberglass batt insl (R-13)	20	SF	$0.260	$0.000	$150.000
Wall cellulose loose insl	20	BAG	$7.000	$0.000	$190.000
Wall fiberglass loose insl	20	BAG	$15.000	$0.000	$190.000
Floor cellulose loose insl	20	BAG	$7.000	$0.000	$160.000
Floor fiberglass loose insl	20	BAG	$15.000	$0.000	$160.000
Roof cellulose loose insl	20	BAG	$7.000	$0.000	$190.000
Roof fiberglass loose insl	20	BAG	$15.000	$0.000	$190.000
Added skirting	10	SF	$0.750	$0.500	$0.000
White roof coating	20	SF	$0.300	$0.100	$0.000
Duct sealing (setup cost)	10	EA	$0.000	$0.000	$0.000
General air sealing (setup cost)	20	EA	$0.000	$0.000	$0.000

Material Costs—Heating Equipment



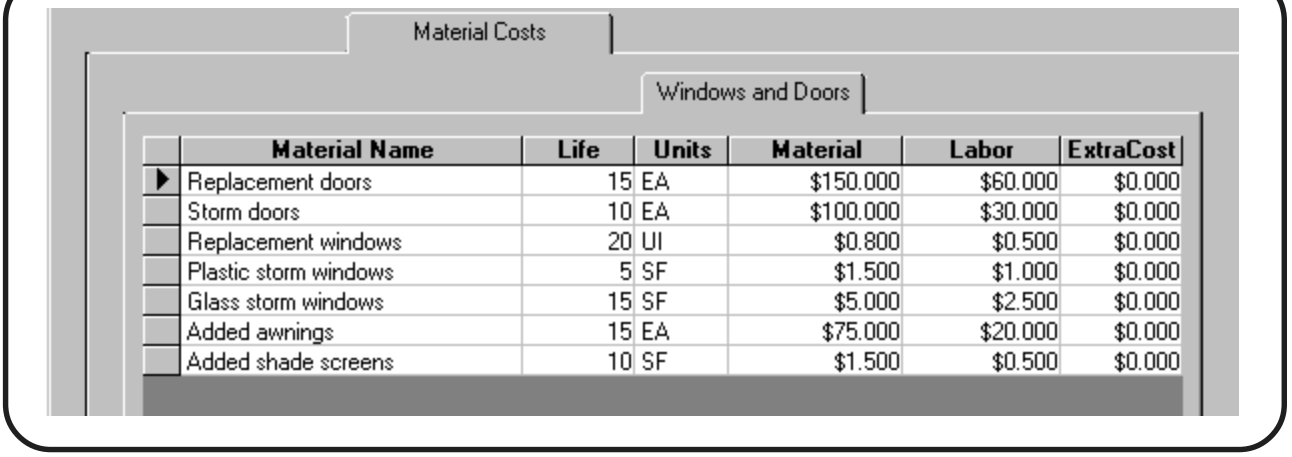
Material Name	Life	Units	Material	Labor	ExtraCost
Setback thermostat	20	EA	$50.000	$25.000	$0.000
Heating system tune up	5	EA	$10.000	$75.000	$0.000
Replacemnet elec furnace	20	EA	$600.000	$200.000	$0.000
Replacement gas furnace	20	EA	$750.000	$200.000	$0.000
Replacement oil/kero furnace	20	EA	$750.000	$200.000	$0.000
Replacement propane furnace	20	EA	$750.000	$200.000	$0.000

Material Costs—Cooling Equipment



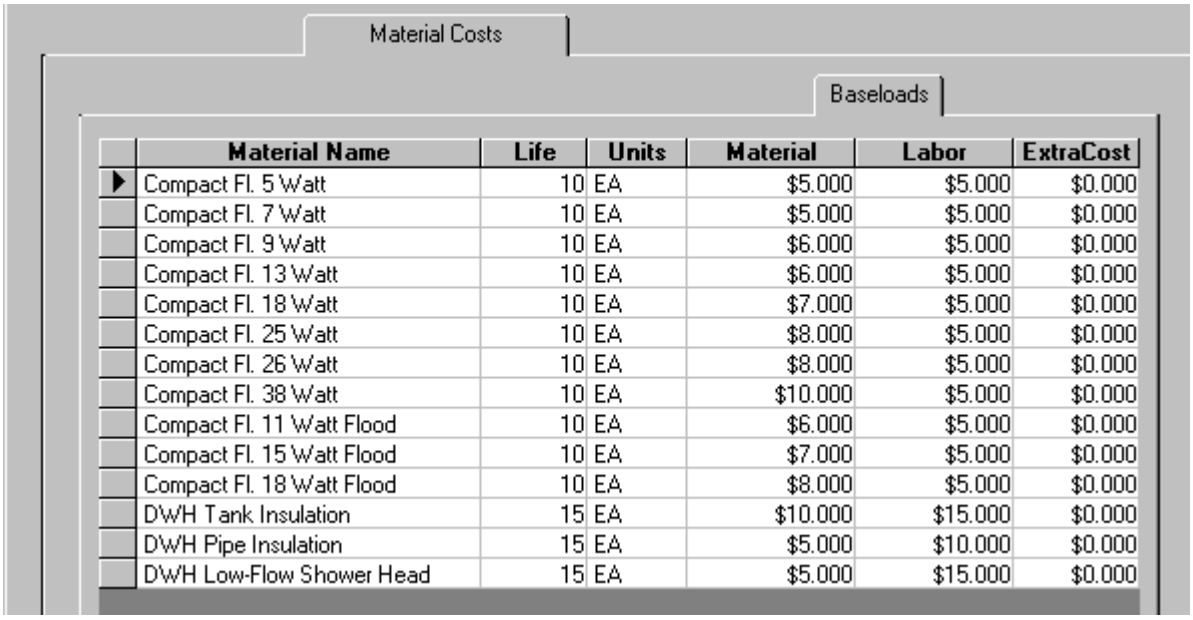
Material Name	Life	Units	Material	Labor	ExtraCost
Cooling system tune up	5	EA	$25.000	$100.000	$0.000
Evaporative cooler	15	EA	$500.000	$200.000	$0.000
Replacement clg (central)	20	EA	$2,000.000	$400.000	$0.000
Replacement clg (heat pump)	20	EA	$2,500.000	$500.000	$0.000
Replacement clg (room AC)	20	EA	$500.000	$40.000	$0.000

Material Costs—Windows and Doors



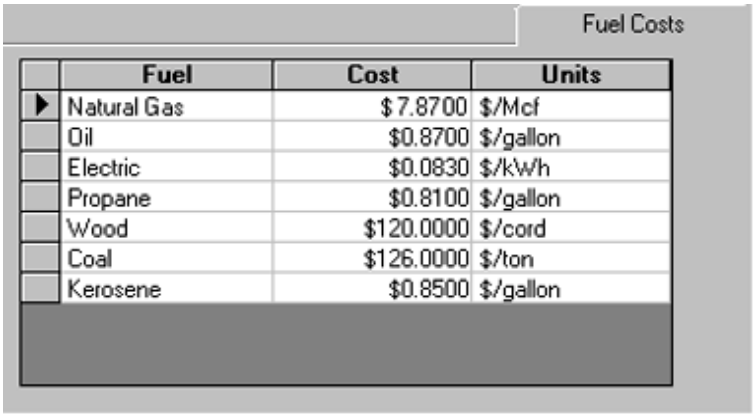
Material Name	Life	Units	Material	Labor	ExtraCost
Replacement doors	15	EA	$150.000	$60.000	$0.000
Storm doors	10	EA	$100.000	$30.000	$0.000
Replacement windows	20	UI	$0.800	$0.500	$0.000
Plastic storm windows	5	SF	$1.500	$1.000	$0.000
Glass storm windows	15	SF	$5.000	$2.500	$0.000
Added awnings	15	EA	$75.000	$20.000	$0.000
Added shade screens	10	SF	$1.500	$0.500	$0.000

Material Costs—Base Loads



Material Name	Life	Units	Material	Labor	ExtraCost
Compact Fl. 5 Watt	10	EA	$5.000	$5.000	$0.000
Compact Fl. 7 Watt	10	EA	$5.000	$5.000	$0.000
Compact Fl. 9 Watt	10	EA	$6.000	$5.000	$0.000
Compact Fl. 13 Watt	10	EA	$6.000	$5.000	$0.000
Compact Fl. 18 Watt	10	EA	$7.000	$5.000	$0.000
Compact Fl. 25 Watt	10	EA	$8.000	$5.000	$0.000
Compact Fl. 26 Watt	10	EA	$8.000	$5.000	$0.000
Compact Fl. 38 Watt	10	EA	$10.000	$5.000	$0.000
Compact Fl. 11 Watt Flood	10	EA	$6.000	$5.000	$0.000
Compact Fl. 15 Watt Flood	10	EA	$7.000	$5.000	$0.000
Compact Fl. 18 Watt Flood	10	EA	$8.000	$5.000	$0.000
DWH Tank Insulation	15	EA	$10.000	$15.000	$0.000
DWH Pipe Insulation	15	EA	$5.000	$10.000	$0.000
DWH Low-Flow Shower Head	15	EA	$5.000	$15.000	$0.000

Fuel Costs



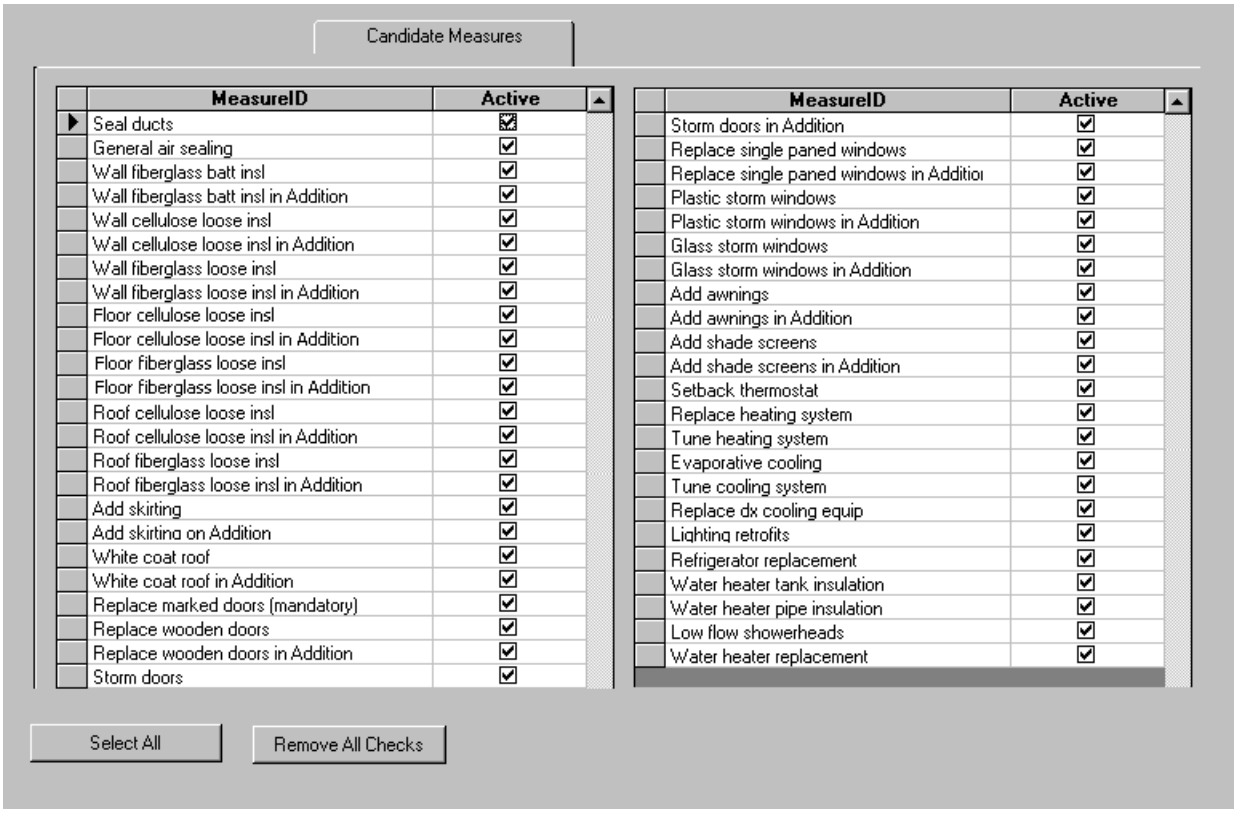
Fuel	Cost	Units
Natural Gas	$7.8700	$/Mcf
Oil	$0.8700	$/gallon
Electric	$0.0830	$/kWh
Propane	$0.8100	$/gallon
Wood	$120.0000	$/cord
Coal	$126.0000	$/ton
Kerosene	$0.8500	$/gallon

Fuel Price Indices (Repeated for all other fuel types)

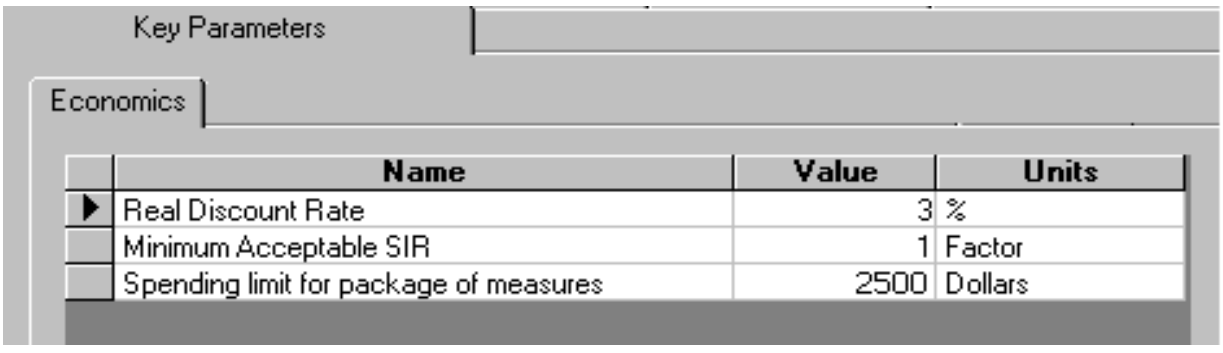
Fuel Price Indices

Fuel	Year	Price Index
Natural Gas	0	1.00
Natural Gas	1	0.99
Natural Gas	2	0.98
Natural Gas	3	0.97
Natural Gas	4	0.96
Natural Gas	5	0.97
Natural Gas	6	0.98
Natural Gas	7	0.99
Natural Gas	8	1.00
Natural Gas	9	1.01
Natural Gas	10	1.01
Natural Gas	11	1.02
Natural Gas	12	1.02
Natural Gas	13	1.03
Natural Gas	14	1.03
Natural Gas	15	1.02
Natural Gas	16	1.02
Natural Gas	17	1.03
Natural Gas	18	1.03
Natural Gas	19	1.03
Natural Gas	20	1.04
Natural Gas	21	1.05
Natural Gas	22	1.06
Natural Gas	23	1.07
Natural Gas	24	1.07
Natural Gas	25	1.08

Candidate Measures



Key Parameters—Economics



Key Parameters—Set Points

Key Parameters

Set Points

Name	Value	Units
Length of day for thermostat setback	16	Hours
Thermstat setback amount	5	deg F
Heating Setpoint (daytime)	68	deg F
Heating Setpoint (nightime)	68	deg F
Cooling Setpoint (daytime)	78	deg F
Cooling Setpoint (nighttime)	78	deg F

Key Parameters—Insulation

Key Parameters

Insulation

Name	Value	Units
Existing Batt/Blanket insulation R-value per inch	3.5	F-sf-h/Btu
Existing Loose insulation R-value per inch	2.5	F-sf-h/Btu
Rigid insulation R-value per inch	4.11	F-sf-h/Btu
Foamcore insulation R-value per inch	5	F-sf-h/Btu
Interior ceiling R-value - Summer	1.32	F-sf-h/Btu
Interior ceiling R-value - Winter	1.01	F-sf-h/Btu
Interior floor R-value - Summer	2.61	F-sf-h/Btu
Interior floor R-value - Winter	2.92	F-sf-h/Btu
Interior wall R-value - Summer	1.03	F-sf-h/Btu
Interior wall R-value - Winter	1.03	F-sf-h/Btu
Outside wall R-value - Summer	0.25	F-sf-h/Btu
Outside wall R-value - Winter	0.17	F-sf-h/Btu
Density of added loose fiberglass insulation	1.5	Lb/cuft
Density of added loose cellulose insulation	3	Lb/cuft
Bag size for loose fiberglass insulation	25	Lb
Bag size for loose cellulose insulation	25	Lb

Key Parameters—Heat Transfer

Key Parameters

Heat Transfer

Name	Value	Units
Free heat from interior sources - Day	2400	Btu/h
Free heat from interior sources - Night	1000	Btu/h
Duct-sealing distribution loss reduction	50	%
Duct insulation dist. loss reduction	10	%
Heating system tune-up efficiency improvement	5	%
Cooling system fan power	60	Watts
Evaporative cooler actual saturating eff	75	%
Saturating eff for evaporative tune-up	80	%
Saturating eff for evaporative rplcmnt	80	%
Home leakiness - Tight	1200	cfm
Home leakiness - Medium	1600	cfm
Home leakiness - Loose	2200	cfm

