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Web-Based Weatherization Assistant Getting Started Guide

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March 2023

OAK RIDGE National Laboratory

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Buildings and Transportation Science Division

WEB-BASED WEATHERIZATION ASSISTANT GETTING STARTED GUIDE

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PURPOSE

This guide provides introductory information on how to get started in using the web-based Weatherization Assistant audit tool and running the National Energy Audit Tool, Manufactured Home Energy Audit, Multifamily Tool for Energy Audits, and Health and Safety Audit. For new users, this guideline also outlines how you can create a client and start an audit for that client.

The Weatherization Assistant is a family of advanced audit tools designed specifically to help states and local weatherization agencies implement the US Department of Energy (DOE) Weatherization Assistance Program. The Weatherization Assistant is developed and maintained by DOE's Oak Ridge National Laboratory (ORNL). It applies engineering and economic calculations to assist states and agencies in selecting energy-efficient retrofit measures that meet government criteria for cost effectiveness and that can be installed in homes of low-income families enrolled in the program. The Weatherization Assistant can be used to select and rank measures for individual houses, or to establish a priority list of weatherization measures for nearly identical housing types.

1. INTRODUCTION

The Weatherization Assistant is composed of the following four audit programs: NEAT (National Energy Audit Tool) for site-built, single-family homes, MHEA (Manufactured Home Energy Audit) for manufactured homes, MulTEA (Multifamily Tool for Energy Audits) for multifamily buildings, and the Health and Safety Audit. The three energy audit tools assist auditors in identifying cost-effective, energy-efficiency retrofit measures for a home or building after taking into account local weather conditions, retrofit measure costs, fuel costs, and specific construction details of the home or building. The Health and Safety Audit is designed to assist auditors in assessing and providing recommendations to address existing health and safety issues in a home, especially those that need to be addressed before weatherization work can be performed and prevent health and safety issues from occurring following weatherization. The four audit programs are described in more detail here.

- **NEAT** – NEAT is a DOE-approved energy audit tool designed to help auditors identify cost-effective energy-efficiency retrofit measures for site-built, single-family homes. NEAT is designed specifically to help states and local weatherization agencies implement the DOE Weatherization Assistance Program. NEAT can also be used with some limitations for small multifamily residences. NEAT was originally developed by ORNL as a DOS-based program, was converted to a Windows-based program under the Weatherization Assistant umbrella, and was later migrated to the web-based Weatherization Assistant.

  NEAT evaluates each home individually after taking into account local weather conditions, retrofit measure costs, fuel costs, and specific construction details of the home. After describing envelope components, systems, and base load equipment (e.g., refrigerators, water heaters, lighting), NEAT produces a prioritized list of cost-effective weatherization measures customized for the dwelling being evaluated. The output includes estimates of the energy savings, cost savings, installation cost, and savings-to-investment ratio (SIR) for each recommended measure. The output also provides a list of the quantities of the major materials necessary to perform the recommended weatherization retrofits and design heating and cooling loads needed to size any replacement equipment.

- **MHEA** – MHEA is a DOE-approved energy audit tool designed to help auditors identify cost-effective energy-efficiency retrofit measures for manufactured homes. MHEA is designed specifically to help states and local weatherization agencies implement the DOE Weatherization Assistance Program. MHEA was originally developed as a DOS-based program by the National Renewable Energy Laboratory. ORNL converted this original version of MHEA to a Windows-based program,

packaged it with NEAT under the Weatherization Assistant umbrella, added features, and migrated it to the web-based Weatherization Assistant. ORNL now maintains and supports the software.

MHEA evaluates homes in a similar way as NEAT and similarly produces a prioritized list of cost-effective weatherization measures customized for the dwelling being evaluated. The output includes the same estimates and list of quantities as NEAT.

- **MulTEA** – MulTEA is a DOE-approved energy audit tool designed to provide auditors with an improved energy simulation tool for multifamily buildings and an improved tool for identifying the cost-effective energy-efficiency retrofit measures for multifamily buildings. MulTEA is designed specifically to help states and local weatherization agencies implement the DOE Weatherization Assistance Program. MulTEA was developed jointly by ORNL and the Lawrence Berkeley National Laboratory.

  MulTEA evaluates buildings in the same way as NEAT and MHEA, and considers the operation details of the building. After describing envelope components, systems, and lighting and appliances, the energy consumption of the existing building can be estimated and calibrated to actual energy consumptions (i.e., utility bills). After an auditor defines and selects the retrofit measures to be analyzed, MulTEA produces a prioritized list of the weatherization measures for the building being evaluated. The output includes the same estimates as NEAT and MulTEA, as well as a package of recommended measures to be installed. It also provides a method for determining the amount of leveraged funds needed to make the DOE Weatherization Assistance Program investment cost effective for each selected measure.

- **Health and Safety Audit** – The Health and Safety Audit tool is a whole-house health and safety audit designed to be used on existing homes or dwelling units of a multifamily building, especially those undergoing weatherization. When combined with weatherization programs, the audit provides a comprehensive evaluation that ensures the health and safety of occupants and weatherization crews during and after weatherization and facilitates integrated interventions of energy efficiency with health and safety. The tool was developed by ORNL for the US Department of Housing and Urban Development Office of Healthy Homes and Lead Hazard Control and its Healthy Homes Program, as well as the DOE Weatherization Assistance Program.

  The tool uses comprehensive checklists along with measured diagnostic data to identify potential health and safety concerns in a home or dwelling unit and provide recommendations for the prevention and mitigation of identified problems. The tool assesses existing health and safety issues, the effects of existing conditions on weatherization work, and the effects of planned weatherization work on the health and safety of occupants and weatherization crews. The audit recommends actions to remediate existing health and safety problems, perform weatherization work in a healthy and safe manner, and prevent potential problems in the future.

  The design of the Health and Safety Audit tool is based on the US Environmental Protection Agency's Healthy Indoor Environment Protocols for Home Energy Upgrades (dated October 2011) and incorporates the guidance contained in DOE Weatherization Program Notice 17-7: Weatherization Health and Safety Guidance (dated August 9, 2017).

The remainder of this guide directs readers through the web-based Weatherization Assistant.

1.1 HARDWARE AND SOFTWARE REQUIREMENTS

The Weatherization Assistant needs web browser, as it is a web-based application. The currently supported browsers, listed in preferential order, are Firefox, Chrome, and Microsoft Edge. The latest

version of each browser is recommended. Current browser requirements are for Windows operating systems a Pentium 4 or higher CPU, 200 MB of free disk space, Windows 7 or higher/Mac OS X 10.5.6 or higher, and 512MB of RAM for 32-bit machines, or 2Gb of RAM for 64-bit machines.

The graphic card and monitor should be able to produce a full display with a minimum resolution of 1680 x 1050 to allow the Weatherization Assistant to be seen without scrolling. Smaller resolutions will work if the browser full screen mode is used, or if the display is scaled, but there are known issues with these approaches. Scaling or zooming in the browser, anything other than 100% either direction, will also present minor issues that will only affect the appearance, and not the functionality of the Weatherization Assistant.

Reports for the Weatherization Assistant are all generated as PDF documents.

1.2 LOGGING INTO THE WEB-BASED WEATHERIZATION ASSISTANT

Log into the web-based Weatherization Assistant (Figure 1.1) using a link and login information (username and password) provided by ORNL, your state, or the agency for which you work. The link will often be in the form of "https://wa-xx.ornl.gov," where the "xx" is the abbreviation for the state where you work. The left side of the login window provides updates made to the latest release of the software.

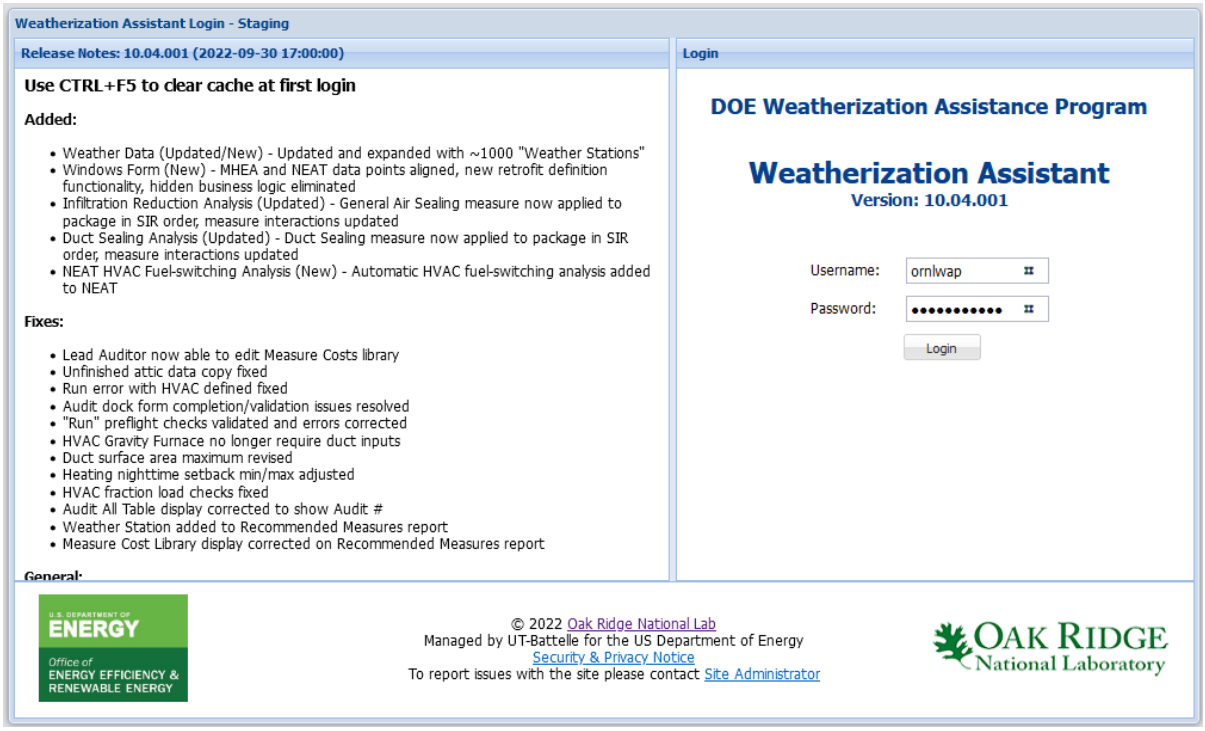


Figure 1.1. Web-based Weatherization Assistant login web page.

The Account form will open upon login, and the menu bar is located at the top of the user interface (Figure 1.2). The menu bar provides access to the administrative forms (agency, contacts, cost centers, account, and user), audits (NEAT, MHEA, MulTEA, and the Health and Safety Audit), work orders, and libraries needed to run NEAT, MHEA, and MulTEA (Economic Parameter Set, Fuel Cost, Measure Cost Set, Key Parameter Set, Supply, and Defined Measure Set). The menu bar also provides a link to obtain more information about the Weatherization Assistant, access release notes, and log out. In the future, it may also provide access to Options and Help menus.

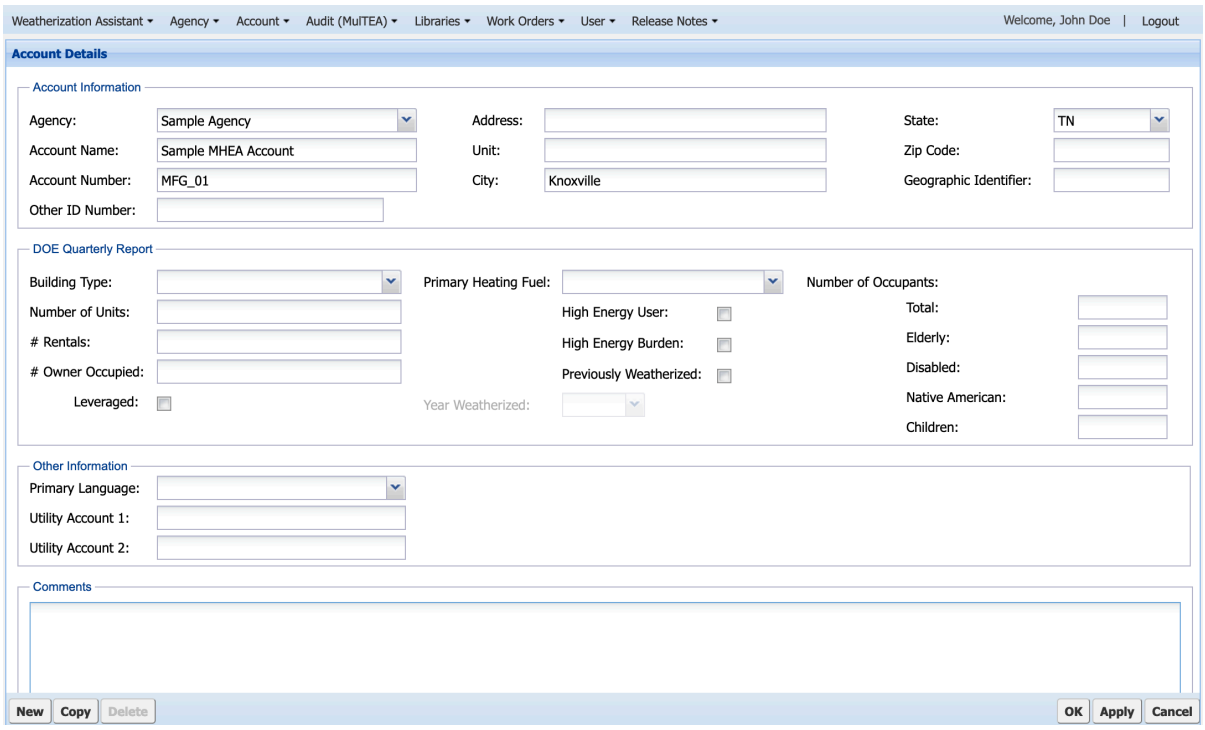


Figure 1.2. Account form with the menu bar at the top.

1.3 GENERAL LAYOUT AND NAVIGATION

A typical form has two sections: the main form at the top for data input and an All table at the bottom that lists the existing records that can be displayed on the main form (the Account form in Figure 1.2 provides an example).

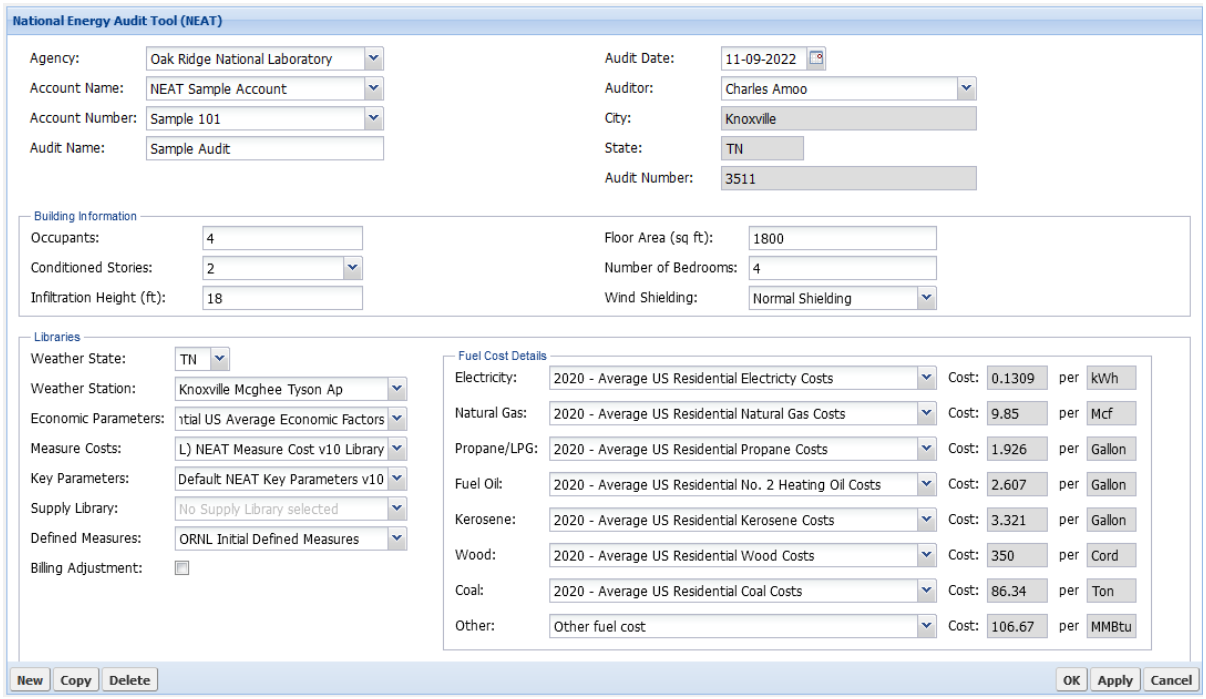


Figure 1.3. NEAT Audit form.

The main form has a title bar at the top, data input fields, and a task bar at the bottom. The title bar shows the name of the form. Data input fields are frequently grouped within a boundary that is called a *field set* (e.g., Building Information in Figure 1.3Figure 1.3). The task bar contains New, Copy, and Delete options to create or delete a record. Selecting OK saves the record and closes the form. Selecting Apply saves the record but leaves the form open. Selecting Cancel closes the form without saving the entries made.

Data input fields are typically ghosted (see Figure 1.4) if not relevant in certain contexts or grayed (Figure 1.5) if read-only. Some data input fields display a tooltip when you hover over the field, which describes the field, the acceptable format, and/or the acceptable range of the input. Data input in individual fields may be required or optional. The form cannot be saved if a required field is left blank or the input is out of range or in an incorrect format. If these issues occur, a red border will appear around the required field and a validation failure message will appear when OK or Apply are selected.

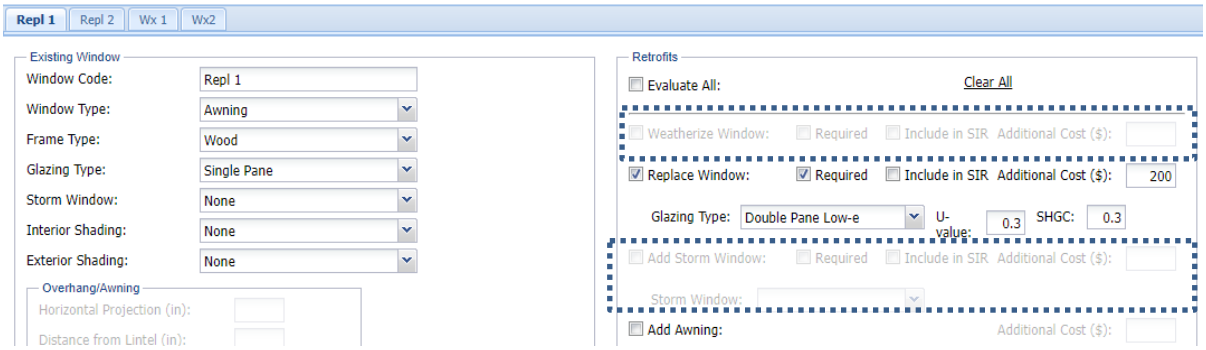


Figure 1.4. Sample form highlighting ghosted fields.

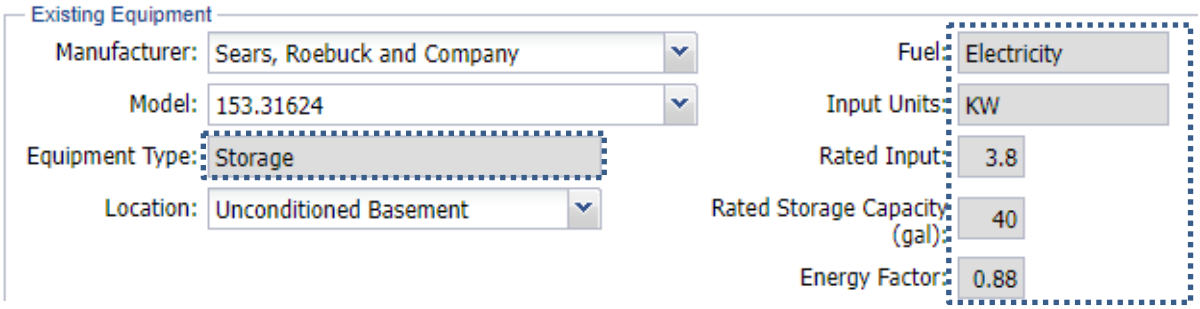


Figure 1.5. Sample form highlighting grayed read-only fields.

The All table at the bottom of the form (Figure 1.6) shows all the records that you can select to be shown on the main form. Select a record in the All table to display it in the main form. The All table has a title bar and header row. The column headers show key field names of the form, each with a mouse-over drop-down button on the right (Figure 1.7) (the button will appear when you hover over the header).

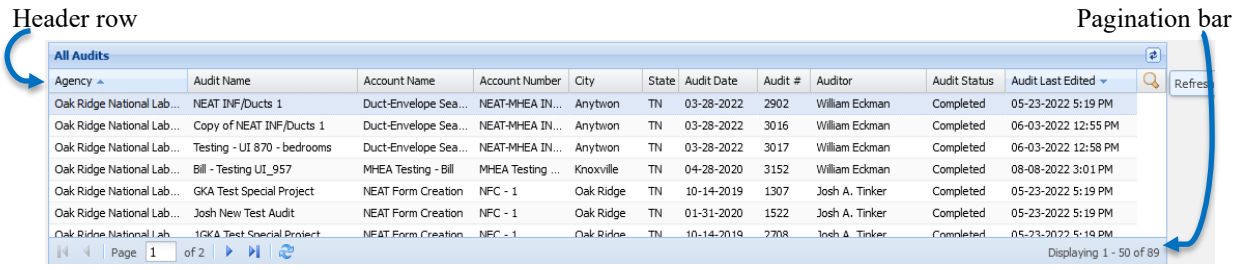


Figure 1.6. All Audits table showing records of NEAT audits.

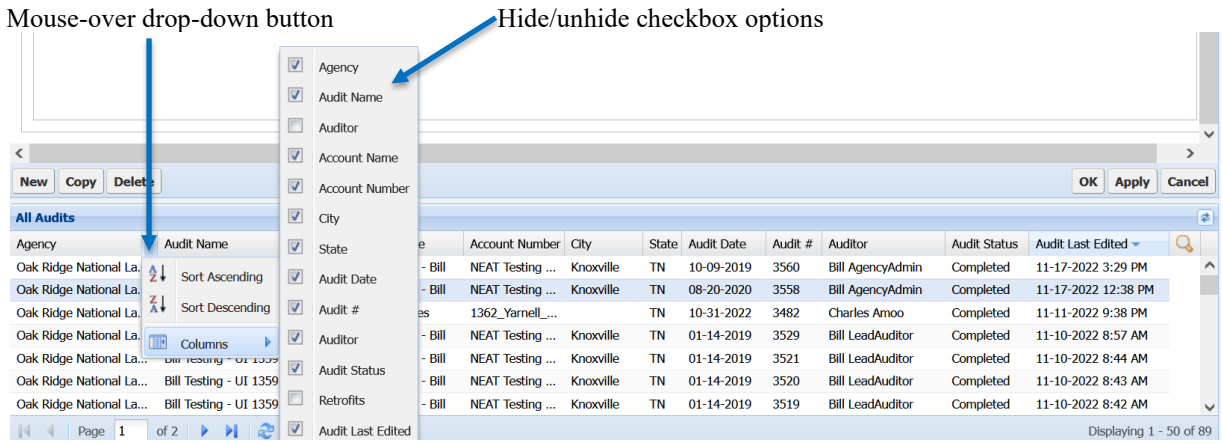


Figure 1.7. Mouse-over drop-down button displaying sorting and column hide/unhide checkbox options.

Selecting this button sorts the records in ascending or descending order. In addition, it provides a means to hide or unhide columns of the table. The All table can further be customized by changing the order and width of the columns. To change the width of a column, drag the boundary of the column heading left or right. To change the width of a column to fit the contents, double-click the boundary to the right of the column header. To change the order of the columns, drag the column heading to a new location. The magnifying glass on the right of the header row, which is available on some forms, is the filter toggle to show or hide a filter bar below the header row.

To filter the records, select the filter toggle and enter the filtering criteria for one or more columns (Figure 1.8). To clear all the filters, select the cross below the filter toggle. Select the options on the pagination bar at the bottom of the All table of the Audit form to navigate between pages. Fifty audits are displayed per page.

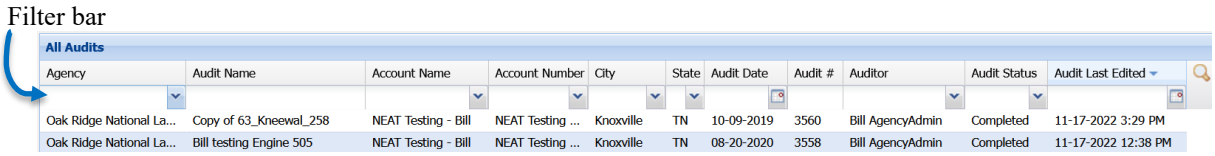


Figure 1.8. All Audits table showing filter bar after selecting the filter toggle (magnifying glass).

1.4 USER FORM

Figure 1.9 shows the option to select the User form (Figure 1.10) in the graphical user interface. Select User → View User to see the user records created by the entity that provided you with your login information (Guests cannot access the User form, as described later). The Privilege Level field lists the privilege level that was assigned to you. Your privilege level determines your access to different forms and records. You may have one of six privilege levels. These levels and their responsibilities and levels of access are summarized in Table 1.1.

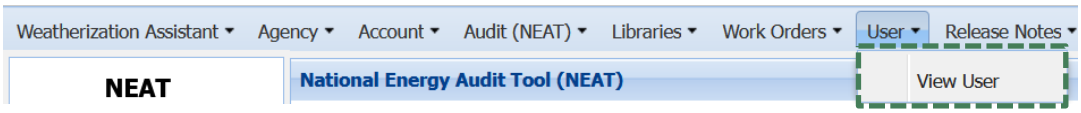


Figure 1.9 The option to select the User form in the graphical user interface.

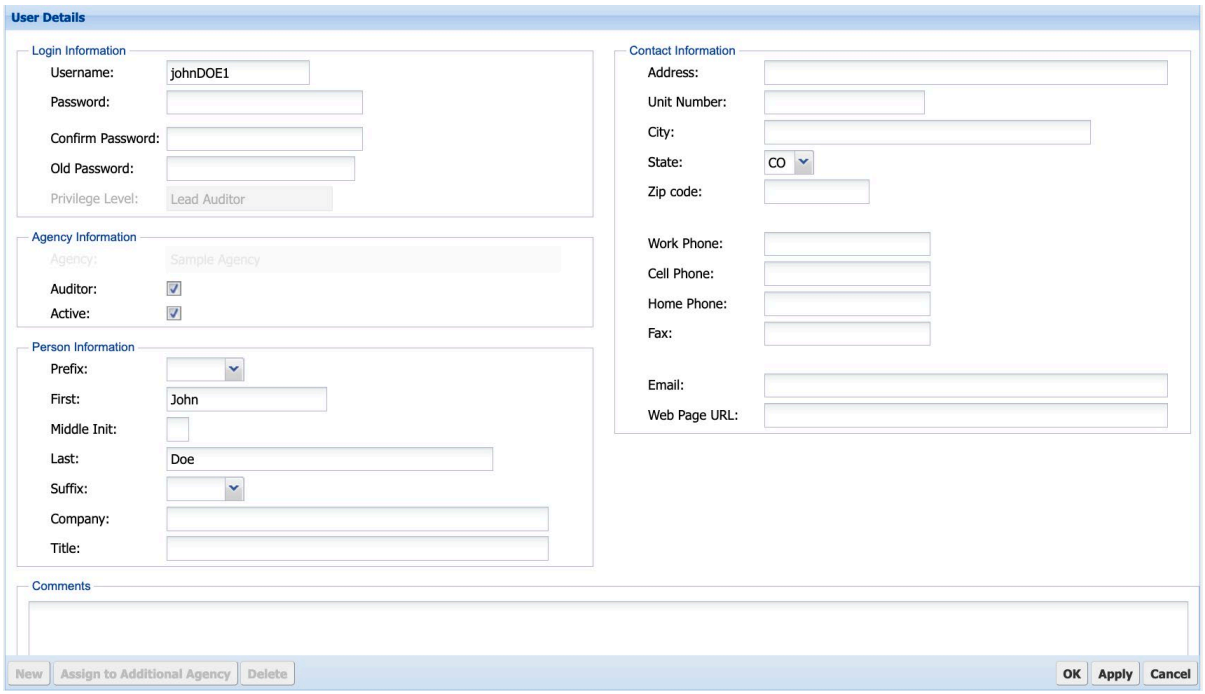


Figure 1.10. User form.

Table 1.1. User privilege

<table>
<tr><th rowspan="2">Entity</th><th rowspan="2">User privilege level</th><th rowspan="2">Scope of access</th><th colspan="6">Responsibilities (in bold) and level of access to records</th></tr>
<tr><th>User records</th><th>Agency records</th><th>Library records</th><th>Account records</th><th>Audit records</th><th>Work orders</th></tr>
<tr><td>ORNL/ developer</td><td>Site Administrator</td><td>All state-specific databases</td><td>- Must create at least one State Administrator per state
- Can edit own user record
- Can create or edit other user records</td><td colspan="5">- Have no restriction to create and edit records (for troubleshooting)</td></tr>
<tr><td>Grantee</td><td>State Administrator</td><td>State database</td><td>- Can edit own user record except privilege level
- Can create or edit other State Administrators
- Must create at least one Agency Administrator per agency
- Can view users for all agencies</td><td>Must create all agencies in the state</td><td colspan="3">Can view libraries, accounts, audits, and work orders</td></tr>
<tr><td rowspan="4">Agency personnel and associates</td><td>Agency Administrator</td><td rowspan="4">Agency records</td><td>- Can edit own user record except privilege level and agency information
- Must create all other users in their agency</td><td>Can edit their agency record</td><td colspan="3">Can create or edit all libraries, accounts, audits, and work orders</td></tr>
<tr><td>Lead Auditor</td><td rowspan="2">- Can edit own user record except privilege level and agency information
- Can view other user records in their agency</td><td rowspan="2">Can view their agency record</td><td>Can create and edit all libraries</td><td colspan="2" rowspan="2">Can create and edit all accounts, audits, and work orders</td></tr>
<tr><td>Auditor</td><td>Can view libraries</td></tr>
<tr><td>Guest</td><td colspan="3">No access</td><td>Can view all audits and work orders</td></tr>
</table>

You may also want to add, edit, or update the information presented in other fields on the User form as needed. The information that can be entered on the User form relates to login information, agency information, person information, and contact information. The only required fields on this form are Username, Password (conditionally hidden for other user accounts based on privilege level), Privilege Level, Agency, Last Name, and State. Make sure the Active checkbox is selected. Also make sure the

Auditor checkbox is selected if you might create an audit in the future. This will list your name on the Auditor drop-down field on the Audit form for NEAT, MHEA, MulTEA, and the Health and Safety Audit. If these checkboxes need to be updated and you are an Auditor or Lead Auditor, then your Agency Administrator may need to make the change.

1.5 AGENCY FORMS

The three agency forms (Figure 1.11) are Agency Details, Agency Contacts, and Agency Cost Center; they can be accessed by selecting Agency on the menu bar. Select Agency → Agency Details to see the agency record (Figure 1.12) to which you have been assigned (Guests are not allowed access to the Agency Details form). The agency may have been created by ORNL or your state. If you are an Agency Administrator, you may want to add, edit, or update the information as needed. The only required fields on this form are Agency Name, Agency Type, and State. Make sure the Active checkbox is selected to have the agency name listed on the Agency drop-down field on the Audit form for NEAT, MHEA, MulTEA, and the Health and Safety Audit.

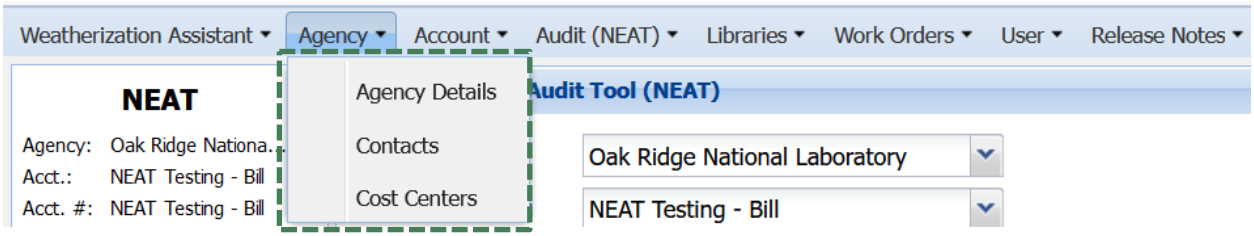


Figure 1.11. Option to select Agency forms in the graphical user interface.