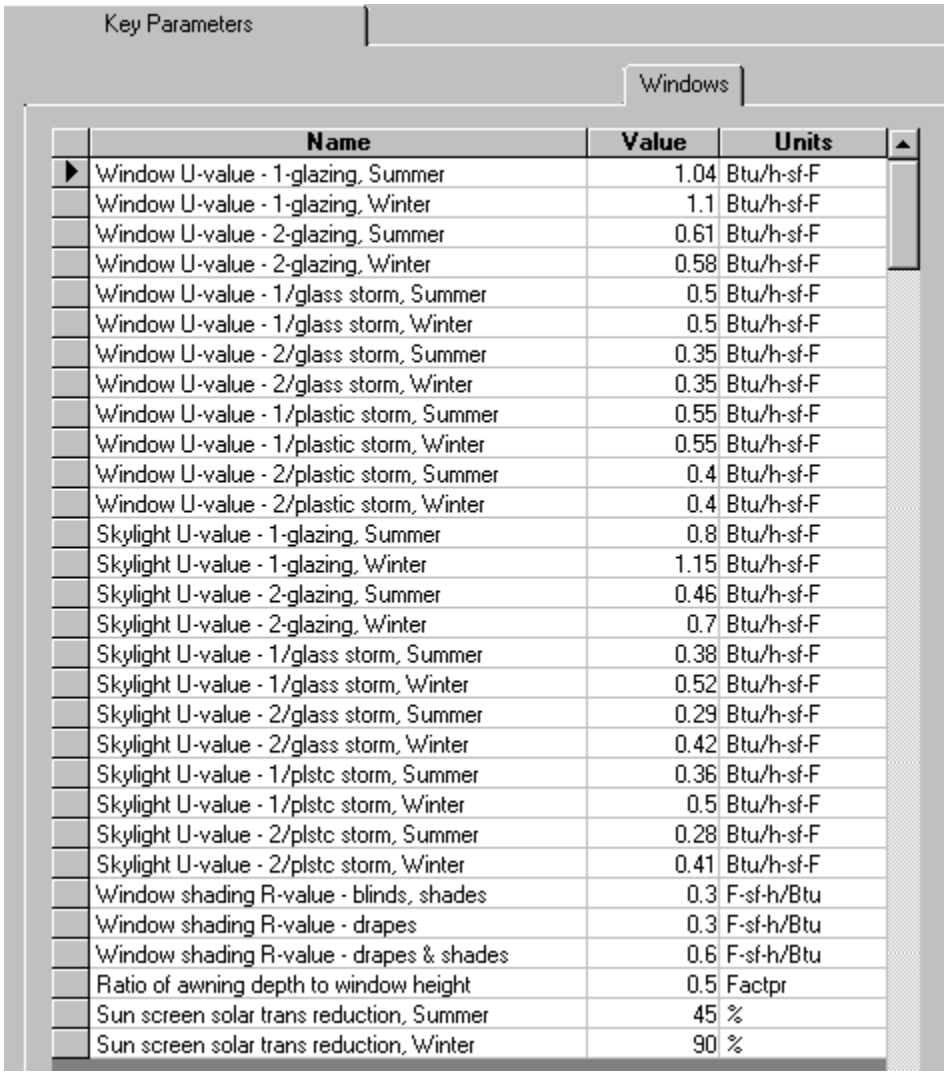
Key Parameters—Doors

Key Parameters

Doors

Name	Value	Units
Door U-value - wood with solid core	0.33	Btu/h-sf-F
Door U-value - wood with hollow core	0.46	Btu/h-sf-F
Door U-value - standard mfg. home door	0.14	Btu/h-sf-F
U-value of replacement door	0.14	Btu/h-sf-F

Key Parameters—Windows

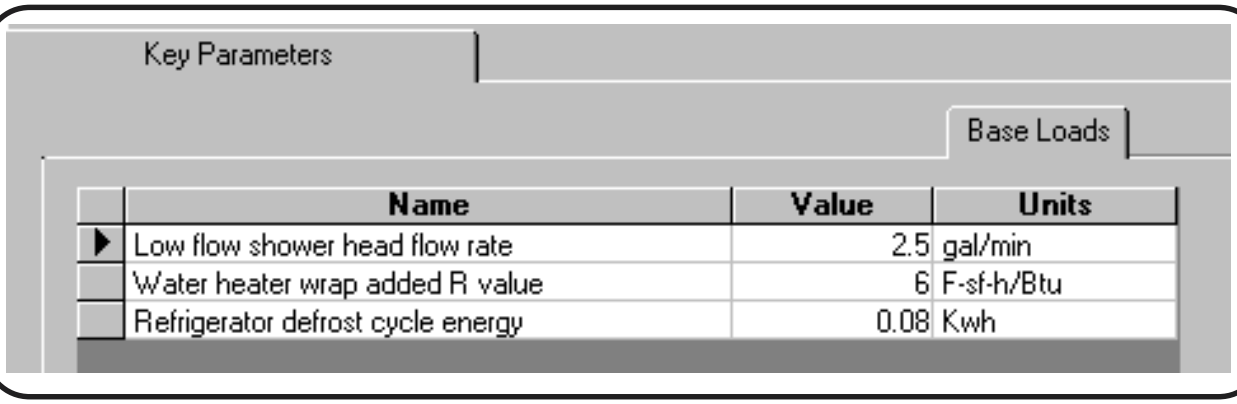


Key Parameters

Windows

	Name	Value	Units
▶	Window U-value - 1-glazing, Summer	1.04	Btu/h-sf-F
	Window U-value - 1-glazing, Winter	1.1	Btu/h-sf-F
	Window U-value - 2-glazing, Summer	0.61	Btu/h-sf-F
	Window U-value - 2-glazing, Winter	0.58	Btu/h-sf-F
	Window U-value - 1/glass storm, Summer	0.5	Btu/h-sf-F
	Window U-value - 1/glass storm, Winter	0.5	Btu/h-sf-F
	Window U-value - 2/glass storm, Summer	0.35	Btu/h-sf-F
	Window U-value - 2/glass storm, Winter	0.35	Btu/h-sf-F
	Window U-value - 1/plastic storm, Summer	0.55	Btu/h-sf-F
	Window U-value - 1/plastic storm, Winter	0.55	Btu/h-sf-F
	Window U-value - 2/plastic storm, Summer	0.4	Btu/h-sf-F
	Window U-value - 2/plastic storm, Winter	0.4	Btu/h-sf-F
	Skylight U-value - 1-glazing, Summer	0.8	Btu/h-sf-F
	Skylight U-value - 1-glazing, Winter	1.15	Btu/h-sf-F
	Skylight U-value - 2-glazing, Summer	0.46	Btu/h-sf-F
	Skylight U-value - 2-glazing, Winter	0.7	Btu/h-sf-F
	Skylight U-value - 1/glass storm, Summer	0.38	Btu/h-sf-F
	Skylight U-value - 1/glass storm, Winter	0.52	Btu/h-sf-F
	Skylight U-value - 2/glass storm, Summer	0.29	Btu/h-sf-F
	Skylight U-value - 2/glass storm, Winter	0.42	Btu/h-sf-F
	Skylight U-value - 1/plstc storm, Summer	0.36	Btu/h-sf-F
	Skylight U-value - 1/plstc storm, Winter	0.5	Btu/h-sf-F
	Skylight U-value - 2/plstc storm, Summer	0.28	Btu/h-sf-F
	Skylight U-value - 2/plstc storm, Winter	0.41	Btu/h-sf-F
	Window shading R-value - blinds, shades	0.3	F-sf-h/Btu
	Window shading R-value - drapes	0.3	F-sf-h/Btu
	Window shading R-value - drapes & shades	0.6	F-sf-h/Btu
	Ratio of awning depth to window height	0.5	Factpr
	Sun screen solar trans reduction, Summer	45	%
	Sun screen solar trans reduction, Winter	90	%

Key Parameters—Base Loads

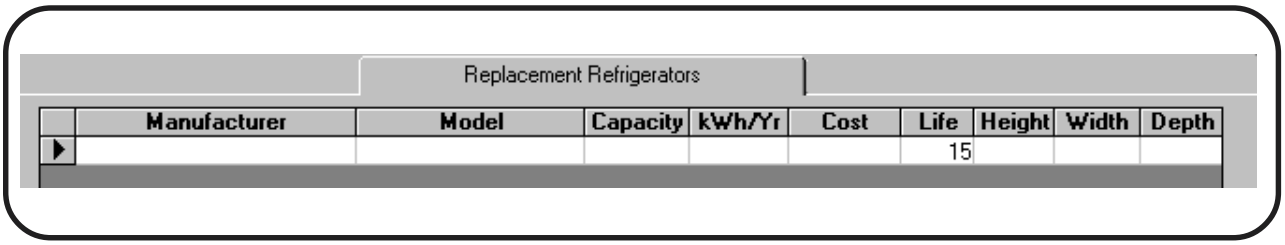


Key Parameters

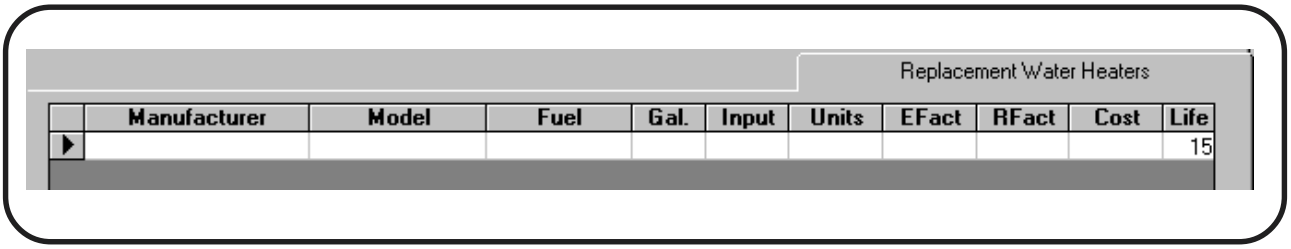
Base Loads

	Name	Value	Units
▶	Low flow shower head flow rate	2.5	gal/min
	Water heater wrap added R value	6	F-sf-h/Btu
	Refrigerator defrost cycle energy	0.08	Kwh

Replacement Refrigerator Library (Empty)



Replacement Water Heater Library (Empty)



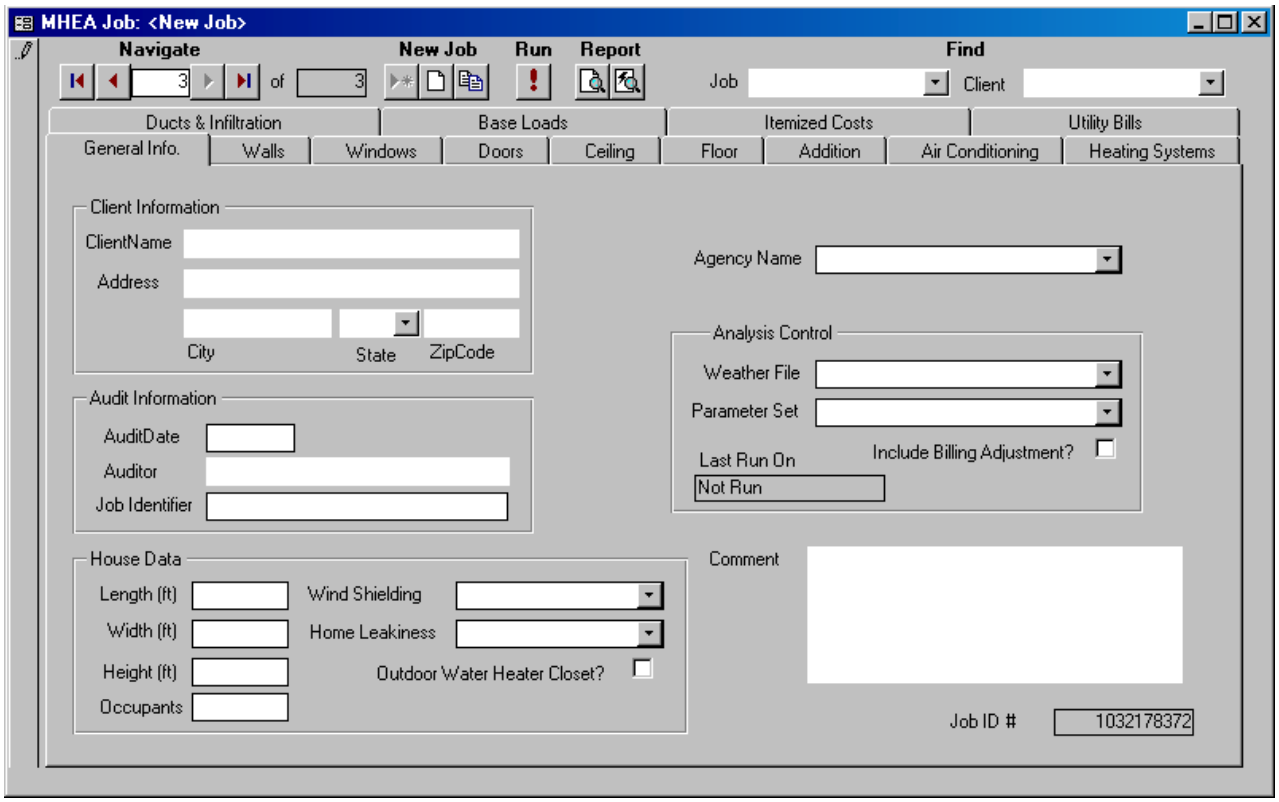
Appendix C

This appendix contains all of the data input forms available in MHEA for describing a specific manufactured home. They have been intentionally left blank for possible use as input forms to be used in the field prior to entering data into the computer. Both the Data Sheet and Form views for the window and door screens have been included, the former for possible use in the field. Shaded column headers indicate optional data on the Data Sheet views while the standard lack of a solid border indicates the same for items in the Form view.

Beneath each form is listed the options for the indicated combo-boxes on that form. Some suggested abbreviations for the selections are indicated, but you may use whatever is most convenient for you. In some instances, the entire selection description my fit in the entry field.

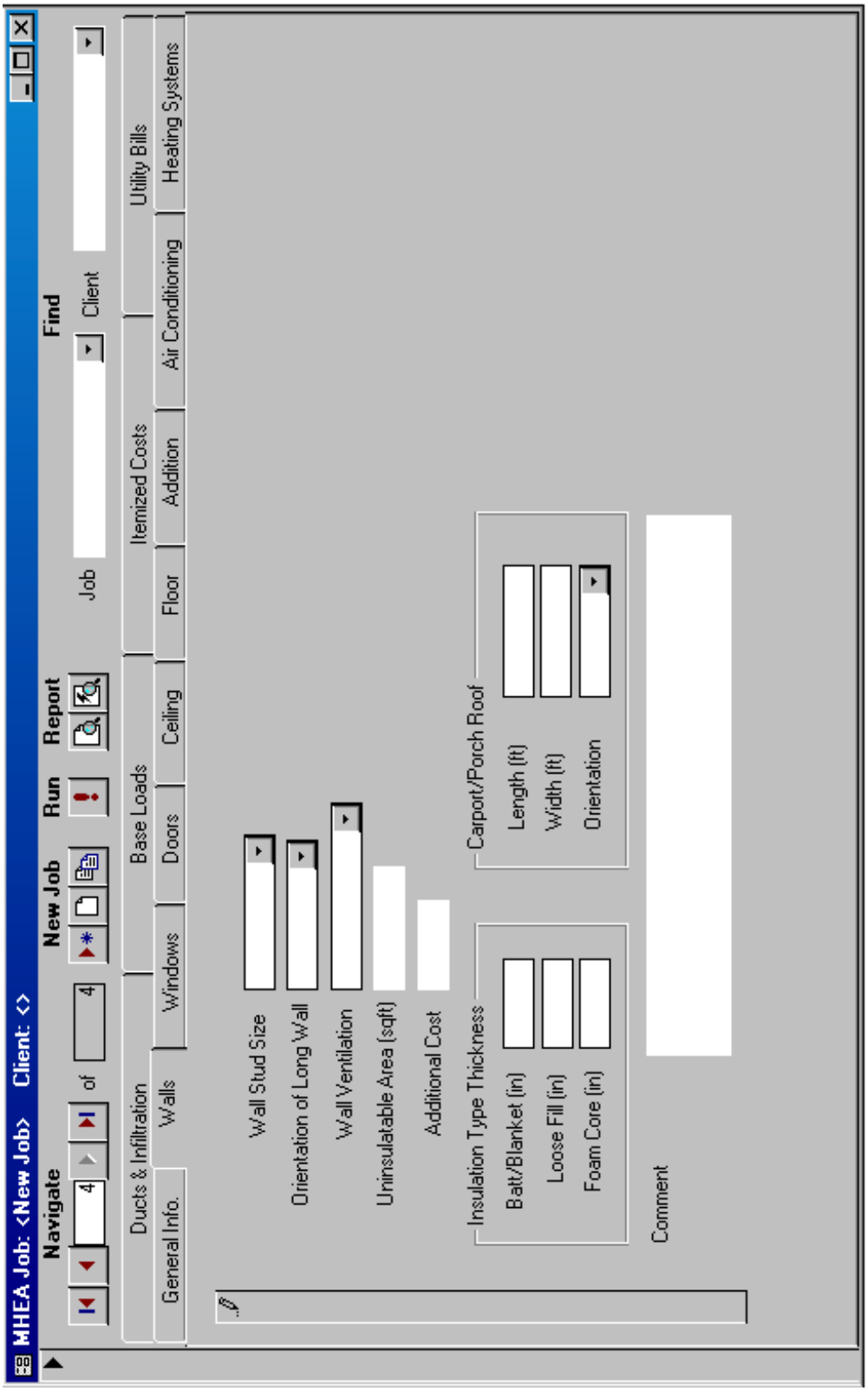
Manufactured Home Energy Audit Forms

General Information



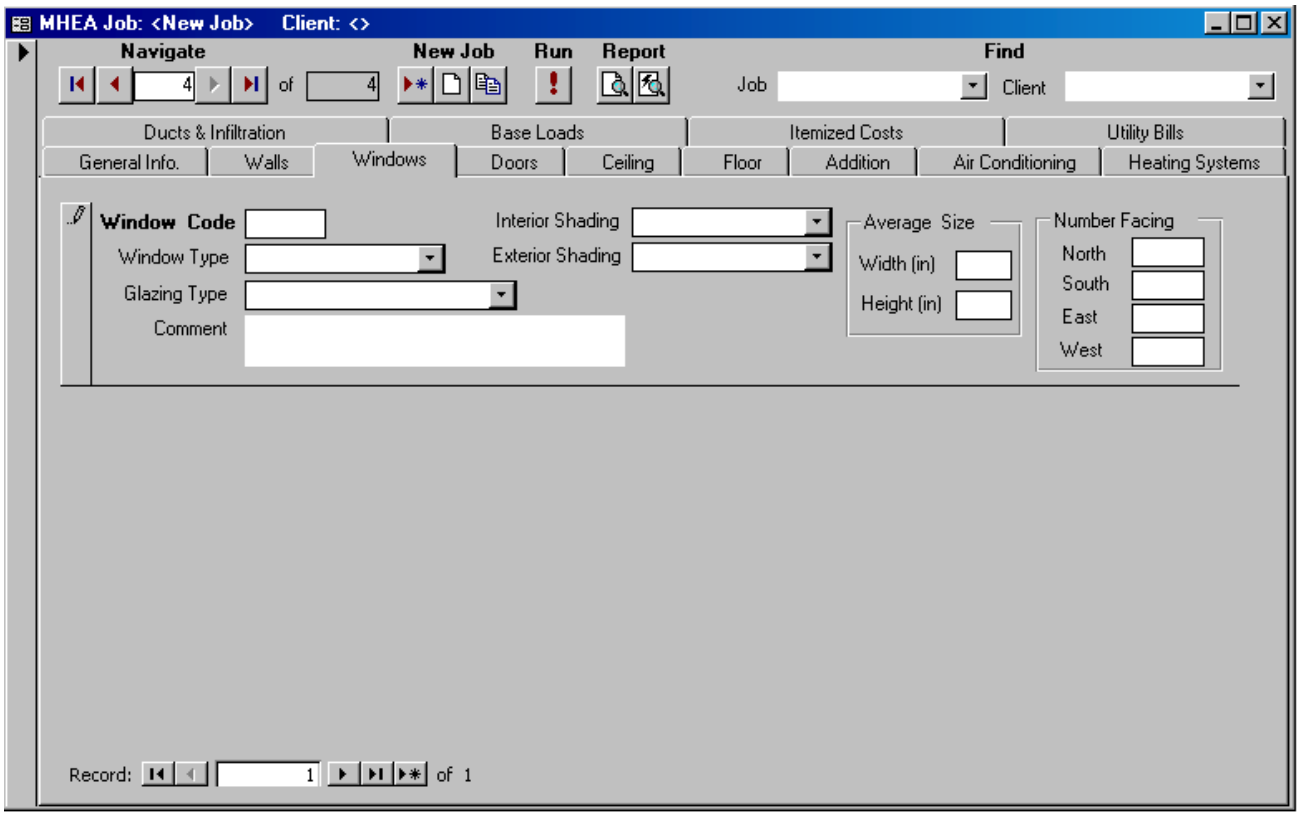
Wind Shielding: W—Well Shielded; N—Normal Shielding; E—Exposed
Home Leakiness: T—Tight; M—Medium; L—Loose

Walls



Wall Stud Size: 1—2 × 2; 2—2 × 3; 3—2 × 4; 4—2 × 6
Orientation of Long Wall: N—North; S—South; E—East; W—West
Wall Ventilation: V—Vented; NV—Not Vented
Orientation (of Carport/Porch Roof): N—North; S—South; E—East; W—West

Windows



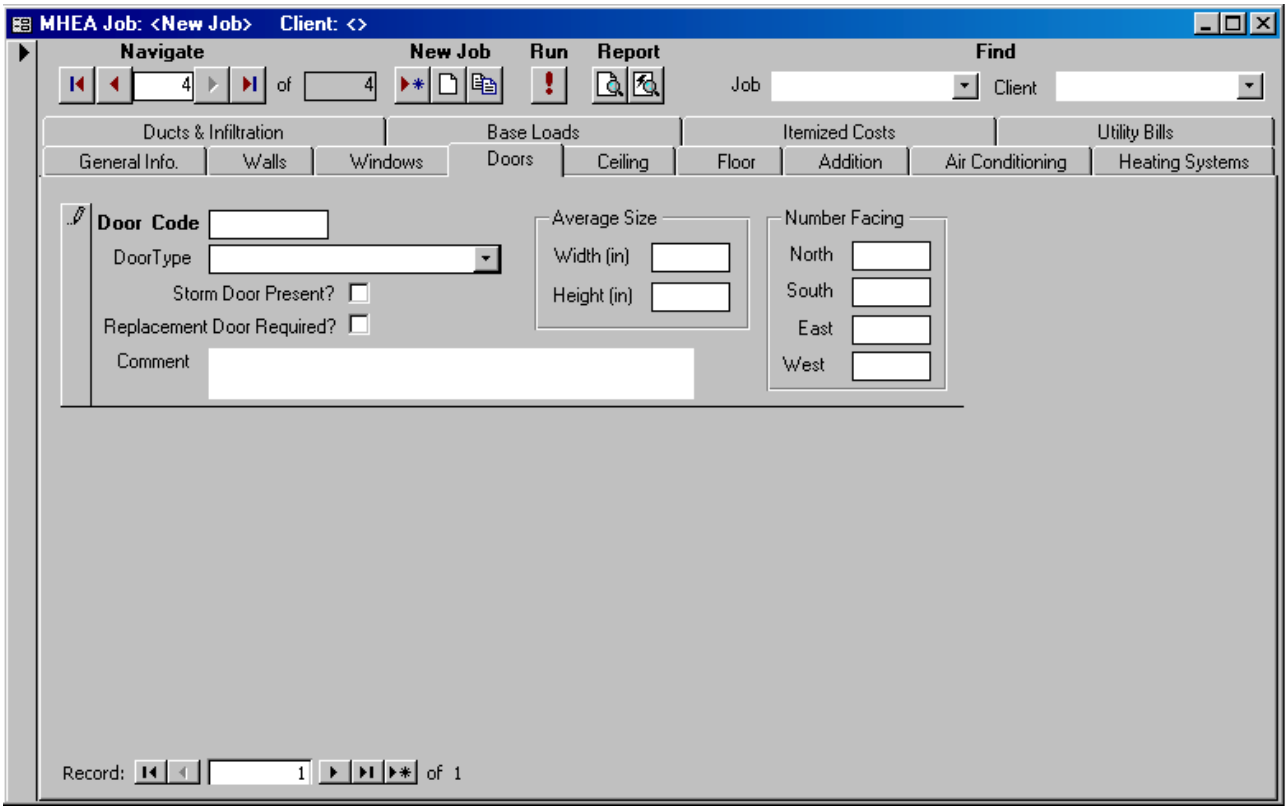
Window Type: 1—Jalousie; 2—Awning; 3—Slider; 4—Fixed; 5—Door Window; 6—Sliding Glass Door; 7—Skylight
Glazing Type: 1—Single; 2—Double; 3—Single with Glass Storm; 4—Double with Glass Storm; 5—Single with Plastic Storm; 6—Double with Plastic Storm
Interior Shading: 1—Drapes; 2—Blinds or Shades; 3—Drapes with Shades; 4—None
Exterior Shading: E—Low-E Film; S—Sun Screen; A—Awning; C—Carport or Porch; N—None

Windows in "Data Sheet" View

Window Code	Window Type	Glazing Type	Width (in)	Height (in)	North	South	East	West	Interior Shading	Exterior Shading	Comment

Window Type: 1—Jalousie; 2—Awning; 3—Slider; 4—Fixed; 5—Door Window; 6—Sliding Glass Door; 7—Skylight
Glazing Type: 1—Single; 2—Double; 3—Single with Glass Storm; 4—Double with Glass Storm; 5—Single with Plastic Storm; 6—Double with Plastic Storm
Interior Shading: 1—Drapes; 2—Blinds or Shades; 3—Drapes with Shades; 4—None
Exterior Shading: E—Low-E Film; S—Sun Screen; A—Awning; C—Carport or Porch; N—None

Doors



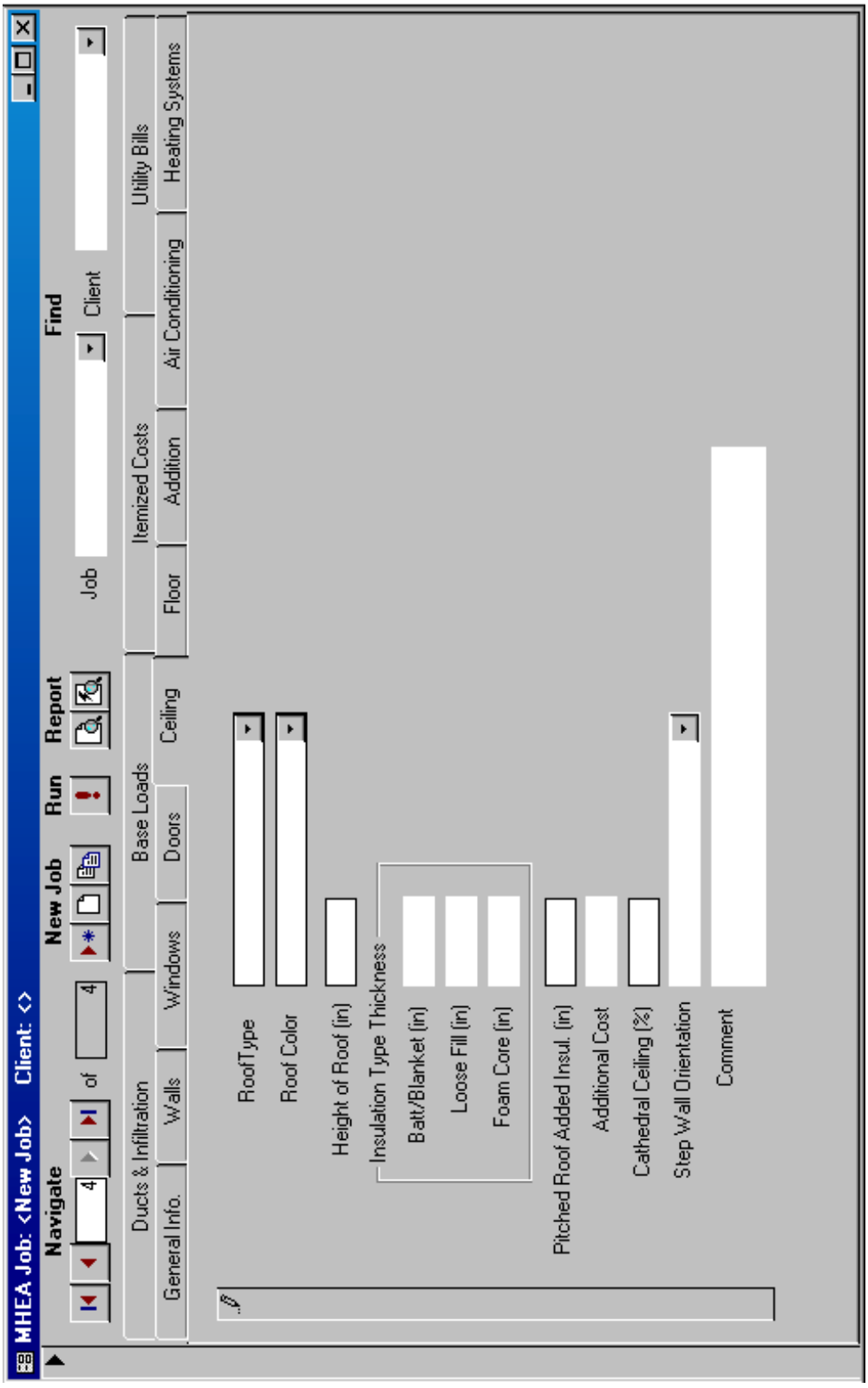
Door Type: 1—Wood, Solid Core; 2—Wood, Hollow Core; 3—Standard Manufactured Home Door

Doors in "Data Sheet" View

Door Code	Door Type	Width (in)	Height (in)	North	South	East	West	Storm Door Present (Y/N)	Replacement Required (Y/N)	Comment

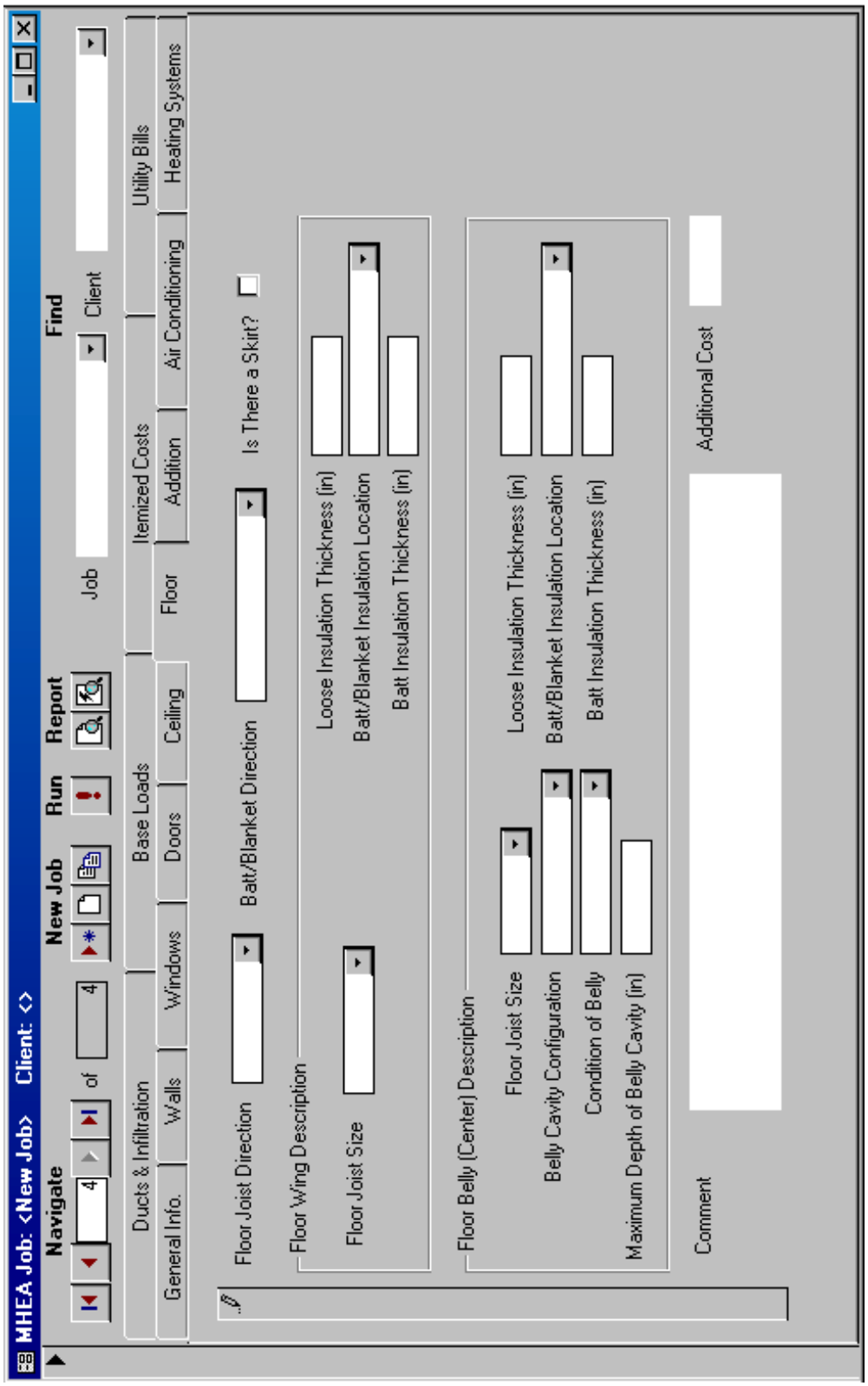
Door Type: 1—Wood, Solid Core; 2—Wood, Hollow Core; 3—Standard Manufactured Home Door

Ceiling



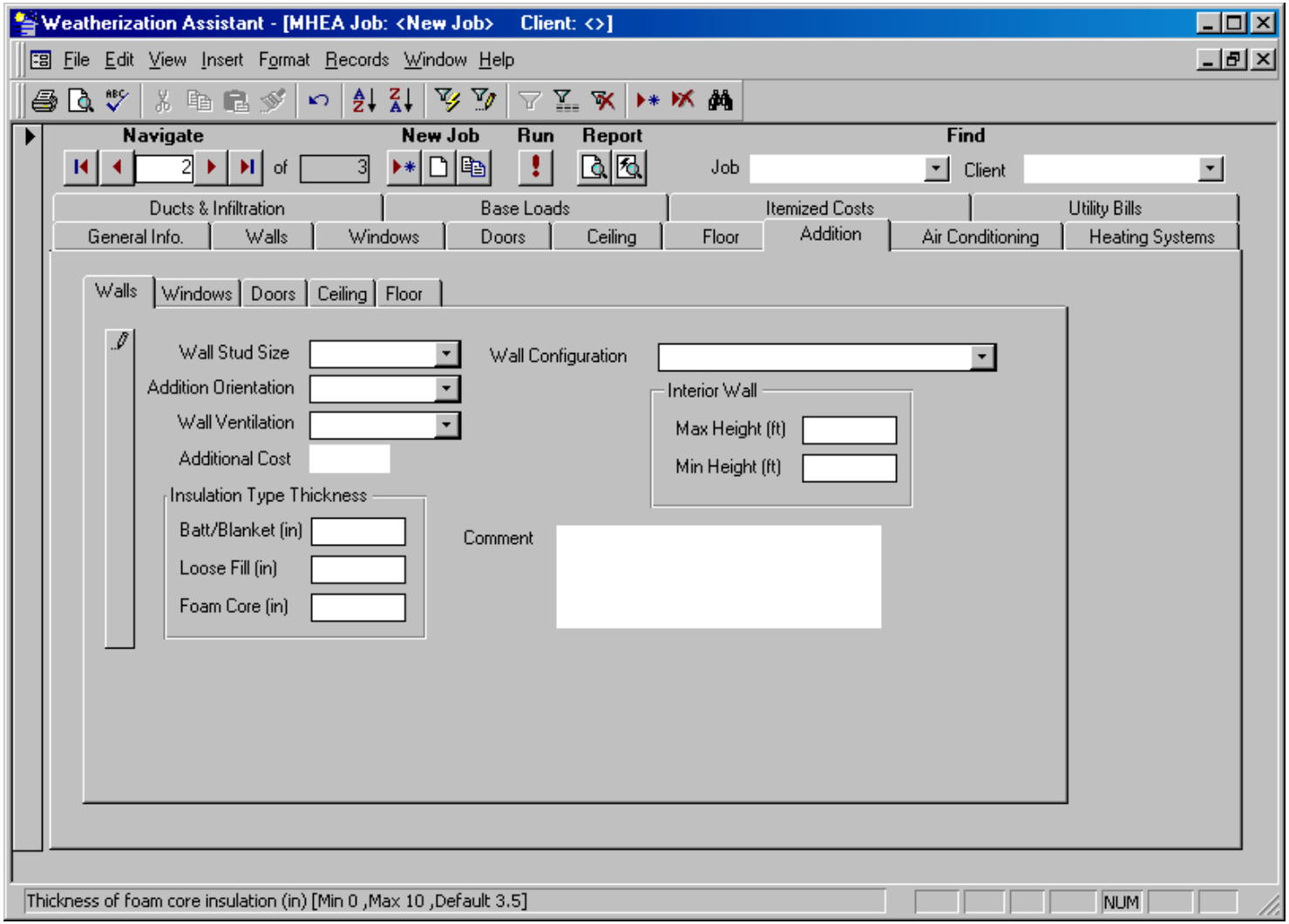
Roof Type: F—Flat; B—Bowstring; P—Pitched
Roof Color: L—Light or Reflective; D—Dark