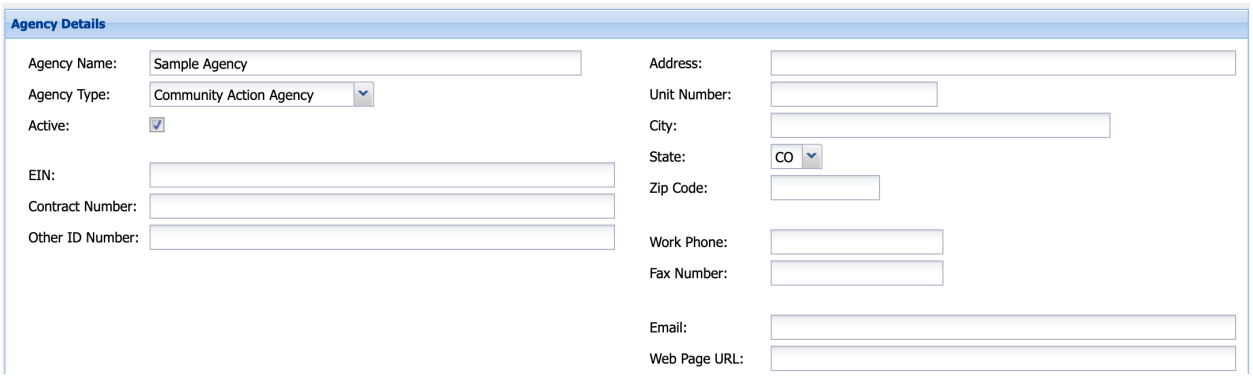


Figure 1.12. Agency Details form.

The Agency Contacts form (relevant to NEAT and MHEA only) is used to enter information on any person associated with the agency, including contractors, suppliers, and in-house crew members. This allows the recommended measures to be assigned to different contractors and suppliers added to supply libraries.

The Agency Cost Center form (relevant to NEAT and MHEA only) is used to set up cost centers or funding sources, to which the cost for individual recommended measures can be assigned.

1.6 LIBRARIES (RELEVANT TO NEAT, MHEA, AND MULTEA ONLY)

Six libraries can be accessed from the menu bar by selecting Libraries → [Library Name] (Guests are not allowed access to the library forms), as shown in Figure 1.13.

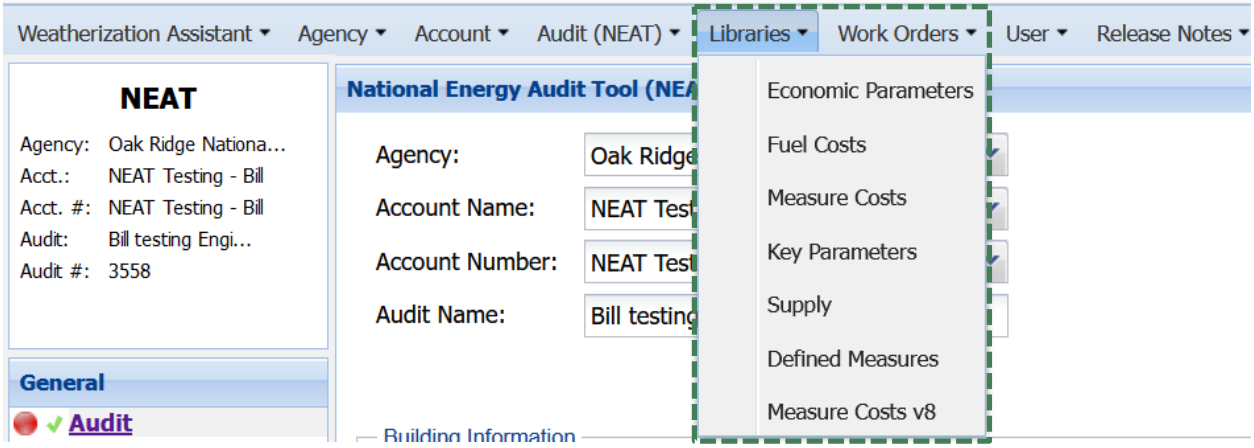


Figure 1.13. Option to select library forms in the graphical user interface.

- **Economic Parameter Set** – These libraries (Figure 1.14) provide the fuel price indices and modified uniform present value factors required to perform economic calculations in NEAT, MHEA, and MulTEA. These are provided for 8 fuels for 30 years: electricity, natural gas, propane, fuel oil, kerosene, wood, coal, and other.

- **Fuel Cost** – These libraries (Figure 1.15) provide the costs for eight fuels used in NEAT, MHEA, and MulTEA: electricity, natural gas, propane, fuel oil, kerosene, wood, coal, and other.

- **Measure Cost Set** – These libraries (Figure 1.16) collect overall measure cost information. They provide access to Retrofit Measure Cost Details forms (Figure 1.17), which collect material and installation cost details for individual retrofit measures programmed into NEAT, MHEA, and MulTEA for use in making economic calculations. These are provided separately for NEAT, MHEA, and MulTEA. For NEAT and MHEA measures that have site- or system-specific costs, including air sealing, duct sealing, and replacement of HVAC equipment, water heaters, refrigerators, and lighting, costs are directly entered on the audit forms and not in the Measure Cost Set Library. The NEAT Measure Cost Set Library also provides access to a form to enter NEAT insulation types.

- **Key Parameter Set (NEAT and MHEA only)** – These libraries (Figure 1.18) provide flexibility to modify some of NEAT's and MHEA's inputs and assumptions. You may replace the existing values on these forms with information for your agency. These forms are provided separately for NEAT and MHEA.

- **Supply (NEAT and MHEA only)** – These libraries (Figure 1.19) provide the ability to identify materials used within your program and their cost. Although primarily used in creating work orders, information entered for refrigerators, water heaters, and lighting can be accessed from within an audit. For each material, you can enter material properties, costs, and energy-related information.

- **Defined Measure Set (NEAT and MHEA only)** – These libraries (Figure 1.20) provide the ability to predefine weatherization activities, including 50 predefined health and safety measures, that are not addressed within the NEAT and MHEA library measures but are commonly encountered during an audit. Defining the measures on this form enables copying them to any audit as an itemized cost.

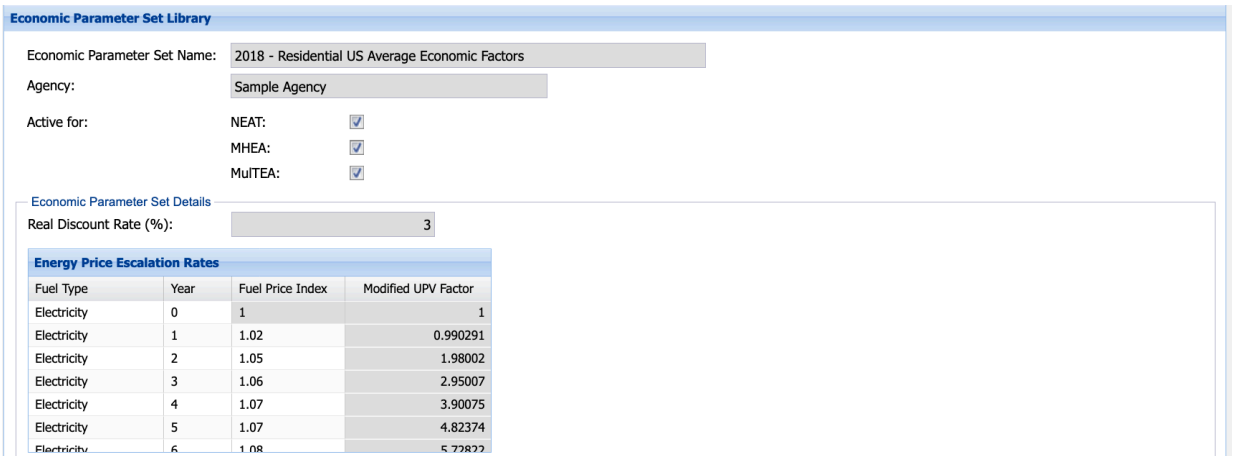


Figure 1.14. Economic Parameter Set Library form.

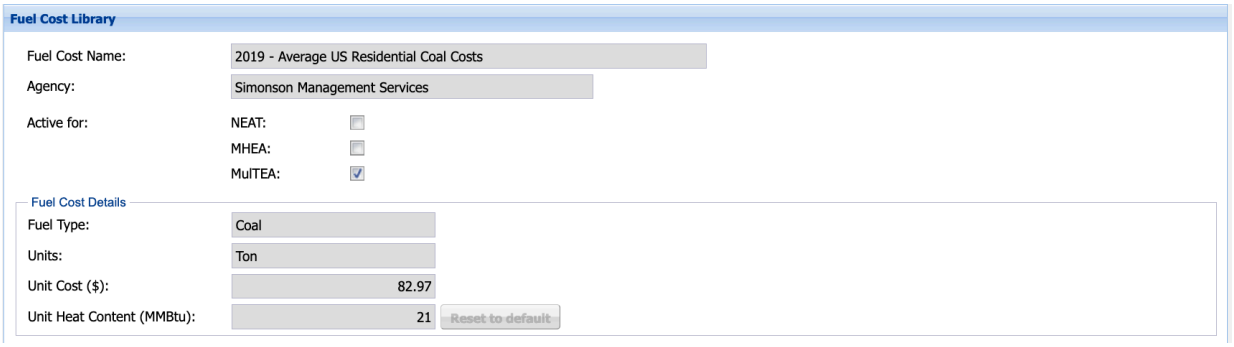


Figure 1.15. Fuel Cost Library form.

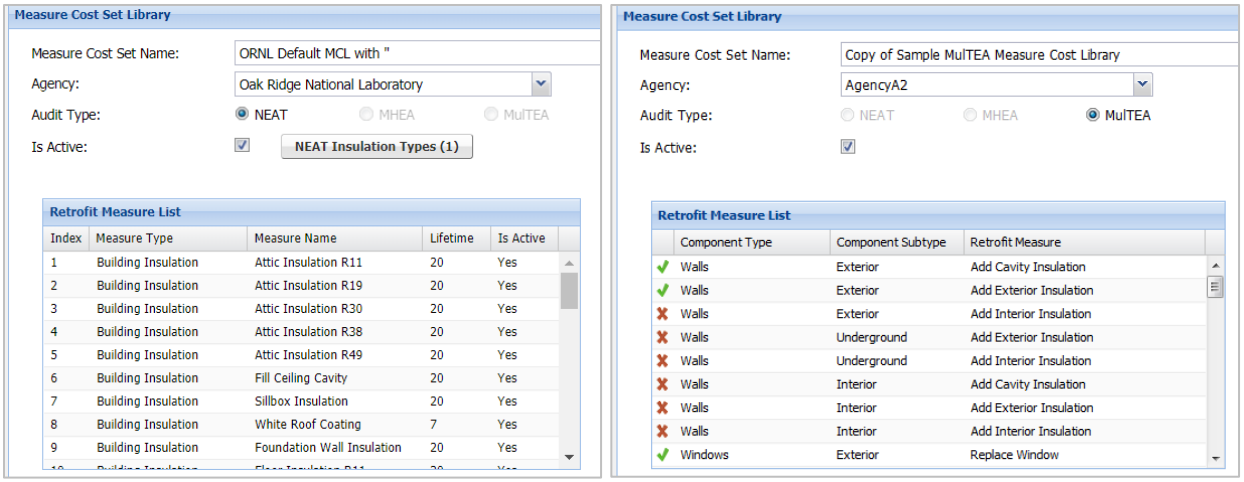


Figure 1.16. (left) NEAT and (right) MulTEA Measure Cost Set Library forms.

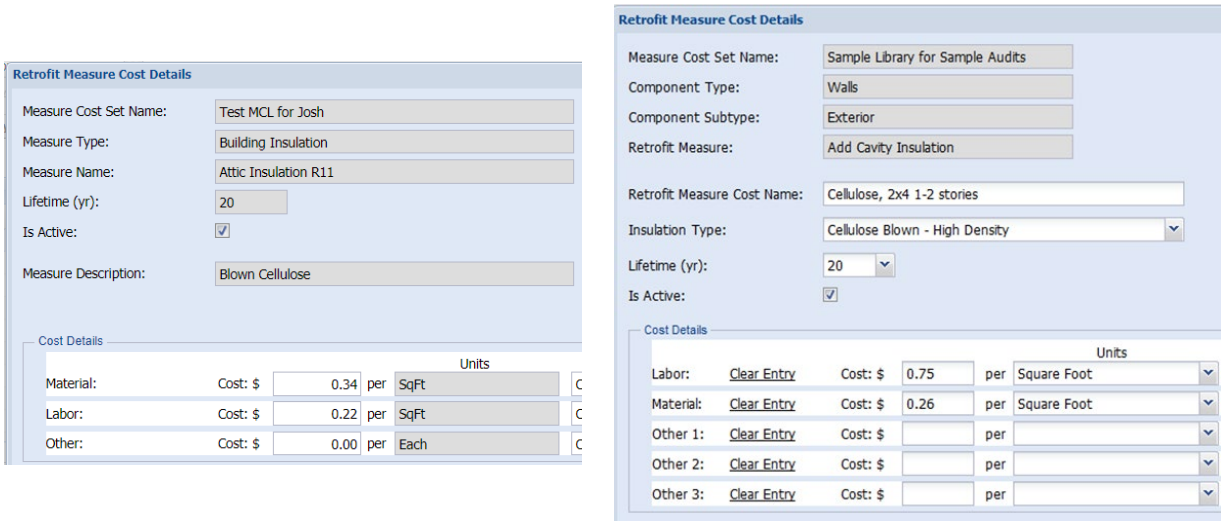


Figure 1.17. (left) NEAT and (right) MulTEA Retrofit Measure Cost Details forms.

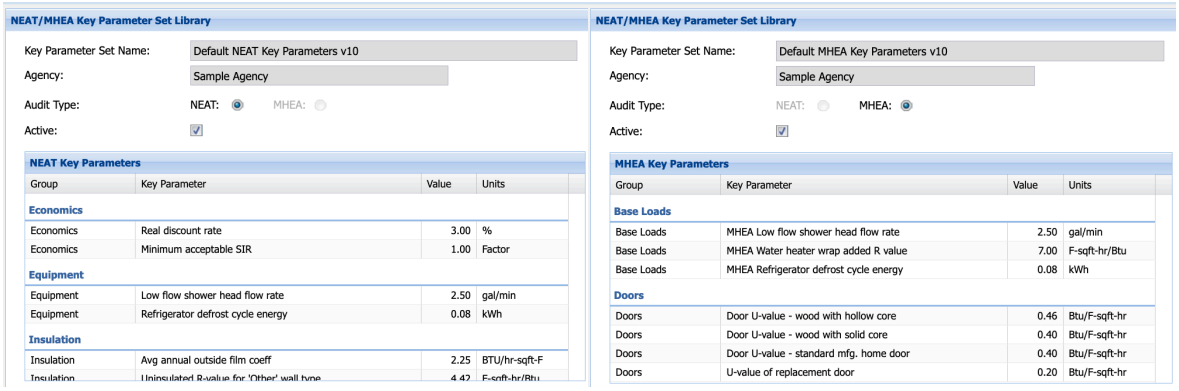


Figure 1.18. (left) NEAT and (right) MHEA Key Parameter Set Library forms.

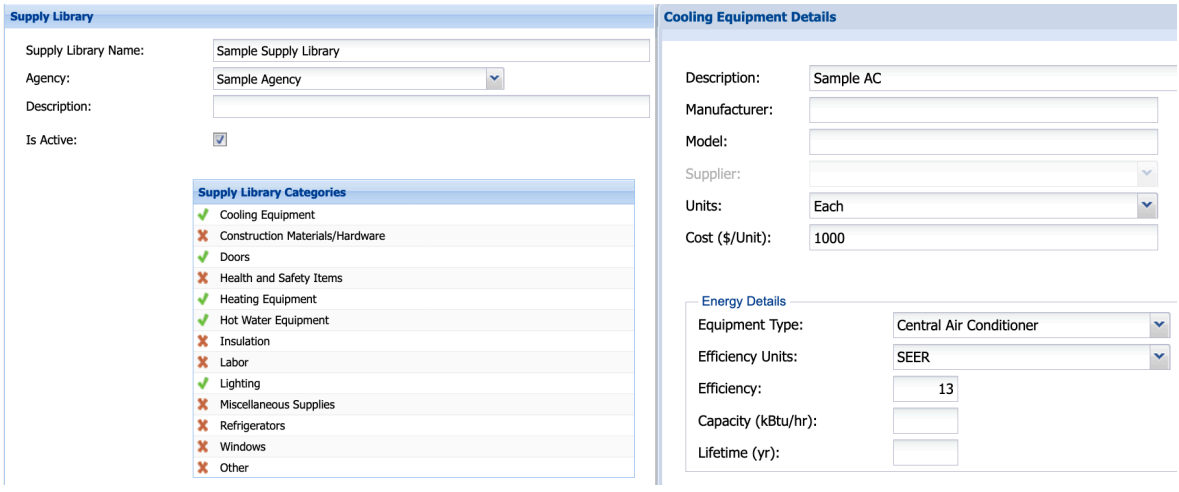


Figure 1.19. (left) Supply Library form and (right) Example Supply Library Category Details form.

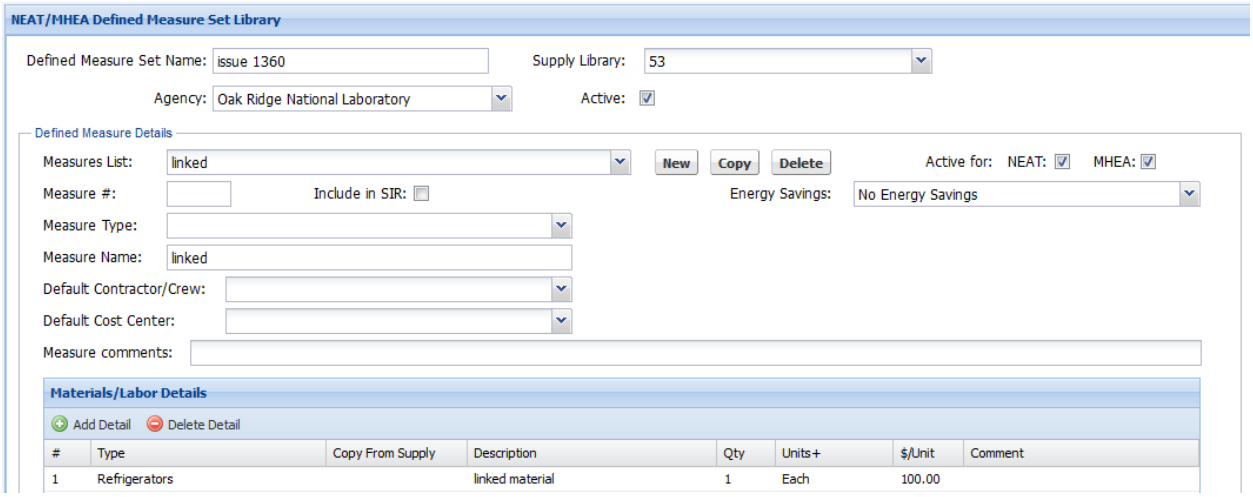


Figure 1.20. NEAT/MHEA Defined Measure Set Library form.

The described libraries are only used by NEAT, MHEA, and MulTEA; they are not used by the Health and Safety Audit. These libraries can only be created/edited by Site Administrators, Agency Administrators, and Lead Auditors.

During initial setup, ORNL creates a new, read-only economic parameter set applicable to the United States and four census regions (Northeast, Midwest, South, and West) each year when new parameters are issued by the National Institute of Standards and Technology, usually in May. Thus, the Economic Parameter Set Library does not need to be replaced or updated unless you want it to be unique to your state or agency.

For full compliance with Weatherization Assistance Program requirements, you will need to create a Fuel Cost Libraries to reflect actual costs for your location and agency. ORNL has created a set of read-only Fuel Cost Libraries that reflect average costs for the United States that you can use as you become familiar with NEAT, MHEA, and MulTEA. Users with library-editing privileges (Agency Administrator or Lead Auditor) must create location/agency specific Fuel Cost Libraries before they are ready to run an audit for an actual home or building you are auditing.

For full compliance with Weatherization Assistance Program requirements, you will need to create your own NEAT and MHEA Measure Cost Set Libraries to reflect actual costs for your location and agency. ORNL has created example read-only Measure Cost Set Libraries for NEAT, MHEA, and MulTEA that you can use as you become familiar with these audits. Measure costs can be entered into MulTEA manually for each building being audited, so initially, an accurate and agency-specific Measure Cost Set Library is not required to run MulTEA, especially as you learn and become familiar with the software. Eventually, however, you may want to develop an agency-specific Measure Cost Set Library for MulTEA to ensure accuracy and ease of use.

Agency Administrators and Lead Auditors: To create a new library, access the library form and either (a) select New on the task bar and complete the form or (b) select an existing library record from the All [library type] table, select Copy on the task bar, and edit the input information as needed. It is recommended that new Economic Parameter Set and Key Parameter Set Libraries be created using the latter approach. Be sure that the Active checkbox for NEAT, MHEA, or MulTEA is selected for new Economic Parameter Set and Fuel Cost Libraries that you create, and that the Active checkbox is selected for new Measure Cost Set, Key Parameter Set, Supply, and Defined Measure Set Libraries. You cannot modify or delete an existing library that is in use for an existing audit (# Audits > 0). You can only edit a

copy of an in-use library to use it for future audits. Where libraries are shared by different agencies, they cannot be modified or deleted. When new libraries are created, consider clearing the Active checkbox for any libraries that should be unavailable for future audits.

1.7 ACCOUNT FORM

Figure 1.21 shows the graphical user interface option to select account forms. Access and fill in a new Account form (Figure 1.22) before you run NEAT, MHEA, MulTEA, or the Health and Safety Audit (you must set up an account for a house, building, or project before you can run an audit). In the Account form, you can enter account information about the house, building, or project such as its name, number (e.g., job number), and address. The only required fields are Agency, Account Name, Account Number, and State. The information in the DOE Quarterly Report field set is data used by Weatherization Assistance Program Grantees in reporting results to DOE and is optional within Weatherization Assistant, as are the Primary Language and Utility Account fields.

To create a new account, select Account → View Account on the menu bar and then select New (State Administrators and Guests are not allowed to create an account). Select Copy to create a new account.

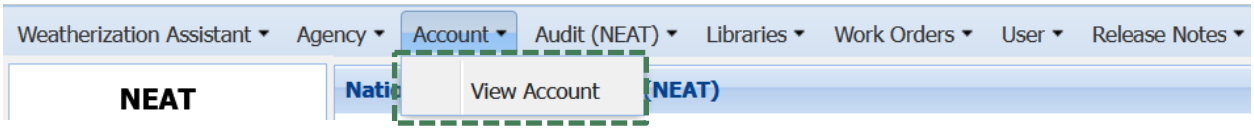


Figure 1.21. Option to select Account forms in the graphical user interface.

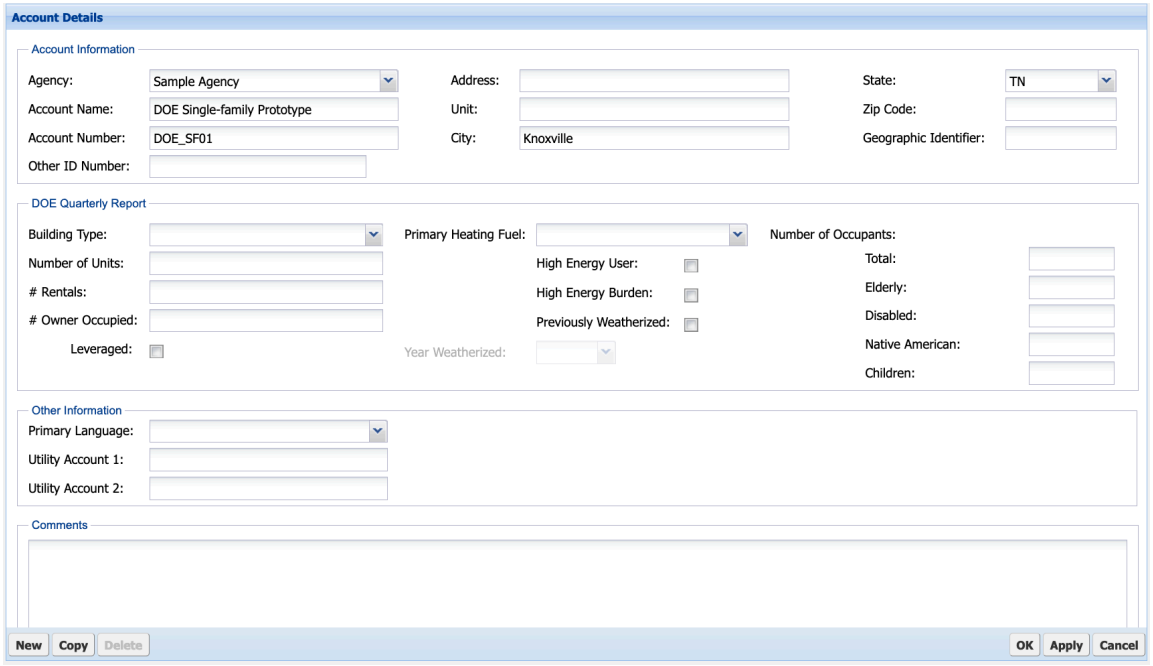


Figure 1.22. Account form.

2. NEAT

Once you have set up an account for a house, you can create and run NEAT on that house. NEAT has multiple forms used to describe a house; each has a main form for data input and possibly an All table for record navigation (Section 1.3). NEAT also has an Audit Dock that is a static feature anchored on the left of each NEAT input form (Figure 2.1) and provides the means of accessing NEAT's various forms and running the audit. The Audit Dock may not be displayed when creating a new audit until after the Audit form has been saved.

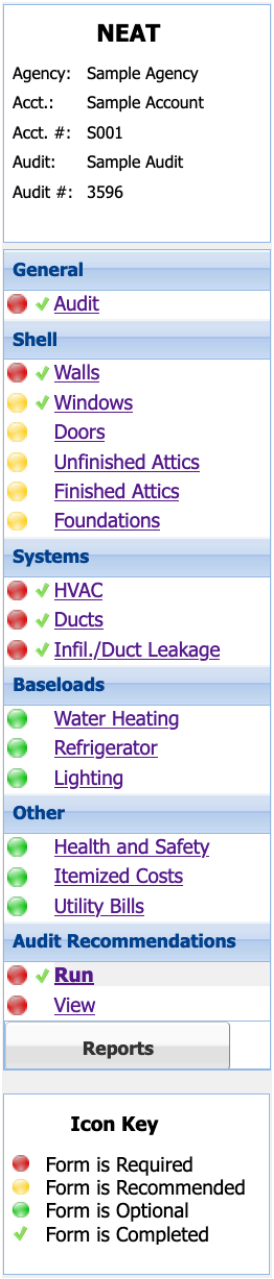


Figure 2.1. NEAT Audit Dock.

At the top of the Audit Dock is an information block that shows key audit information entered on the Audit form for the audit that is currently active (i.e., being viewed). Links to each of NEAT's 16 data input forms used to describe the house are provided below the information block. These links are organized into five groups: General, Shell, Systems, Baseloads, and Other. Colored icons are presented beside these links to indicate if the form is required, recommended, or optional, and if the form has been completed. A legend for the icons is shown in the Icon Key at the bottom of the Audit Dock. Links are provided in an Audit Recommendations group to run NEAT or view results of the last run for that audit. Finally, Reports can be selected to access various reports available within NEAT for the audit being viewed.

Many of the data input forms in NEAT allow multiple records to be described for a building component. For example, in Figure 2.2, multiple walls are entered on the Wall form. These forms have New and Copy options to create multiple records. For each record, a tab named by the user-entered code is created at the top of the form. The All table presented at the bottom of each of these forms lists these records (i.e., the tabs) (Figure 2.3).

To complete 1 of the 16 NEAT data input forms, select the form in the Audit Dock, input appropriate data in the main form, and select Apply to save the form or OK to save and exit the form. Select Cancel to exit the form without saving the entries that you just made. Select New or Copy (if applicable) to create additional records. The completed records will be listed in the All table. To view or edit an existing record, select the tab or the record in the All table.

On most of the Shell, Systems, and Baseloads forms, field sets on the left of the main form describe a selected component of the existing building. A field set on the right of the main form describes retrofit measure technical details for the component. For cases in which the cost of a measure is site- or system-specific (including air sealing, duct sealing, replacement of HVAC equipment, water heaters, refrigerators, and lighting), the retrofit measure field sets can be used to directly enter the total costs associated with the measure because they cannot be described in the Measure Cost Set Library. In other cases, such as on the Shell forms, the retrofit measure field sets can be used to enter an additional cost associated with installing the measure that will be added to the cost calculated from the Measure Cost Set Library.

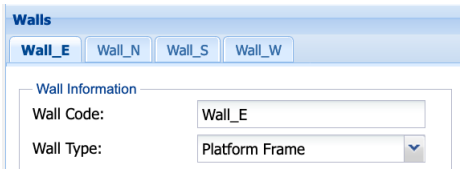
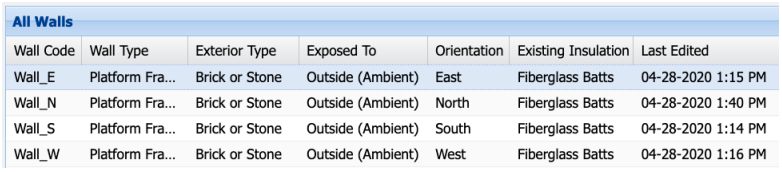


Figure 2.2. Tabs on NEAT's Walls form.



Wall Code	Wall Type	Exterior Type	Exposed To	Orientation	Existing Insulation	Last Edited
Wall_E	Platform Fra...	Brick or Stone	Outside (Ambient)	East	Fiberglass Batts	04-28-2020 1:15 PM
Wall_N	Platform Fra...	Brick or Stone	Outside (Ambient)	North	Fiberglass Batts	04-28-2020 1:40 PM
Wall_S	Platform Fra...	Brick or Stone	Outside (Ambient)	South	Fiberglass Batts	04-28-2020 1:14 PM
Wall_W	Platform Fra...	Brick or Stone	Outside (Ambient)	West	Fiberglass Batts	04-28-2020 1:16 PM

Figure 2.3. All Walls table on NEAT's Walls form.

NEAT evaluates all retrofit measures that are indicated as being active in the Measure Cost Set Library and applicable to the house. However, many of the data input forms in NEAT provide the option to evaluate only certain measures for a component, which will exclude evaluation of other active measures for that component. In that case, NEAT also provides an option to include the energy savings and cost of the measure in calculating the package SIR. Measures for which "Required" is selected but that are not included in the package SIR are normally related to health and safety or are measures funded by a source other than the Weatherization Assistance Program. Measures with both "Required" and "Include in SIR" selected will be included in the package SIR and will always be recommended regardless of their SIR (this option is generally used for incidental repair measures). Check the guidance for your program in deciding if and how these features can be used.

2.1 DESCRIBING A HOUSE IN NEAT

To create a new NEAT audit, select Audit → NEAT on the menu bar and then select New on the Audit form (State Administrators and Guests are not allowed to create an audit). Select Copy to create a new audit from an existing audit. You may want to create a new audit using Copy to make multiple audit runs for a house (e.g., to evaluate different retrofit options or replacement equipment for a given house) but still see the results of previous runs.

When creating a new audit using New, fill in the Audit form first before entering information on the other forms. Also, you will need to fill in the Wall form before completing the Window and Door forms. In general, completing forms in top to bottom order from the Audit Dock is the best practice for Audit input.

Each of NEAT's input forms are described briefly here. Section 2.2 describes how to run NEAT.

Audit form (required) – The Audit form is used to enter general audit information and select weather files and libraries needed to run the audit (Figure 2.4). All the fields on this form that are not disabled or read-only are required.

At the top of the form, select your Agency and then select the account using either the Account Name or Account Number field (the other data field will be autofilled using information from the Account form). Enter an Audit Name and the Audit Date, and then select the Auditor Name (auditor names provided in the drop-down list will include all users for the Agency that are marked as Active and Auditor on the User form). The City and State fields will be autofilled using information from the Account form. The Audit Number will be automatically assigned by NEAT.