Floor



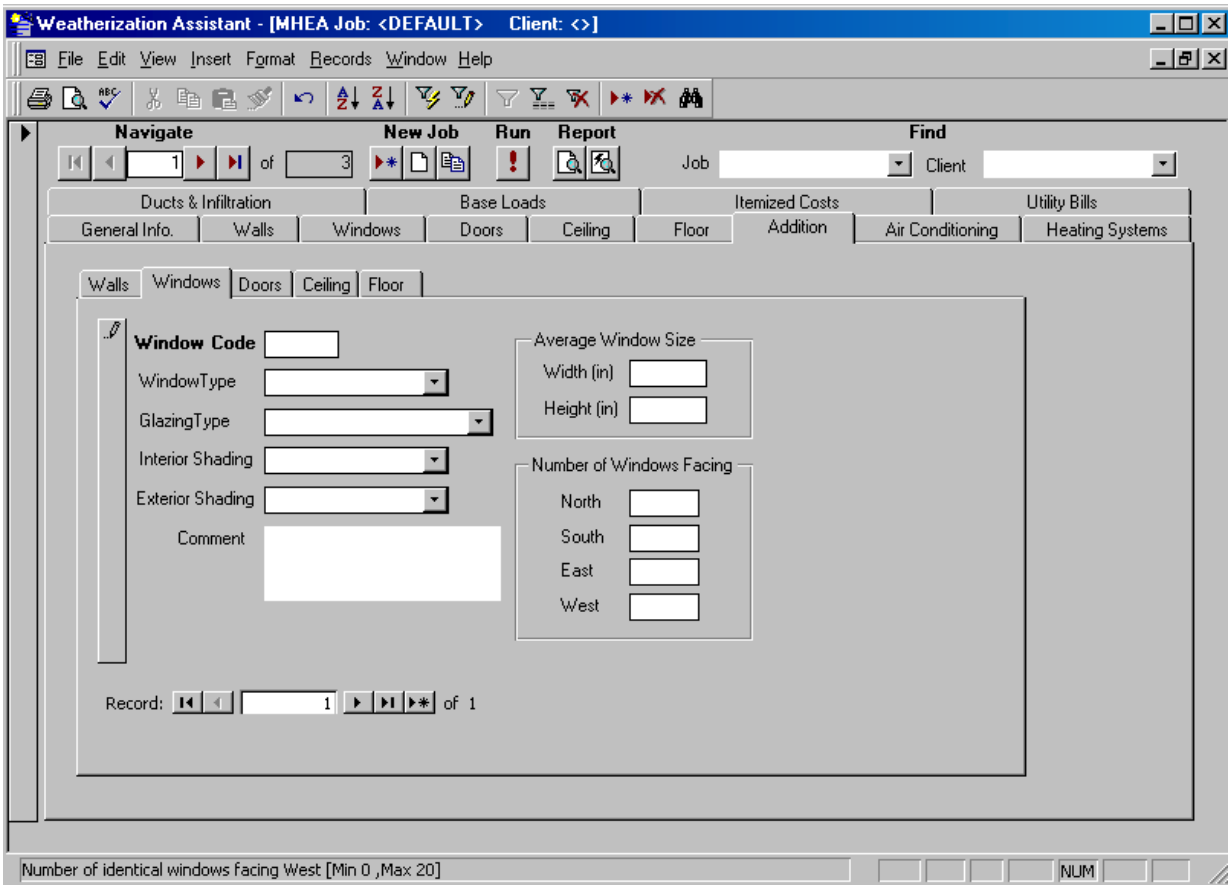
Floor Joist Direction: L—Lengthwise; W—Widthwise
Batt/Blanket Direction: L—Lengthwise; W—Widthwise; N—No Batts or Blanket
Floor Joist Size: 1—2 × 4; 2—2 × 6; 3—2 × 8
Batt/Blanket Insulation Location: F—Attached to Flooring; J—Attached to Joists; D—Draped Below Floor Joist (Center Only)
Belly Cavity Configuration: S—Square; R—Rounded; Fl—Flat
Condition of Belly: G—Good; A—Average; P—Poor

Addition Walls



Wall Stud Size: 1—2 × 2; 2—2 × 3; 3—2 × 4; 4—2 × 6
Addition Orientation: N—North; S—South; E—East; W—West
Wall Ventilation: V—Vented; NV—Not Vented
Wall Configuration: I—Maximum Wall Height at Interior Wall; C—Maximum Wall Height in Center of Addition; S—All Addition Wall the Same Height

Addition Windows



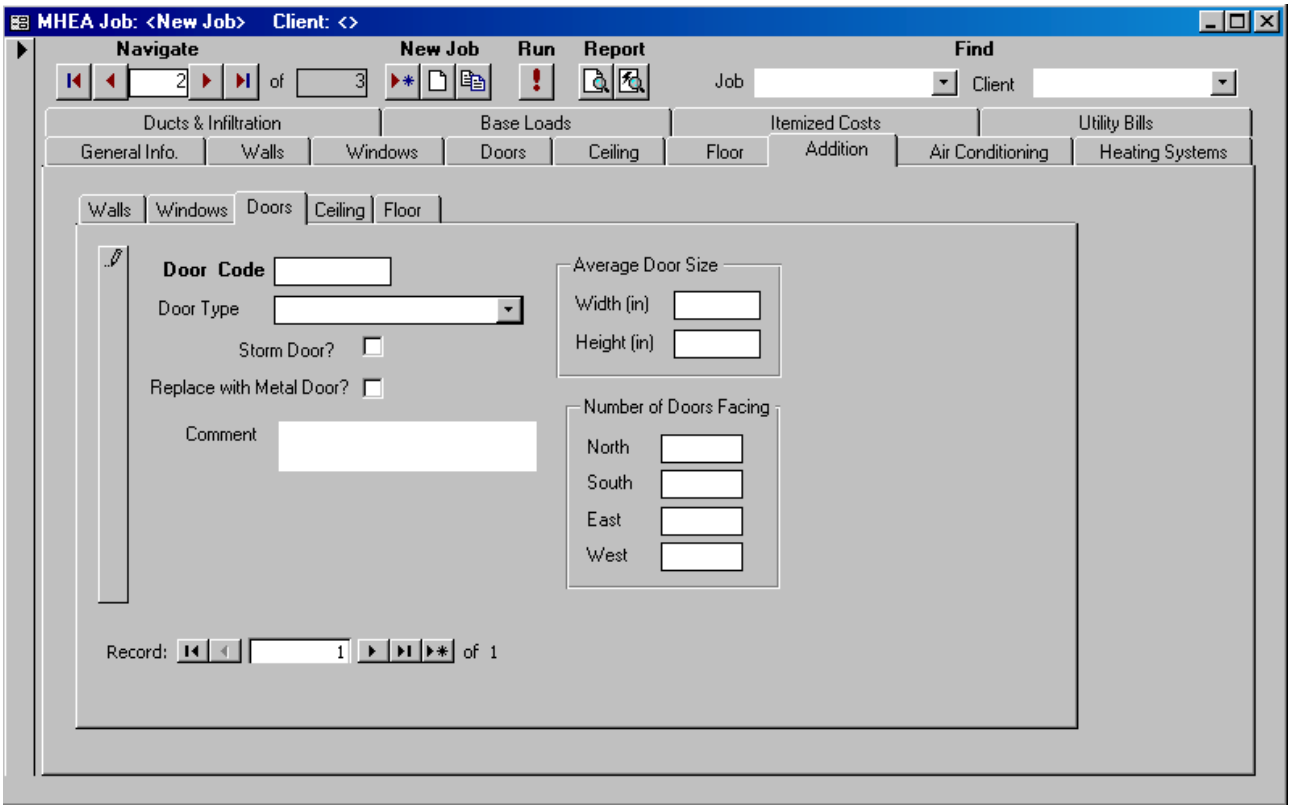
Window Type: 1—Jalousie; 2—Awning; 3—Slider; 4—Fixed; 5—Door Window; 6—Sliding Glass Door; 7—Skylight
Glazing Type: 1—Single; 2—Double; 3—Single with Glass Storm; 4—Double with Glass Storm; 5—Single with Plastic Storm; 6—Double with Plastic Storm
Interior Shading: 1—Drapes; 2—Blinds or Shades; 3—Drapes with Shades; 4—None
Exterior Shading: 1—Low-E Film; 2—Sun Screen; 3—Awning; 4—Carport or Porch; 5—None

Addition Windows in "Data Sheet" View

Window Code	Window Type	Glazing Type	Width (in)	Height (in)	North	South	East	West	Interior Shading	Exterior Shading	Comment

Window Type: 1—Jalousie; 2—Awning; 3—Slider; 4—Fixed; 5—Door Window; 6—Sliding Glass Door; 7—Skylight
Glazing Type: 1—Single; 2—Double; 3—Single with Glass Storm; 4—Double with Glass Storm; 5—Single with Plastic Storm; 6—Double with Plastic Storm
Interior Shading: 1—Drapes; 2—Blinds or Shades; 3—Drapes with Shades; 4—None
Exterior Shading: 1—Low-E Film; 2—Sun Screen; 3—Awning; 4—Carport or Porch; 5—None

Addition Doors



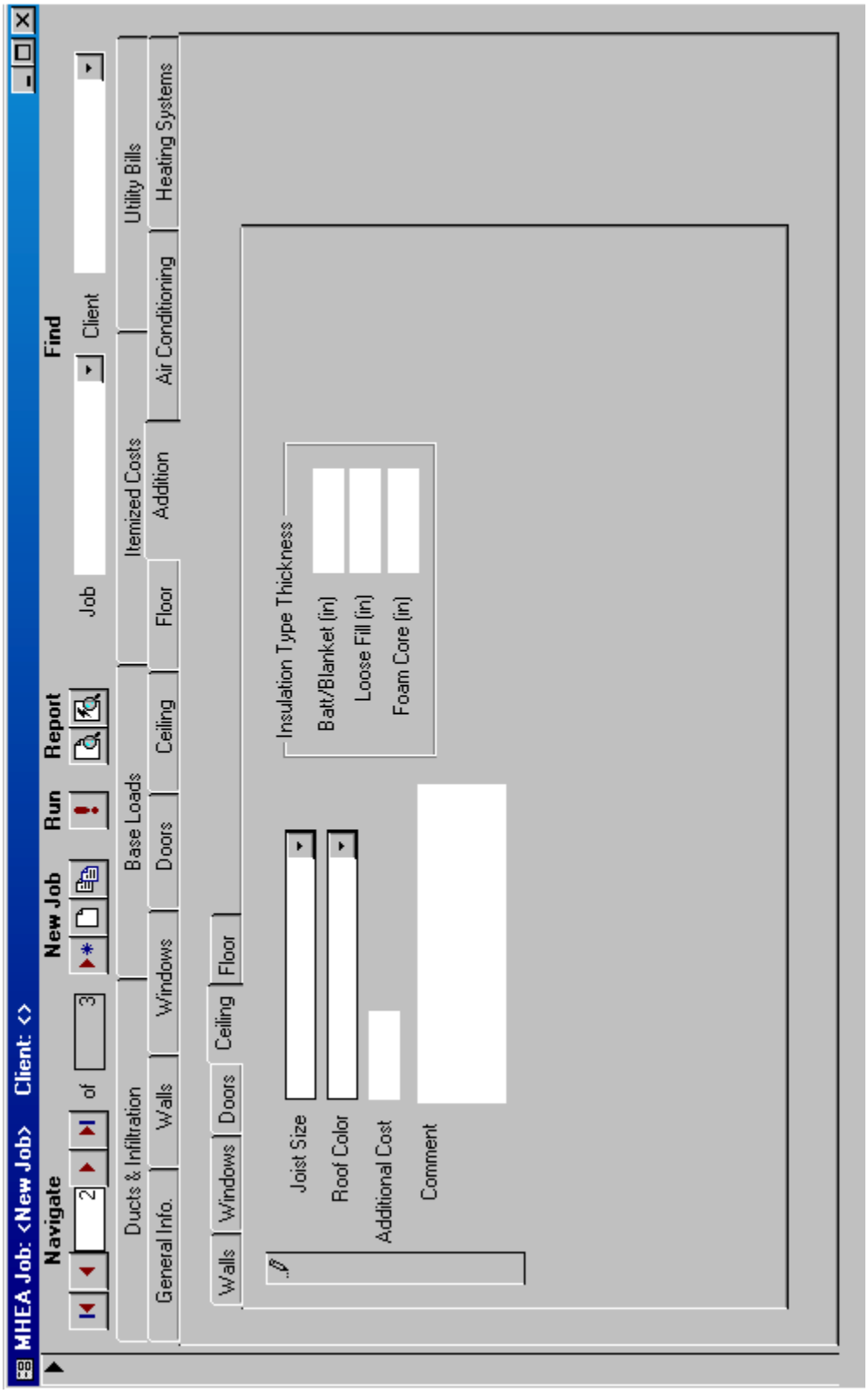
Door Type: 1—Wood, Solid Core; 2—Wood, Hollow Core; 3—Standard Manufactured Home Door

Addition Doors in "Data Sheet" View

Door Code	Door Type	Width (in)	Height (in)	North	South	East	West	Storm Door Present (Y/N)	Comment

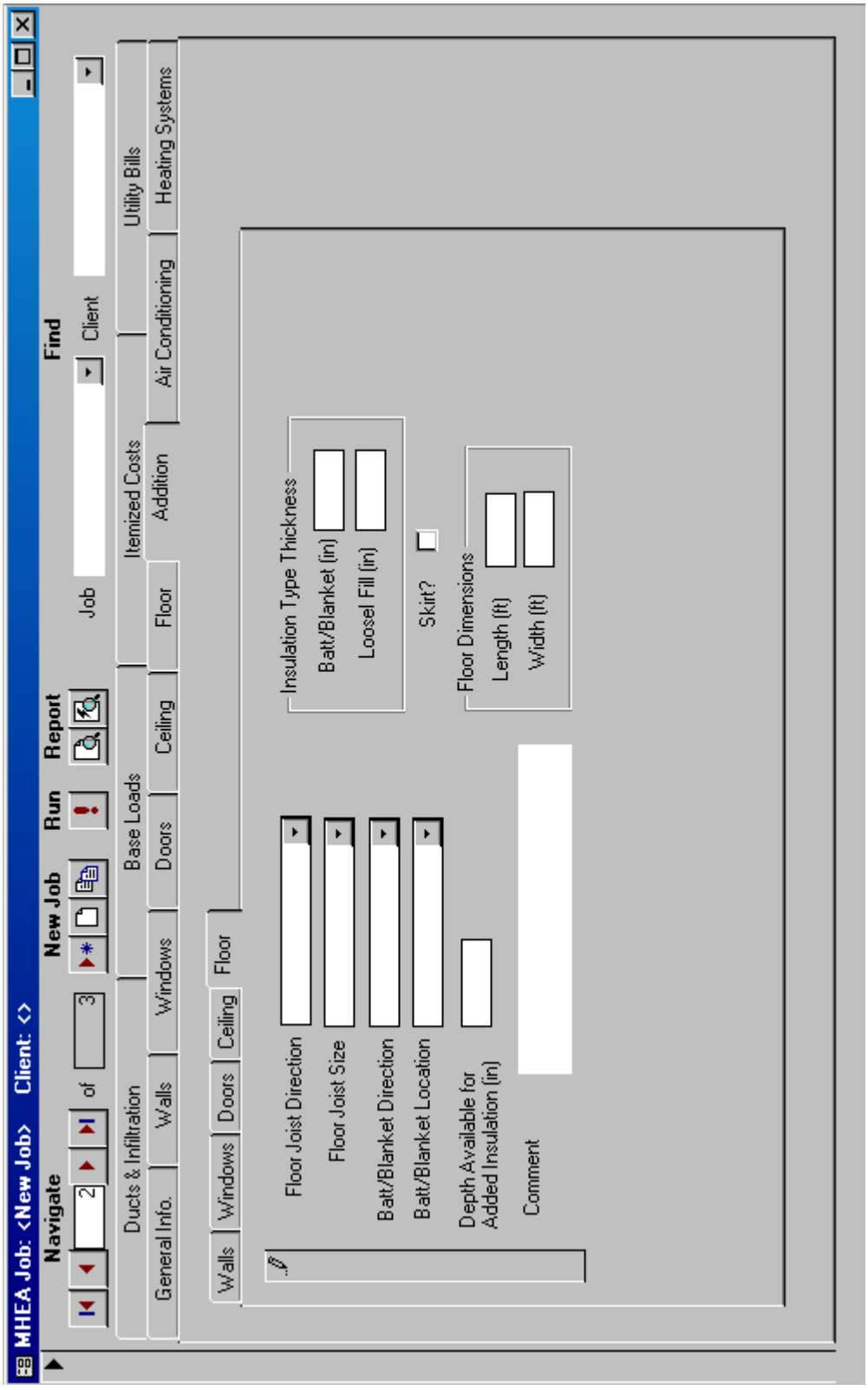
Door Type: 1—Wood, Solid Core; 2—Wood, Hollow Core; 3—Standard Manufactured Home Door

Addition Ceiling



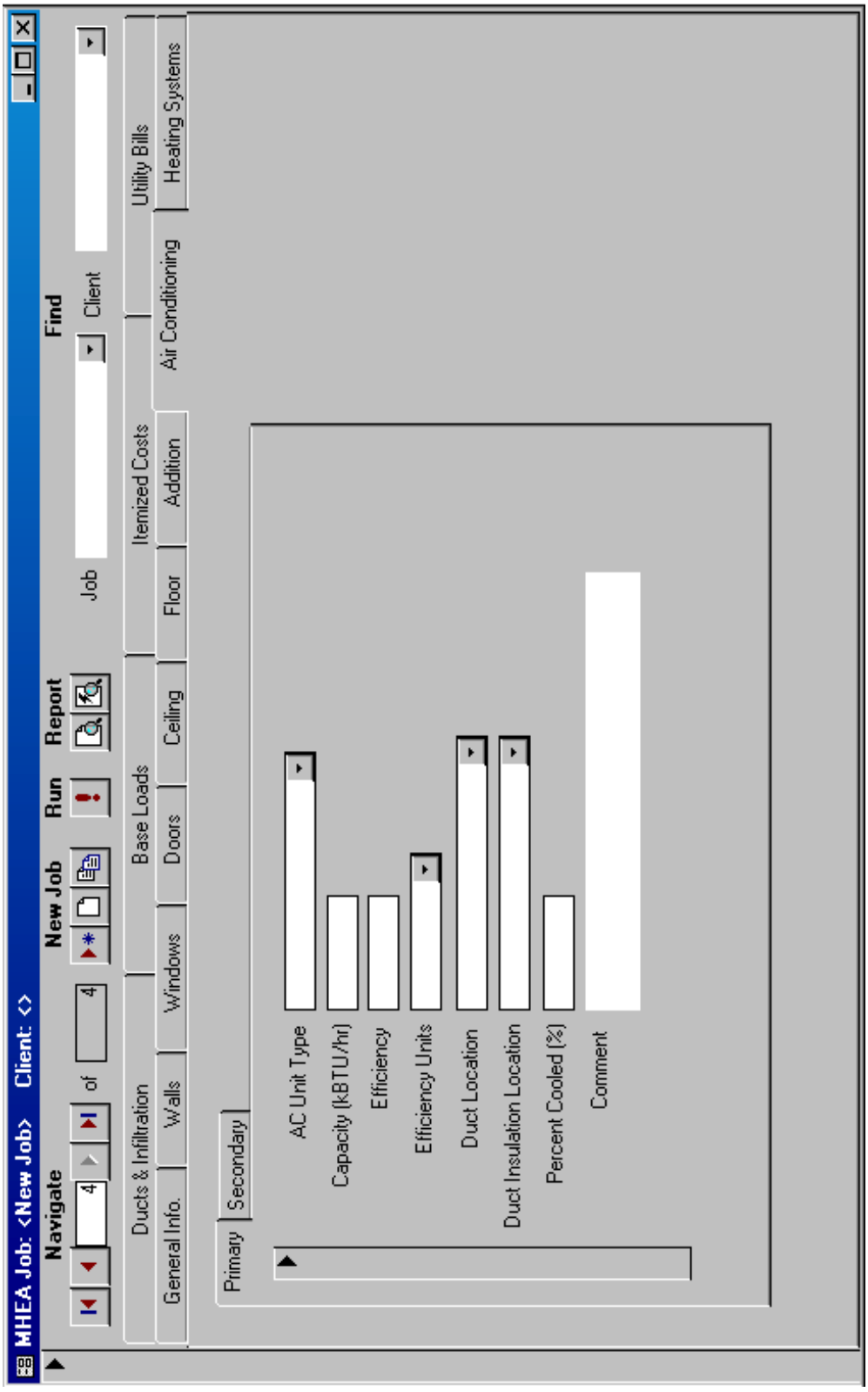
Joist Size: 1—2 × 4; 2—2 × 6; 3—2 × 8
Roof Color: L—Light or Reflective; D—Dark

Addition Floor



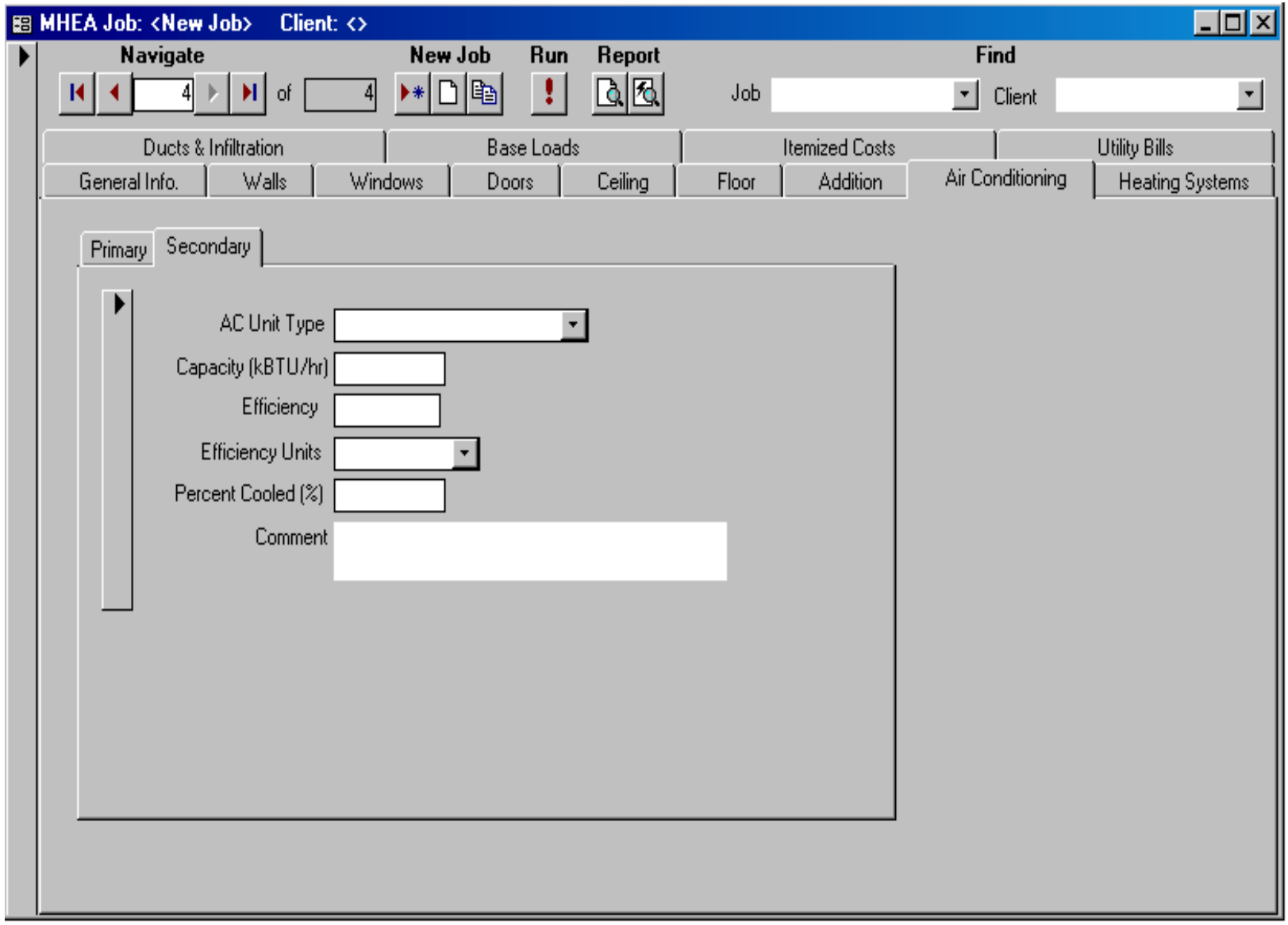
Floor Joist Direction: L—Lengthwise; W—Widthwise
Floor Joist Size: 1—2 × 4; 2—2 × 6; 3—2 × 8
Batt/Blanket Direction: L—Lengthwise; W—Widthwise; N—No Batts or Blanket
Batt/Blanket Location: F—Attached to Flooring; J—Attached to Joists

Air Conditioning—Primary



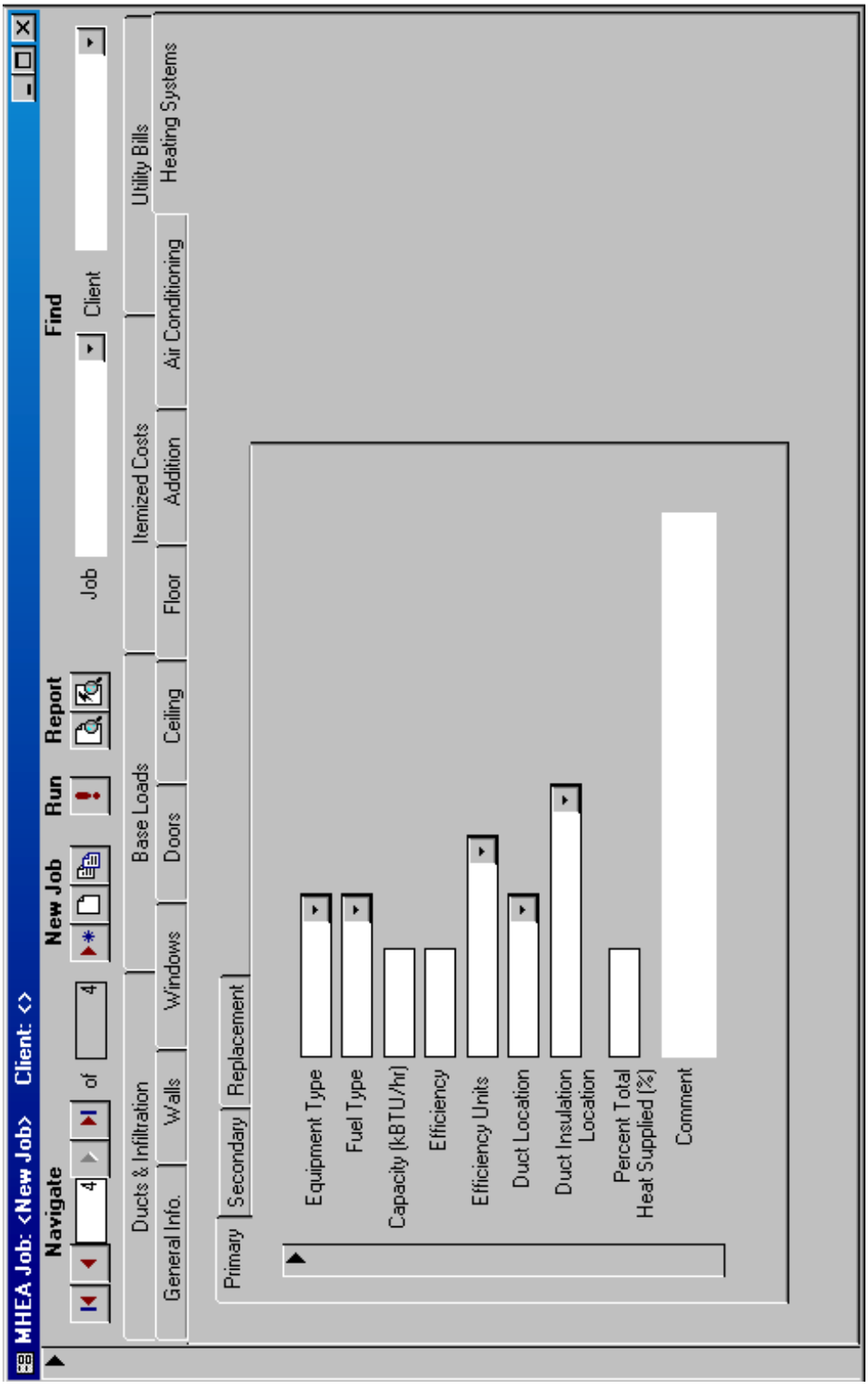
AC Unit Type: E—Evaporative Cooler; C—Central Air Conditioner; R—Room Air Conditioner; H—Heat Pump; N—None
Duct Location: F—Floor; C—Ceiling; N—None
Duct Insulation Location: A—Above Duct; B—Below Duct; D—Around Duct or Ductboard; N—No Insulation

Air Conditioning—Secondary



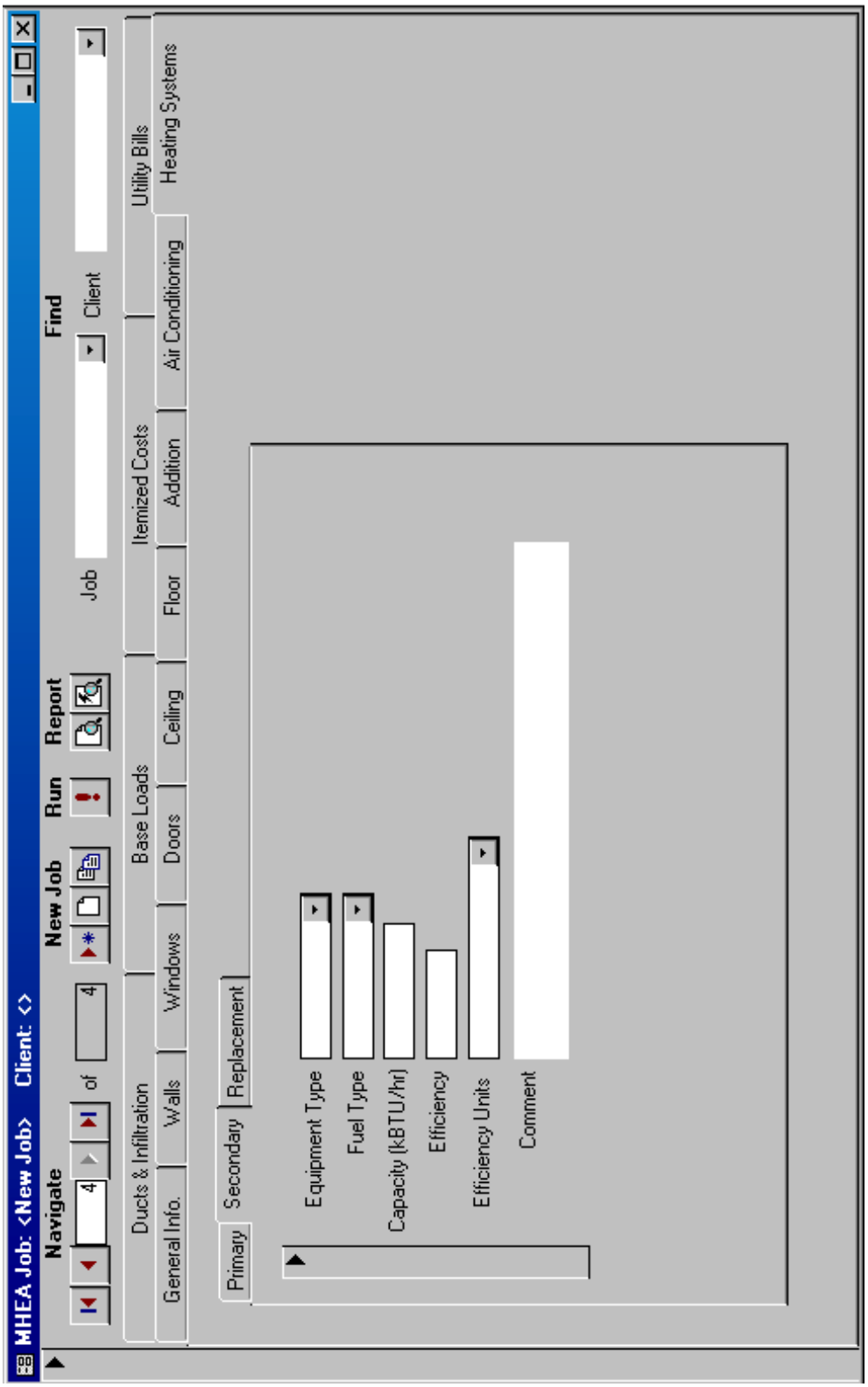
AC Unit Type: E—Evaporative Cooler; C—Central Air Conditioner; R—Room Air Conditioner; H—Heat Pump; N—None

Primary Heating System



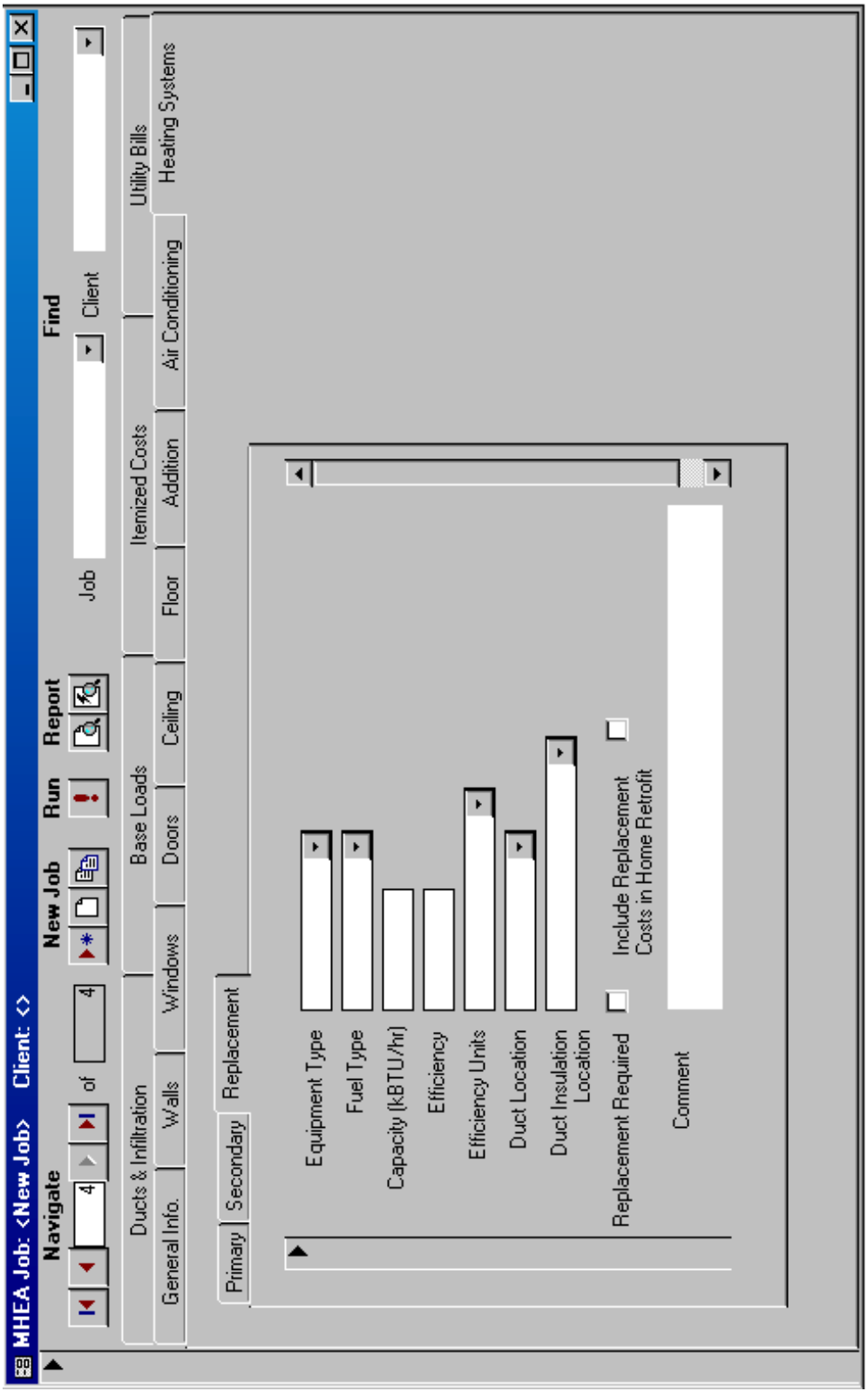
Equipment Type: F—Furnace; H—Heat Pump; S—Space Heater; N—None
Fuel Type: N—Natural Gas; O—Oil; E—Electric; P—Propane; W—Wood; C—Coal; K—Kerosene
Duct Location: F—Floor; C—Ceiling; N—None
Duct Insulation Location: A—Above Duct; B—Below Duct; D—Around Duct or Ductboard; N—No Insulation