Next, enter the building information: Occupants, Conditioned Stories, Infiltration Height, Floor Area, Number of Bedrooms, and Wind Shielding. Then, select the Weather State, Weather Station, and the following libraries: Economic Parameter Set, Measure Cost Set, Key Parameter Set, Supply (optional), Defined Measure Set, and Fuel Cost. NEAT has 1,000+ US weather stations that are filtered by weather state. You may also consider cities near you in states that border your own. The libraries listed in the drop-down lists are restricted to those that have been created in the respective libraries for this agency and marked Active for NEAT. For the Fuel Cost, you can select None for fuel types that will not be used in the audit except for electricity. The fuel costs associated with the selected Fuel Cost names will be

autofilled. Finally, for NEAT to adjust energy savings estimates and recommend measures based on the actual pre-weatherization energy consumption of the home, select the Billing Adjustment checkbox.

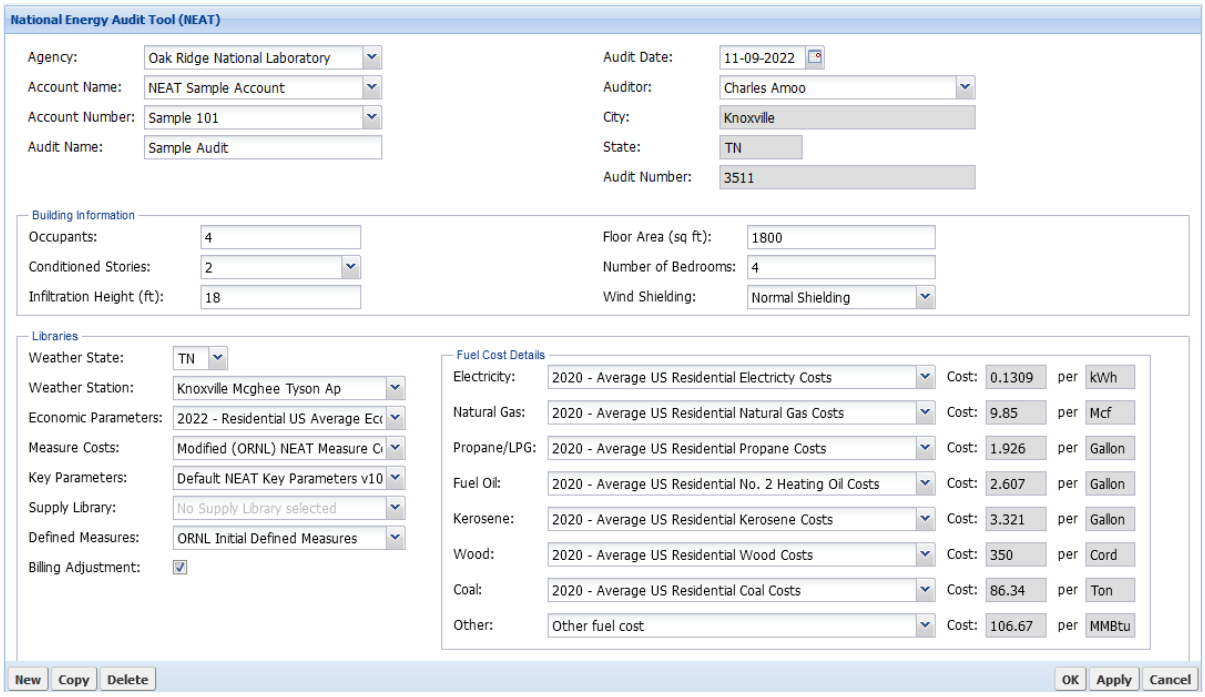


Figure 2.4. NEAT Audit form.

Shell forms – Shell forms are used to describe the walls, windows, doors, attics, and foundations of a house. The forms are used to describe all the shell components in the house that define the thermal boundary, select retrofit options, and describe any additional costs associated with the installation of the retrofit unique to the house being audited that are not described in the Measure Cost Set Library. You must enter one wall description on the Wall form to meet the minimum requirements of NEAT; the remaining shell forms are optional. These forms are used to describe a horizontally or vertically attached house, where no heat is lost to the outside through some of the envelope components. In most buildings, though, multiple wall descriptions will be entered on the Wall form and entries will be made on the Window, Door, Attics, and Foundation forms. On the Wall, Attics, and Foundation forms, a Measure # field is provided to specify if multiple segments of a shell component should be combined into groups when evaluating retrofit measures. Select different measure numbers for segments that you want to evaluate as separate measures.

The **Wall form** (required) is used to describe all the walls of the house that define the thermal boundary. Walls that differ by orientation, exposure (i.e., to the ambient conditions, buffered space such as a garage or attic), construction, or insulation level should be described separately because the cost of insulating the walls and the energy savings from insulating the walls will differ. To describe all the exterior walls of a house most efficiently, you may combine multistoried walls or separate wall segments that have the same orientation and construction.

The **Window and Door forms** (optional) are used to describe all the windows and doors on the walls that are exposed to the outside. The number of each type of window or door is entered by their parent wall, or attic assembly in the case of skylights. Notably, a skylight cannot be defined and saved until after the associated attic assembly has been defined on the appropriate attic form.

The **Unfinished and Finished Attic forms** (optional) are used to describe the attics in the house. The Unfinished Attic form is used to describe typical attic areas such as those built using ceiling joists and roof rafters or trusses and cathedral or flat ceilings. If an attic built from joists or trusses has flooring installed over the joists (e.g., plywood so that items may be stored in the attic), then it is Floored. Cathedral and flat ceilings are attic areas where the roof and interior ceiling are parallel. The Finished Attic form is used to describe attic areas that result when a portion of the attic is included in the conditioned space of the home: outer ceiling joist, collar beam, knee wall, and roof rafter (Figure 2.5). Attic areas should generally be entered separately.

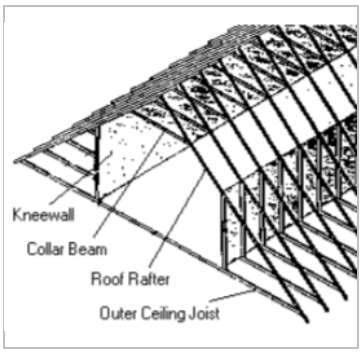


Figure 2.5. Components of a finished attic.

The **Foundation form** (optional) is used to describe the foundations of the house, including basements, crawlspaces, slab-on-grade floors, and floors exposed directly to the outside air. Foundations can be insulated by insulating the floor, sill box, and/or wall of the foundation depending on what type of foundation it is, the intended use of the foundation space, and what areas of the foundation are currently insulated. For basements and crawlspaces, NEAT will never recommend both floor insulation and sill and/or wall insulation for the same foundation. To describe a foundation, you must first select the Foundation Type from the following options: conditioned, non-conditioned, vented non-conditioned, unintentionally conditioned, uninsulated slab, insulated slab, and exposed floor. Crawlspaces are typically vented non-conditioned, and basements are conditioned, non-conditioned, or unintentionally conditioned.

Systems forms – Systems forms are used to describe the HVAC equipment, ducts, and infiltration and duct leakage associated with a house. You must enter one heating system and enter infiltration data on the Infiltration/Duct Leakage form to meet the minimum requirements of NEAT. The remaining forms are optional unless deemed required based on other inputs. For example, the Duct form may be required depending on HVAC entries. The selections made in the HVAC form, especially with regard to heating, will determine whether the Duct form remains optional or becomes required.

The **HVAC form** (required) is used to describe the heating and cooling equipment installed in the house and select retrofit options. In NEAT, you can describe as many equipment as are required to describe the heating and cooling sources in the house. At least one equipment that provides heating must be described in this form. The selected equipment may provide either heating or cooling or both. To describe an equipment, first enter the equipment type (and fuel if heating-only equipment) and then enter the data in the applicable fields, which vary depending on the selection for equipment type and fuel. Inputs related to equipment type and fuel will filter out other necessary inputs, as well as the retrofit options that will be available for evaluation. For example, choosing a central heat pump will disenable the retrofit option for installing a smart thermostat, and selecting a space heater will disenable tune up as a retrofit option. The Replace the Equipment retrofit option is always enabled for possible selection and is used to specify if the measure replaces one or more existing equipment described in other HVAC sub-forms. Selecting a measure as required will disable other measures that are mutually exclusive to the required measure. Unlike in Weatherization Assistant Version 8, heating/cooling equipment inputs are not limited to primary and secondary systems. Each type of existing heating and/or cooling equipment in the home may be entered as separate records. Weatherization Assistant Version 10 determines the primary system based on the Fraction of Load Served value that is either input or estimated by the software. Inputs made on any optional forms (e.g., other field measurements or health and safety observations) are informational only and are not used in running the audit analysis.

The **Duct form** (conditionally required) is used to describe the supply and return ducts for ducted HVAC equipment. A duct system with varying characteristics (e.g., location, insulation) must be described as multiple segments. All ducted HVAC equipment must be selected as served by at least one supply duct. To evaluate a duct insulation measure, you must enter the measured duct surface area and insulation R-value. If sufficient details relating to duct size and/or surface area and insulation R-value are unknown, then Weatherization Assistant Version 10 can estimate the values by selecting Use Defaults (Figure 2.6). To calculate these estimates and view the results, select the Use Defaults checkbox. To edit the values, clear the Use Defaults checkbox and input other values. Select Apply or OK to save the inputs.

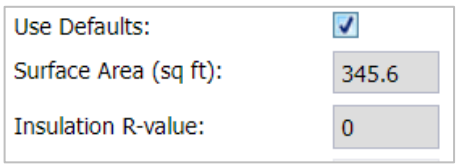


Figure 2.6. Use Defaults checkbox selected.

The **Ducts/Infiltration form** (required) is used to enter air and duct leakage data to evaluate the effectiveness of infiltration reduction work and duct sealing. The data input fields on the Ducts/Infiltration form change depending on whether duct sealing will be evaluated and, if so, which method—whole house blower door, blower door subtraction or duct blower measurements—will be used. To evaluate infiltration reduction as a retrofit measure, you must, at a minimum, enter the pre-weatherization whole-house air leakage rate (usually measured), an estimated or target rate after weatherization, house pressure differences for these rates, and the cost of the infiltration reduction work. A set of optional forms (Blower Doors, Zonal Pressures, Pressure Pans, and Room Pressure Balances) can be used to enter measurements made during the infiltration and duct leakage measurements or health and safety observations related to the HVAC systems. Information entered on these optional forms is not used in running an audit.

Baseloads forms (optional) – Baseloads forms are used to describe water heating retrofits, refrigerator replacement, and lighting retrofits. These forms are optional and are used to evaluate specific retrofit measures.

The **Water Heating form** (optional) is used to enter information necessary to evaluate four water heating retrofit measures: tank insulation, pipe insulation, low-flow showerheads, and water heater replacement. You may describe the existing water heater by selecting from the list of manufacturer and model number, which will autofill the energy use characteristics of the water heater, or by directly entering the data on the form. To evaluate a water heater replacement, you may either select a water heater you have already described in the Supply Library, which will autofill the data, or directly enter the data on the form.

The **Refrigerator form** (optional) is used to enter information necessary to evaluate a refrigerator replacement. Here, you may specify the energy use characteristics of the existing and replacement refrigerators. For the existing refrigerator, you may either select from the list of manufacturers and model numbers, which will autofill the energy use characteristics of the refrigerator, or directly enter the data on the form. For the replacement refrigerator, you may either select a refrigerator you have already described in the Supply Library, which will autofill the data, or directly enter the data on the form.

The **Lighting form** (optional) is used to describe lighting replacement retrofits. You may specify the quantity, usage, and energy use characteristics of the existing and replacement lighting and cost of the replacement lighting. For the existing and/or replacement lighting system, you may either select lighting you have already described in the Supply Library, which will autofill the energy and cost data, or directly enter the data on the form.

Other forms (optional) – Other forms can be used to describe health and safety observations in the house, repair or health and safety measures or your own energy measure, and utility bills.

The **Health and Safety form** (optional) can be used to enter health and safety measurements and observations that you have made of the house. Items on this form help identify potential health and safety hazards related to the whole house, equipment, and shell; record worst-case draft measurements for space heating equipment and the water heater; and determine ventilation requirements to comply with ASHRAE Standard 62.2.

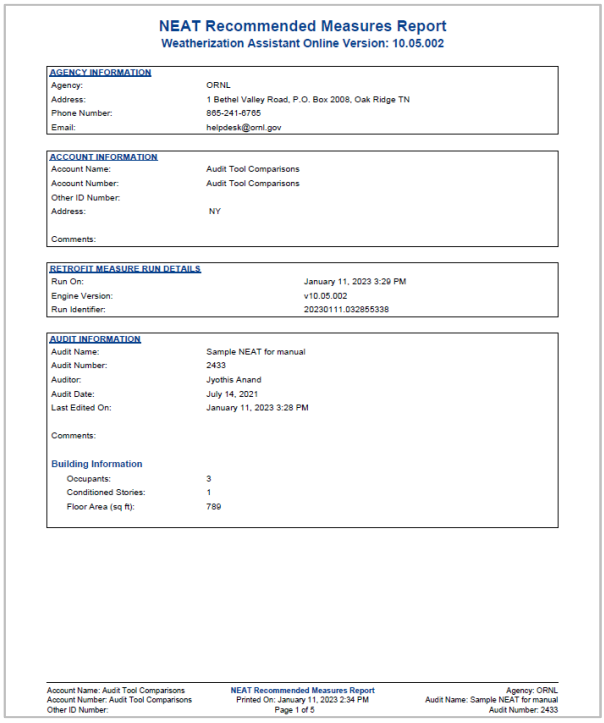
The **Itemized Costs form** (optional) can be used to enter necessary repair and health and safety measures associated with recommended energy measures and their costs. You can also use this form to enter your own energy saving measures (that you define) not addressed under the Measure Cost Set Library. For an energy saving measure, you must determine and enter the associated annual energy savings. Once fully defined on the Itemized Costs form, a user-entered energy measure is treated by NEAT the same as the library measures.

The **Utility Bills form** (optional) can be used to enter pre-retrofit utility bills associated with heating and cooling if you want NEAT to compare them with NEAT's heating and cooling energy consumption estimates as part of an audit calibration process and adjust energy savings estimates for the recommended measures. For NEAT to adjust its energy savings estimates and develop a second set of recommended weatherization measures based on the actual pre-weatherization energy consumption of the house, select the Billing Adjustment checkbox. Comparison of the predicted base case energy use against utility bills is more appropriate for metered fuels, such as natural gas and electricity. Bulk fuels such as propane, fuel oil, and kerosene, 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.

2.2 RUNNING NEAT AND VIEWING RESULTS

Audit recommendations – You can run NEAT after you have entered all the information for the house on the data input forms. The Run on the Audit Dock link will be activated as soon as all the required data input forms have been completed. When you select Run, the status of the run will be displayed, and the Recommended Measures Report will be opened in a separate window. Once an audit has been run, the link to View will be activated. You can select View to see a NEAT Recommended Measures Report that has already been created and saved from a previous run.

Figure 2.7 shows the title page of the NEAT Recommended Measures Report. The title page identifies your Agency, Account, Audit, and Audit Run; provides key information you have entered on the Agency, Account, and Audit forms; and provides additional information about the audit run to track the audit results. After the title page, the report lists all the recommended measures along with their estimated energy and cost savings, measure costs and SIRs, and primary material quantities needed to perform them (Figure 2.8).



NEAT Recommended Measures Report
Weatherization Assistant Online Version: 10.05.002

AGENCY INFORMATION
Agency: ORNL
Address: 1 Bethel Valley Road, P.O. Box 2008, Oak Ridge TN
Phone Number: 865-241-6765
Email: helpdesk@ornl.gov

ACCOUNT INFORMATION
Account Name: Audit Tool Comparisons
Account Number: Audit Tool Comparisons
Other ID Number:
Address: NY
Comments:

RETROFIT MEASURE RUN DETAILS
Run On: January 11, 2023 3:29 PM
Engine Version: v10.05.002
Run Identifier: 20230111.032855338

AUDIT INFORMATION
Audit Name: Sample NEAT for manual
Audit Number: 2433
Auditor: Jyothis Anand
Audit Date: July 14, 2021
Last Edited On: January 11, 2023 3:28 PM
Comments:

Building Information
Occupants: 3
Conditioned Stories: 1
Floor Area (sq ft): 789

Account Name: Audit Tool Comparisons
Account Number: Audit Tool Comparisons
Other ID Number:
NEAT Recommended Measures Report
Printed On: January 11, 2023 2:34 PM
Page 1 of 5
Agency: ORNL
Audit Name: Sample NEAT for manual
Audit Number: 2433

Figure 2.7. NEAT Recommended Measures Report: title page.

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating		Cooling		BaseLoad		Total	
			(MMBtu)	($)	(kWh)	($)	(kWh)	($)	(MMBtu)	($)
1	General Air Sealing	50	1.8	$69	112	$15	0	$0	2.2	$83
2	Attic Insulation R30	A1	13.5	$518	1,141	$149	0	$0	17.4	$667
3	Floor Insulation R19	Fl1	15.9	$611	-336	-$44	0	$0	14.8	$567
4	Refrigerator Replacement	Refrigerator	0.0	$0	0	$0	2,211	$289	7.5	$289
5	Wall Insulation	W1,W2,W3,W4,W5,W6	4.1	$157	780	$102	0	$0	6.8	$259
6	Water Heater Pipe Insulation	Water Heating	0.0	$0	0	$0	238	$8	0.8	$8
7	Add Storm Window	Wn4,Wn1,Wn3,Wn2	2.2	$85	278	$36	0	$0	3.2	$121
8	Water Heater Tank Insulation	Water Heating	0.0	$0	0	$0	273	$9	0.9	$9

Economics

Index	Recommended Measure	Components	Measure Savings ($/yr)	Measure Cost ($)	Measure SIR
Weatherization Measures					
1	General Air Sealing	Ducts/Infiltration	$83	$50	14.62
2	Attic Insulation R30	A1	$667	$710	14.47
3	Floor Insulation R19	Fl1	$567	$845	10.34
4	Refrigerator Replacement	Refrigerator	$289	$800	4.47
5	Wall Insulation	W1,W2,W3,W4,W5,W6	$259	$998	4.00
6	Water Heater Pipe Insulation	Water Heating	$8	$30	2.86
7	Add Storm Window	Wn4,Wn1,Wn3,Wn2	$121	$661	2.26
8	Water Heater Tank Insulation	Water Heating	$9	$45	2.19
Health and Safety Measures or Other Funding Sources					
9	CO Monitor is Needed	Itemized Cost	$0	$60	0.00
10	Fix Ventilation Inadequate (Attic)	Itemized Cost	$0	$90	0.00
11	Practice Lead Safe Weatherization (Walls)	Itemized Cost	$0	$324	0.00
12	Replace Heating System	Itemized Cost	$0	$3,500	0.00
13	Smoke Detector is Needed	Itemized Cost	$0	$50	0.00
Total			$2,004	$8,163	7.00

Materials

Index	Material	Type	Quantity	Units
1	Wall Insulation	Blown Cellulose - 2x4 Filled	988	SqFt
2	Attic Insulation R30	Blown Cellulose	789	SqFt
3	General Air Sealing	General Air Sealing	1	Each Measure
4	New Refrigerator	WRT314TDFW00	1	Each

Figure 2.8. NEAT Recommended Measures Report: recommended measures.

If you entered utility bills on the Utility Bills form, the report will also provide a revised set of tables for the recommended measures based on adjusted estimates of energy and cost savings and SIRs, and a comparison of NEAT's estimates of the house's heating and/or cooling energy consumptions with the utility bills. Notably, NEAT's estimates are based on Typical Meteorological Year (TMY3) weather data, whereas the utility bills reflect energy consumption for the actual weather that occurred during the billing period. If you also entered degree days associated with the utility bills, they will be compared with the TMY3 weather data used to make the home's energy estimates so that you can determine the degree to which differences between predicted energy consumptions and utility bills might be due to weather differences.

The report also provides other information such as the annual heating and cooling loads (MMBtu/year), energy consumptions (MMBtu/year), and peak (i.e., design) heating and cooling loads (heating: kBtu/h; cooling: t) for the house before and after weatherization (Figure 2.9).

House Loads and Energy Consumptions				
	Before Weatherization		After Weatherization	
	Heating	Cooling	Heating	Cooling
Annual Load (MMBtu/yr)	35.6	55.4	3.1	34.3
Annual Energy (MMBtu/yr)	35.6	30.0	3.3	9.5
Design Day Heat Loss/Gain (kBtu/hr)	50.5	27.4	12.5	10.4
Design Day Output Required (kBtu/hr)(ton)	60.7	3.0	14.4	1.2

Peak Heating Load				
Component Type	Component Name	Area or Volume (Infiltration)	Before Weatherization Load (Btu/h)	After Weatherization Load (Btu/h)
Wall (Btu/h)	W1	178	2,158.2	664.9
Wall (Btu/h)	W2	160	1,945.4	599.4
Wall (Btu/h)	W3	367	4,456.2	1,372.9
Wall (Btu/h)	W4	80	972.7	299.7
Wall (Btu/h)	W5	126	1,532.0	472.0
Wall (Btu/h)	W6	78	948.4	292.2
Window (Btu/h)	Wn1	12	479.7	479.7
Window (Btu/h)	Wn2	23	959.3	959.3
Window (Btu/h)	Wn3	12	479.7	479.7
Window (Btu/h)	Wn4	6	250.3	99.7
Door (Btu/h)	D1	21	498.6	498.6
Door (Btu/h)	D2	21	498.6	498.6
Attic (Btu/h)	A1	789	21,173.0	1,161.4
Foundation (Btu/h)	Fl1	960	10,538.6	2,228.4
Infiltration (Btu/h)	Inf	6,312	3,654.8	2,436.5
Total heat loss (Btu/h)	Tot	0	50,545.3	12,542.9
Duct loss (Btu/h)	Duct	213	10,109.1	1,881.4
Output required (Btu/h)	Output	0	60,654.3	14,424.4

Peak Cooling Load				
Component Type	Component Name	Area or Volume (Infiltration)	Before Weatherization Load (Btu/h)	After Weatherization Load (Btu/h)
Wall (Btu/h)	W1	178	799.7	246.4
Wall (Btu/h)	W2	160	720.8	222.1
Wall (Btu/h)	W3	367	1,651.2	508.7
Wall (Btu/h)	W4	80	360.4	111.0
Wall (Btu/h)	W5	126	273.6	84.3
Wall (Btu/h)	W6	78	169.4	52.2
Window (Btu/h)	Wn1	12	978.7	978.7
Window (Btu/h)	Wn2	23	1,957.4	1,957.4
Window (Btu/h)	Wn3	12	978.7	978.7
Window (Btu/h)	Wn4	6	510.6	466.9
Door (Btu/h)	D1	21	184.8	184.8
Door (Btu/h)	D2	21	184.8	184.8
Attic (Btu/h)	A1	789	12,757.3	965.1
Foundation (Btu/h)	Fl1	960	2,320.8	405.5
Infiltration (Btu/h)	Inf	6,312	1,567.2	1,094.9
People (Btu/h)	People	3	776.0	776.0
Appliances (Btu/h)	Appl	1	1,200.0	1,200.0
Total Sensible (Btu/h)	TotS	0	27,391.2	10,417.4
Ducts (Btu/h)	Ducts	0	4,108.7	1,562.6
Total (with ducts) (Btu/h)	TotW	0	31,499.9	11,980.0
Size (tons)	Size	0	2.6	1.0
Latent Load (inf) (Btu/h)	LatentI	0	3,206.0	2,239.9
Latent Load (occ) (Btu/h)	LatentO	0	690.0	690.0
Latent Load (tot) (Btu/h)	LatentT	0	3,896.0	2,929.9
Total Load (Btu/h)	Total	0	35,395.9	14,909.9
Size (tons)	Size	0	2.9	1.2

Figure 2.9. NEAT Recommended Measures Report: house loads, energy consumptions, and peak loads before and after weatherization.

Reports – The Reports drop-down field on the Audit Dock is used to select two reports associated with NEAT and the audit. The Audit Input report provides a printout of all the input made in NEAT. The Audit Recommendations report provides the NEAT Recommended Measures Report for the most recent run of the audit (equivalent to the View link).

2.3 CREATING A NEAT WORK ORDER

Create a work order to prepare a detailed list of tasks to be performed as part of implementing the recommended measures generated from an energy audit. The work order includes materials and labor, as well as their quantities and costing details. Work orders may be created for NEAT from a successfully completed and run audit or by selecting Work Orders on the menu bar.

2.3.1 Creating a Work Order Automatically

A work order is typically created from the Audit form when it has been completed and run. On the Audit Dock anchored to the left of an audit, select View under the Audit block Audit Recommendations to display a NEAT Audit Recommendations page, which includes a View Measures button at the bottom (Figure 2.10. NEAT audit showing View and View Measures.).

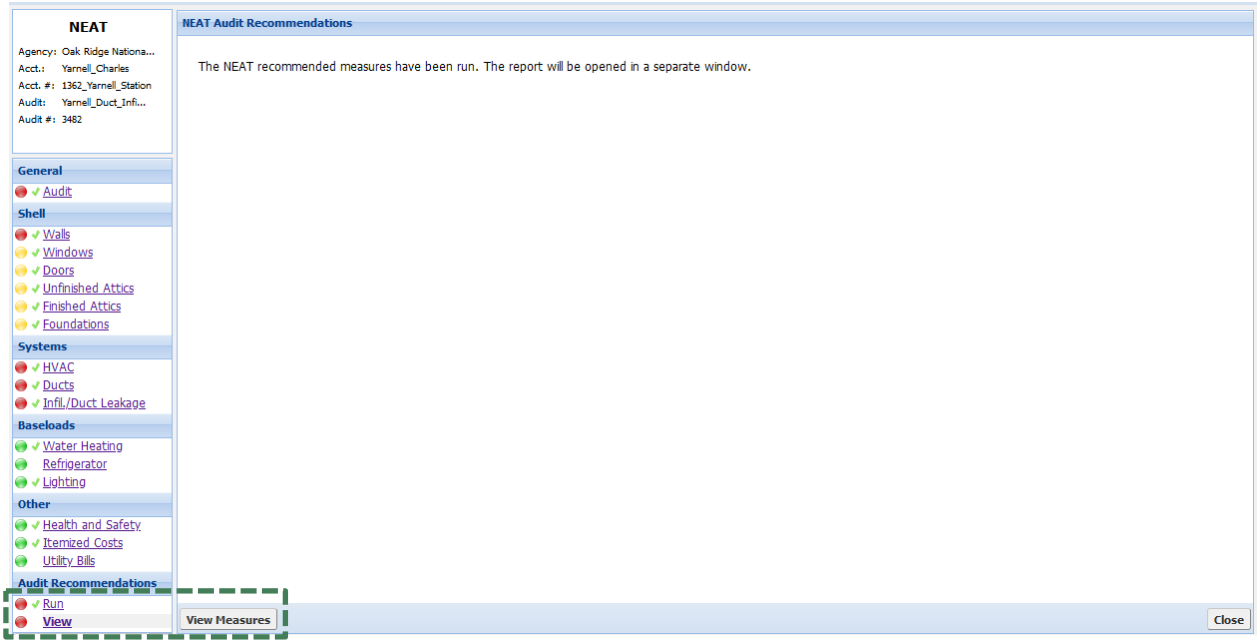


Figure 2.10. NEAT audit showing View and View Measures.

Select View Measures to open the Audit Run Measures form (Figure 2.11), which displays a table of run measures for which work orders could be created, and a navigation bar at the bottom, which lists the itemized costs for the selected measure.

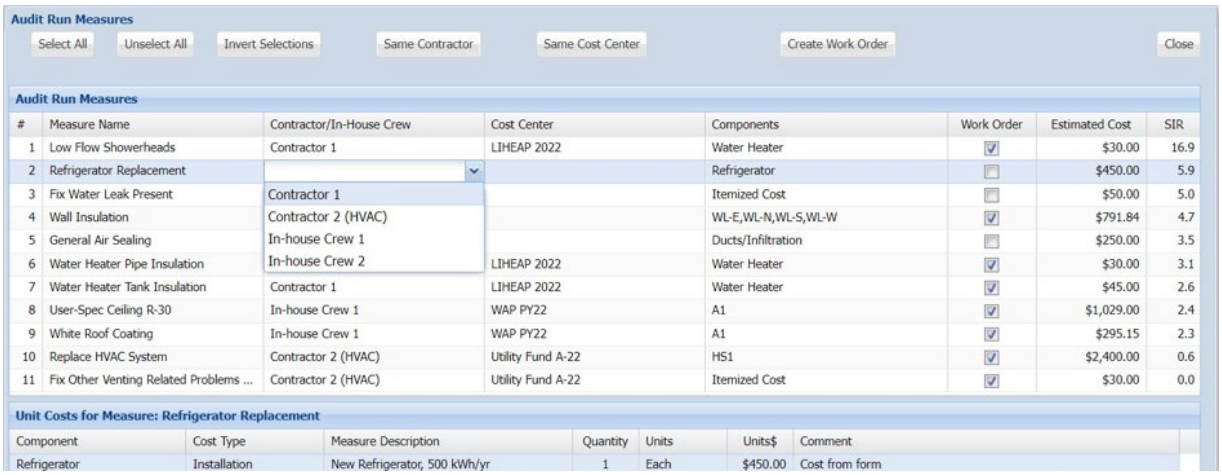


Figure 2.11. Audit Run Measures form.

Use the checkboxes under the Work Order column to select the audit measures for which you want to create work orders. Select the contractor/in-house crew or cost center from the drop-down list that is displayed when a field under the Contractor/In-House Crew or Cost Center column is selected, respectively (see Figure 2.11. Audit Run Measures form). Navigate through the audit measures by selecting any of the measures to display the cost details of that measure in the navigation bar Unit Costs for Measure: [Measure Name]. To create work orders for each measure checked in the rows, select Create Work Order at the top of the form. You may view the created work order by selecting Work Orders → View Work Orders on the menu bar and then locating the work order from the All Work Orders navigation bar.

The pop-up window in Figure 2.12. Information pop-up window for a successfully created work order. will appear when you select Create Work Order; the window describes that the work order was created successfully and how many work orders were created.

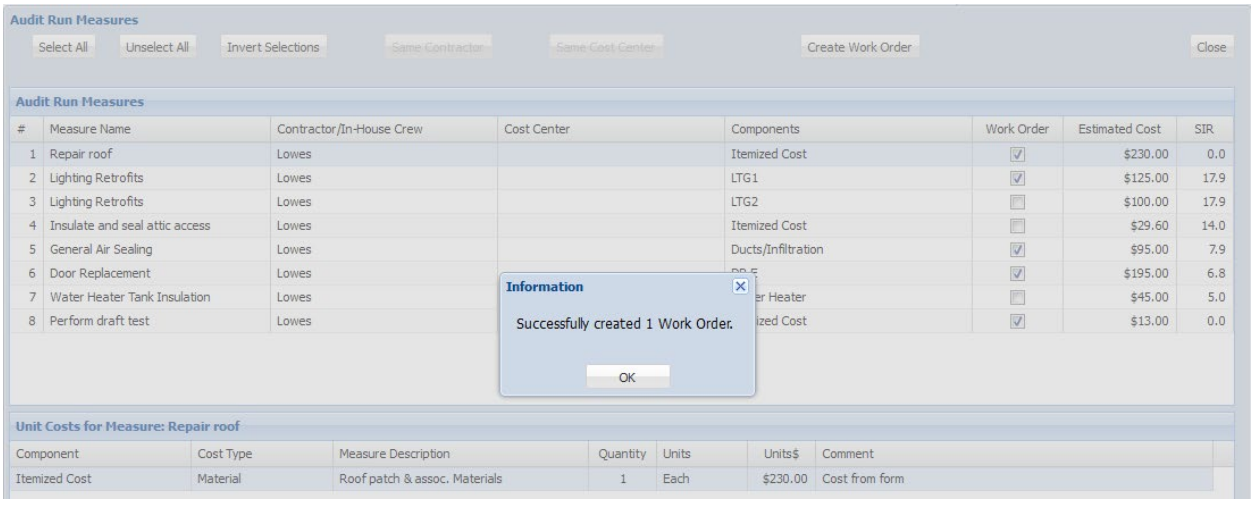


Figure 2.12. Information pop-up window for a successfully created work order.