Secondary Heating System



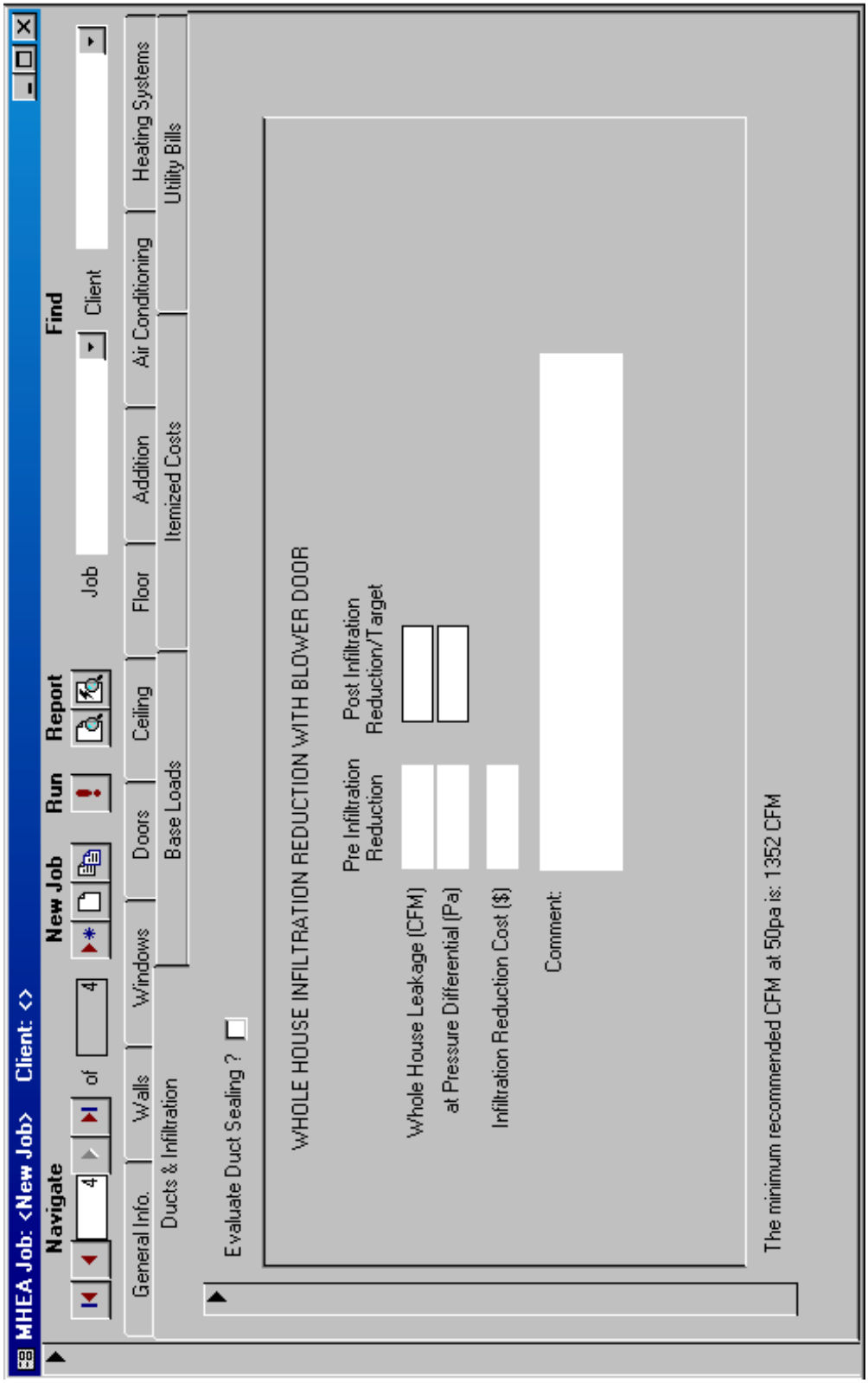
Equipment Type: F—Furnace; H—Heat Pump; S—Space Heater; N—None
Fuel Type: N—Natural Gas; O—Oil; E—Electric; P—Propane; W—Wood; C—Coal; K—Kerosene

Replacement Heating System



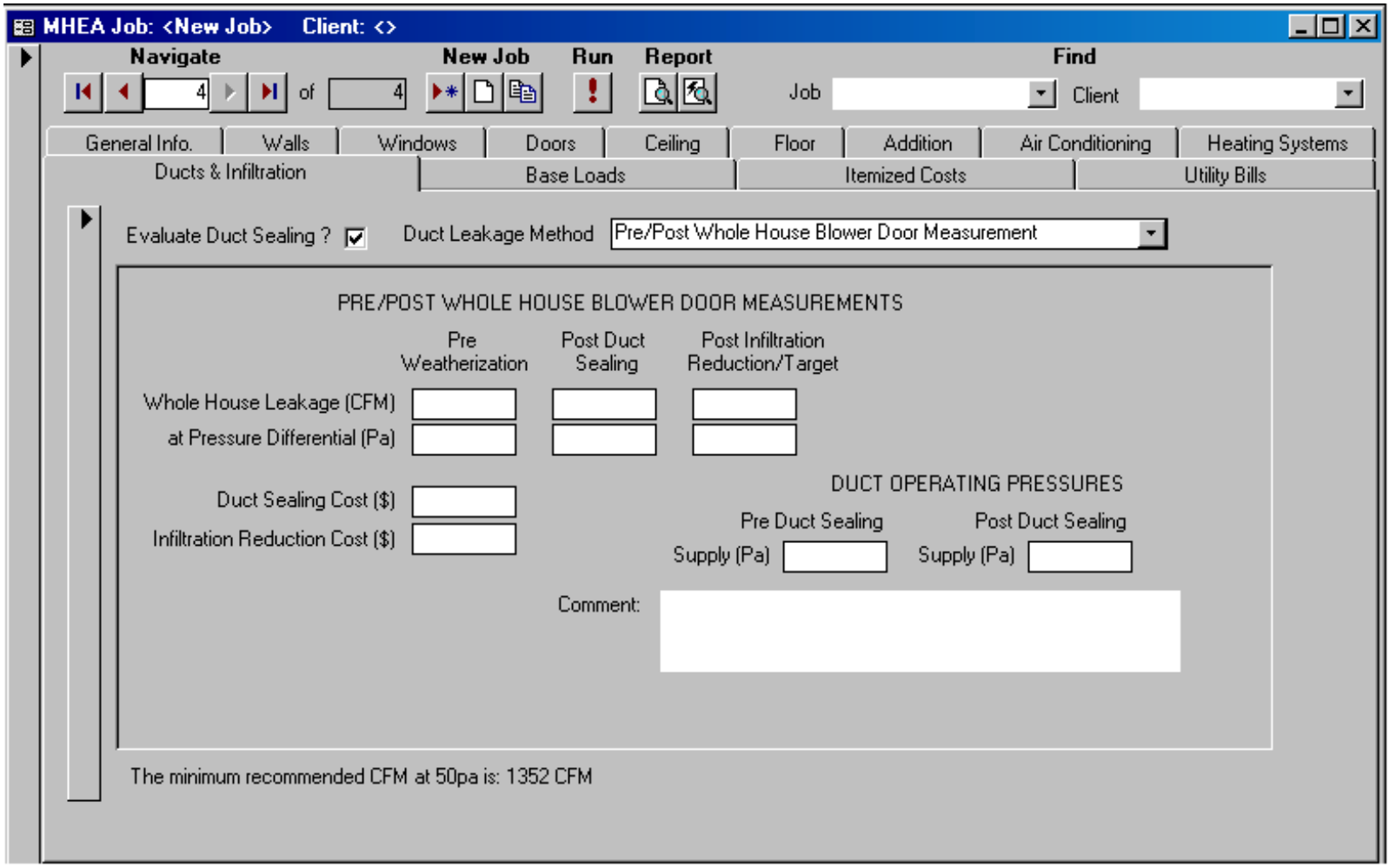
Equipment Type: F—Furnace; H—Heat Pump; S—Space Heater; N—None
Fuel Type: N—Natural Gas; O—Oil; E—Electric; P—Propane; W—Wood; C—Coal; K—Kerosene
Duct Location: F—Floor; C—Ceiling; N—None
Duct Insulation Location: A—Above Duct; B—Below Duct; D—Around Duct or Ductboard; N—No Insulation

Infiltration



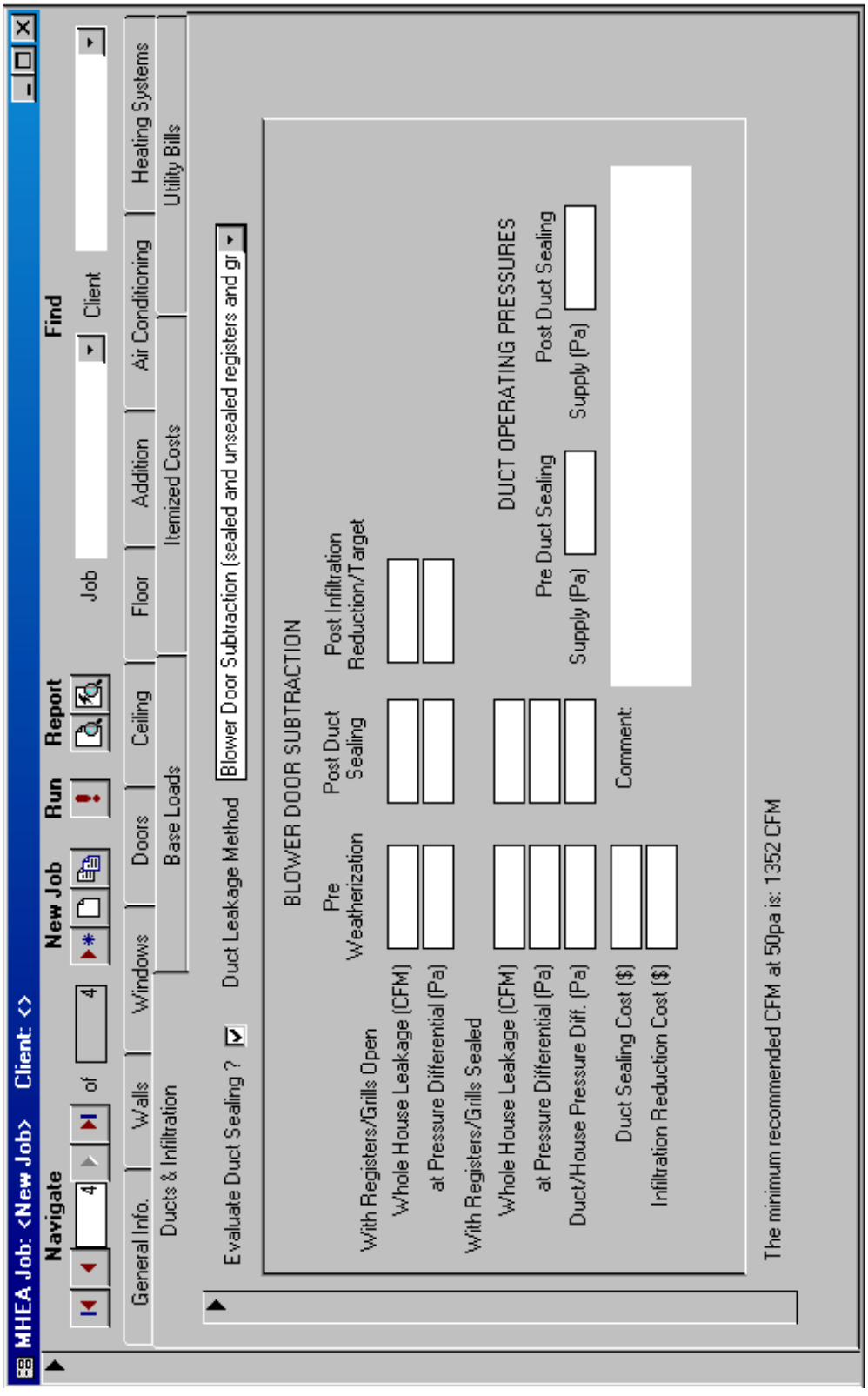
Duct Leakage Method: W—Pre/Post Whole House Blower Door Measurement; S—Blower Door Subtraction; D—Duct-Blower Pressure Tests; P—Pressure Pan Measurements

Duct and Infiltration—Pre/Post Whole House Blower Door Measurement



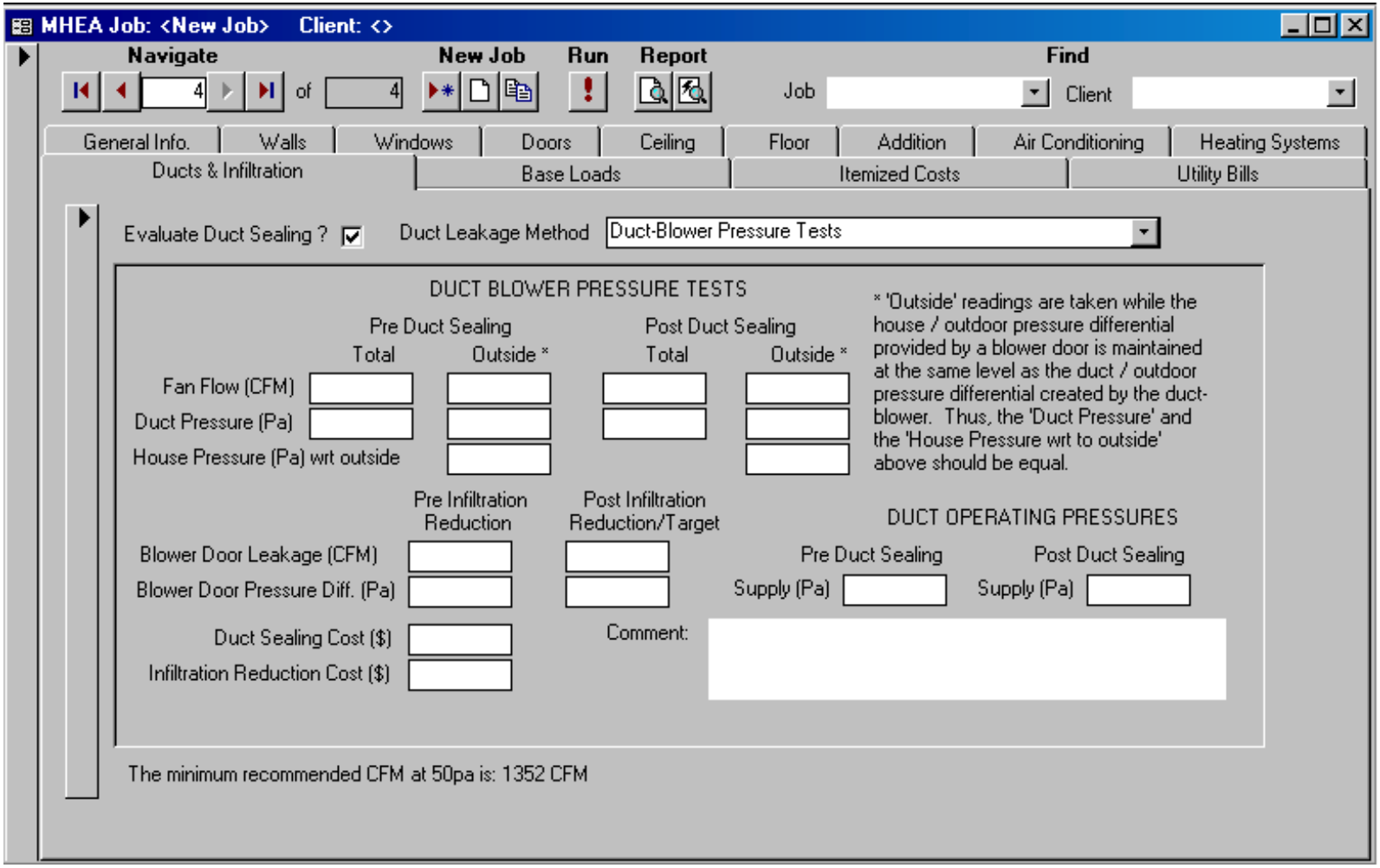
Duct Leakage Method: W—Pre/Post Whole House Blower Door Measurement; S—Blower Door Subtraction; D—Duct-Blower Pressure Tests; P—Pressure Pan Measurements

Duct and Infiltration—Blower Door Subtraction



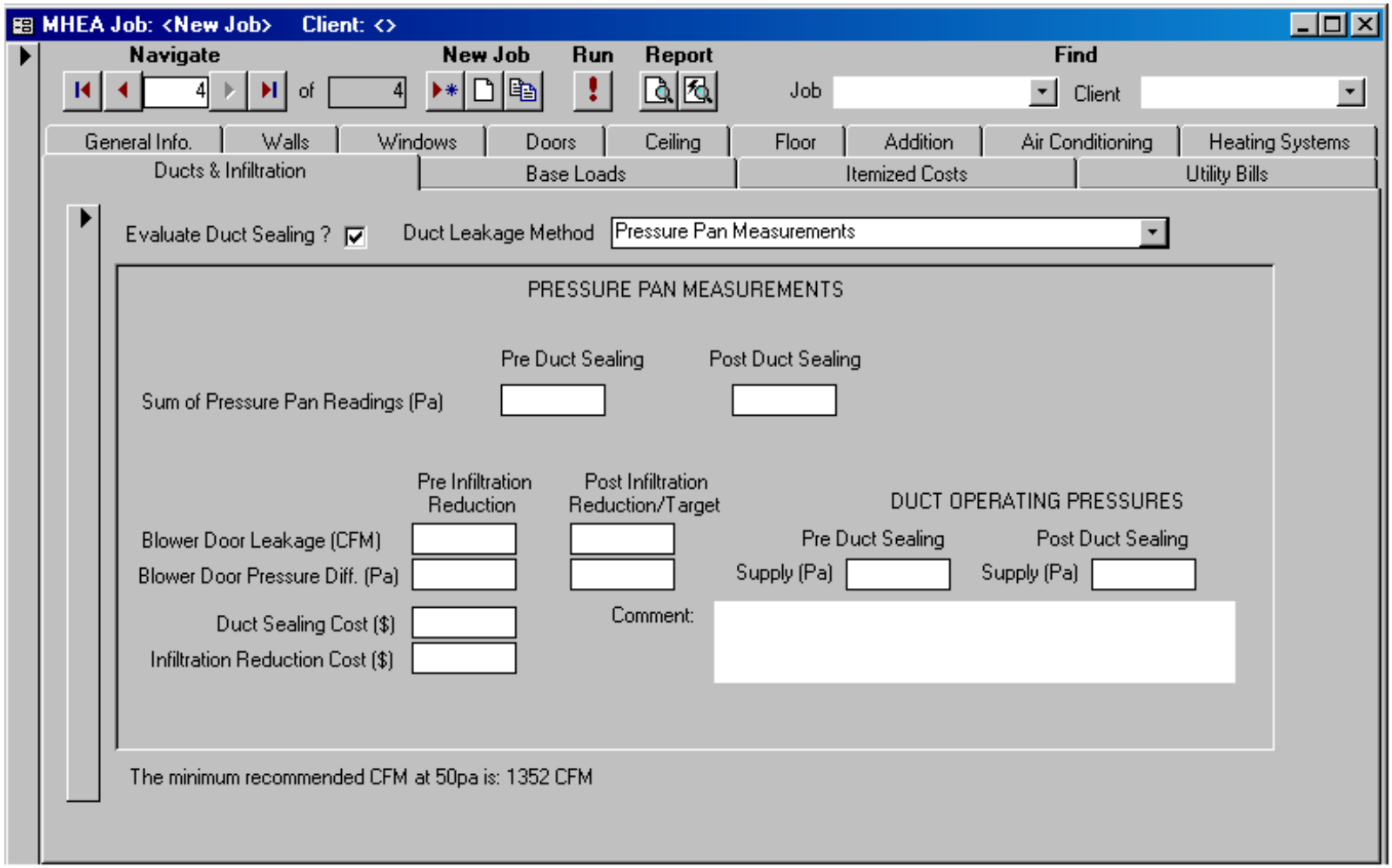
Duct Leakage Method: W—Pre/Post Whole House Blower Door Measurement; S—Blower Door Subtraction; D—Duct-Blower Pressure Tests; P—Pressure Pan Measurements

Duct and Infiltration—Duct-Blower Pressure Tests



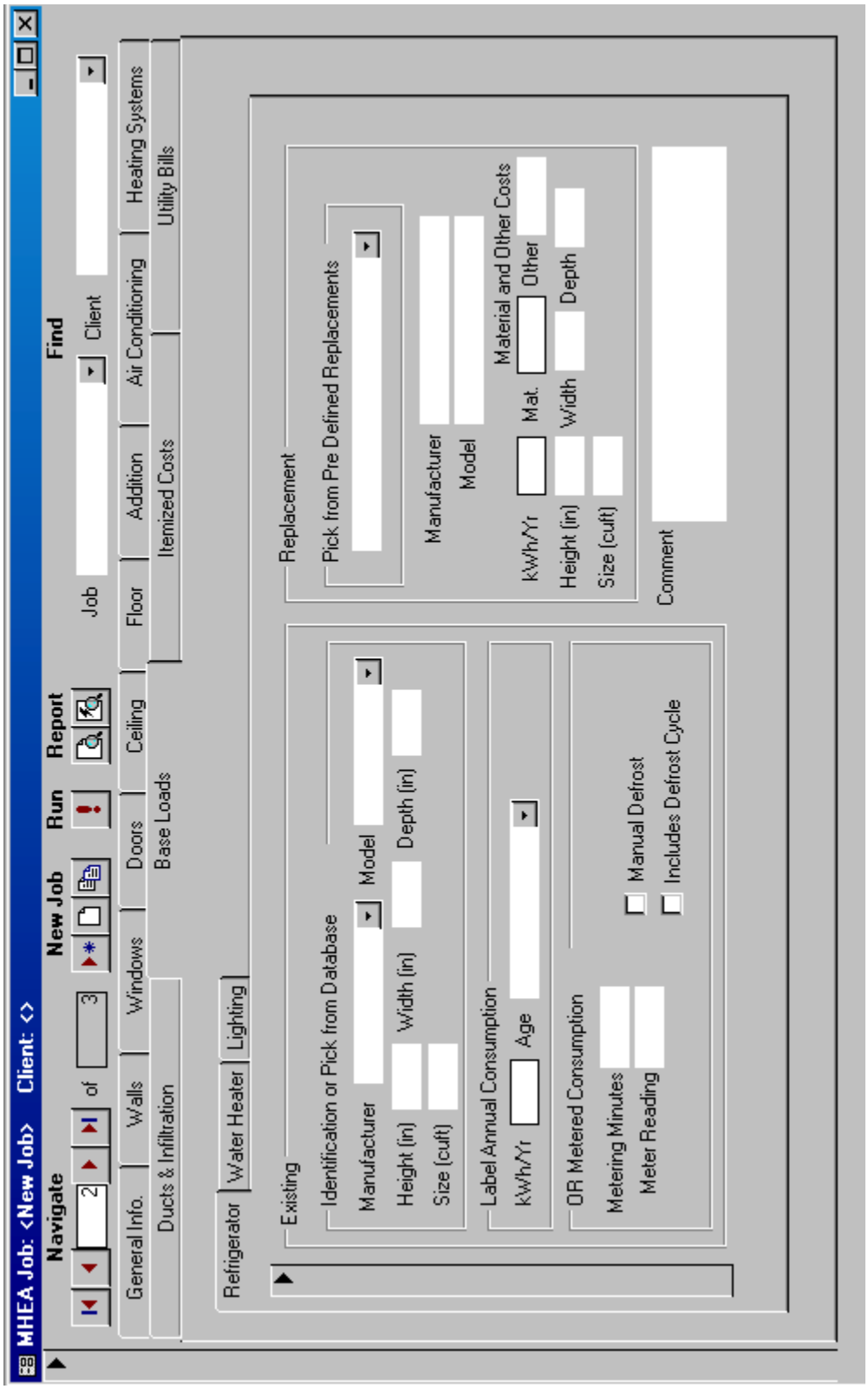
Duct Leakage Method: W—Pre/Post Whole House Blower Door Measurement; S—Blower Door Subtraction; D—Duct-Blower Pressure Tests; P—Pressure Pan Measurements

Duct and Infiltration—Pressure Pan Measurements



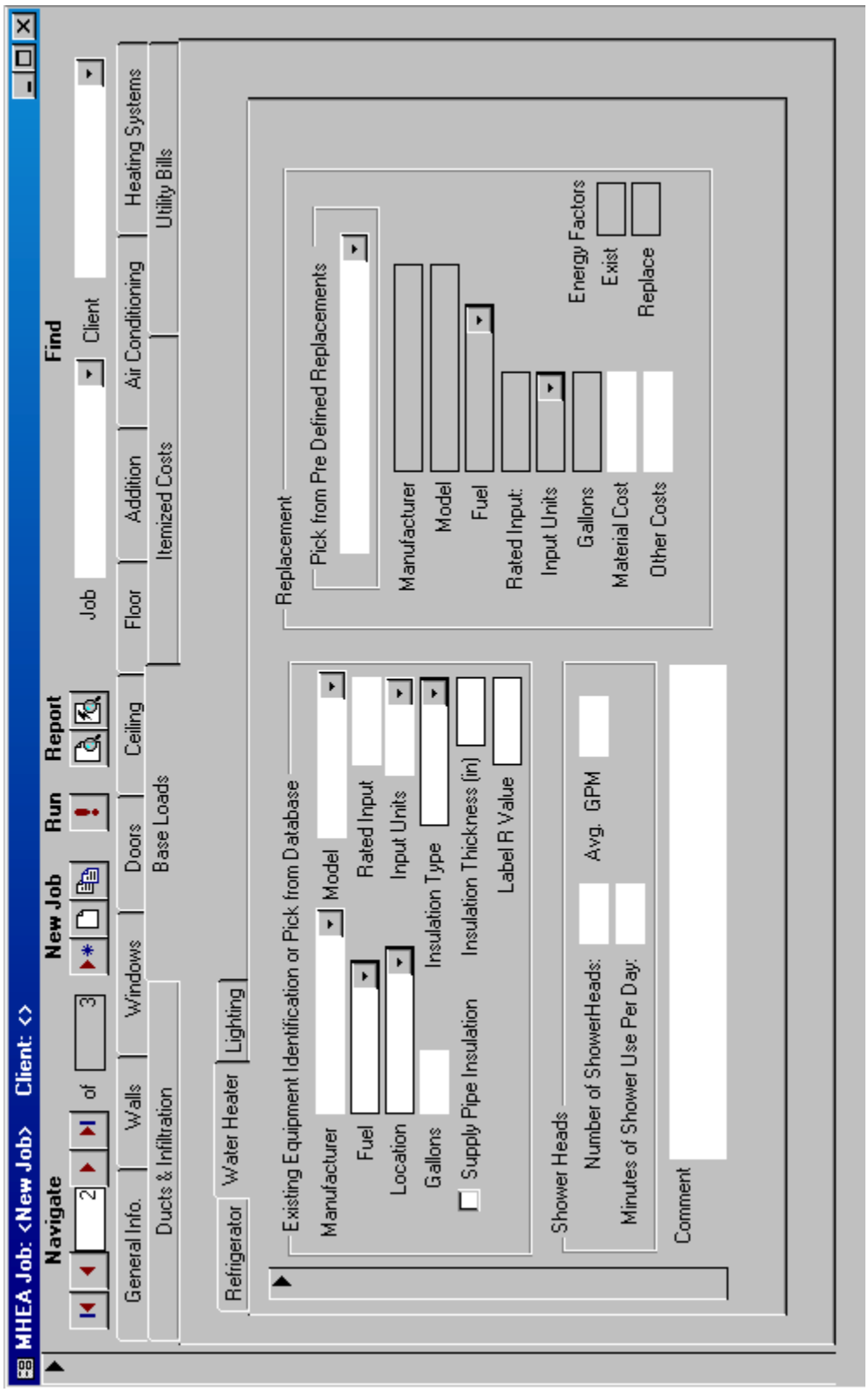
Duct Leakage Method: W—Pre/Post Whole House Blower Door Measurement; S—Blower Door Subtraction; D—Duct-Blower Pressure Tests; P—Pressure Pan Measurements

Refrigerator



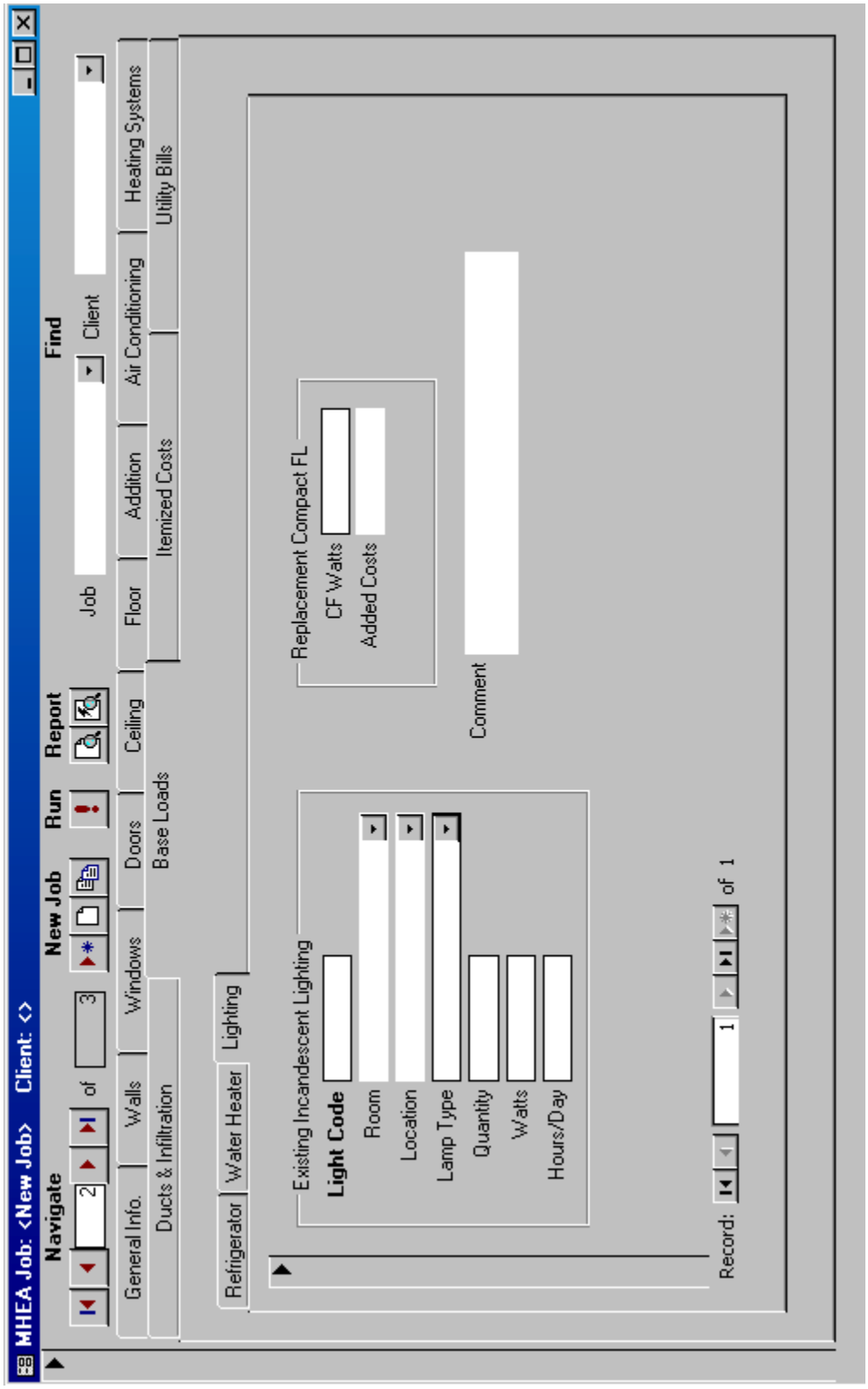
Age: L—Less than 5 years; 5-10—5 to 10 years; 10-15—10 to 15 years; M—More than 15 years

Water Heating



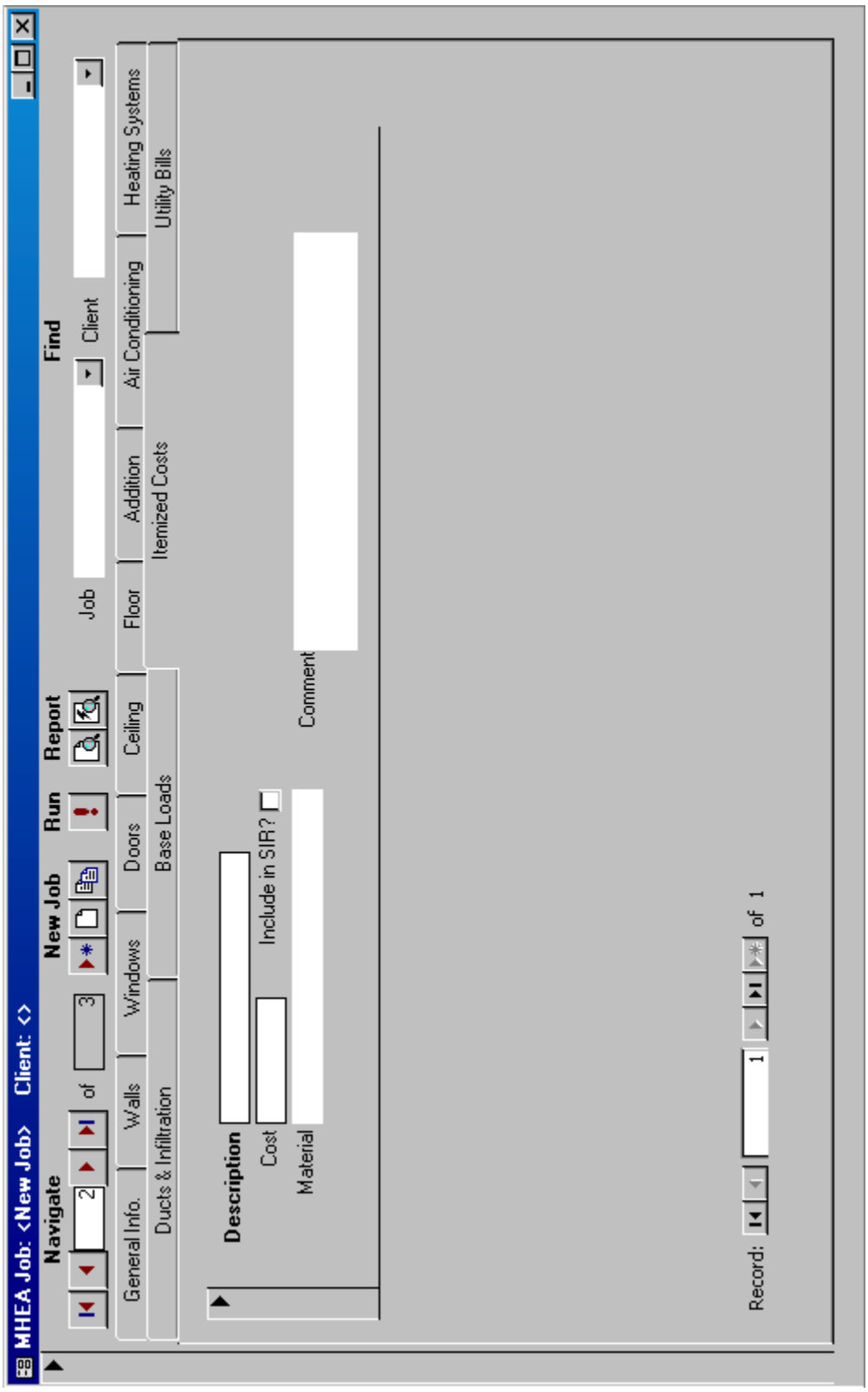
Fuel: N—Natural Gas; E—Electric; P—Propane
Location: H—Heated Space; U—Unheated Space
Input Units: B—kBtu; W—kW
Insulation Type: F—Fiberglass; P—Polyurethane