If work orders were already created for that particular audit, another pop-up window will be displayed with three options (Figure 2.13). Choose how to proceed with the work order by selecting one of three options: (1) Save the previously generated Work Order and create new ones, (2) Replace the previously

generated Work Order with new ones, or (3) Cancel the creation of Work Orders. After selecting an option, select OK and the selection action (i.e., work order) will be created.

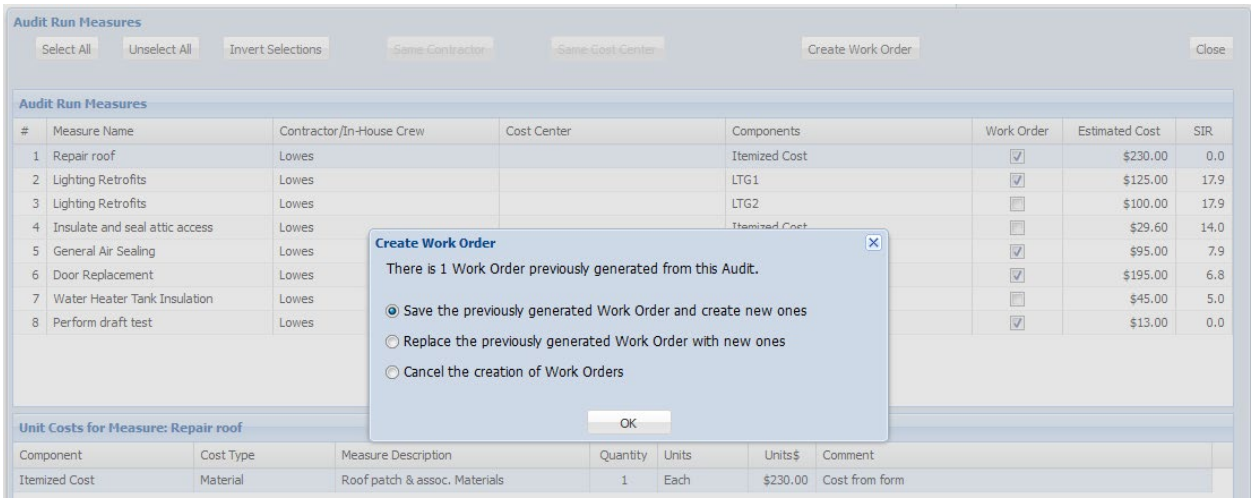


Figure 2.13. Pop-up window showing options for creating another work order for the same audit.

2.3.2 Creating a Work Order Manually

The other way to create a work order is from the menu bar, although this is not the typical route taken by most auditors. To use this route, select Work Orders → View Work Orders on the menu bar (Figure 2.14).

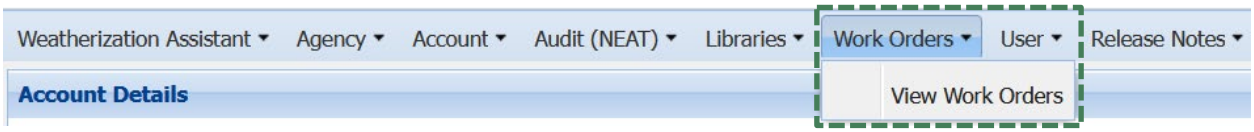


Figure 2.14. Menu bar highlighting Work Orders.

Next, select New (Figure 2.15). Select New to create a new work order. The Work Order Details form provides groups of data input or selection fields such as Work Order Information, Account Information, and Work Order Economic Summary. The Status information describes the current status of the work order. Start by filling the Work Order Information fields by providing a work order name, and then choose either the Account Name or Account Number. This will autofill the Agency and State fields. Choose a Supply Library containing inventory items from which selections may be made (optional). You can also choose the supplier of materials for the work order from the drop-down list for the Contractor/Crew field (optional; a Contractor/Crew list could be created by selecting Agency → Contacts on the menu bar and filling in the details). The last field to complete under Work Order Information is the Work Order Type, which designates whether the work order relates to Weatherization, Re-Weatherization, Emergency Repair or Replacement, Response to Client Request, or another type of work. Once these are completed and saved, a record for the work order will be created in the All Work Orders navigation block at the bottom of the form.

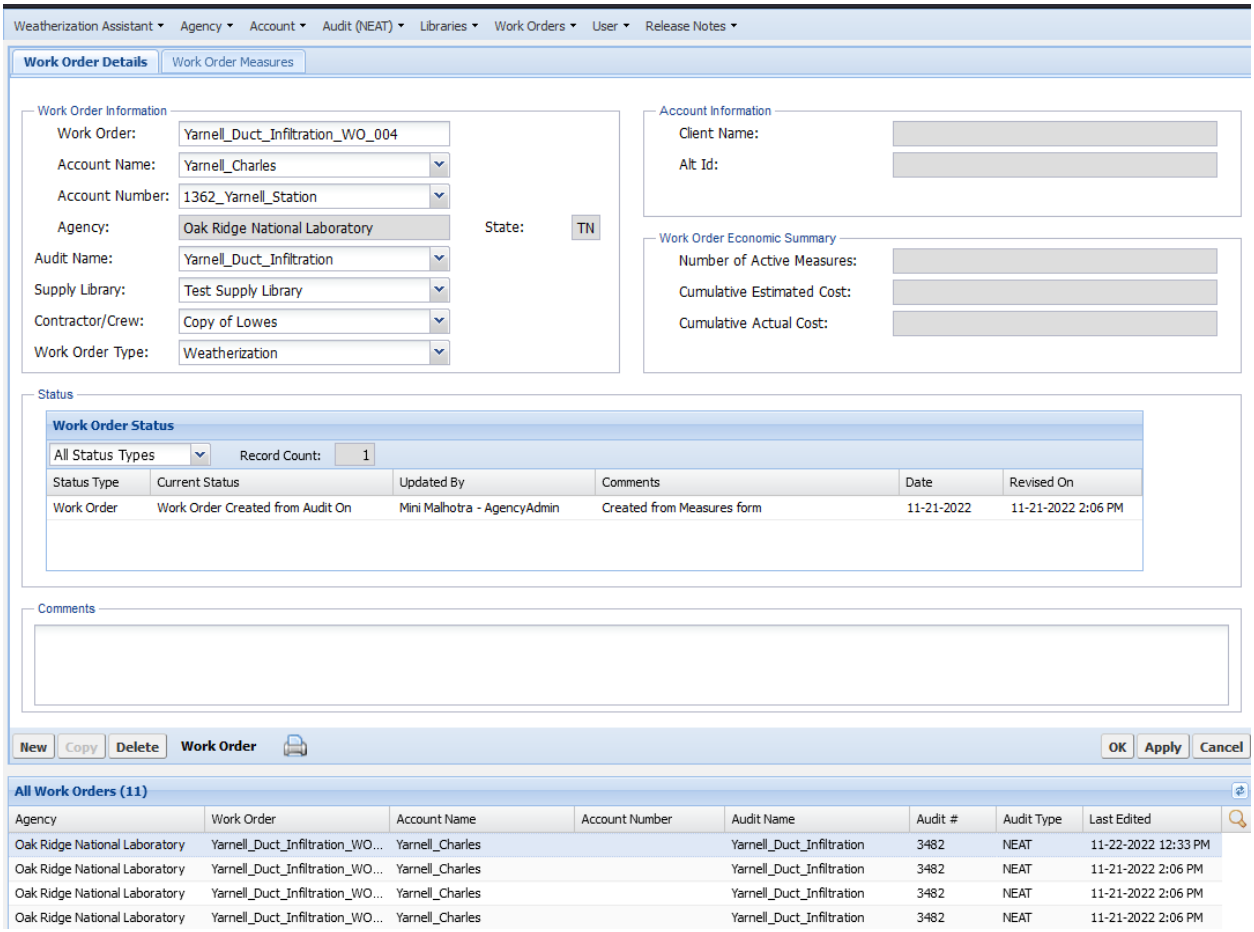


Figure 2.15. Work Order Details form.

The Work Order Measures form (Figure 2.16) includes a record of all the measures of the active work order. The Work Order Measures form includes a read-only field with the work order name and other input fields to choose the Measure Type (Base Loads, Building Insulation, Client Education, Doors and Windows, General Heat Waste and Air Infiltration, General Repairs, Health and Safety, HVAC Systems, or Other); provide a name for the measure; and input an integer value for the Order # to identify the work order by a unique code, for a Component field to identify a name or code of all building components to which the measure will be applied, and for a Cost Center field, which provides a drop-down list of the funding sources to which the actual cost of the measure will be charged. Keep the active checkbox selected to include the measure in the work order. A Materials/Labor Details sub-form in the middle of the form page is used to add or remove a record for the measure that describes measure cost, units, and quantity. This can be done manually by editing the records in each row or by choosing from the Supply Library in the drop-down under the Copy From Supply column.

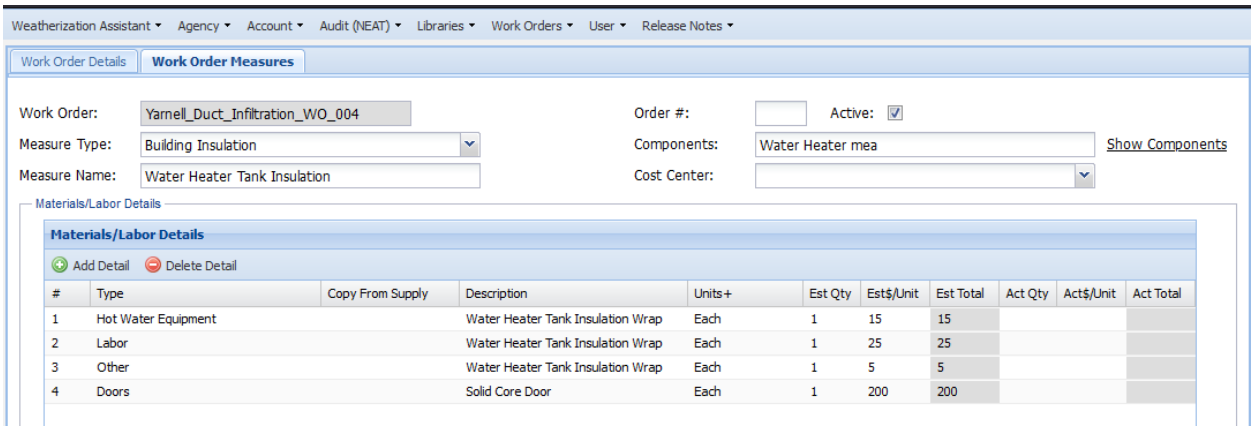


Figure 2.16. Work Order Measures form.

On this form, multiple work orders may be created for different measures by selecting New at the bottom of the form, below the Comments field. Each record of a measure will be shown in the All Work Order Measures navigation bar. Select the Print icon to view a PDF of the work order for the measure, which will open in new tab on the browser.

3. MHEA

Once you have set up an account for a manufactured home, you can create and run MHEA on that home. MHEA has multiple forms used to describe a manufactured home with each having a main form for data input and possibly an All table for record navigation (Section 1.3). MHEA also has an Audit Dock that is a static feature anchored on the left of each MHEA input form (Figure 3.1) and provides the means of accessing MHEA's various forms and running the audit. The Audit Dock may not be displayed when creating a new audit until after the Audit form has been saved.

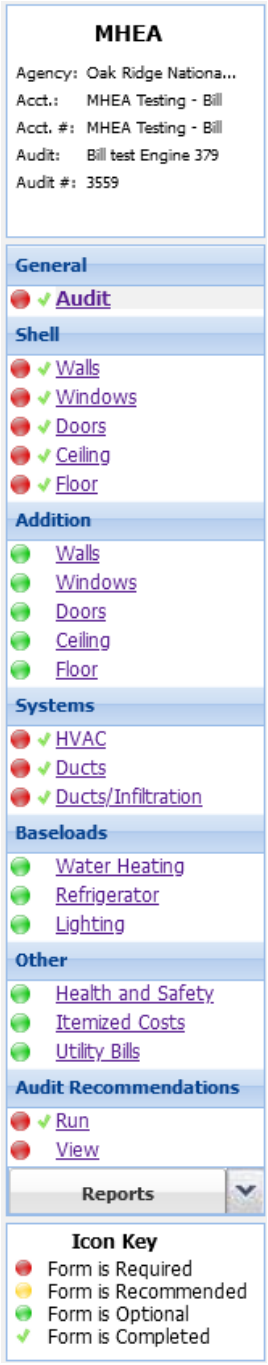


Figure 3.1. MHEA Audit Dock.

At the top of the Audit Dock is an information block that shows key audit information entered on the Audit form for the audit that is currently active (i.e., being viewed). Links to each of MHEA's 20 data input forms used to describe the house are provided below the information block. These links are organized into six groups: General, Shell, Addition, Systems, Baseloads, and Other. Colored icons are presented beside these links to indicate if the form is required, recommended, or optional, and if the form has been completed. A legend for the icons is shown in the Icon Key at the bottom of the Audit Dock. Links are provided in an Audit Recommendations group to run MHEA or view results of the last run for that audit. Finally, Reports can be selected to access various reports available within MHEA for the audit being viewed.

Some of the data input forms in MHEA allow multiple records to be described for a building component. For example, in Figure 3.2, multiple windows are entered on the Window form. These forms have New and Copy options to create multiple records. For each record, a tab named by the user-entered Code is created at the top of the form. The All table presented at the bottom of each of these forms lists these records (i.e., the tabs) (Figure 3.3).

To complete one of the 20 MHEA data input forms, simply select the form in the Audit Dock and then complete the form. Select Apply to save and remain on the form or OK to save and exit the form. Select Cancel to exit the form without saving the entries that you just made. Select New or Copy (if applicable) to create additional records. The completed records will be listed in the All table. To view or edit an existing record, select the tab or the record in the All table.

On most of the Shell, Addition, Systems, and Baseloads forms, field sets on the left part of the main form describe a selected component of the existing building. A field set on the right of the main form describes retrofit measure technical details for the component. In some cases, the retrofit measure field sets can be used to directly enter the total costs associated with the measure because it cannot be described in the Measure Cost Set Library. In other cases, the retrofit measure field sets can be used to enter an Additional Cost associated with installing the measure that will be added to the cost calculated from the Measure Cost Set Library.

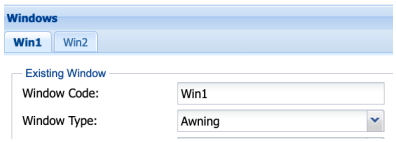


Figure 3.2. Tabs on MHEA's Window form.

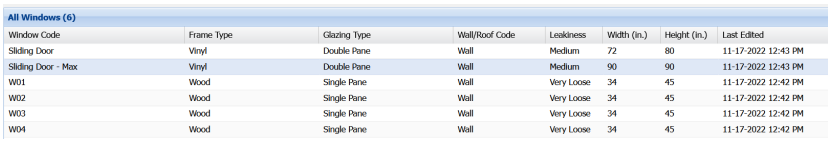


Figure 3.3. All Windows table on MHEA's Window form.

MHEA will evaluate all retrofit measures that are indicated as being active in the Measure Cost Set Library and applicable to the home. However, some of the data input forms in MHEA provide the option to evaluate only certain measures for a component, which will exclude evaluation of other active measures for that component. In that case, MHEA also provides an option to include the energy savings and cost of the measure in calculating the package SIR. Measures where "Required" is selected, but not included in the package SIR are normally related to health and safety or are measures funded by a source other than the Weatherization Assistance Program. A measure with both "Required" and "Include in SIR" selected will be included in the package SIR and will always be recommended regardless of its SIR (this option is generally used for Incidental Repair Measures). Check the guidance for your program in deciding if and how these features can be used.

3.1 DESCRIBING A MANUFACTURED HOME IN MHEA

To create a new MHEA audit, select Audit → MHEA on the menu bar and then select New on the Audit form (State Administrators and Guests are not allowed to create an audit). Select Copy to create a new audit from an existing audit. You may want to create a new audit using Copy to make multiple audit runs for a home (e.g., to evaluate different retrofit options or replacement equipment for a given home) but still see the results of previous runs.

When creating a new audit using New, fill in the Audit form first before entering information on the other forms.

Each of MHEA's input forms are described briefly here. Section 3.2 describes how to run MHEA.

Audit form (required) – The Audit form is used to enter general audit information and select weather files and libraries needed to run the audit (Figure 3.4). All the fields on this form that are not disabled or read-only are required.

At the top of the form, select your Agency and then select the account using either the Account Name or Account Number field (the other data field will be autofilled using information from the Account form). Enter an Audit Name and the Audit Date, and then select the Auditor Name (auditor names provided in the drop-down list will include all users for the Agency that are marked as Active and Auditor on the User form). The City and State fields will be autofilled using information from the Account form. The Audit Number will be automatically assigned by MHEA.

Next, enter the building information: Occupants, Length, Width, Exterior Wall Height, Infiltration Height, Number of Bedrooms, Wind Shielding, and the presence of Outdoor Water Heater Closet. Then, select the Weather State, Weather Location, and the following libraries: Economic Parameter Set, Measure Cost, Key Parameter Set, Supply, Defined Measure Set, and Fuel Cost for each fuel type. MHEA has 1,000+ US weather stations, which are filtered by weather state. You may also consider cities near you in states that border your own. The libraries listed in the drop-down lists are restricted to those that have been created in the respective libraries for this agency and marked Active for MHEA. For the Fuel Cost, you can select None for fuel types that will not be used in the audit except for electricity. The fuel costs

associated with the selected Fuel Cost names will be autofilled. Finally, for MHEA to adjust energy savings estimates and recommend measures based on the actual pre-weatherization energy consumption of the home, select the Billing Adjustment checkbox.

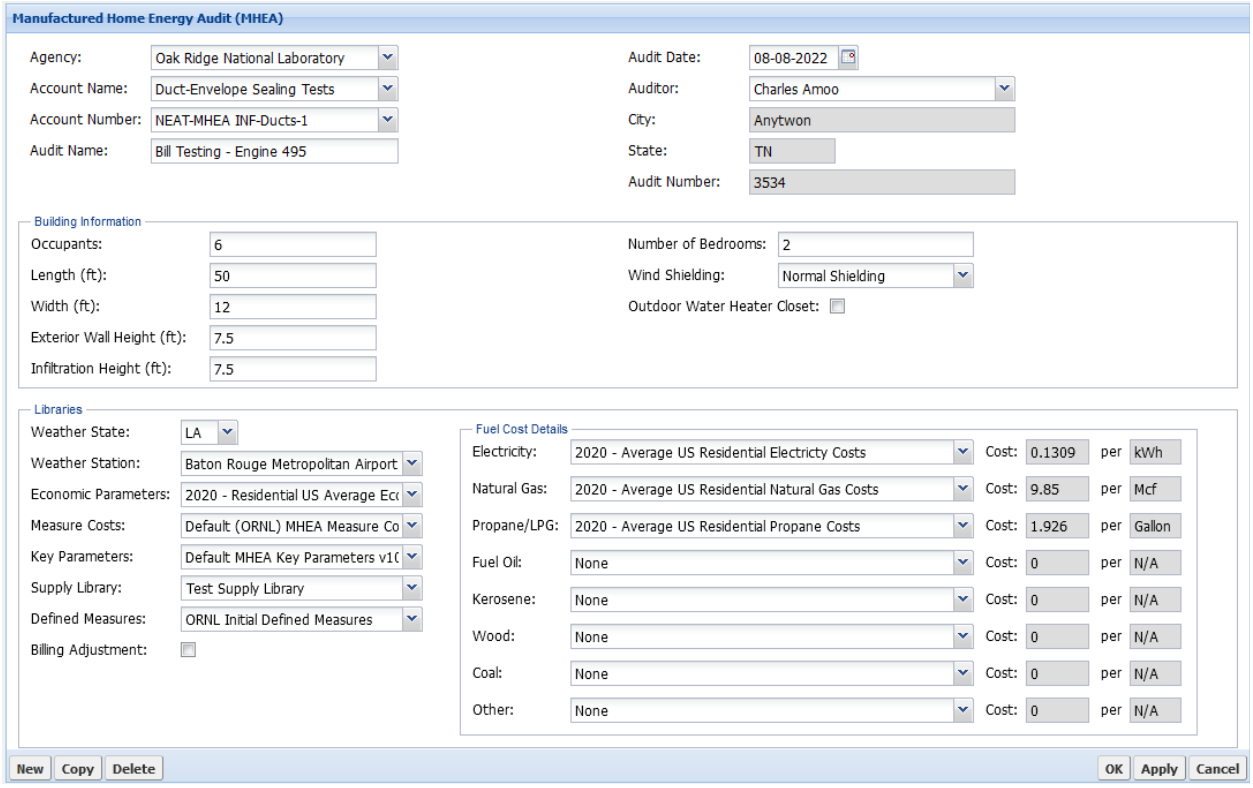
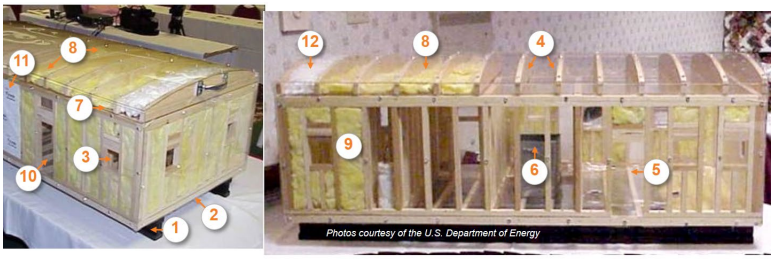


Figure 3.4. MHEA Audit form.

Shell forms – Shell forms are used to describe the walls, windows, doors, ceiling, and floor of a manufactured home. Use these forms to describe all the shell components in the home that define thermal boundary (as illustrated in Figure 3.5), select retrofit options, and describe any additional costs associated with the installation of the retrofit unique to the home being audited that is not described in the Measure Cost Set Library. Each of the shell forms is required.



1. Main beam
2. Band joist
3. Rough window opening
4. Bowstring trusses
5. Floor joists
6. Heating/AC duct
7. Top plate
8. Ceiling joist cavity
9. Wall section
10. Rough door opening
11. Vapor barrier
12. Blown-in insulation

Figure 3.5. Typical mobile home components.

The **Wall form** (required) is used to describe the four primary walls of the home that enclose the conditioned space of the home. MHEA assumes that a manufactured home is rectangular in shape, the walls are wood-frame construction, and the walls facing different orientations have identical construction characteristics; therefore, MHEA uses only one form to describe all four primary walls.

The **Window and Door forms** (required) are used to describe all the windows and exterior doors of the home. The number of each type of window or door entered is entered by its orientation.

The **Ceiling form** (required) is used to describe the ceiling (i.e., the roof) in the home. To describe a roof, you must first select the roof type from the following options: Flat, Bowstring, and Pitched (Figure 3.6), enter the joist size for flat roofs, height of roof at center for bowstring roofs, or desired amount of insulation to add at center for pitched roofs (Figure 3.7); select the roof color; and describe the cathedral ceiling if one exists (see Figure 3.8Figure 3.9 and Figure 3.9 for different cathedral ceiling configurations).

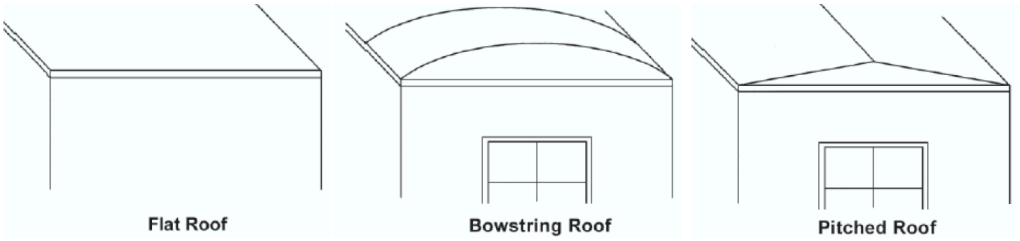


Figure 3.6. Typical manufactured home roof configurations.

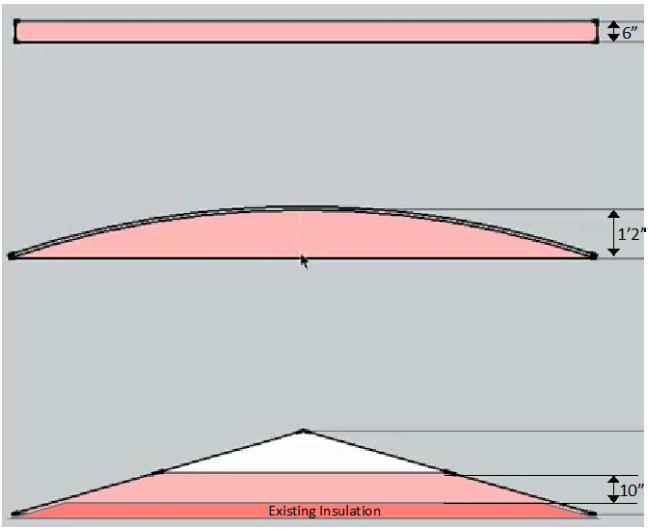


Figure 3.7. Section drawings of manufactured home roof configurations (from top to bottom: flat roof, bowstring roof, pitched roof).

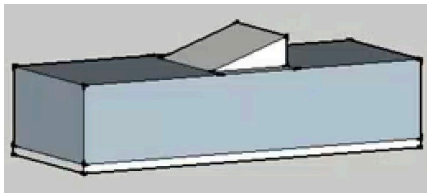


Figure 3.8. Sloped roof cathedral ceiling with step wall, typical with flat roofs.

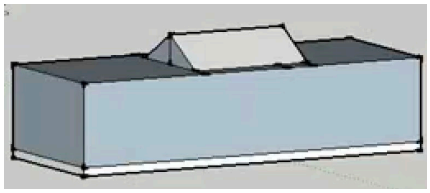


Figure 3.9. Cathedral ceiling configurations with no step wall, typical with pitched roofs.

The **Floor form** (required) is used to describe the floor of the home, defined in MHEA to comprise wing and belly sections (Figure 3.10). The wing and belly sections are protected from outside elements (including water, wind, and rodents) using an insulation wrap attached to the underside of the floor joists. The space available for adding insulation depends on the direction and size of the floor joists, the location and thickness of the existing insulation in the wing and belly sections, and the belly cavity configuration (Figure 3.11). The manufactured home may also have skirting installed around the perimeter of the floor. The floor joists could be placed along the length or width of the floor area (Figure 3.12).

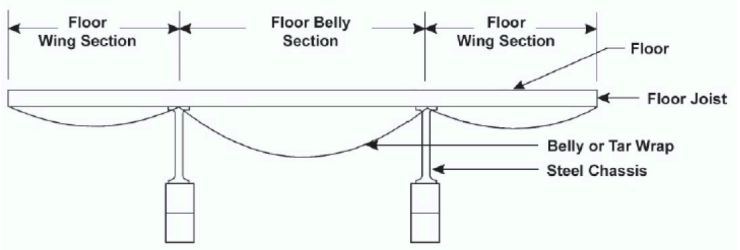


Figure 3.10. Widthwise floor joist direction.

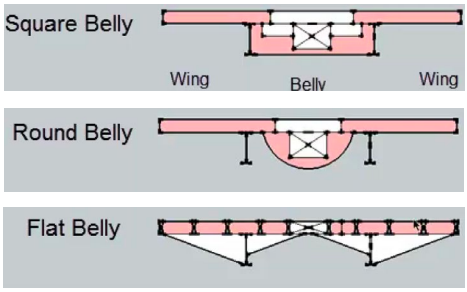


Figure 3.11. Typical manufactured home belly configurations.

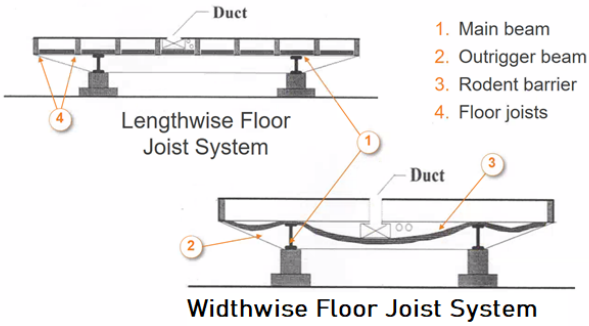


Figure 3.12. Manufactured homes joist spacing and direction.

Addition forms – Addition forms are used to describe the walls, windows, exterior doors, ceiling, and floor of a conditioned room attached to the manufactured home. MHEA assumes that the manufactured home addition is rectangular in shape with wood-frame construction and has three exposed walls, a flat, shed or gable roof, and a crawlspace, slab on grade, or exposed floor (see Figure 3.13, Figure 3.14, and Figure 3.15). Use these forms to describe all the shell components in the addition through which heat flows, select retrofit options, and describe any additional costs associated with the installation of the retrofit unique to the house being audited that are not described in the Measure Cost Set Library. If there is no addition, you do not need to access the addition forms. However, if entry is begun on any one of the addition forms, then the **Walls form**, **Ceiling form**, and **Floor form** must be completed. The **Window and Door forms** are optional.

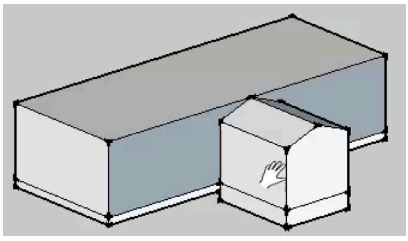


Figure 3.13. Gable roof configuration.

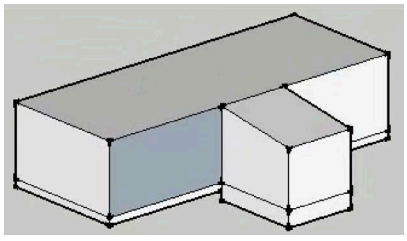


Figure 3.14. Shed roof configuration.

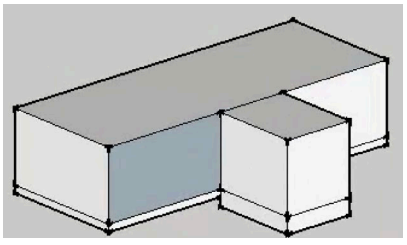


Figure 3.15. Flat roof configuration.

Systems forms – Systems forms are used to describe the HVAC systems, ducts, and duct leakage and infiltration associated with a manufactured home. You must enter one heating system and enter infiltration data on the Ducts/Infiltration form to meet the minimum requirements of MHEA. The

remaining forms are optional unless deemed required based on other inputs. For example, the Duct form may be required depending on HVAC entries. The selections made in the HVAC form, especially with regard to heating, will determine whether the duct form remains optional or becomes required. In most homes, though, both heating and cooling systems will be entered on the HVAC form.

The **HVAC form** (required) is used to describe the heating and cooling equipment installed in the house and select retrofit options. In MHEA, you can describe as many equipment as are required to describe the heating and cooling sources in the house. At least one equipment that provides heating must be described in this form. The selected equipment may provide either heating or cooling or both. To describe an equipment, first enter the equipment type (and fuel if heating-only equipment) and then enter the data in the applicable fields, which vary depending on the selection for equipment type and fuel. Inputs related to equipment type and fuel will filter out other necessary inputs, as well as retrofit options that will be available for evaluation. For example, choosing a central heat pump will disenable the retrofit option for installing a smart thermostat, and selecting a space heater will disenable tune up as a retrofit option. The Replace the Equipment retrofit option is always enabled for possible selection and is used to specify if the measure replaces one or more existing equipment described in other HVAC sub-forms. Selecting a measure as required will disable other measures that are mutually exclusive to the required measure. Unlike in Weatherization Assistant Version 8, heating/cooling equipment inputs are not limited to primary and secondary systems. Each type of existing heating and/or cooling equipment in the home may be entered as separate records. Weatherization Assistant Version 10 determines the primary system based on the Fraction of Load Served value that is either input or estimated by the software. Inputs made on any optional forms (e.g., other field measurements or health and safety observations) are informational only and are not used in running the audit analysis.

The **Duct form** (conditionally required) is used to describe the supply and return ducts for ducted HVAC equipment. A duct system with varying characteristics (e.g., location, insulation) must be described as multiple segments. All ducted HVAC equipment must be selected as served by at least one supply duct. To evaluate a duct insulation measure, you must enter the measured duct surface area and insulation R-value. If sufficient details relating to duct size and/or surface area and insulation R-value are unknown, then Weatherization Assistant Version 10 can estimate the values. To calculate these estimates and view the results, select the Use Defaults checkbox (Figure 3.16). To edit the values, clear the Use Defaults checkbox and input other values. Select Apply or OK to save the inputs. Figure 3.17 shows the typical furnace and duct system layout in a mobile home.

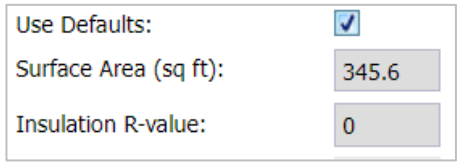


Figure 3.16. Use Defaults checkbox selected.

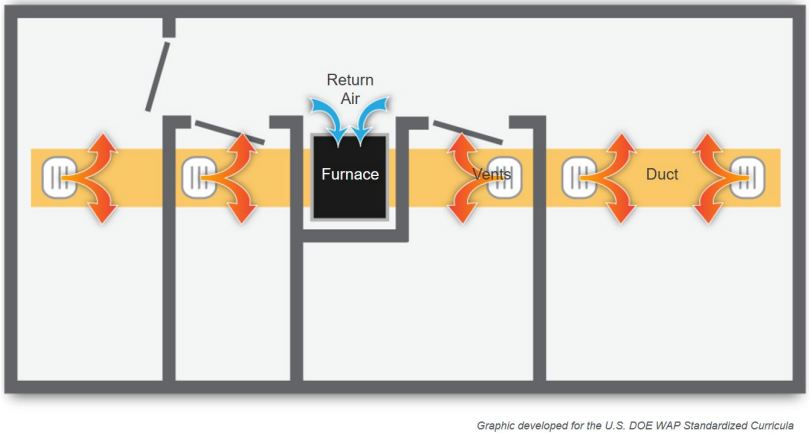


Figure 3.17. Typical furnace and duct system layout in a mobile home.

The **Ducts/Infiltration form** (required) is used to enter air and duct leakage data to evaluate the effectiveness of infiltration reduction work and duct sealing. The data input fields on the Ducts/Infiltration form change depending on whether duct sealing will be evaluated and, if so, which method—whole house blower door, blower door subtraction, or duct blower measurements—will be used. To evaluate infiltration reduction as a retrofit measure, you must, at a minimum, enter the pre-weatherization whole-house air leakage rate (usually measured), an estimated or target rate after weatherization, house pressure differences for these rates, and the cost of the infiltration reduction work. A set of optional forms (Blower Doors, Zonal Pressures, Pressure Pans, and Room Pressure Balances) can be used to enter measurements made during the infiltration and duct leakage measurements or health and safety observations related to the HVAC systems. Information entered on these optional forms is not used in running an audit.

Baseloads forms (optional) – Baseloads forms are used to describe water heating retrofits, refrigerator replacement, and lighting retrofits. These forms are optional and are used to evaluate specific retrofit measures.

The **Water Heating form** (optional) is used to enter information necessary to evaluate four water heating retrofit measures: tank insulation, pipe insulation, low-flow showerheads, and water heater replacement. This is optional even though many Grantees may require it. You may describe the existing water heater either by selecting from the list of manufacturer and model number, which will autofill the energy use characteristics of the water heater, or by directly entering the data on the form. To evaluate a water heater replacement, you may either select a water heater you have already described in the Supply Library, which will autofill the data, or directly enter the data on the form. A set of optional water heating forms (Operational Tests, Vent Tests, and Inspections) can be used to enter measurements made on the water heating system or health and safety observations related to the water heating system. Information entered on these optional forms is not used in running an audit.

The **Refrigerator form** (optional) is used to enter information necessary to evaluate a refrigerator replacement. Here, you may specify the energy use characteristics of the existing and replacement refrigerators. For the existing refrigerator, you may either select from the list of manufacturers and model numbers, which will autofill the energy use characteristics of the refrigerator, or directly enter the data on the form. For the replacement refrigerator, you may either select a refrigerator you have already described in the Supply Library, which will autofill the data, or directly enter the data on the form.

The **Lighting form** (optional) is used to describe lamp replacement retrofits. You may specify the quantity, usage, and energy use characteristics of the existing and replacement lighting and cost of the replacement lighting. For the existing and/or replacement lighting, you may either select lighting you have already described in the Supply Library, which will autofill the energy and cost data, or directly enter the data on the form.

Other forms (optional) – Other forms can be used to describe health and safety observations in the home; repair or health and safety measures or your own energy measure; and utility bills.

The **Health and Safety form** (optional) can be used to enter health and safety-related measurements and observations that you have made of the home. Items on this form help identify potential health and safety hazards related to the whole house, equipment, and the shell; record worst-case draft measurements for space heating equipment and the water heater; and determine ventilation requirements to comply with ASHRAE Standard 62.2.

The **Itemized Costs form** (optional) can be used to enter necessary repair and health and safety measures associated with recommended energy measures and their costs. You can also use this form to enter your

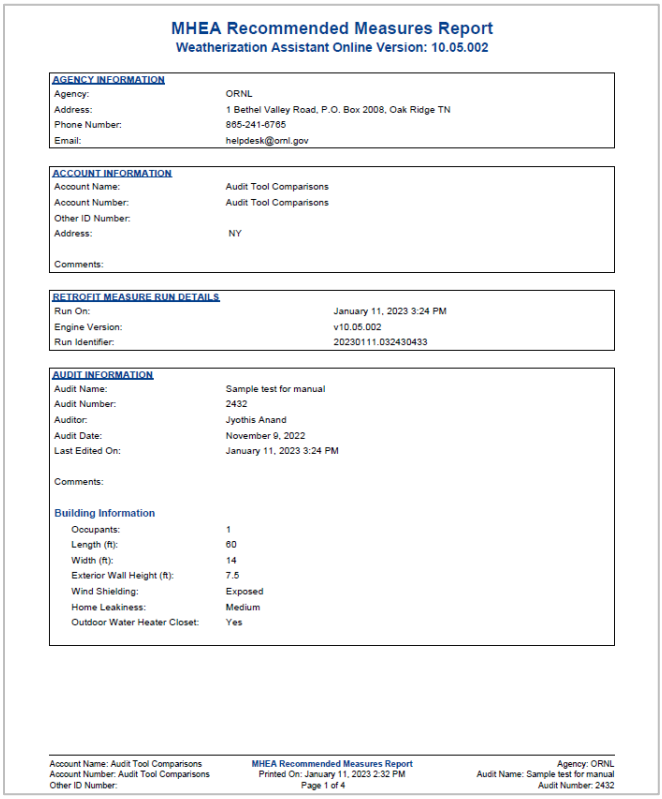
own energy saving measures (that you define) not addressed under the Measure Cost Set Library. For an energy saving measure, you must determine and enter the associated annual energy savings. Once fully defined on the Itemized Costs form, a user-entered energy measure is treated by MHEA the same as the library measures.

The **Utility Bills form** (optional) can be used to enter pre-retrofit utility bills associated with heating and cooling if you want MHEA to compare them with MHEA's heating and cooling energy consumption estimates as part of an audit calibration process and adjust energy savings estimates for the recommended measures. For MHEA to adjust its energy savings estimates and develop a second set of recommended weatherization measures based on the actual pre-weatherization energy consumption of the home, select the Billing Adjustment checkbox. Comparison of the predicted base case energy use against utility bills is more appropriate for metered fuels, such as natural gas and electricity. Bulk fuels such as propane, fuel oil, and kerosene, which are delivered in bulk and stored in tanks at the home, 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.

3.2 RUNNING MHEA AND VIEWING RESULTS

Audit recommendations – You can Run MHEA after you have entered all the information for the home on the data input forms. The Run on the Audit Dock link will be activated as soon as all the required data input forms have been completed. When you select Run, the status of the run will be displayed, and the Recommended Measures Report will be opened in a separate window. Once an audit has been run, the link to View will be activated. You can select View to see a MHEA Recommended Measures Report that has already been created and saved from a previous run.

Figure 3.18 shows the title page of the MHEA Recommended Measures Report. The title page identifies your Agency, Account, Audit, and Audit Run; provides key information you have entered on the Agency, Account, and Audit forms; and provides additional information about the audit run to track the audit results. After the title page, the report lists all the recommended measures along with their estimated energy and cost savings, measure costs and SIRs, and primary material quantities needed to perform them (Figure 3.19).



MHEA Recommended Measures Report
Weatherization Assistant Online Version: 10.05.002

AGENCY INFORMATION
Agency: ORNL
Address: 1 Bethel Valley Road, P.O. Box 2008, Oak Ridge TN
Phone Number: 865-241-6765
Email: helpdesk@ornl.gov

ACCOUNT INFORMATION
Account Name: Audit Tool Comparisons
Account Number: Audit Tool Comparisons
Other ID Number:
Address: NY
Comments:

RETROFIT MEASURE RUN DETAILS
Run On: January 11, 2023 3:24 PM
Engine Version: v10.05.002
Run Identifier: 20230111.032430433

AUDIT INFORMATION
Audit Name: Sample test for manual
Audit Number: 2432
Auditor: Jyothis Anand
Audit Date: November 9, 2022
Last Edited On: January 11, 2023 3:24 PM
Comments:

Building Information
Occupants: 1
Length (ft): 60
Width (ft): 14
Exterior Wall Height (ft): 7.5
Wind Shielding: Exposed
Home Leakiness: Medium
Outdoor Water Heater Closet: Yes

Account Name: Audit Tool Comparisons
Account Number: Audit Tool Comparisons
Other ID Number:
MHEA Recommended Measures Report
Printed On: January 11, 2023 2:32 PM
Page 1 of 4
Agency: ORNL
Audit Name: Sample test for manual
Audit Number: 2432

Figure 3.18. MHEA Recommended Measures Report: title page.

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating		Cooling		BaseLoad		Total	
			(MMBtu)	($)	(kWh)	($)	(kWh)	($)	(MMBtu)	($)
1	Low Flow Showerheads	Water Heating	0.0	$0	0	$0	256	$34	0.9	$34
2	Water Heater Pipe Insulation	Water Heating	0.0	$0	0	$0	159	$21	0.5	$21
3	Lighting Retrofits	L1	0.0	$0	0	$0	178	$23	0.6	$23
4	Water Heater Tank Insulation	Water Heating	0.0	$0	0	$0	230	$30	0.8	$30
5	General Air Sealing	Ducts/Infiltration	0.8	$50	16	$2	0	$0	0.8	$52
6	Roof Fiberglass Loose Insulation	Roof	1.1	$70	609	$80	0	$0	3.2	$149
7	Replace HVAC System	AC	5.7	$365	2,337	$306	0	$0	13.7	$671

Economics

Index	Recommended Measure	Components	Measure Savings ($/yr)	Measure Cost ($)	Measure SIR
Weatherization Measures					
1	Low Flow Showerheads	Water Heating	$34	$23	18.42
2	Water Heater Pipe Insulation	Water Heating	$21	$15	15.18
3	Lighting Retrofits	L1	$23	$30	11.96
4	Water Heater Tank Insulation	Water Heating	$30	$40	8.28
5	General Air Sealing	Ducts/Infiltration	$52	$101	4.47
6	Roof Fiberglass Loose Insulation	Roof	$149	$672	3.43
7	Replace HVAC System	AC	$671	$4,000	2.07
Health and Safety Measures or Other Funding Sources					
8	Door Replacement	DR2	$3	$218	0.19
9	Smoke Detector is Needed	Itemized Cost	$0	$10	0.00
Total			$983	$5,109	2.54

Materials

Index	Material	Quantity	Units
1	Low Flow Showerheads	1	Each
2	Water Heater Pipe Insulation	1	Each
3	LED Lamp 10.0 watts	3	Each Bulb
4	Water Heater Tank Insulation Wrap	1	Each
5	General Air Sealing	1	Each
6	Roof Fiberglass Loose Insulation	16	Bag
7	Replace HVAC System	1	Each
8	Door Replacement	1	Each Door

Figure 3.19. MHEA Recommended Measures Report: recommended measures.

If you entered utility bills on the Utility Bills form, the report will also provide a revised set of tables for the recommended measures based on adjusted estimates of energy and cost savings and SIRs, and a comparison of MHEA's estimates of the home's heating and/or cooling energy consumptions with the utility bills. MHEA's estimates are based on TMY3 weather data, whereas the utility bills reflect energy consumption for the actual weather that occurred during the billing period. If you also entered degree days associated with the utility bills, they will be compared with the TMY3 weather data used to make the home's energy estimates so that you can determine the degree to which differences between predicted energy consumptions and utility bills might be due to weather differences.

The report also provides other information such as the annual energy consumptions for heating, cooling, and baseloads of the home before and after weatherization (Figure 3.20).

House Energy Consumptions						
	Before Weatherization			After Weatherization		
	Heating (MMBtu)	Cooling (kWh)	Baseload (kWh)	Heating (MMBtu)	Cooling (kWh)	Baseload (kWh)
Annual Energy	13.2	6,734.4	0.0	5.6	3,752.8	-2.8

Peak Heating Load		
Component Type	Before Weatherization Load (Btu/h)	After Weatherization Load (Btu/h)
Wall	3,280.8	3,280.8
Floor	3,051.1	3,051.1
Roof	2,624.2	1,090.3
Windows	2,900.0	2,900.0
Doors	410.1	311.1
Infiltration	3,134.0	2,162.6
Duct Loss	0.0	0.0
Total	15,400.1	12,795.8

Figure 3.20. MHEA Recommended Measures Report: energy consumptions and peak heating load components before and after weatherization.

Reports – The Reports drop-down field on the Audit Dock can be used to select two reports associated with MHEA and the audit. The Audit Input report provides a printout of all the input made in MHEA. The Audit Recommendations report provides the MHEA Recommended Measures Report for the most recent run of the audit (equivalent to the View link).

Sample MHEA
Recommended Mea

3.3 CREATING A MHEA WORK ORDER

Create a work order to prepare a detailed list of tasks to be performed as part of implementing the recommended measures generated from an energy audit. The work order includes materials and labor, their quantities and costing details. Work orders may be created for MHEA in one of two ways: from a successfully completed and run audit or by selecting Work Orders on the menu bar.

3.3.1 Creating a Work Order Automatically

A work order is typically created from the Audit form when it has been completed and run. On the Audit Dock anchored to the left of an audit, select View (Figure 3.21) under the Audit block Audit Recommendations. This will display a MHEA Audit Recommendations page, which includes a View Measures button at the bottom (Figure 3.21).

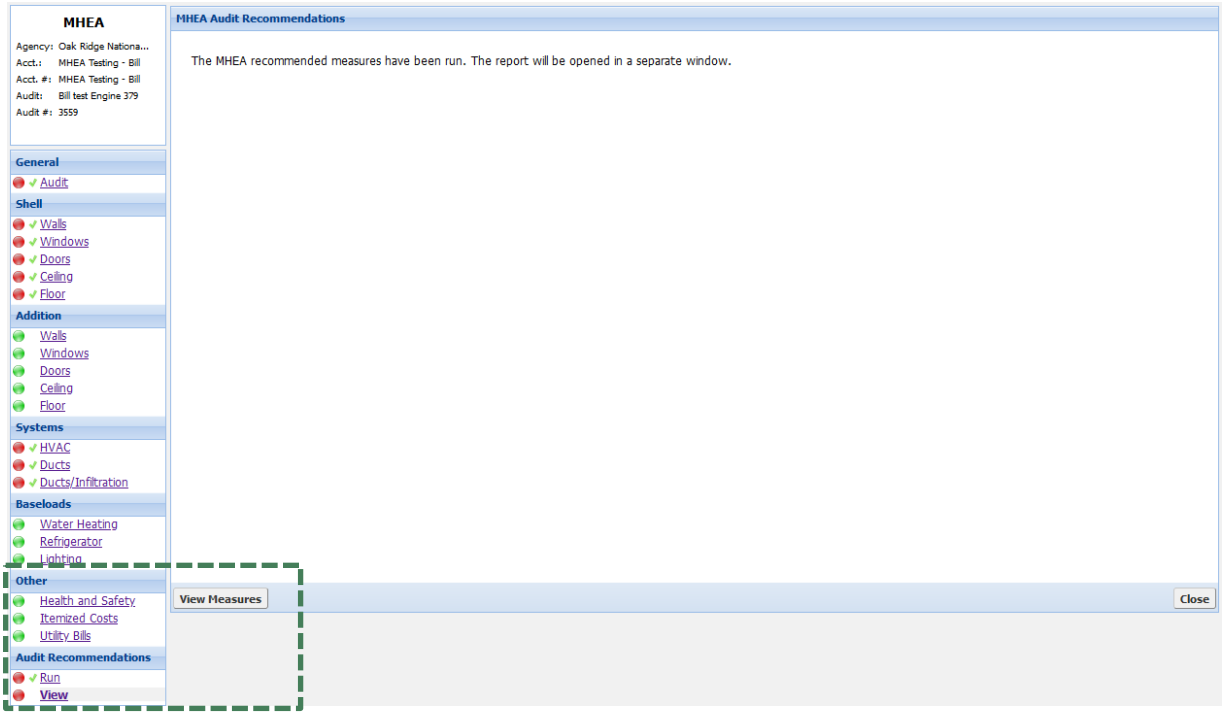


Figure 3.21. MHEA audit showing View and View Measures.

Select View Measures to open the Audit Run Measures form (Figure 3.22), which displays a table of run measures for which work orders could be created, and a navigation bar at the bottom, which displays a breakdown of the itemized cost for the selected measure.

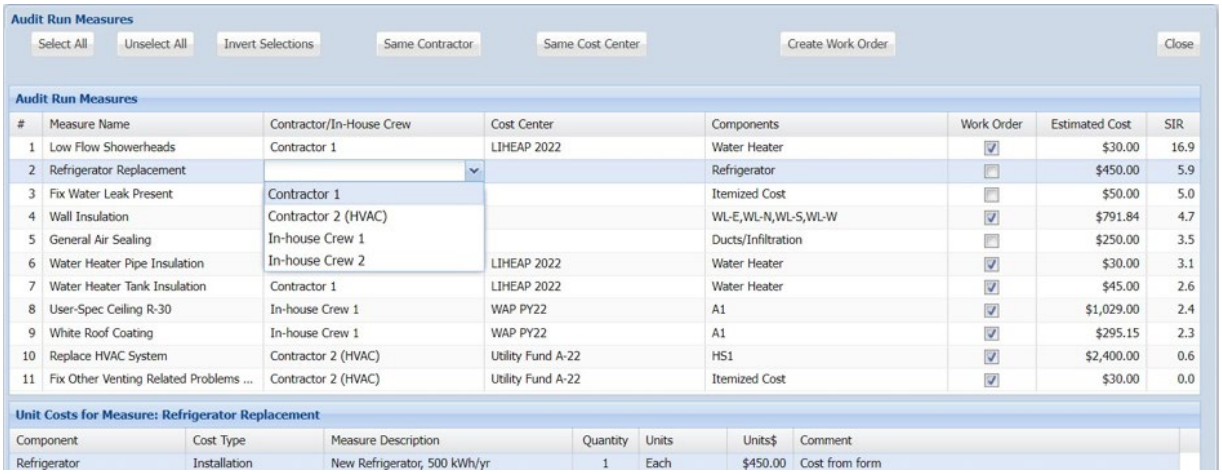


Figure 3.22. Audit Run Measures form.

Use the checkboxes under the Work Order column to select the audit measures for which you want to create work orders. Select the contractor/in-house crew or cost center from the drop-down list that is displayed when a field under the Contractor/In-House Crew or Cost Center column is selected, respectively (see Figure 3.22). Navigate through the audit measures by selecting any of the measures to display the cost details of that measure in the navigation bar Unit Costs for Measure: [Measure Name]. To create work orders for each of the measures checked in the rows, select Create Work Order at the top of

the form. You may view the created work order by selecting Work Orders → View Work Orders on the menu bar and then locating the work order from the All Work Orders navigation bar.

The pop-up window in Figure 3.23 will appear when you select Create Work Order; the window describes that the work order was created successfully and how many work orders were created.

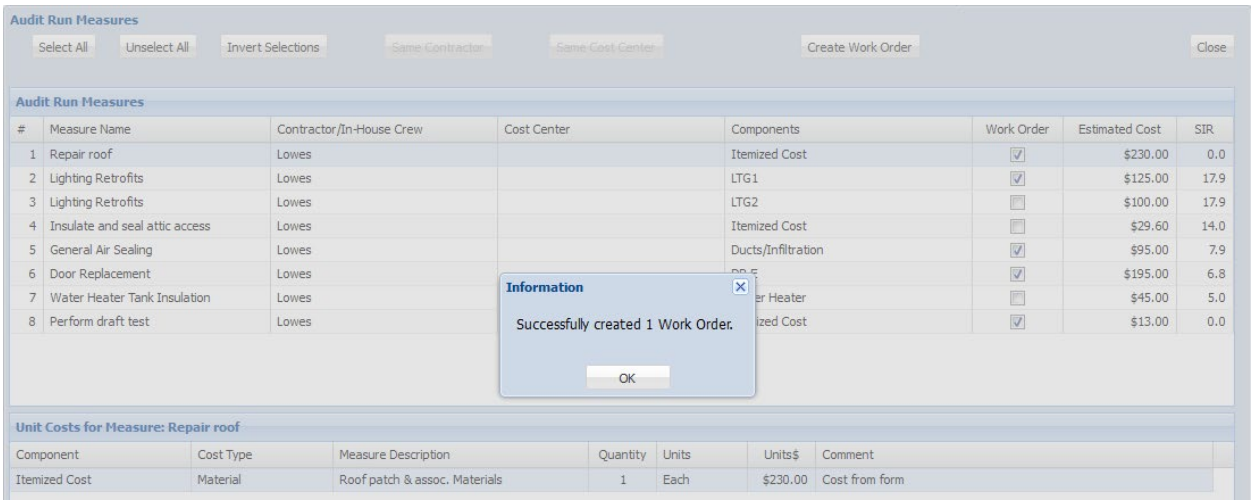


Figure 3.23. Information pop-up window for a successfully created work order.

If work orders were already created for that particular audit, another pop-up window will be displayed with three options (Figure 3.24). Choose how to proceed with the work order by selecting one of three options: (1) Save the previously generated Work Order and create new ones, (2) Replace the previously generated Work Order with new ones, or (3) Cancel the creation of Work Orders. After selecting an option, select OK and the selected action (i.e., work order) will be created.

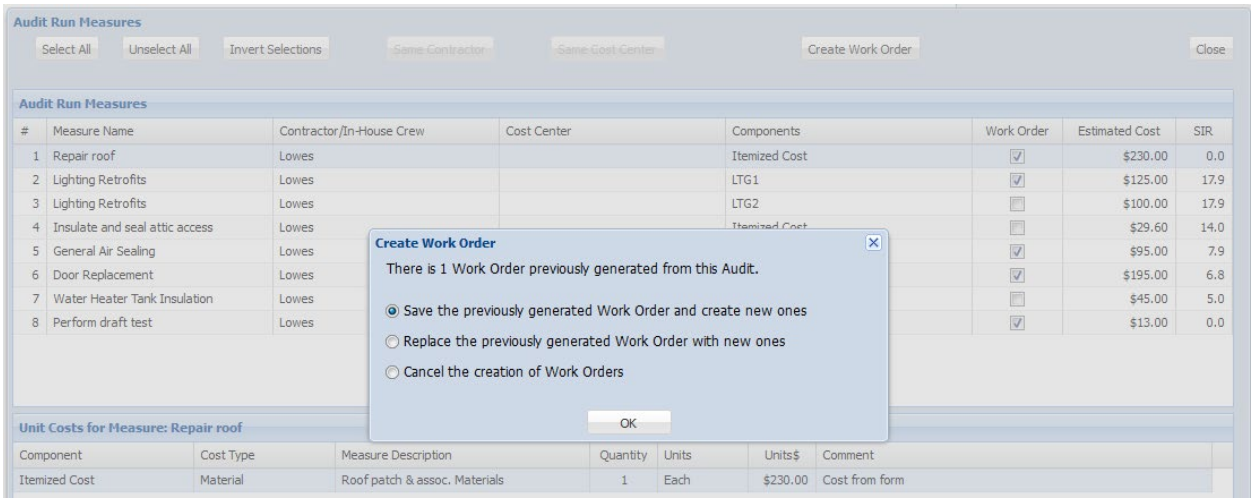


Figure 3.24. Pop-up window showing options for creating another work order for the same audit.

3.3.2 Creating a Work Order Manually

The other way to create a work order is from the menu bar, although this is not the typical route taken by most auditors. To use this route, select Work Orders → View Work Orders on the menu bar (Figure 3.25).

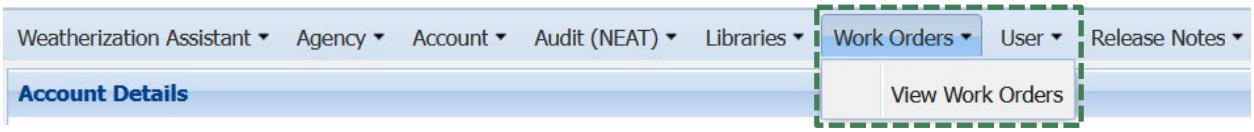


Figure 3.25. Menu bar highlighting Work Orders.

Next, select New (Figure 3.26). Select New to create a new work order. The Work Order Details form provides groups of data input or selection fields such as Work Order Information, Account Information, and Work Order Economic Summary. The Status information describes the current status of the work order. Start by filling the Work Order Information fields by providing a work order name, and then choose either the Account Name or Account Number. This will autofill the Agency and State fields. Choose a Supply Library containing inventory items from which selections may be made (optional). You can also choose the supplier of materials for the work order from the drop-down list for Contractor/Crew field (optional; a Contractor/Crew list could be created by selecting Agency → Contacts on the menu bar and filling in the details). The last field to complete under Work Order Information is the Work Order Type, which designates whether the work order relates to Weatherization, Re-Weatherization, Emergency Repair or Replacement, Response to Client Request or another type of work. Once these are completed and saved, a record for the work order will be created in the All Work Orders navigation block at the bottom of the form.

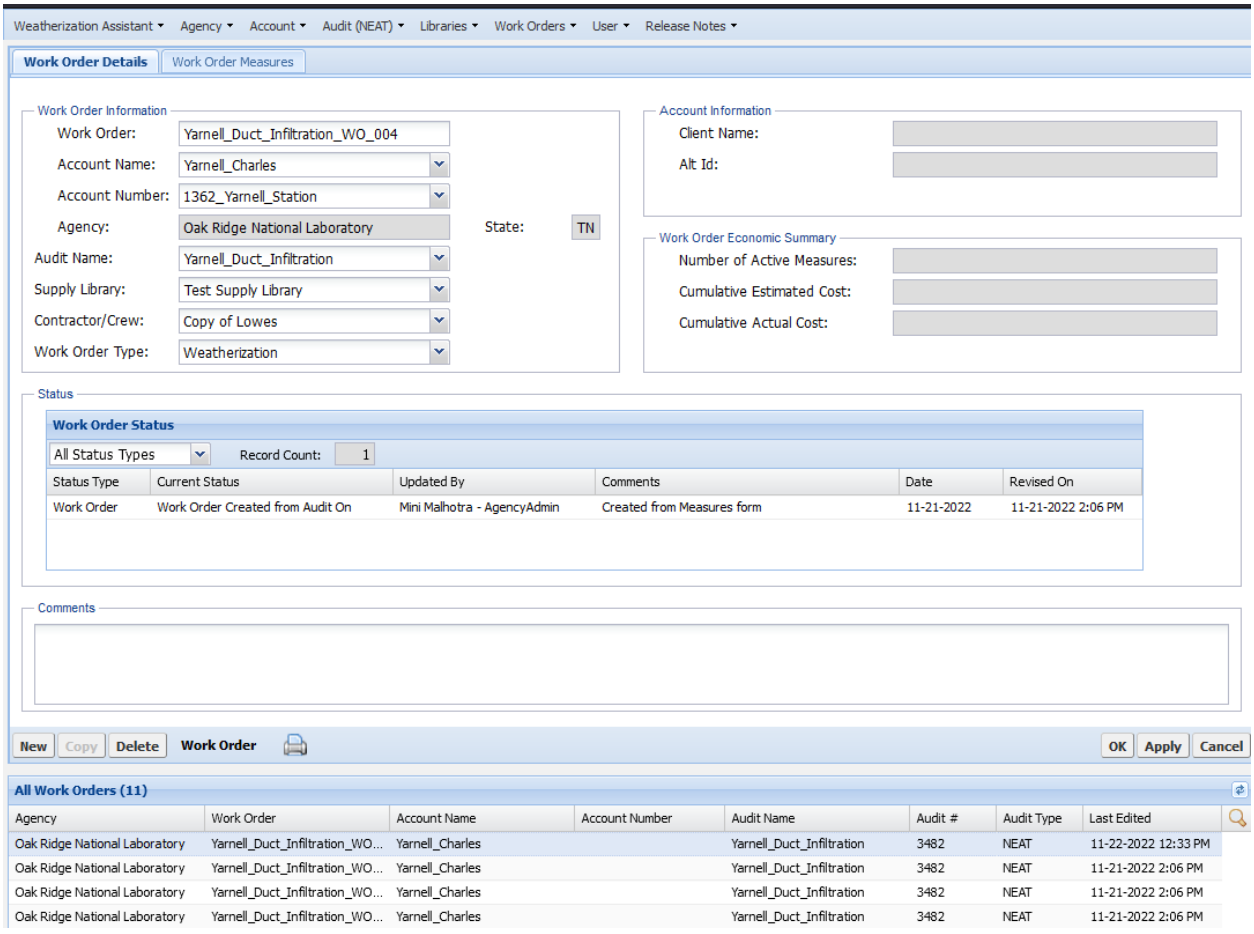


Figure 3.26. Work Order Details form.

The Work Order Measures form (Figure 3.27) includes a record of all the measures of the active work order. The Work Order Measures form includes a read-only field with the work order name and other input fields to choose the Measure Type (Base Loads, Building Insulation, Client Education, Doors and Windows, General Heat Waste and Air Infiltration, General Repairs, Health and Safety, HVAC Systems, or Other); provide a name for the measure; and input an integer value for the Order # to identify the work order by a unique code, for a Component field to identify a name or code of all building components to which the measure will be applied, and for a Cost Center field, which provides a drop-down list of the funding sources to which the actual cost of the measure will be charged. Keep the active checkbox selected to include the measure in the work order. A Materials/Labor Details sub-form in the middle of the form page is used to add or remove a record for the measure that describes measure cost, units, and quantity. This can be done manually by editing the records in each row or by choosing from the Supply Library in the drop-down under the Copy From Supply column.

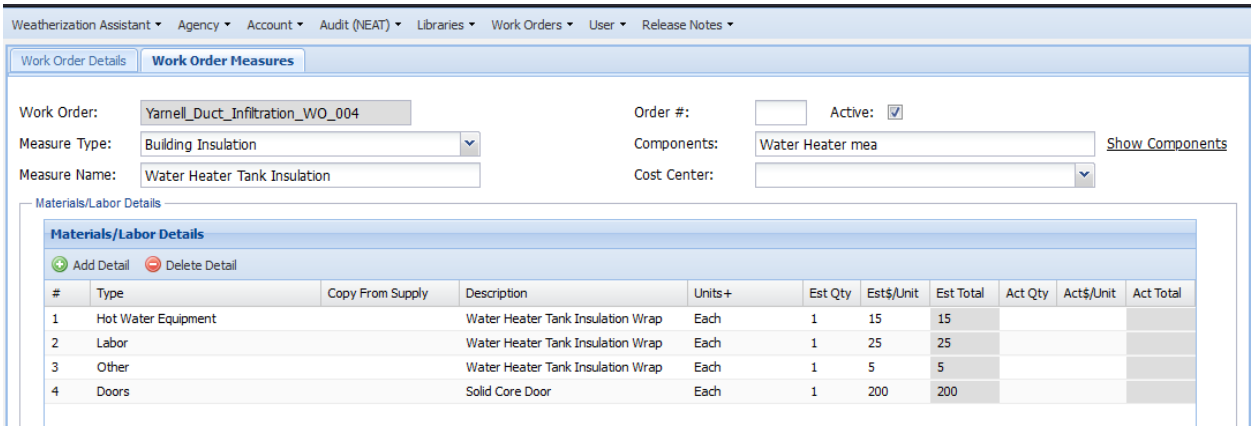


Figure 3.27. Work Order Measures form.

On this form, multiple work orders may be created for different measures by selecting New at the bottom of the form, below the Comments field. Each record of a measure will be shown in the All Work Order Measures navigation bar. Select the Print icon to view a PDF of the work order for the measure, which will open in new tab on the browser.