Lighting

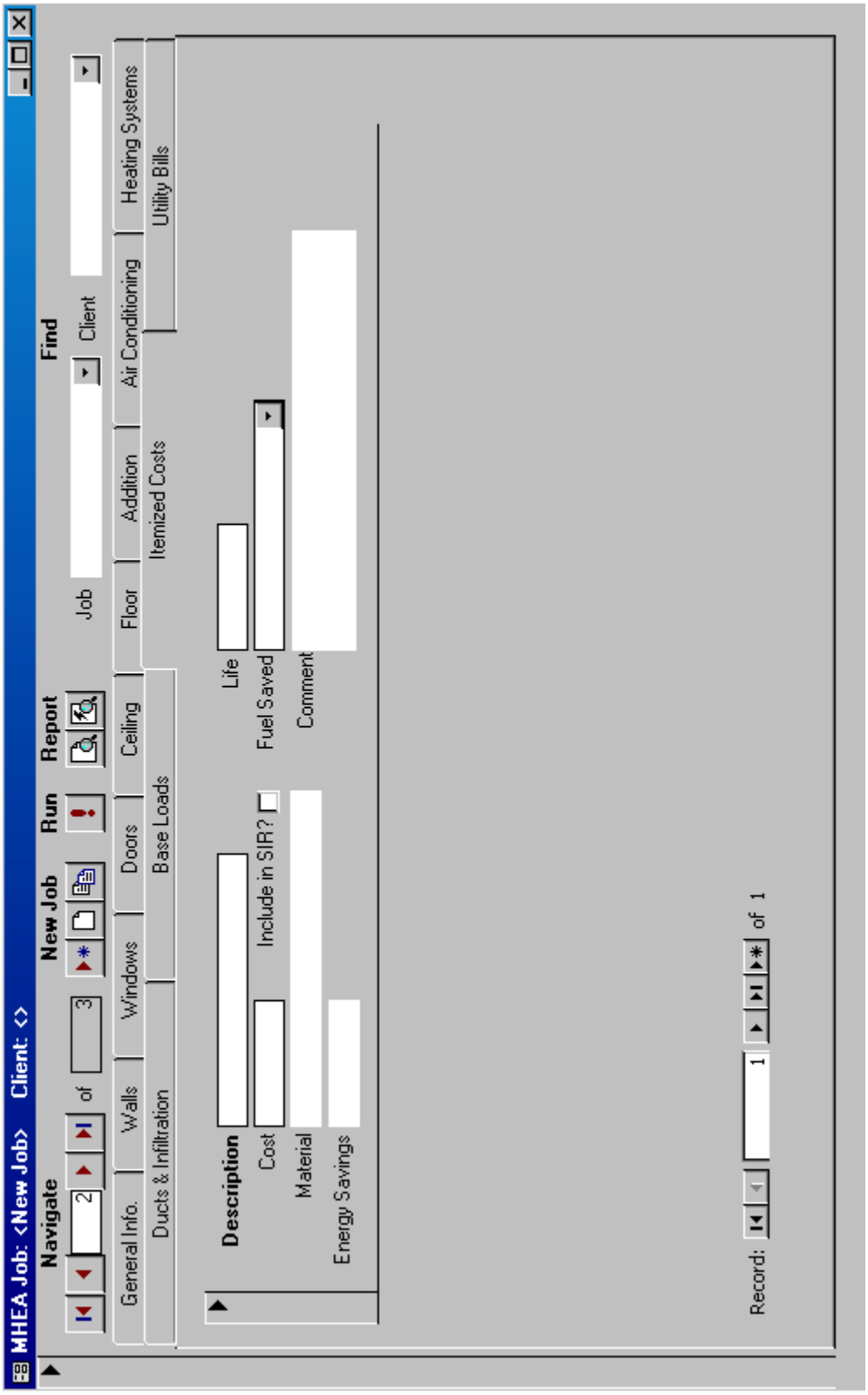


Room: F—Family Room; K—Kitchen; L—Living Room; R—Rec Room; D—Dining; Bd—Bedroom; Bt—Bathroom; U—Utility
Location: C—Ceiling; F—Floor; T—Table; W—Wall
Lamp Type: S—Standard; F—Flood

Itemized Cost

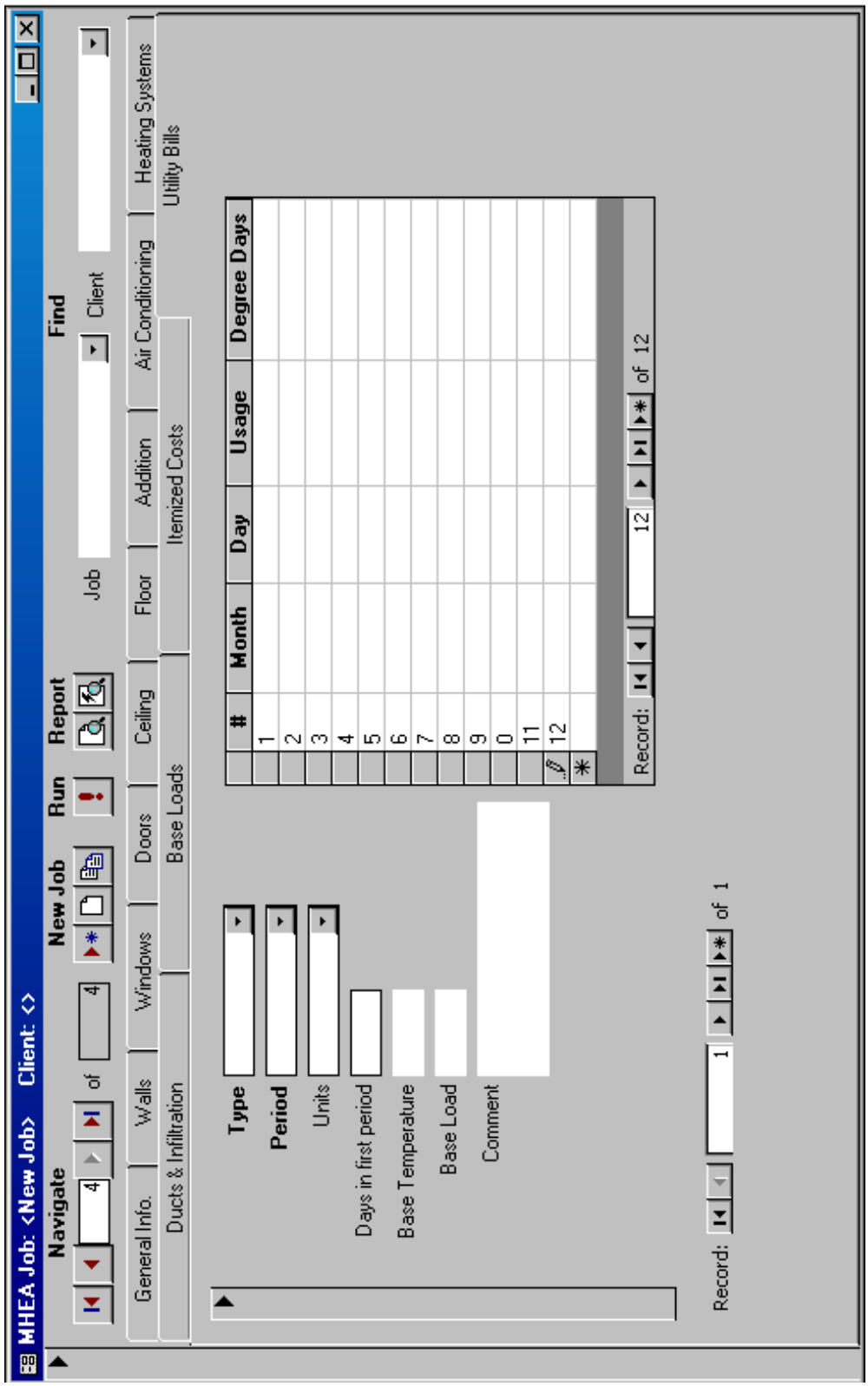


User Defined Measures



Fuel Saved: N—Natural Gas; O—Oil; E—Electric; P—Propane; W—Wood; C—Coal; K—Kerosene

Billing



Type: H—Heating; C—Cooling
Period: B—Pre-Retrofit; A—Post-Retrofit
Units: T—Therms; W—KWh

Audit—The process of identifying energy conservation opportunities in houses. As used here, MHEA audit means a computer selection technique which optimizes the Savings-to-Investment Ratio of various energy conservation measures.

Auditor—A person who performs an audit.

Balance point—For heating, the balance point is the outside temperature above which no heating is needed. For cooling, the balance point is the outside temperature below which no cooling is needed.

Base load—The energy required to operate the domestic hot water heater, lights, cooking, clothes washing, and other household appliances that are used throughout the year. For example, if the heating equipment uses natural gas, the base electricity load can be estimated by averaging the monthly electricity consumption during the winter months.

Base temperature—Base temperature is the outdoor temperature below which heating or above which cooling systems are used. Assume a base temperature of 65°F for HDD's and 78°F for CDD's, unless a different base temperature is listed on the utility bill.

Belly—The under side of a manufactured home consisting of a rodent barrier, floor trusses, and insulation.

Boot—The process of turning on or re-initializing a computer. Also, a segment of duct connecting the duct to the register.

Bowstring—wood roof trusses in the shape of a bow which support the weight of the roof.

British thermal unit—The quantity of heat required to raise one pound of water one degree Fahrenheit.

Buffered—A wall which is protected by an unconditioned, attached enclosure—like a garage or an enclosed porch.

Btu—Acronym for British thermal unit.

Ccf—One hundred cubic feet (usually natural gas).

CDD—Acronym for Cooling Degree Day.

Ccm—Cubic centimeter per minute. Refers to fluid flow.

Glossary

Cfm—Cubic feet per minute.

Character—A single digit, letter or symbol.

Code—Abbreviated names composed of a group of letters and/or numbers that identify a particular line of data on the MHEA data entry screens. MHEA uses the codes to identify lines of data and cross reference input screens.

Combustion tester—A device used to analyze the steady-state efficiency of combustion heating units.

Component—A segment of a building normally described by a single line within the MHEA home description data input, having sufficiently uniform construction and orientation to be considered as a single unit (for example, a portion of a home's exterior walls facing the same direction with similar construction and retrofit potential).

Conditioned—Intentionally heated or cooled areas of the home are conditioned.

Cooling degree day (CDD)—During a 24 hour period, each degree that the average daily temperature is above the base temperature (usually 78°F) constitutes one cooling degree day unit.

Cost-effective—Having an acceptable Savings-to-Investment Ratio to the person using the term. The standards for cost-effectiveness vary.

Cursor—A flashing line or rectangle on the computer screen that tells you where a letter, number or space will appear when you next strike a key.

Cumulative—Including all previously identified items or items higher on the list.

Default—A choice made by the computer representing a typical value of the number in question.

Dialog box—A box which pops up on the computer screen containing a sentence which provides instruction, asks a question, or gives a choice.

Directory—A named collection of files grouped together for convenience of the computer user in finding and accessing the files. A root directory is named by the drive (for example, c: or a:).

Discount rate—The percent by which a dollar today is worth more than a dollar one year from today. For example, when you put money into a 5 percent savings account, you are agreeing that today's dollar is worth a dollar and five cents of next year's currency.

Disk—The physical devices on which information (files) are stored on the computer. Two broad types exist: (1) Hard disks, integral parts of the computer itself; (2) Floppy disks (or diskettes), which are portable and may be transferred from one computer to another. Floppy disks are either 5 ¼ in. or 3 ½ in. in size.

Disk Operating System (DOS)—The Disk Operating System is the software that controls the operation of the computer, and is normally included with the computer purchase.

Draft diverter—A device located in exhaust pipes, used to prevent outside air from flowing into the pipe.

DOS—Acronym for Disk Operating System.

DOS prompt—A computer symbol containing the cursor, the name of the disk drive, and the directory currently accessed. For example, the DOS prompt C:\>SAM_ means that the computer is ready for your command, while accessing the directory named SAM on the C: drive.

EER—Acronym for Energy Efficiency Ratio.

Electric damper—See "vent damper."

Energy Consumption—Energy consumption is the energy used by the occupants of a manufactured home. This energy is either electricity supplied by a utility or fuel that is burned in the home (i.e., natural gas, wood, etc.). Occupants consume energy to heat and cool their homes, cook, heat water, power lights, and other uses.

Energy cost escalation rate—The energy cost escalation rate is the federal government's best guess of how much energy costs will increase above the rate of inflation from one year to another.

Energy efficiency ratio (EER)—A measurement of energy efficiency for room air conditioners. The EER is computed by dividing cooling capacity—measured in British Thermal Units per hour (Btu/hour)—by the watts of power used. This is a steady-state efficiency.

Envelope—The physical boundary of a building (i.e., wall, roof) which encloses the interior space.

Field—An entry blank on the screen used for data entry or comments.

File—A collection of information stored in the computer, referenced by a "file name" normally selected by the user. Examples of information stored in files include a letter, a report, data, or instructions for the computer to perform a specific function.

Floor joist—The wood or metal framing members which support the floor.

Floppy disk—See "disk."

Hard disk—See "disk."

Heat anticipator—A device located in a thermostat which can be adjusted to prevent overshooting the desired thermostatic set point.

Heating degree day (HDD)—During a 24 hour period, each degree that the average daily temperature is below the base temperature (usually 65°F) constitutes one heating degree day unit.

HDD—Acronym for Heating Degree Day.

Home description—Information used to describe a specific manufactured home to MHEA.

IID—Acronym for Intermittent Ignition Device.

Infiltration—Air leakage in or out of a building under natural conditions rather than under artificial pressurization by a blower door.

Input rating—The rate of the fuel's theoretically available energy the furnace, boiler, or space heater is capable of receiving (kBtu/hour; gal/hour; lb/hour; ccm).

Intermittent ignition device (IID)—A device that automatically ignites the gas burner on a gas heater only when the thermostat calls for heat, thus saving the energy that a continuous pilot light consumes.

Job identifier—An string of typed characters that uniquely identifies a particular home receiving a MHEA audit.

Joist—A horizontal, wooden framing member supporting a floor or ceiling.

Kilowatt-hour—A unit of energy (usually in reference to electricity).

Low-E window—A multi-pane window with a metalized coating on one of the interior surfaces. Low-E windows save energy during the winter by reflecting heat rays originating in the house back indoors. During the summer, low-E windows reflect solar heat outdoors. Low-E windows have a higher R-value than standard windows.

Manufactured home—A manufactured home is constructed in a factory and has a permanent chassis as part of the frame so that it can be easily moved. Manufactured homes are constructed either as one unit (usually less than 20 feet wide) or as two long units (each unit is usually less than 20 feet wide) that are attached at the center after the two parts have been moved separately to the site the home will occupy.

Mcf—Thousand cubic feet (usually natural gas).

Measures—Energy conservation projects under consideration for a house which are analyzed by MHEA.

Menu box—A box which pops up on the screen at the appropriate time and gives the user a selection of numbered or lettered choices.

MHEA—Acronym for the Manufactured Home Energy Audit, the name of the software tool designed to recommend weatherization retrofit measures for manufactured homes. MHEA evaluates energy use and analyzes the effect of installing weatherization retrofit measures in order to prioritize the most effective measures recommended for installation.

Output capacity—The rate of actual heat delivered by the heating device after flue losses and combustion inefficiencies are considered (in kBtu/hour).

Pascal—A unit of pressure (kilogram-per-square meter).

Random access memory (RAM)—This is memory that can be changed. It is the primary type of memory storage.

RAM—Acronym for Random Access Memory.

Re-boot—See "boot."

Real discount rate—See "discount rate."

Report—The product of the MHEA audit is a report that lists the measures with their costs, savings, and SIRs. The report also contains a materials list for the recommended measures.

Retrofit—The process of improving the efficiency of a system, such as adding insulation to the walls of a house.

Savings-to-investment ratio (SIR)—A ratio of the lifetime savings-to-initial investment. The SIR calculates the "present value" of dollars saved by an energy conservation measure, by adjusting the future savings to reflect energy cost escalation rates and discount rates. A SIR of one indicates that the investment will pay for itself over the lifetime of the measure. A SIR greater than one indicates an earlier recovery of initial investment.

Seasonal energy efficiency ratio—A measurement of energy efficiency for central air conditioners. The SEER is computed by dividing cooling capacity—measured in British thermal units per hour (Btu/hour)—by the watts of power used. This seasonal efficiency accounts for start-up, jacket, and flue losses.

SEER—Acronym for Seasonal Energy Efficiency Ratio.

Setup—'Setup' contains material cost data, fuel prices, key parameters, weather data, fuel escalation rates, and measures to be considered, all of which can be altered to meet the auditor's specifications and local conditions.

Screen—The contents of a single screen of the computer used to enter data into MHEA.

SIR—The acronym for Savings-to-Investment Ratio.

Space bar—The bar-shaped key at the bottom of the keyboard that inserts a space between letters or numbers when struck.

Steady-state efficiency—The efficiency of a combustion heater reflecting how much of the fuel's theoretically available heat exits the heat exchanger.

Stud—A vertical framing member that is the structure of the wall of a wood frame home.

Sub-directory—(See "directory.") Located one step down in the directory hierarchy. Sub-directories are used for the purpose of organizing directories just as a file cabinet organizes files.

Tabular screen—A screen describing a general component type (i.e., Windows or Doors), that has several lines of input available for specific components.

Therm—A unit of energy. One therm equals 29.3 kilowatt-hours.

Ventilated wall—A manufactured home wall which has space for air to flow between the exterior and interior wall materials. The insulation in a ventilated wall will often be excessively dirty.

Window frame—The sides, top, and sill of the window which forms a box around all the window components.

Wing—the part of a manufactured home belly outside the central supports.

Window sash—The part of the window that surrounds and supports the glass.