4. MULTEA

Once an Account for a building or project is made, you can create and then run MulTEA for that building or a building within the project. MulTEA uses multiple forms used to describe a building with each having a main form for data input and possibly an All table for record navigation (Section 1.3). MulTEA also includes an Audit Dock that is a static feature anchored on the left of each MulTEA form (Figure 4.1) and provides a means of accessing MulTEA's various forms and running the audit. Note that the Audit Dock may not be displayed when creating a new audit until after the Audit form has been saved.

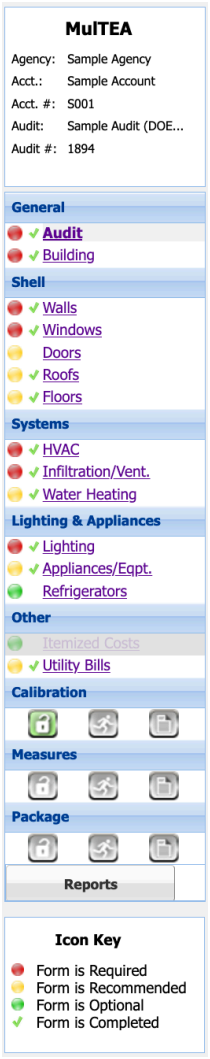


Figure 4.1. MulTEA Audit Dock.

At the top of the Audit Dock is an information block that shows key audit information entered on the Audit form for the currently active audit (i.e., being viewed). Links to each of MulTEA's 14 data input forms, used to describe the building, are provided below the information block. These links are organized into five groups: General, Shell, Systems, Lighting & Appliances, and Other. Colored icons presented beside these links indicate if the form is required, recommended, or optional, and if the form has been completed. A legend for the icons is shown in the Icon Key at the bottom of the Audit Dock. Three options (Calibration, Measures, and Package) are provided to lock audit inputs and run MulTEA. The use of these options is described in Section 4.2. Finally, Reports can be selected to access various reports available within MulTEA for the active audit.

Many of the data input forms in MulTEA allow multiple records to be described for a building component. For example, in Figure 4.2, several different exterior, underground, and interior wall types can be entered on the Wall form. These forms have tabs at the top of the form to provide access to blank forms to create records. The All table presented at the bottom of each of these forms lists the records (i.e., the tabs) that have been described (Figure 4.3).

To complete 1 of the 14 MulTEA data input forms, select the form in the Audit Dock, select the desired tab (if applicable), and then complete the form. Select Apply to save the form or OK to save and exit the form. Select Cancel to exit the form without saving the current entries. Completed records are listed in the All table. To view or edit an existing record, select the tab or the record in the All table.

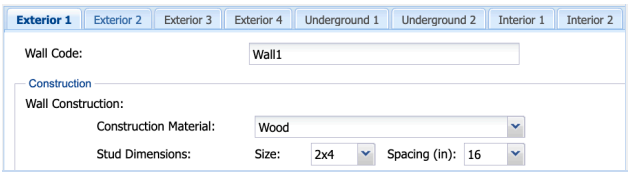


Figure 4.2. Tabs on MulTEA's Wall form.

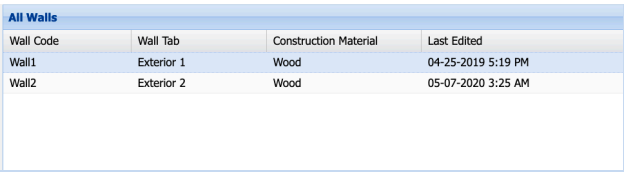


Figure 4.3. All Walls table on MulTEA's Wall form.

On the Shell, Systems, and Lighting & Appliances forms, the upper part of the main input form describes a selected component of the existing building. A field set at the bottom of the main input form describes possible retrofit measures' technical details. The retrofit measure sections are used to enter technical details about each retrofit measure. Costs for the measures are entered as part of running the audit and are discussed later in Section 4.2. Complete the retrofit measures sections as the building is being entered or before a Calibration Run is performed.

MulTEA will calculate the energy savings for a measure when the Measures Run is performed only if you have selected the Active checkbox in front of the retrofit measure. After the Measures Run has been performed, you will be able to select which measures you want to analyze as a package for the building (all measures initially analyzed will not need to be included in the package). Therefore, you can enter mutually exclusive measures (i.e., measures that cannot be performed at the same time on a building component, such as replacing a window and adding a storm window to the same window) as the building is described and analyze them when the Measures Run is performed.

4.1 DESCRIBING A BUILDING IN MULTEA

To create a new MulTEA audit, select Audit → MulTEA on the menu bar and then select New on the Audit form (State Administrators and Guests are not allowed to create an audit). Select Copy to create a new audit from an existing audit; however, this approach is not recommended the first time an audit is created for a building because of the dynamics between the information entered on the Building form and how subsequent forms (e.g., Walls, Floors) are set up. You may want to create a new audit using Copy to make multiple audit runs for a building (e.g., to analyze different packages for a given building) but still see the results of previous runs. This is discussed more in the Run 3: Package Run section.

When creating a new audit using New, fill in the Audit form first and then the Building form before entering information on the other forms. The formats of other forms are dependent on some of the Building form entries. Complete the Wall form before completing the Window and Door forms.

The Audit and especially the Building forms are described in detail here because of their uniqueness to MulTEA. Less detail is provided on the other forms because their completion is similar to other Weatherization Assistant audit tools. Section 4.2 describes how to run MulTEA.

Audit form (required) – The Audit form is used to enter general audit information and to select weather files (stations) and libraries needed to run the audit (Figure 4.4). All the fields on this form that are not disabled or read-only are required.

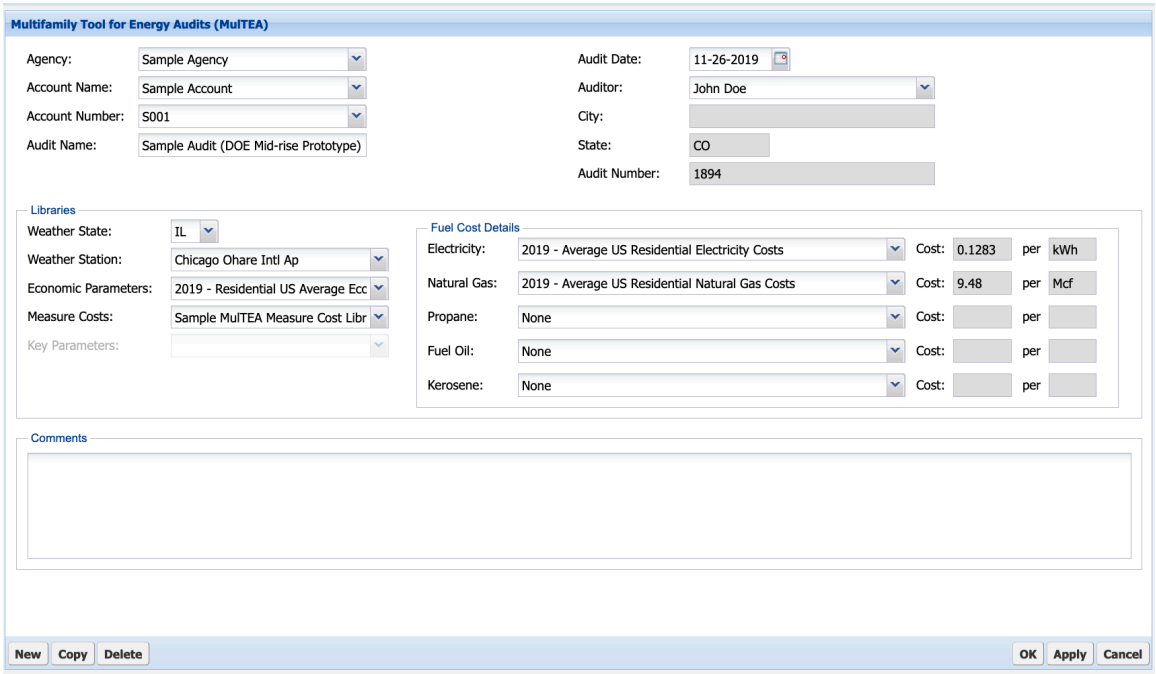


Figure 4.4. MulTEA Audit form.

At the top of the form, select the Agency and then select the account using either the Account Name or Account Number field (the other data field will be autofilled using information from the Account form). Enter an Audit Name and the Audit Date, and then select the Auditor Name (auditor names provided in the drop-down list will include all users for the Agency that are marked as Active and Auditor on the User form). The City and State fields will be autofilled using information from the Account form. The Audit Number will be automatically assigned by MulTEA.

Select the Weather State and Weather Station, Economic Parameter Set, Measure Cost Set, and Fuel Cost for each fuel type. MulTEA has ~1,000 US weather stations, which are filtered by weather state. You may also consider cities near you in states that border your own. The libraries listed in the drop-down lists are restricted to those that have been created in the respective libraries for this agency and marked Active for MulTEA. For the Fuel Cost, you can select None for fuel types that will not be used in the audit except for electricity. The fuel costs associated with the selected Fuel Cost names will be autofilled.

Building form (required) – The Building form is used to enter the overall characteristics of the building and its spaces (Figure 4.5). It defines the framework for data inputs on the Shell, Systems, and Lighting & Appliances forms.

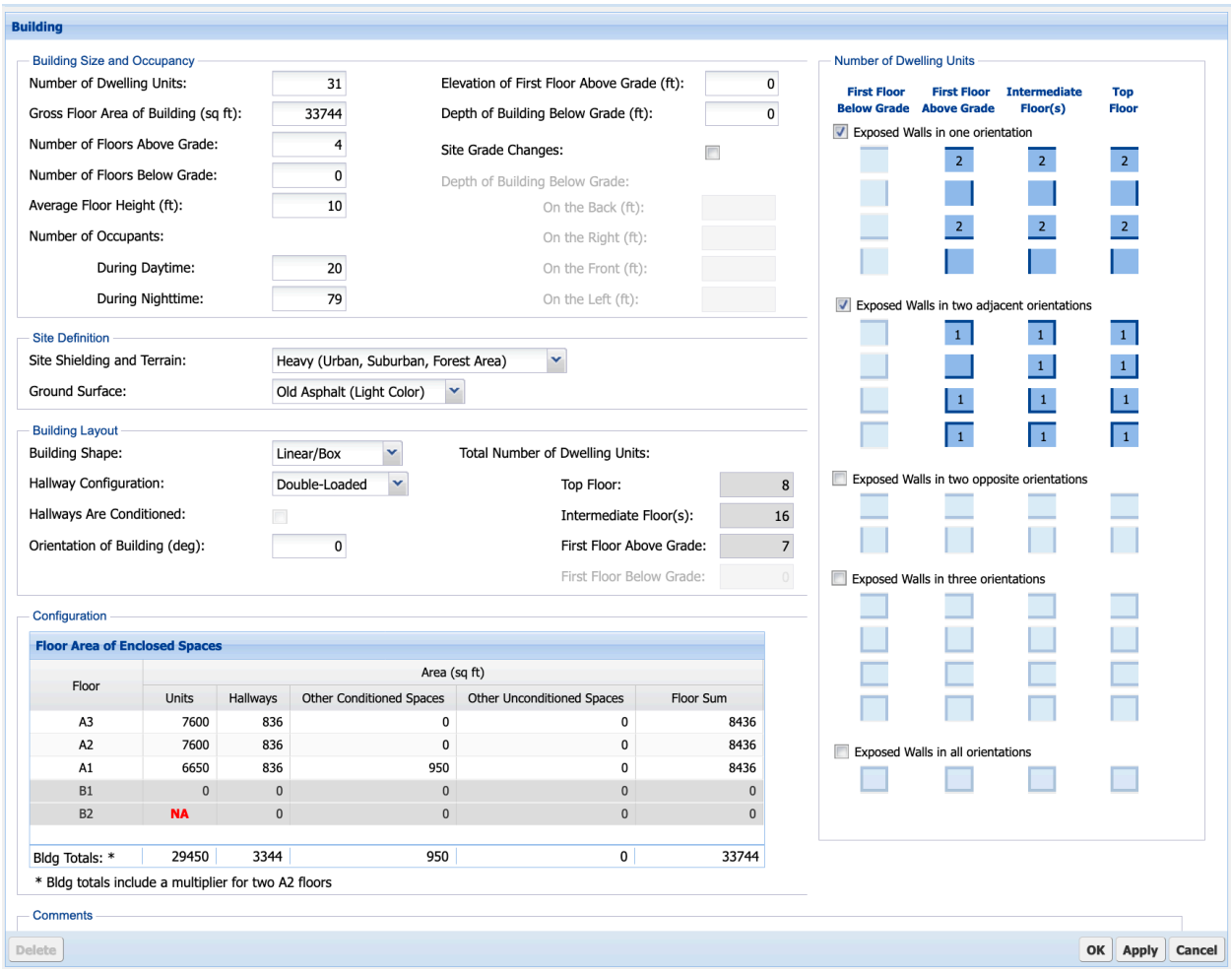


Figure 4.5. MulTEA Building form.

Before completing the Building form, first conceptualize the building as an assemblage of multiple thermal zones on different floors. Multifamily buildings typically have dwelling units facing different orientations, common areas (e.g., open or enclosed, conditioned or unconditioned hallways, lobby, laundry, mechanical room), and dissimilar layouts on different floors. Conceptualize the building as having up to four typical floors: a below-ground floor B1 (if any), a first floor A1, a top floor A3 (if the building is two stories or higher), and a typical intermediate floor A2 with a floor-multiplier (if the building is three stories or higher). Further conceptualize each typical floor as having up to four thermal zones: dwelling units, an unconditioned or conditioned hallway, any other conditioned space, and any other unconditioned space.

All fields on the Building form that are not disabled or read-only are required. You must fill in the Building form correctly and completely, with no future changes anticipated, before you save the form. Once the Building form is saved, the number of floors cannot be reduced, and the area of zones cannot be set to zero.

- **Building Size and Occupancy field set** – This field set is used to enter the number of dwelling units in the building, the total gross area of the building (including the conditioned and unconditioned zones), the number of floors above grade, the number of floors below grade (including a floor that is partially below grade), the average floor height, the elevation of the first floor above grade, the depth of the building below grade, the depth of the building below grade on all orientations if the site grade changes around the perimeter, and the number of occupants during the daytime and nighttime. MulTEA uses the number of floors above and below grade, the elevation of the first floor above grade, the depth of the building below grade, and the average floor height to determine the *z*-coordinate of the spaces and shell components on different floors. MulTEA also uses these values with details on the Wall form to model the exterior and underground walls.

- **Site Definition field set** – This field set is used to select the site shielding and terrain of the building site. Based on the selection, MulTEA will modify the wind speed in the weather file (typically measured nearest to the airport at 30 m above the ground) to the site terrain. Select the ground surface surrounding the building. Based on the selection, MulTEA will assign a ground reflectance value to be used for simulating the impact of solar radiation reflected from the ground and incident on the exterior walls, windows, and doors on the energy calculations.

- **Building Layout field set** – This field set is used to select the building shape that best represents the actual building. Also select the hallway configuration and select the checkbox if the hallways are conditioned. If there are no hallways, then the checkbox will be disabled. These selections do not affect MulTEA's energy use calculations, but they are provided to understand the building shape and configuration when describing the building and shell components. Enter the orientation of the building (i.e., the direction the back of the building faces). As shown in Figure 4.6, this is the clockwise angle between north and the building's *y*-axis (e.g., north = 0, east = 90, south = 180, and west = 270). The Total Number of Dwelling Units is a set of items showing the auto-calculated number of units on each floor. The calculation is based on the inputs in the Number of Dwelling Units field set. The value for the intermediate floor is the sum of dwelling units on all intermediate floors.

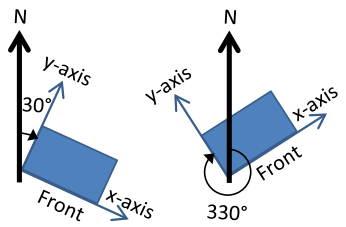


Figure 4.6. Building orientation.

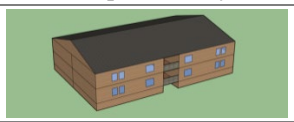
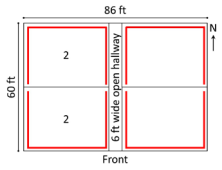
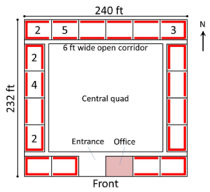
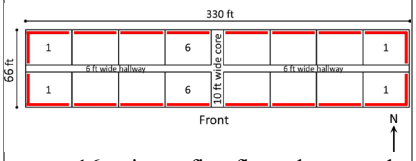
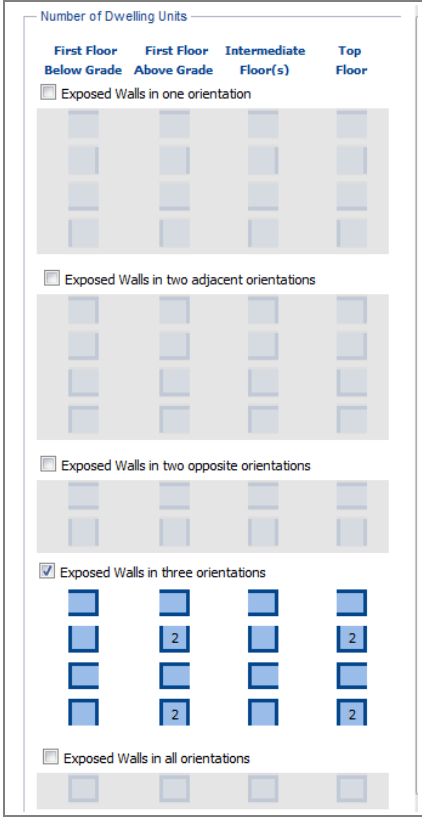
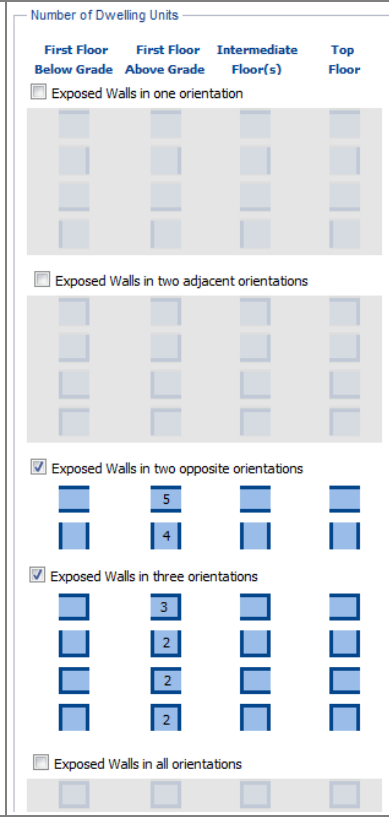
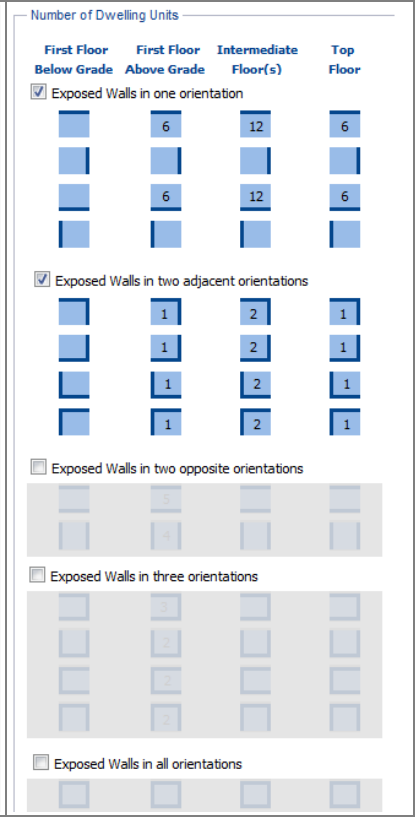
- **Number of Dwelling Units field set** – This field set is used to enter the number of dwelling units on each floor with exposure to the outside in different configurations. Boxes represent the dwelling units. The exposures to the outside are represented by bold lines. A dwelling unit of any footprint shape but

without orthogonal walls can have exterior walls facing one orientation, two adjacent orientations, two opposite orientations, three orientations, or all four orientations. A dwelling unit with nonorthogonal walls must be simplified to align the orientation of walls in the closest direction. The directions are back, right, front, and left. Enter this information assuming that you are facing the front of the building.

- Table 4.1 provides examples of how the number of dwelling units for multifamily buildings of different configurations should be described.

- **Configuration field set** – This field set is used to enter the floor area of the building space(s) on each floor by dwelling units, hallways, other conditioned space, and other unconditioned space. The floor sums and building totals are calculated automatically.

Table 4.1. Dwelling units for different multifamily building configurations

Two-story building on a crawlspace with an open hallway	One-story building on a slab with a central quad	Four-story, two-wing building over an open parking garage
		
		
• 4 units on first floor above grade • 4 units on second floor	All units on first floor	• 16 units on first floor above grade • 32 units on intermediate floors • 16 units on top floor
		

Shell forms – Shell forms are used to describe the walls, windows, doors, roofs, and floors of a building. Use these forms to describe all the thermal boundaries and the retrofit measures that you want to evaluate for these surfaces. Enter at least one wall description on the Wall form to meet the minimum requirements of MulTEA; the remaining forms are optional. These forms can be used to describe only the multifamily portion of a mixed-use building, where no heat is lost to the outside through some of the envelope components. In most buildings, though, multiple wall descriptions will be entered on the Wall form, and entries will be made on the Window, Door, Roof, and Floor forms.

The **Wall form** (required) is used to describe all exterior walls exposed to ambient conditions, underground walls of zones (including a crawlspace) that are partially or fully below the ground, and interior walls between conditioned and unconditioned spaces. Four exterior walls, two underground walls, and two interior walls can be described. Wall areas and exposed perimeters (for underground walls only) are entered by their parent thermal zone (i.e., dwelling unit, hallways, other conditioned space, and crawlspace) and orientation (i.e., back, right, front, and left sides of the building).

The **Window and Door forms** (optional) are used to describe all the windows and doors on the exterior walls. Describe up to eight different types/sizes of windows and four different types/sizes of doors. The number of each type of window is entered by the parent wall (e.g., Exterior 1, Exterior 3), thermal zone, and orientation.

The **Roof form** (optional) is used to describe all the various roof segments of the building, including attic, cathedral, and flat roofs. Their areas are entered by the parent floor (e.g., A1, A3) and thermal zone they enclose. As shown in Figure 4.7, roof insulation and ceiling insulation can be described for each of the roof types. For an attic roof, ceiling insulation is insulation on the attic floor and roof insulation is insulation on the underside the roof. For a cathedral ceiling, ceiling insulation is not applicable and roof insulation is installed in the roof cavity. For a flat roof, ceiling insulation is on the underside of the roof, and roof insulation is over the roof. A radiant barrier is applicable only to an attic roof.

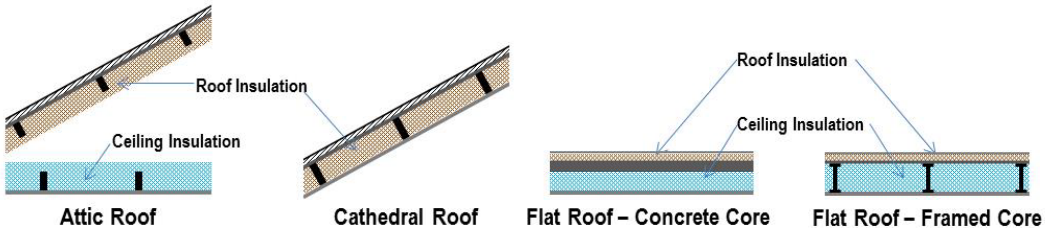
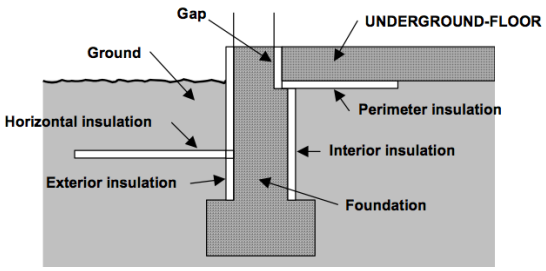
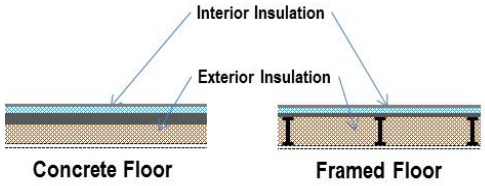


Figure 4.7. Roof insulation locations.

The **Floor form** (optional) is used to describe all the floor segments of the building, including underground floors (i.e., slab floors for thermal zones on floors A1 and/or B1), exposed floors (i.e., floors exposed to ambient conditions such as above an open parking garage), interior floors (i.e., floors of a conditioned zone above an unconditioned zone and vice versa), and floors above a crawlspace. Floor areas and exposed perimeters are entered by the parent floor and the thermal zone they enclose. Slab insulation, exterior insulation, interior insulation, and sill box insulation can be described for the floor segment depending on the floor type. For an underground floor, slab insulation can be described as installed in one of four configurations: exterior, interior, perimeter, and horizontal (Figure 4.8). Exterior insulation and interior insulation can be described for an exposed floor, interior floor, or a floor above a crawlspace, as shown in Figure 4.8. Exterior insulation is below the floor deck (within and below the floor joists), whereas interior insulation is above the floor (below the floor finish). Sill box insulation can also be described for an interior floor and a floor above the crawlspace. Sill box insulation is in the sill box of the wood frame or metal frame floor.



Underground floor

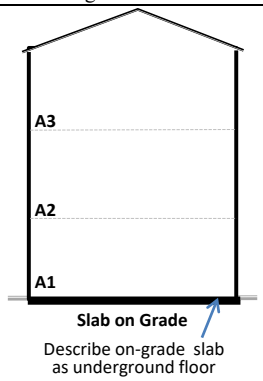
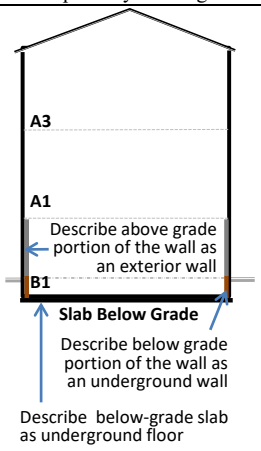
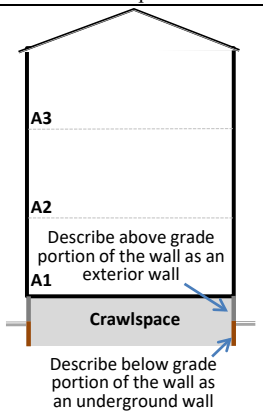


Exposed, interior, or above-crawlspace floor

Figure 4.8. Floor insulation locations.

Describing the different types of floors in MulTEA can be complex, especially for crawlspaces and below-grade floors. A correct description requires consistent entries on the Building, Floor, and Wall forms. Table 4.2 provides examples to clarify the entries for three primary foundation types: slab-on-grade floor, below-grade floor, and crawlspace.

Table 4.2. Foundation type scenarios

Foundation type	Slab-on-grade floor	Below-grade floor	Crawlspace
Description	3-story building with a slab-on-grade floor	3-story building with the bottom floor partially below grade	3-story building with a crawlspace
			
Building form			
Number of floors above grade	3	2	3
Number of floors below grade	0	1	0
Elevation of first floor above grade	0 ft	7 ft	4 ft
Depth of building below grade	0 ft	3 ft	2 ft
Floor area of enclosed spaces	Enter areas for A3, A2, and A1	Enter areas for A3, A1, and B1	Enter areas for A3, A2, and A1
Wall form		**Exterior**	**Exterior**
Construction		Describe the 7 ft above-grade portion of wall on B1	Describe the 4 ft above-grade portion of the crawlspace wall
Gross area of wall		Enter the wall area on B1 for all zones applicable	Enter the wall area in the Crawlspace row
Wall form		**Underground**	**Underground**
Construction		Describe the 3 ft below-grade portion of wall on B1	Describe the 2 ft below-grade portion of the crawlspace wall
Gross area of wall		Enter wall area for all zones applicable	Enter the wall area in the Crawlspace row
Floor form	**Underground**	**Underground**	**Above crawlspace**
Construction	Describe the slab floor of A1	Describe the slab floor of B1	Describe the floor of A1
Area and exposed perimeter	Enter the floor area and exposed perimeter for A1	Enter the floor area and exposed perimeter for B1	Enter the floor area and exposed perimeter for A1

Systems forms – Systems forms are used to describe the HVAC systems, thermostat settings, water heaters, and infiltration and ventilation associated with a building. You must enter one HVAC system, either a heating system or a cooling system, on the HVAC form and enter infiltration data on the Infiltration/Ventilation form to meet the minimum requirements of MulTEA. The Water Heating form is optional. In most buildings, though, both heating and cooling systems will be entered on the HVAC form and entries will be made on all of the other forms.

The **HVAC form** (required) is used to model HVAC systems serving individual dwelling units and individual common spaces on each floor. The System sub-form is used to describe up to six HVAC system types and specify the number of similar systems and the thermal zones they serve. The system configuration field is used to specify if the system is heating equipment only, cooling equipment only, or both (i.e., combined). If the system is a heat pump, it must be described as combined. You can describe heating equipment and cooling equipment serving the same location on the same form provided the number of similar systems applies to both. The Thermostat sub-forms are used to describe a custom thermostat schedule and/or evaluate a custom thermostat schedule as a retrofit measure in dwelling units, conditioned hallways, and another conditioned zone. These forms are optional if the thermostat schedule for all spaces is the default (i.e., 68°F for heating and 76°F for cooling for all days of the year) and no new thermostat schedule needs to be evaluated as a retrofit measure. Since you can enter only one thermostat schedule per space (i.e., dwellings, hallways, and other conditioned zone), you may need to estimate an average schedule for each space if subspaces have different schedules (e.g., if a building has 10 dwelling units and each unit has a different thermostat schedule, then determine an average schedule that is representative of all 10 units). To evaluate a new thermostat schedule as a retrofit measure, select if this measure will be implemented by installing a programmable thermostat or through client education. The energy savings will be the same, but the cost of the retrofit measure will be different for the two options, which will affect the SIR of the retrofit measure.

The **Infiltration/Ventilation form** (required) is used to enter infiltration and mechanical ventilation data. The Infiltration sub-form is used to enter infiltration as estimated air-changes per hour for the whole building or for individual spaces. Alternatively, you can enter blower door readings at 50 Pa. The Mechanical Ventilation sub-form is not activated yet. When activated, it will be used to enter space-specific or whole-building ventilation rates.

The **Water Heating form** (optional) is used to model either individual water heaters serving individual dwelling units or a central water heater serving all dwelling units in the building. Describe up to four individual water heaters using the Individual System sub-forms or a central water heater using the Central System sub-form. Both individual and central water heating systems cannot be entered into MulTEA. If an individual system has been entered and saved by selecting OK or Apply, then the Central System sub-form cannot be accessed. Conversely, if a central system has been entered, then the Individual System sub-forms cannot be accessed.

For commercial central water heaters, MulTEA requires the following nameplate type information to perform its calculations: rated input, steady-state efficiency in units of percent, and standby loss (Btu/h or %/h). The AHRI Directory of Certified Product Performance[1] can be used to find performance specifications for commercial type water heaters (select Water Heaters under Commercial). Although only newer models may be included in the database, the database may be useful to help determine reasonable estimates for specifications for older units. In general, typical standby losses appear to be approximately 0.5%–2% per hour (divide rated standby loss by rated input).

[1] http://www.ahridirectory.org/ahriDirectory/pages/home.aspx

Two entries that must be provided in the Distribution System—Central field set on the Central System form includes the number of distribution loops and the branch factor (i.e., average units per branch). Figure 4.9 is provided to help clarify these inputs. The figure shows a central water heating system with one distribution system and two branches, with five apartment units on one branch and three units on a second branch. In this case, the branch factor would be four.

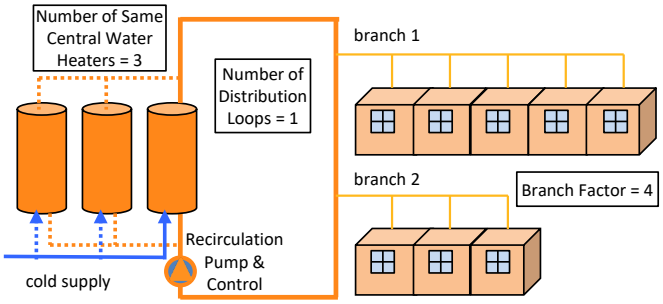


Figure 4.9. Central water heater distribution loops.

Lighting & Appliances forms – Lighting & Appliances forms are used to describe the lighting loads and lighting retrofits, appliance loads, and replacement refrigerators. You must enter the lighting loads to meet the minimum requirements of MulTEA. Refrigerator inputs are optional and only require entry to evaluate a refrigerator retrofit measure.

On the **Lighting form** (required) and the **Appliances form** (optional), enter the loads as a power density in the Loads field set of each form. The power density can be calculated by adding up the wattage of all the lighting or all the appliances/ equipment and dividing by the total floor area. For example, if 180 W of lamps were found in a 360 ft^2 room, the lighting power density would be 180/360 = 0.5 W/ft^2. Table 4.3 provides some guidance on typical power densities. Power densities are discussed more in Sections 4.5.2 and 6 of the *Technical Guidelines for Multifamily Building Energy Audits* (ORNL/TM-2014/0297).

Choose the usage schedule for lighting and appliances in the Loads field set on each of the Lighting & Appliances forms. The power densities entered into MulTEA are multiplied by appropriate lighting and appliance load schedule values to arrive at resultant powers. Medium usage should be selected when you think the use of the lights and appliances by the occupants is that of a typical multifamily building. High usage is 20% greater than medium usage and might be applicable to a building in which most of the occupants are present in their dwelling units during the day. Low usage is 20% less than medium usage and might be applicable to a building in which most of the occupants are at work during the day.

Table 4.3. Typical power density ranges (W/ft^2)

Space type	Lighting	Appliances/ equipment
Apartment	0.3–0.9	0.6–1.2
Halls	0.4–0.8	0
Office	0.7–1.3	0.7–3.0
Activity room	0.8–1.3	0–1.0
Laundry	0.6–1.1	3.0–15.0
Garage	0.1–0.2	0

Finally, enter the total installed wattage of exterior lighting in the Lighting Loads field set of the Lighting form. This should be the total wattage of exterior lights that are left on most of the night.

The Retrofit Measures field set on the Lighting form is used to describe lighting retrofit measures and is required to analyze a lighting retrofit measure. The energy use of existing lights and their heat gain to the building are already accounted for by the lighting power densities and lighting usage schedule entered in the Lighting Loads field set. In the Lighting Systems field set, describe both the existing lighting system to be a retrofit and the retrofit lighting system itself. Select Add on the Lighting Systems Dock on the left of the Lighting Systems field set, enter a Lighting System Code, select the Location, and then enter the remaining data for the existing and retrofit lighting systems. You can enter any number of lighting retrofit measures. MulTEA uses the existing and replacement lighting system information to calculate reductions in the lighting power densities for the retrofitted building.

The **Refrigerator form** (optional) is used to enter information necessary to evaluate the refrigerator replacement measure. The energy use of existing refrigerators and their heat gain to the building are already addressed by the appliance power densities and appliance usage schedule entered in the Basecase Appliance Loads field set on the Appliance form. You can evaluate up to eight types of refrigerator replacements. Specify the location and number of refrigerators to be replaced, select an input method for entering the energy use characteristics, and then enter the data accordingly. As with lighting, MulTEA uses the existing and replacement refrigerator information to calculate reductions in the appliance power densities for the retrofitted building.

Other forms (optional) – In Other forms, the **Utility Bills form** is used to enter pre-retrofit utility bills for electricity and a fossil fuel and calibration of the building inputs against these utility bills. The energy consumption of the building as predicted by MulTEA will be compared with the utility bill data on the Calibration Report. Completing the Utility Bills form is optional, but it is highly recommended because there is usually greater uncertainty in the building description data and assumptions associated with multifamily buildings than single-family homes. Comparison of the building's predicted energy use (i.e., base case prediction) against utility bills provides an opportunity to fine-tune the building description such that the energy use prediction is close to the utility bills. With a more accurate base case building description, the energy savings predictions for retrofit measures will be more reliable. Comparison of the predicted base case energy use against utility bills is more appropriate for metered fuels, such as natural gas and electricity. Bulk fuels such as propane, fuel oil, and kerosene, which are delivered in bulk and stored in tanks at the building site, 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.

Currently, in MulTEA, you can enter whole-building utility bills only, as indicated by the read-only field for Coverage, as opposed to utility bills that metered only a specific end use (e.g., the heating system, the water heating system). If multiple meters are present in a building, aggregate or total these utility bills prior to entry. To enter utility bills, perform the following steps:

1. Select weather data for calibration: Actual Meteorological Year (AMY) or TMY3. Select AMY unless AMY weather data are unavailable for the utility bill periods. This selection applies to both Electricity and Fossil Fuel tabs.

2. Enter a meter code to identify the meter.

3. Select the units of energy for the billing data: kilowatt hours or megawatt hours for electricity, and millions of British thermal units, thousand cubic feet, hundred cubic feet, or therms for fossil fuels. Propane, fuel oil, and kerosene are usually metered in gallons. Convert the gallons of fuel into millions of British thermal units by multiplying gallons by the heat content as described in Table 4.4.

Table 4.4. Fuel heat capacities

Fuel	Heat capacity (MMBtu)/gal
Propane	0.0915
Oil	0.139
Kerosene	0.135

4. In the Utility Bill Information field set, enter the billing dates and metered energy usage during the billing period. Up to 30 bills can be entered. The utility bills must be entered in chronological order. There can be gaps in the utility bills (e.g., a monthly bill may be missing), and the utility bills may extend from one year into the next. A set of utility bills that covers at least 365 days is recommended. Examples of entries are 12 consecutive monthly readings, an annual consumption, or any number of consecutive periods spanning more than a year.

5. Review the graph of the utility bills after they have been entered to determine if any period has anomalous energy use. If so, you may want to exclude that period. Use the checkboxes to select the utility bills that you want to use for calibrating the simulation results. Select or deselect all the bills at once using the buttons at the top of the table.

4.2 RUNNING MULTEA AND VIEWING RESULTS

A MulTEA audit comprises three runs (Figure 4.10):

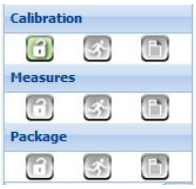


Figure 4.10. Run control buttons.

1. A **Calibration Run** to estimate the existing (i.e., base case) energy consumption of the building and calibrate the building inputs using utility bills

2. A **Measures Run** to evaluate the energy savings and cost effectiveness of individual retrofit measures applied to the building individually: In this run, each measure is analyzed as if it were the only measure applied to the building, so there are no interactive effects among measures. This run provides information to help select the measures to be included in the final package.

3. A **Package Run** to evaluate the energy savings and cost effectiveness of a selected package of retrofit measures: In this run, the interactive effects among measures are accounted for.

These runs are performed sequentially using three sets of three run control buttons (Figure 4.10) provided on the Audit Dock. Each set of buttons includes Lock, Run, and Results. The color of the buttons indicates the status of the audit run. The initial status of all buttons is gray. Figure 4.11 shows the status of the run control buttons during these runs. The steps for performing the three runs are described next.

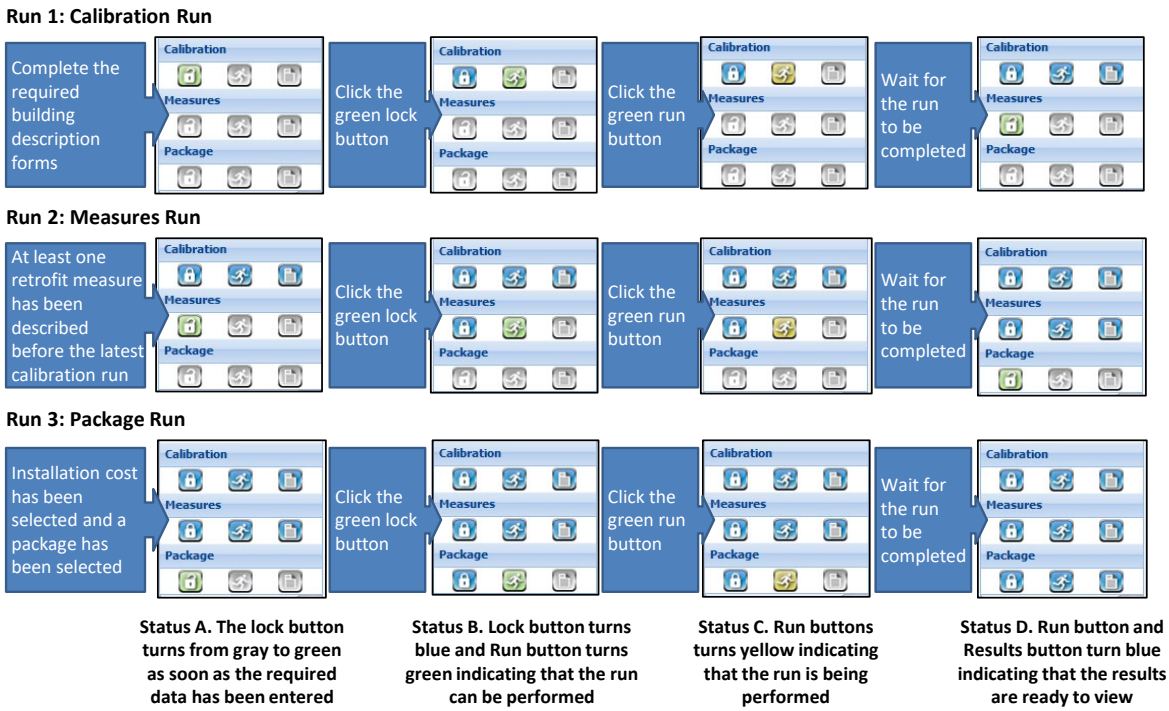


Figure 4.11. Status of run control buttons during the Calibration, Measures, and Package Runs.

Run 1: Calibration Run – Perform a Calibration Run after entering all the information for the building on the building description forms. Also enter the desired retrofit measures on the building description

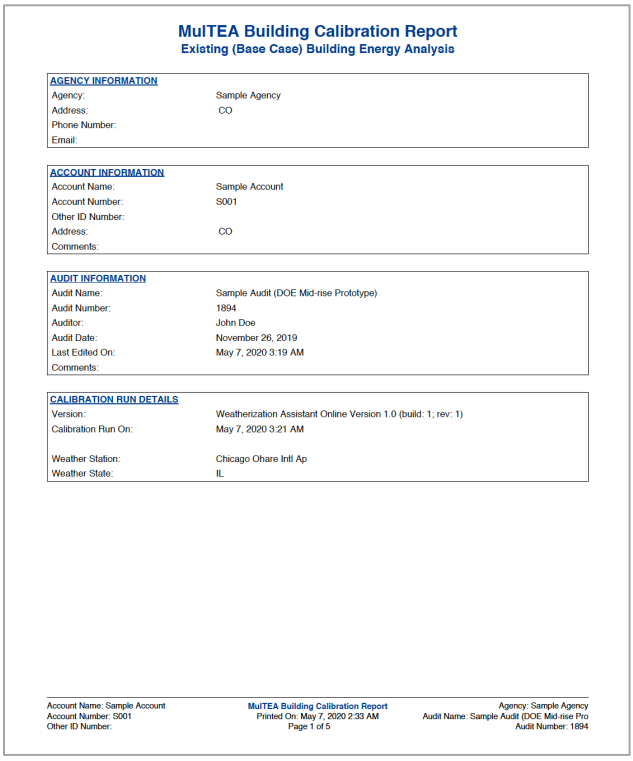
forms and make them active. They can be described and activated later, in which case the Calibration Run will have to be performed again. Utility bills can be entered to calibrate the building inputs. A Calibration Run is possible without entering utility bills, in which case only MulTEA's estimates of the building's current energy consumptions will be provided. Calibration Lock will turn green as soon as all of the required buildings forms have been completed (Status 1A in Figure 4.11).

To start a Calibration Run, select the green Calibration Lock. Calibration Lock will turn blue to indicate that the building forms are locked and prevent any changes on the building description forms (i.e., you will be able to view the building description forms, but you will not be able to make or save any changes to the forms because OK and Apply will be deactivated). Also, Calibration Run will turn green to indicate that the run can now be performed (Status 1B). Next, select the green Calibration Run. Calibration Run will turn yellow (Status 1C) to indicate that the Calibration Run has started. After the run is complete, Calibration Run and Calibration Results will turn blue (Status 1D) to indicate that the run is complete and the results are ready to view.

To view the Calibration Report, select the blue Calibration Results. Figure 4.12 shows the title page of the Calibration Report. The title page identifies the Agency, Account, Audit, and Calibration Run; provides key information you have entered on the Agency, Account, and Audit forms; and provides additional information about the Calibration Run to track the audit results.

After the title page, MulTEA's estimates of the electricity and fossil fuel consumption of the base case building are provided by end use (Figure 4.13). These results are based on TMY3 weather data.

If you entered electricity and/or fossil fuel utility bills on the Utility Bills form, MulTEA's estimates of the building's total electricity and fossil fuel consumptions will be compared with the utility bills (Figure 4.14). Data will be shown only for utility bills that were selected on the Utility Bills form. These results are based on AMY or TMY3 weather data depending on the selection for Weather Year for Calibration on the Utility Bills form.



MulTEA Building Calibration Report
Existing (Base Case) Building Energy Analysis

AGENCY INFORMATION

Agency:	Sample Agency
Address:	CO
Phone Number:	
Email:	

ACCOUNT INFORMATION

Account Name:	Sample Account
Account Number:	S001
Other ID Number:	
Address:	CO
Comments:	

AUDIT INFORMATION

Audit Name:	Sample Audit (DOE Mid-rise Prototype)
Audit Number:	1894
Auditor:	John Doe
Audit Date:	November 26, 2019
Last Edited On:	May 7, 2020 3:19 AM
Comments:	

CALIBRATION RUN DETAILS

Version:	Weatherization Assistant Online Version 1.0 (build: 1; rev: 1)
Calibration Run On:	May 7, 2020 3:21 AM
Weather Station:	Chicago Ohare Intl Ap
Weather State:	IL

Figure 4.12. MulTEA Building Calibration Report: title page.

Review the Calibration Run results, including the metrics for calibration, carefully. If the results are not satisfactory, make adjustments to the building description inputs and rerun the calibration. Inputs that may need adjustment include thermostat settings, infiltration rates, lighting and appliance power densities, and system efficiencies. To make adjustments, select the blue Calibration Lock. Calibration Lock will turn green to indicate that the building description forms are unlocked and can be changed. Also, Calibration Run and Calibration Report will turn gray to indicate that the previous run and results are now unavailable (Status 1A). Then, modify the appropriate building inputs, lock the forms, perform the Calibration Run again, and view the results. If the Calibration Run results are satisfactory, a Measures Run may be performed.

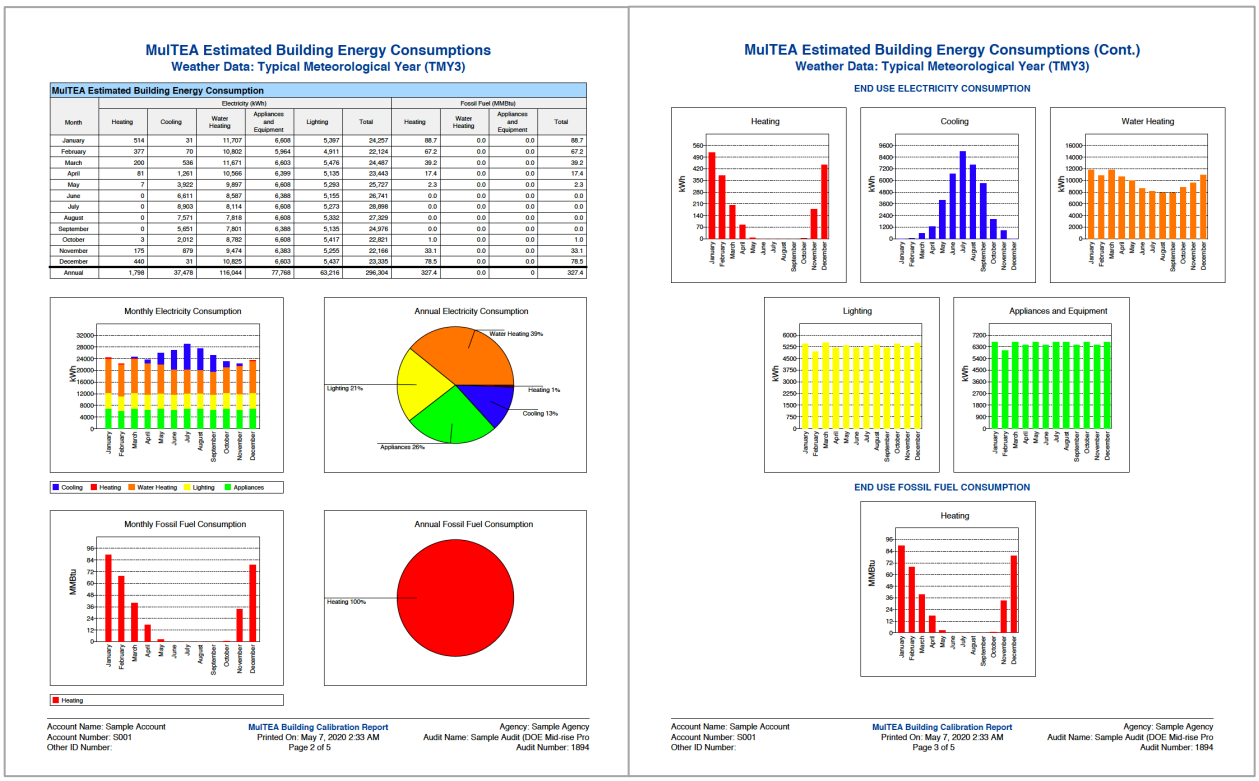


Figure 4.13. MulTEA Calibration Report: estimated energy consumptions by end use.

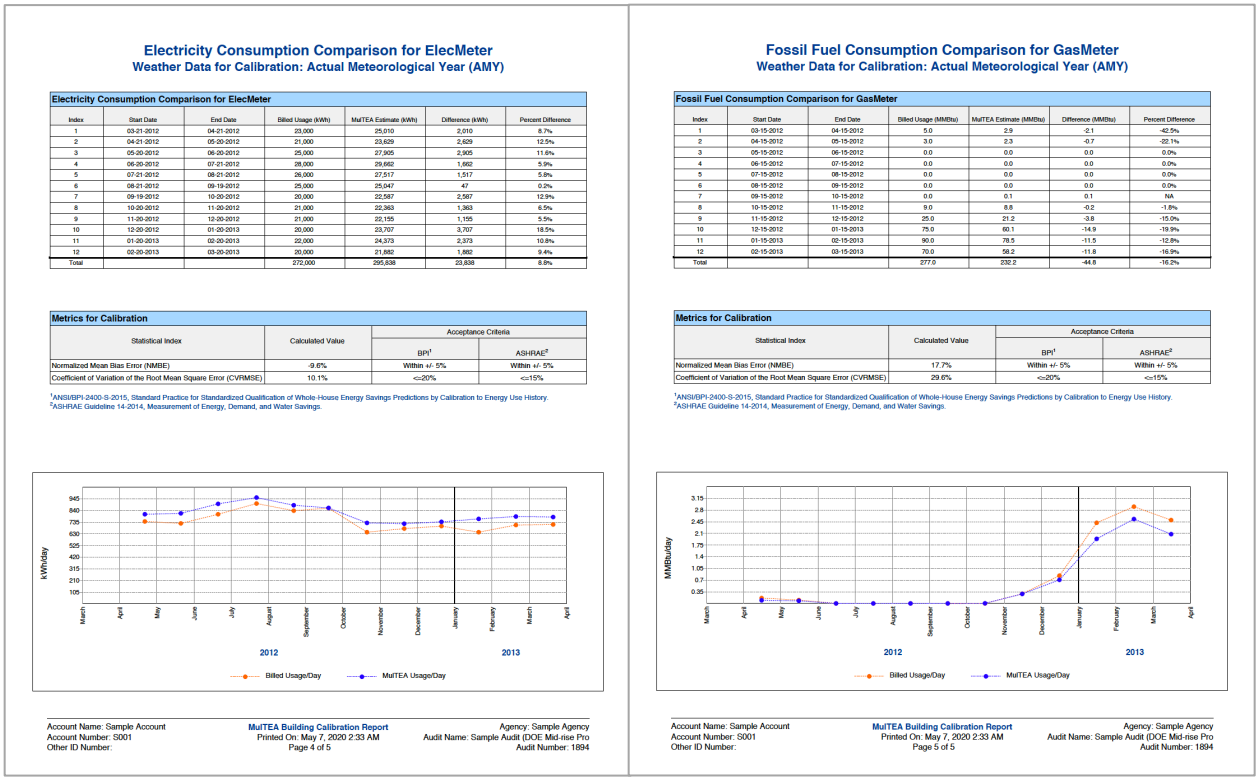


Figure 4.14. MulTEA Calibration Report: comparison of energy consumptions to utility bills.

Run 2: Measures Run – If at least one retrofit measure has been described and activated on the building forms before the last Calibration Run, Measures Lock will turn green as soon as the Calibration Run is complete (Status 2A). If you have not described and activated any retrofit measures on the building forms (i.e., Measures Lock is still gray) or they need to be modified, select the blue Calibration Lock to unlock the building description forms. Calibration Lock will turn green to indicate that the building description forms are unlocked and can be changed. Also, Calibration Run and Calibration Report will turn gray to indicate that the previous run and results are now unavailable (Status 1A). Describe/modify and activate the retrofit measures, lock the forms, and perform the Calibration Run again. In this case, the base case building inputs were not modified and the Calibration Results will return unchanged from the previous run.

To start a Measures Run, select the green Measure Lock. Measure Lock will turn blue to indicate that the building forms are locked, preventing any changes on the building description forms. Also, Measures Run will turn green to indicate that the run can now be performed (Status 2B). Select the green Measures Run. Measures Run will turn yellow (Status 2C) to indicate that the Measures Run has started. After the run is complete, Measures Run and Measures Results will turn blue (Status 2D) to indicate that the run is complete and the results are ready to view.

To view the Measures Results, select the blue Measure Results. The Measures Results consist of four forms to view energy and cost savings for individual measures, enter installation cost information, view the cost effectiveness of individual measures, and select a package of measures for further analysis (Figure 4.15). Each form has two sections: audit information on the top and results in tabular format on the bottom. All the tables list the name of the retrofit measure and the component, sub-form (if applicable), and code with which the retrofit is associated (e.g., replace the windows associated with the window WIN 1 on the Window 1 tab of the Window form).

Once you have reviewed MulTEA's predicted annual energy savings and cost savings for each measure on the Energy Savings and Cost Savings forms, respectively, enter the installation cost (materials plus labor) for each measure on the Installation Costs form. If the Retrofit Measure Cost Name for a measure shows None Defined (to indicate that no Retrofit Measure Cost Name for this measure has been defined in the Measure Cost Set Library for this audit), then enter the installation cost manually in the Adjustment column. Otherwise, you can use costs that have been entered in the Measure Cost Set Library selected for the audit to calculate the installation cost for the measure. To do this, select a name from the Retrofit Measure Cost Name drop-down list. This list will include all the Retrofit Measure Cost Names that have been created for that measure in the Measure Cost Set Library for this audit. Selecting a name will calculate an installation cost entered in the Default Estimated Installation Cost column. Fine-tune the measure cost by entering a cost adjustment in the Adjustment column (positive or negative value). The total cost will be the sum of the calculated (i.e., default) and adjustment values. You can also enter a cost directly by selecting None in the Retrofit Measure Cost Name column and then entering the total installation cost in the adjustment column. Be sure to save the installation costs that you have entered by selecting OK or Apply.

Finally, review the economics of each measure on the Economics form. The Economics form shows the SIR and simple payback period for each measure based on the predicted annual cost savings, estimated installation cost, measure lifetime, and economic parameters contained in the Economic Parameter Set Library for this audit.

Energy Savings | Cost Savings | Installation Costs | Economics

Agency: SMS
Account Name: NorthernTest
Account Number: 9999999999
Audit Name: TEST2
Audit Number: 733

Retrofit Measure Energy Savings (No Interaction Among Measures) - Table is Read Only

#	Retrofit Measure	Component	Tab	Code	Predicted Annual Energy Savings									
					Electricity (kWh)						Fossil Fuel (MBtu)			
					Heating	Cooling	Water Heating	Appliances and Equipment	Lighting	Total	Heating	Water Heating	Appliances and Equipment	Total
1	Replace Window	Windows	Window 1	WIN1	1,422	-63	0	0	0	1,358	144.20	0.00	0.00	144.20
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	107	-242	0	0	0	-136	24.30	0.00	0.00	24.30
3	Replace the System	HVAC	System 1	HEAT1	0	0	0	0	0	0	88.20	0.00	0.00	88.20
4	Air Sealing	Infiltration/Ventilation	Infiltration	Infiltration	688	573	0	0	0	1,260	50.70	0.00	0.00	50.70
5	Replace the Refrigerator	Refrigerator	Refrigerator 1	Refrig1	-4,261	17,409	0	142,214	0	155,362	-388.40	0.00	0.00	-388.40

(a) Measures: Energy Savings form

Retrofit Measure Cost Savings (No Interaction Among Measures) - Table is Read Only

#	Retrofit Measure	Component	Tab	Code	Predicted Annual Cost Savings ($)					
					Heating	Cooling	Water Heating	Appliances and Equipment	Lighting	Total
1	Replace Window	Windows	Window 1	WIN1	1,480	-8	0	0	0	1,472
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	233	-30	0	0	0	203
3	Replace the System	HVAC	System 1	HEAT1	798	0	0	0	0	798
4	Air Sealing	Infiltration/Ventilation	Infiltration	Infiltration	543	71	0	0	0	614
5	Replace the Refrigerator	Refrigerator	Refrigerator 1	Refrig1	-4,039	2,150	0	17,563	0	15,675

(b) Measures: Cost Savings form

Retrofit Measure Installation Costs

#	Retrofit Measure	Component	Tab	Code	Material Details	Retrofit Measure Cost Name	Estimated Installation Cost ($)		
							Default	Adjustment (+/-)	Final
1	Replace Window	Windows	Window 1	WIN1	Double Pane, Gas Filled - Lo...	Double Pane,Gas filled, Low-...	16,000	0	16,000
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	Fiberglass Blown	Joe's Attic Insulation	3,601	0	3,601
3	Replace the System	HVAC	System 1	HEAT1		None	0	0	0
4	Air Sealing	Infiltration/Ventilation	Infiltration	Infiltration		None	0	0	0
5	Replace the Refrigerator	Refrigerator	Refrigerator 1	Refrig1		None	0	0	0

(c) Measures: Installation Costs form

Retrofit Measure Economics (No Interaction Among Measures)

Include in Package	#	Retrofit Measure	Component	Tab	Code	Predicted Annual Cost Savings ($)	Estimated Installation Cost ($)	Lifetime (years)	Savings-to-Investment Ratio (SIR)	Simple Payback Period (years)
☑	1	Replace Window	Windows	Window 1	WIN1	1,472	16,000	20.0	1.6	10.9
☑	2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	203	3,601	25.0	1.2	17.7
☐	3	Replace the System	HVAC	System 1	HEAT1	798	0	15.0	0.0	0.0
☐	4	Air Sealing	Infiltration/Ventilation	Infiltration	Infiltration	614	0	10.0	0.0	0.0
☐	5	Replace the Refrigerator	Refrigerator	Refrigerator 1	Refrig1	15,675	0	15.0	0.0	0.0

(d) Measures: Economics form

Figure 4.15. MulTEA Measures Results forms.

Select the print icon in the upper right corner of each of the four forms to obtain a printable report of the Measures Run results. This report can also be accessed from the Reports field on the Audit Dock.

Once the Measures Run is complete and is satisfactory (e.g., installation costs are final, all desired measures are analyzed), a Package Run can be performed. If adjustments need to be made to the building description input forms (e.g., add or modify retrofit measures), you will need to unlock the forms, make the changes, and then perform the Calibration and Measures Runs again. To do so, select the blue Calibration Lock. Calibration Lock will turn green to indicate that the building description forms are unlocked and can be changed. In addition, all other Calibration and Measure buttons will turn gray to indicate that the previous runs and results are now unavailable (Status 1A). Then, modify the retrofit measures, lock Calibration Lock, perform the Calibration Run again, lock Measures Lock, perform the

Measures Run again, view the Measures Results, enter the installation costs, and view the economics of the measures.

Run 3: Package Run – The first step in performing a Package Run is to select the retrofit measures to analyze as a package. To do so, select the blue Measures Results, go to the Economics form, select the Include in Package checkboxes for the retrofit measures to analyze in a package, and then save the form by selecting OK or Apply. After you have saved the Retrofit Measures → Economics form with at least one retrofit measure selected to be analyzed in the package, Package Lock will turn green (Status 3A). To start a Package Run, select the green Package Lock. Package Lock will turn blue to indicate that the Measures Results are locked, preventing any changes to the installation costs and package selection. Also, Package Run will turn green to indicate that the run can now be performed (Status 3B). Next, select the green Package Run. Package Run will turn yellow (Status 3C) to indicate that the Package Run has started. After the run is complete, Package Run and Package Results will turn blue (Status 3D) to indicate that the run is complete and results are ready to view.

To view the Package Results, select the blue Package Results. The first three Package Results forms are used to view the interrelated energy savings, cost savings, and cost effectiveness of the individual measures in the package and the package as a whole, and to enter repair measures (Figure 4.16). A fourth form is used to enter cost sharing/leveraging and to see its effect on SIRs from the perspective of the weatherization program. Each form has two sections: audit information on the top and results in tabular format on the bottom. All the tables show the name of the retrofit measure and the component, sub-form (if applicable), and code with which the retrofit is associated (e.g., replace the windows associated with the window WIN 1 on the Window 1 tab on the Window form). The last row in the tables shows the Package Run results.

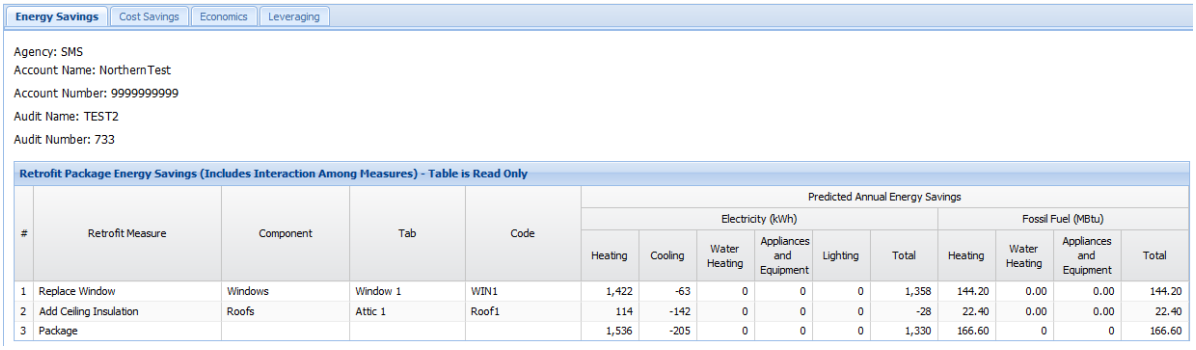
The Energy Savings, Cost Savings, and Economics forms present the individual measures in decreasing order of their SIR, which is the order in which they were applied to the building to calculate their interactive effects. The Economics form shows the SIR and simple payback period for the measures in the package based on the interrelated cost savings predicted for each measure, estimated installation cost, measure lifetime, and economic parameters contained in the Economic Parameter Set Library for this audit. The Economics form can also be used to describe and enter the costs of repair items and health and safety items. To do this, select Add Repair Cost and fill in the information in the blank row.

The Leveraging form is used to enter a buy down amount for a retrofit measure that will be obtained by leveraging another funding source (e.g., building owner contribution). The goal is usually to reduce the cost paid by the weatherization program for the retrofit measure so that the SIR from the program's perspective is 1.0 or greater. The Buydown for SIR = 1.0 column is provided for guidance and indicates the buydown amount needed to achieve an SIR of exactly 1.0. Enter the actual buydown in the next column. The estimated program installation cost and program SIR will then be calculated.

If a Package Run needs to be modified (e.g., select or remove a retrofit measure), select the blue Package Lock. Package Lock will turn green to indicate that the Retrofit Measure → Economics form is again accessible. Also, Package Run and Package Results will turn gray (Status 3A) to indicate that the package runs and results are now unavailable. Modify the package selection on the Retrofit Measure → Economics form, save the form, and then perform the Package Run again.

Select the print icon in the upper right corner of each of the four forms to obtain a printable report of the Package Run results. This report can also be accessed from the Reports field on the Audit Dock.

To save the results of several different Package Runs, go the Audit form, copy the audit, give the copied audit a new Audit Name (e.g., Example Building – Package B), perform the Calibration and Measures Runs again, select a different package, and then perform the Package Run.



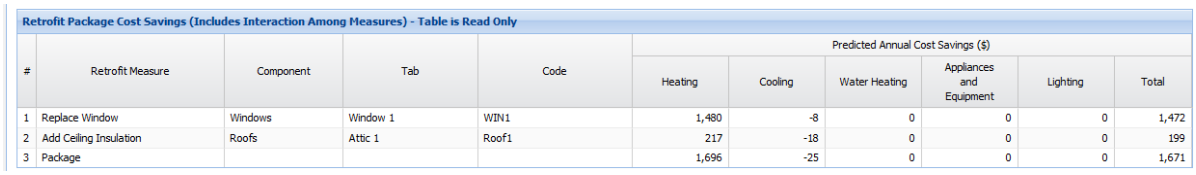
Energy Savings | Cost Savings | Economics | Leveraging

Agency: SMS
Account Name: NorthernTest
Account Number: 9999999999
Audit Name: TEST2
Audit Number: 733

Retrofit Package Energy Savings (Includes Interaction Among Measures) - Table is Read Only

#	Retrofit Measure	Component	Tab	Code	Predicted Annual Energy Savings									
					Electricity (kWh)						Fossil Fuel (MBtu)			
					Heating	Cooling	Water Heating	Appliances and Equipment	Lighting	Total	Heating	Water Heating	Appliances and Equipment	Total
1	Replace Window	Windows	Window 1	WIN1	1,422	-63	0	0	0	1,358	144.20	0.00	0.00	144.20
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	114	-142	0	0	0	-28	22.40	0.00	0.00	22.40
3	Package				1,536	-205	0	0	0	1,330	166.60	0	0	166.60

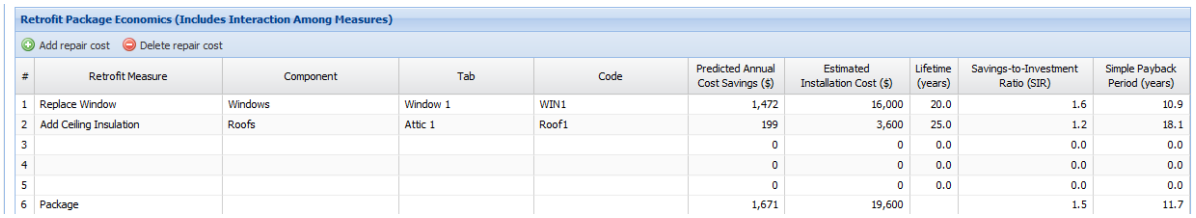
(a) Package: Energy Savings form



Retrofit Package Cost Savings (Includes Interaction Among Measures) - Table is Read Only

#	Retrofit Measure	Component	Tab	Code	Predicted Annual Cost Savings ($)					
					Heating	Cooling	Water Heating	Appliances and Equipment	Lighting	Total
1	Replace Window	Windows	Window 1	WIN1	1,480	-8	0	0	0	1,472
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	217	-18	0	0	0	199
3	Package				1,696	-25	0	0	0	1,671

(b) Package: Cost Savings form

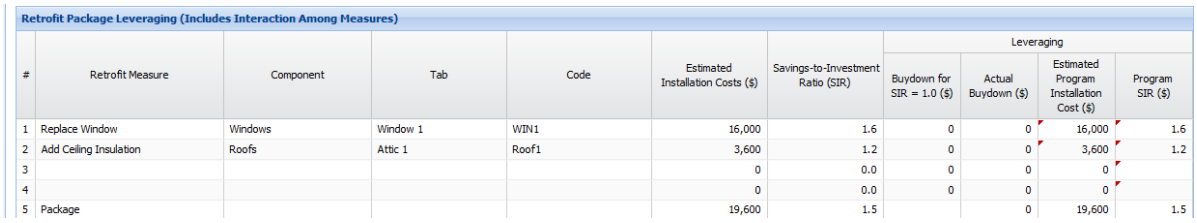


Retrofit Package Economics (Includes Interaction Among Measures)

Add repair cost | Delete repair cost

#	Retrofit Measure	Component	Tab	Code	Predicted Annual Cost Savings ($)	Estimated Installation Cost ($)	Lifetime (years)	Savings-to-Investment Ratio (SIR)	Simple Payback Period (years)
1	Replace Window	Windows	Window 1	WIN1	1,472	16,000	20.0	1.6	10.9
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	199	3,600	25.0	1.2	18.1
3					0	0	0.0	0.0	0.0
4					0	0	0.0	0.0	0.0
5					0	0	0.0	0.0	0.0
6	Package				1,671	19,600		1.5	11.7

(c) Package: Economics form



Retrofit Package Leveraging (Includes Interaction Among Measures)

#	Retrofit Measure	Component	Tab	Code	Estimated Installation Costs ($)	Savings-to-Investment Ratio (SIR)	Leveraging			
							Buydown for SIR = 1.0 ($)	Actual Buydown ($)	Estimated Program Installation Cost ($)	Program SIR ($)
1	Replace Window	Windows	Window 1	WIN1	16,000	1.6	0	0	16,000	1.6
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	3,600	1.2	0	0	3,600	1.2
3					0	0.0	0	0	0	
4					0	0.0	0	0	0	
5	Package				19,600	1.5		0	19,600	1.5

(d) Package: Leveraging form

Figure 4.16. MulTEA Package Results forms.

Reports – The Reports drop-down field on the Audit Dock is used to select an Audit Input report that provides a printout of all the inputs made in MulTEA. Printable reports of the Calibration Run, Measure Run, and Package Run results can also be accessed from the Reports field.

5. HEALTH AND SAFETY AUDIT

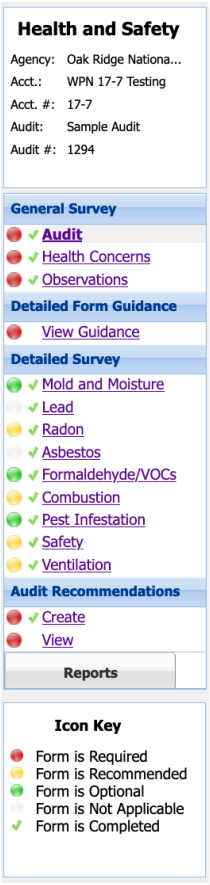


Figure 5.1. Health and Safety Audit Dock.

Once you have set up an account for a house, building, or project, you can run the Health and Safety Audit for a house or individual dwelling unit of a multifamily building within the audit project. In addition to the main forms for data input, the Health and Safety Audit has an Audit Dock that is a static feature anchored on the left (Figure 5.1), which provides a means of accessing the Health and Safety Audit's various forms and running the audit. The Audit Dock may not be displayed when creating a new audit until after the Audit form has been saved.

At the top of the Audit Dock is an information block that shows key audit information entered on the Audit form for the audit that is currently active (i.e., being viewed). Links to each of the Health and Safety Audit's 14 forms are provided below the information block. These links are organized into four groups: General Survey (data input), Detailed Form Guidance (read-only output), Detailed Survey (data input), and Audit Recommendations (output). Colored icons are presented beside these links to indicate if the form is required, recommended, or optional. A legend for the icons is shown in the Icon Key at the bottom of the Audit Dock. Finally, Reports can be selected to access various reports available within the Health and Safety Audit for the active audit.

Many of the Detailed Survey forms in the Health and Safety Audit have separate data input sections to document evidence of a particular issue and the source of the issue (e.g., the Radon form). Several forms have tabs at the top of the form to provide access to different data input sections (Figure 5.2).

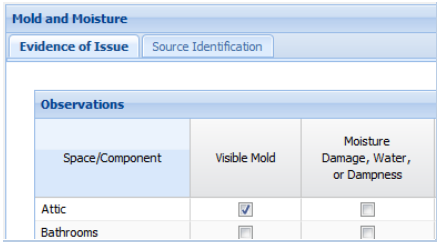


Figure 5.2. Tabs on the Mold and Moisture form.

To access 1 of the 14 forms, select the form in the Audit Dock, select the desired tab if applicable, and then complete the form (unless read-only). Select Apply to save the form or OK to save and exit the form. Select Cancel to exit the form without saving the current entries.

To use the Health and Safety Audit, first complete the General Survey forms, which include audit information and preliminary screening questions on health and safety issues (Figure 5.3). Select View Guidance to see guidance on which of the Detailed Survey forms need to be completed to investigate specific health and safety issues based on the preliminary screening questions. Follow the guidance and complete only the recommended Detailed Survey forms, or complete any of the optional forms to further investigate those health and safety issues. The audit uses the inputs on the Detailed Survey forms to generate its recommendations.

Figure 5.3. Schematic of the Health and Safety Audit.

5.1 DESCRIBING A HOUSE OR DWELLING UNIT IN THE HEALTH AND SAFETY AUDIT

To create a new Health and Safety audit, select Audit → Health and Safety Audit on the menu bar and then select New on the Audit form (State Administrators and Guests are not allowed to create an audit). Select Copy to create a new audit from an existing audit. When creating a new audit using New, fill in the Audit form first and then the remaining General Survey forms before entering information on the Detailed Survey forms. The Audit form is described in some detail here because of its uniqueness to the Health and Safety Audit. Less detail is provided on the other forms because their completion is more straightforward. Section 5.2 describes how to run the Health and Safety Audit.

Audit form (required) – The Audit form is used to enter general audit information and select a weather file needed to run the audit (Figure 5.4). All the fields on this form that are not disabled or read-only are required.

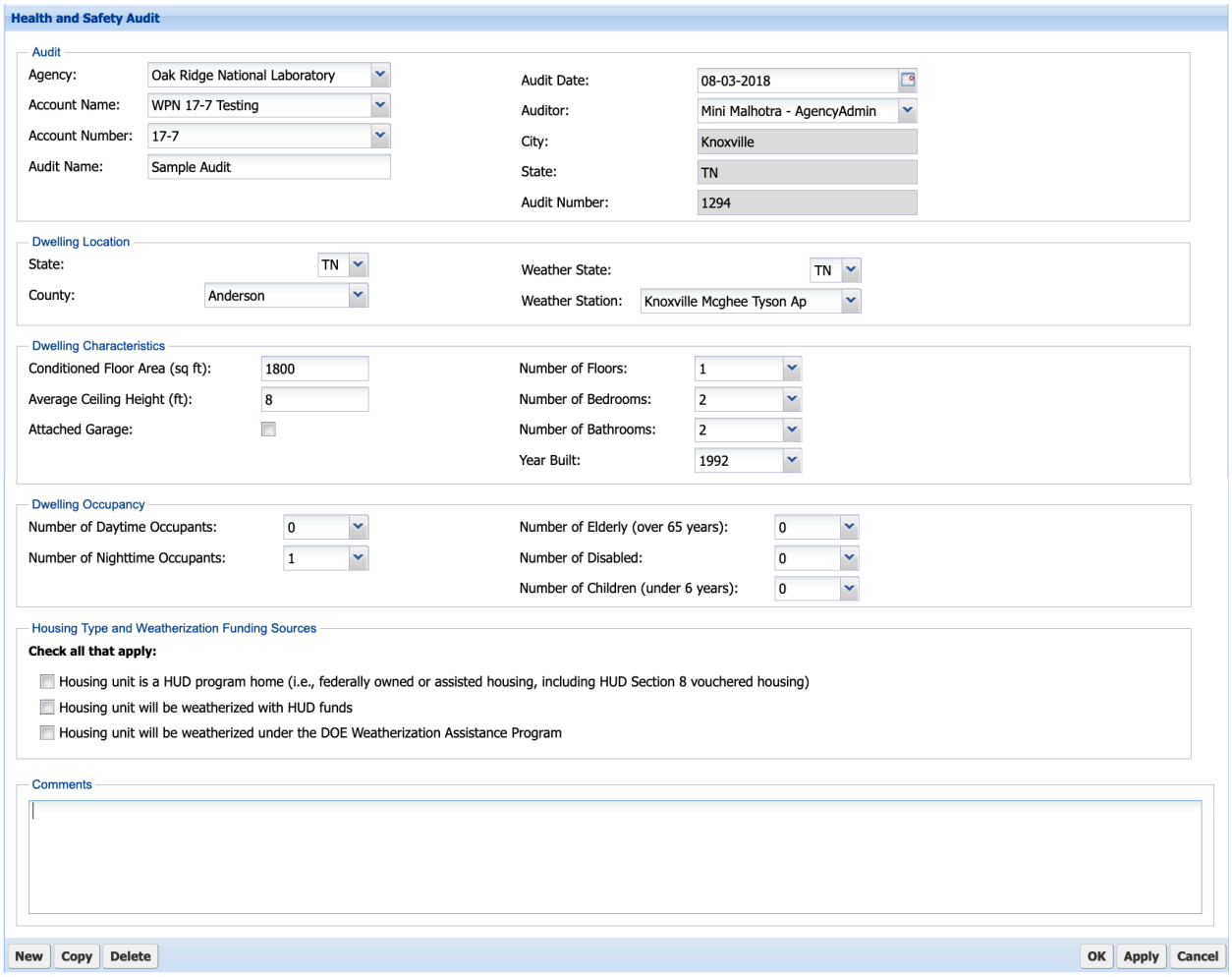


Figure 5.4. Health and Safety Audit form.

At the top of the form, select the appropriate Agency and then select the account using either the Account Name or Account Number field (the other data field will be autofilled using information from the Account form). Enter an Audit Name and the Audit Date, and then select the Auditor Name (auditor names provided in the drop-down list will include all users for the Agency that are marked as Active and Auditor on the User form). The City and State fields will be autofilled using information from the Account form. The Audit Number will be automatically assigned by the Health and Safety Audit.

Select the state and county where the house or dwelling unit is located (these are used to identify the radon zone for the building) and the Weather State and Weather Station (weather information is used in the ventilation calculations). The Health and Safety audit has ~1,000 US weather stations, which are filtered by weather state. You may also consider cities near you in states that border your own.

Finally, enter the information requested in the data fields in both the Dwelling Characteristics and Dwelling Occupancy field sets, and select the applicable checkboxes in the Housing Type and Weatherization Funding Sources field set (Figure 5.5, Figure 5.6). You may have to scroll down to see the latter two field sets.

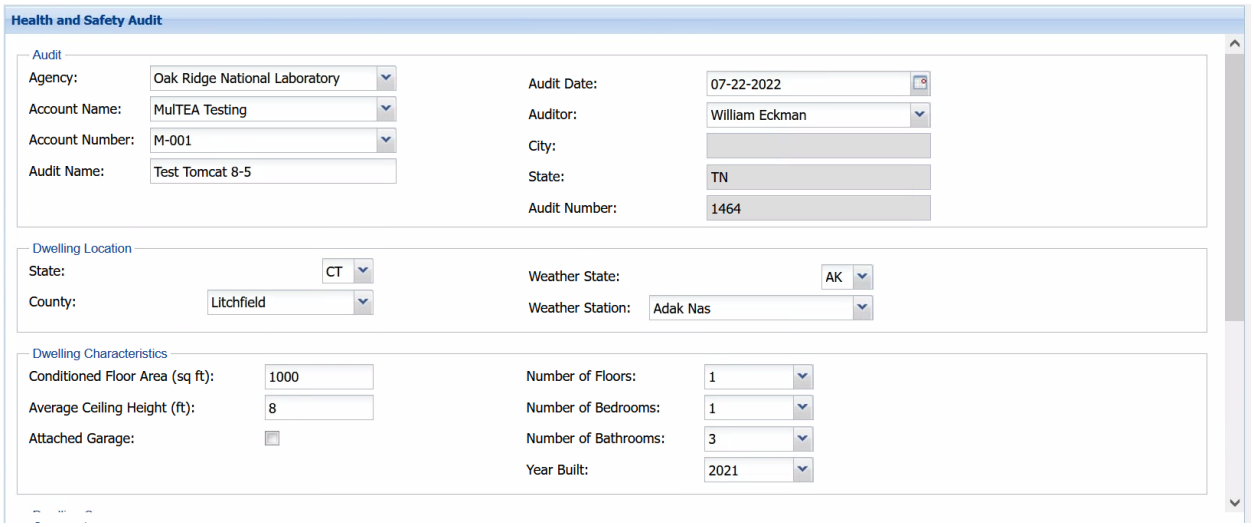


Figure 5.5. Health and Safety Audit form (top portion).

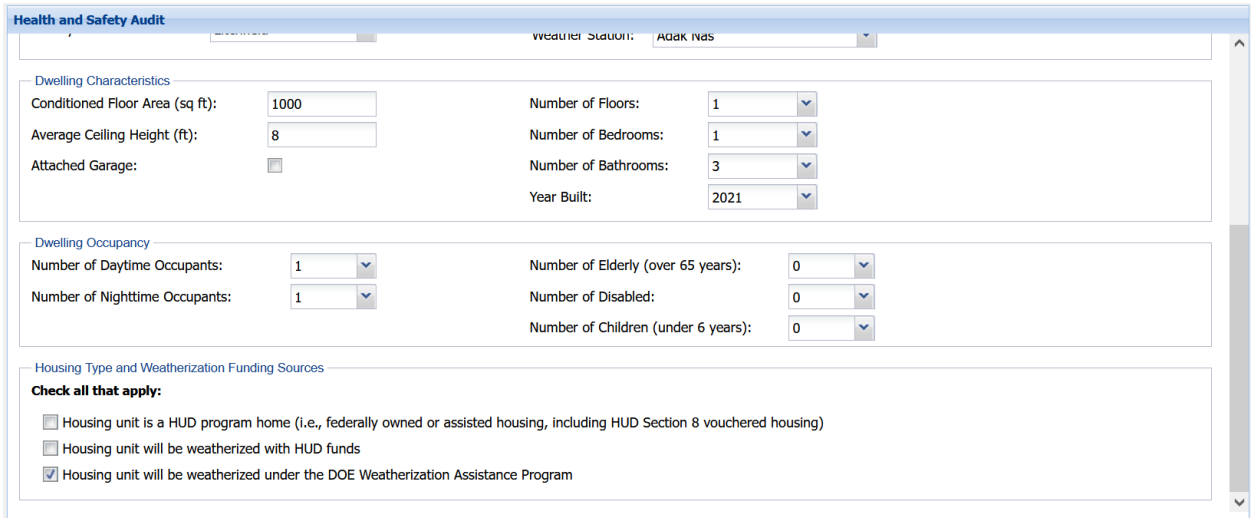
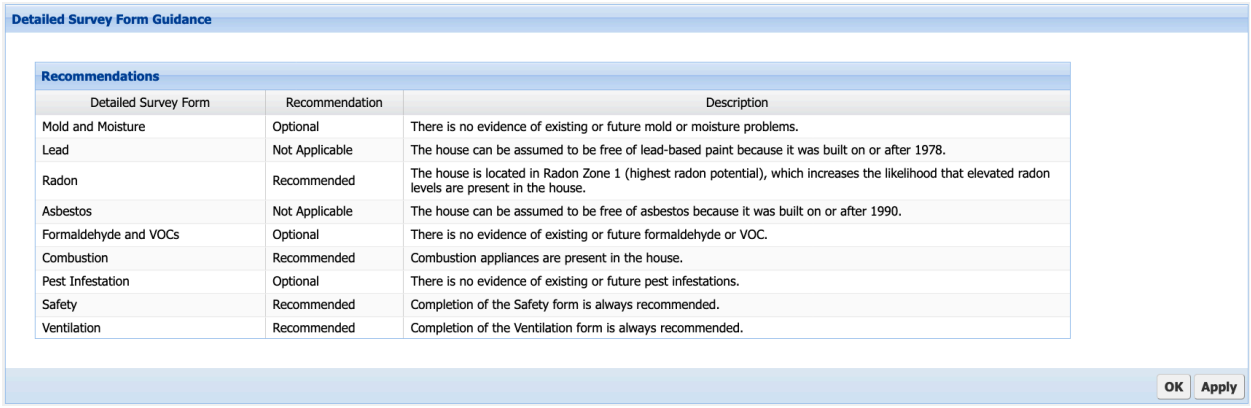


Figure 5.6. Health and Safety Audit form (bottom portion).

General Survey forms – General Survey forms include three data input forms. The **Audit form**, as discussed, is used to enter general audit information and details about the house or dwelling unit. The **Health Concerns form** is used to identify specific occupant health symptoms that may indicate the presence of existing health and safety issues in the dwelling. The **Observations form** is used to identify general observations regarding the dwelling that may indicate the presence of existing or potential problems. Observations related to mold and moisture, lead, radon, formaldehyde and volatile organic

compounds (VOCs), combustion appliances, pest infestation, and planned weatherization work can be identified. Complete each of these three forms and then select OK or Apply to activate the Detailed Survey Form Guidance.

Detailed Survey Form Guidance – Based on your inputs on the General Survey forms, the audit generates Detailed Survey Form Guidance to provide the status of existing or potential health and safety issues and recommendations regarding which issues warrant a detailed survey. Select the View Guidance form (read-only) to view the audit's recommendations regarding which of the Detailed Survey forms are Recommended, Optional, or Not Applicable, and the audit's explanation as to why the guidance is presented (Figure 5.7). The audit will always recommend completion of the Safety and Ventilation forms. You must view the Detailed Survey Form Guidance form and select OK or Apply to activate the Detailed Survey forms.



Detailed Survey Form	Recommendation	Description
Mold and Moisture	Optional	There is no evidence of existing or future mold or moisture problems.
Lead	Not Applicable	The house can be assumed to be free of lead-based paint because it was built on or after 1978.
Radon	Recommended	The house is located in Radon Zone 1 (highest radon potential), which increases the likelihood that elevated radon levels are present in the house.
Asbestos	Not Applicable	The house can be assumed to be free of asbestos because it was built on or after 1990.
Formaldehyde and VOCs	Optional	There is no evidence of existing or future formaldehyde or VOC.
Combustion	Recommended	Combustion appliances are present in the house.
Pest Infestation	Optional	There is no evidence of existing or future pest infestations.
Safety	Recommended	Completion of the Safety form is always recommended.
Ventilation	Recommended	Completion of the Ventilation form is always recommended.

Figure 5.7. Health and Safety Audit Detailed Survey Form Guidance.

Detailed Survey forms – Detailed Survey forms include data input forms corresponding to the nine health and safety issues addressed in the audit: mold and moisture, lead, radon, asbestos, formaldehyde and VOCs, combustion appliances, pest infestation, safety, and ventilation. These forms are used to determine the existence and severity of problems from visual assessments, make quantifying measurements, and pinpoint the sources of existing or potential problems. Each of the nine forms is discussed here.

Data on the **Mold and Moisture form** are entered on two sub-forms. First, indicate the evidence of mold and moisture in different spaces and components on the Evidence of Issue sub-form (Figure 5.2). Then, on the Source Identification sub-form, identify sources where you have indicated the evidence of an issue. The items related to sources of mold and moisture are grouped by the spaces and components listed on the Evidence of Issue sub-form.

The **Lead form** is used to provide details about interior and exterior painted surfaces that may be disturbed by weatherization and indicate the results of lead testing, if performed. Refer to the notes provided on the form for guidance on completing the form.

The **Radon form** is used to indicate whether you want to conduct radon testing both before and after weatherization, post-weatherization only, or not at all. Data fields in the Indoor Radon Measurements table will be activated or deactivated depending on your selection under Radon Assessment Approach. Enter the testing information in the Indoor Radon Measurements table as applicable. Indicate if the dwelling has an existing radon reduction system, and then identify potential radon entryways in the Source Identification form.

The **Asbestos form** is used to (potentially) indicate asbestos-containing materials present on different building and system components. For components where asbestos may be present, indicate the condition of the asbestos-containing material. Refer to the notes provided on the form for guidance on completing the form.

The **Formaldehyde and VOCs form** is used to enter the results of a formaldehyde measurement (if conducted) and identify existing and potential sources and conditions that could cause formaldehyde and VOCs to be present in the dwelling.

The **Combustion form** is applicable only if the presence of combustion appliance(s) is indicated on the General Survey → Observations form. Combustion information is entered on two sub-forms. Complete the Safety Inspection sub-form first. Identify all the combustion appliances in the dwelling on this form, and then enter safety inspection observations for each appliance. Enter combustion-related measurements on the Performance Testing sub-form after the Safety Inspection sub-form has been completed. All the vented combustion appliances identified on the Safety Inspection sub-form will be listed automatically in the Measurements table in the CAZ Measurements field set of the Performance Testing sub-form.

Data on the **Pest Infestation form** are entered on two sub-forms. Indicate the evidence of pest infestation on the Evidence of Issue sub-form. Identify sources of pest infestation on the Source Identification sub-form, including pest harborage, food and water sources, and pest entryways that may encourage pest infestation.

Safety related questions are grouped under four sub-forms of the **Safety form**. In the General Safety sub-form, hazards are categorized as injury prevention, hazards for people who area elderly and disabled, and child safety hazards. Hazards in the Structural Safety sub-form are grouped by structural components, including roof, walls, windows, doors, stairs, floor, and porch, patio, or balcony. In the Fire Safety sub-form, hazards are grouped to identify the absence of or malfunctioning fire safety equipment, including smoke alarms, CO alarms, and fire extinguisher. The presence of other fire hazards can also be identified. In the Electrical Safety sub-form, hazards are grouped to identify issues related to knob and tube wiring and other electrical hazards.

The **Ventilation form** is used to check compliance with ASHRAE Standard 62.2 and provides recommendations to achieve compliance. Indicate if the exception to the ASHRAE Standard 62.2 whole-building mechanical system requirement applies to the dwelling unit. Then, select the ASHRAE Standard 62.2 version with which to check compliance. The options are 2010, 2013, 2016, and Not Applicable. Indicate if the exception to the ASHRAE 62.2 occupant density calculation applies. Read-only fields that you entered on the Audit form and that are pertinent to the ventilation calculations are displayed. Enter dwelling unit specific data in the Fields pertinent to the 2013/2016 field set, which appears if the ASHRAE Standard 62.2 version selected is 2013 or 2016. Enter observations about the clothes dryer exhaust; these inputs will be checked against the prescriptive requirements of ASHRAE Standard 62.2 and recommendations will be generated accordingly. Enter observations and measurements about the kitchen and bath exhausts; these inputs will be used in calculating the mechanical ventilation requirement as well as recommending any prescriptive measures**.** Finally, enter pre-weatherization, target, and/or post-weatherization blower door measurements. Select the blower door measurements to use in calculating the required whole-building mechanical ventilation rate. Fields for entering blower door measurements are activated only when an infiltration credit can be taken (i.e., depending on the version of ASHRAE Standard 62.2 selected and the type of dwelling unit selected).

5.2 RUNNING THE HEALTH AND SAFETY AUDIT AND VIEWING RESULTS

Based on inputs on the Detailed Survey forms, audit recommendations are generated to

- Recommend remedial actions to address existing health and safety issues and preventive measures for potential issues

- Provide notification when weatherization work should be delayed until corrective actions are taken

- Enable measure selection and identification of a responsible organization

To create the audit recommendations, select Create. Audit recommendations are provided on different tabs corresponding to each of the nine health and safety issues (Figure 5.8). Each tab provides a list of recommendations for each Detailed Survey form completed. For each recommendation, checkboxes are provided to indicate when the action must be performed before weatherization. You can also identify if your intended action is to implement the recommendation under weatherization, refer the recommendation to another organization, recommend to the client that they need to address the issue, or defer the recommendation. To help determine your intended action, guidance based on WPN 17-7 and other supplementary sources is provided under four categories:

- Factors to consider in determining if recommendation required before or as part of weatherization

- General notes regarding interaction with weatherization measures

- Mold cleanup guidance and radon mitigation guidance under respective forms

- Notes applicable to the Weatherization Assistance Program

Select the drop-down box for each category to view the guidance.

Once an audit has been run (i.e., you have selected Create), you can select View to see audit recommendations that have already been created and saved.

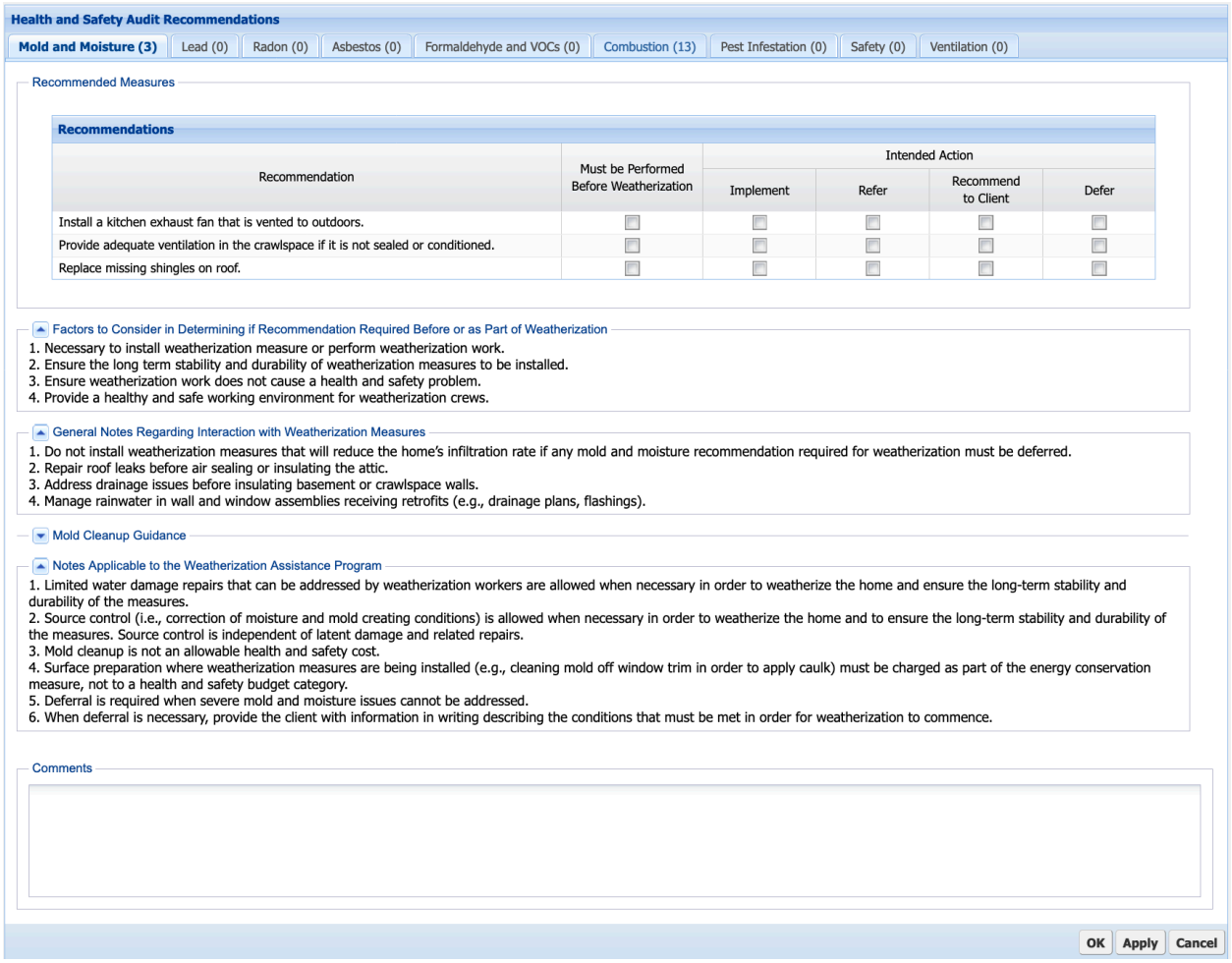


Figure 5.8. Health and Safety Audit Recommendations form.

Reports – The Reports drop-down field on the Audit Dock is used to select Audit Results and provides a printable report of the audit recommendations. The Reports field also provides access to an Audit Input report, which provides a printout of all the input made in a Health and Safety Audit and a Data Collection report, which further provides a form for collecting the Health and Safety Audit information in the field.