WEB-BASED WEATHERIZATION ASSISTANT GETTING STARTED GUIDELINE
June 6, 2017

This guideline provides introductory information on how to get started in using the web-based Weatherization Assistant audit tool and running a Multifamily Tool for Energy Audits (MulTEA) or a Health and Safety audit. The guideline covers the following topics:

INTRODUCTION

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's (DOE's) Weatherization Assistance Program. It is also used by utilities and other home energy professionals. The Weatherization Assistant is developed and maintained by the Oak Ridge National Laboratory (ORNL).

The Weatherization Assistant is composed of the following four audit programs: the National Energy Audit Tool (NEAT) for site-built single-family homes, the Manufactured Home Energy Audit (MHEA) for mobile homes, MulTEA for multifamily buildings, and the Health and Safety Audit. The three energy audit tools assist auditors in identifying the 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 to prevent health and safety issues from occurring following weatherization

The application-based Weatherization Assistant currently provides access to NEAT and MHEA. The web-based version of the Weatherization Assistant, which this guideline addresses, provides access to MulTEA and the Health and Safety Audit.

MulTEA

MulTEA is an 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 is a DOE-approved audit tool for use in the Weatherization Assistance Program in all multifamily buildings with

individual heating and cooling systems. MulTEA was developed jointly by the ORNL and the Lawrence Berkeley National Laboratory.

MulTEA evaluates each building individually after taking into account local weather conditions, retrofit measure costs, fuel costs, and specific construction and operation details of the building. After describing envelope components, heating and cooling systems, and base load equipment (e.g., refrigerators, water heaters, lighting), 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 estimates of the energy savings, dollar savings, installation cost, and savings-to-investment ratio (SIR) for each recommended measure and the package of recommended measures to be installed. A method for determining the amount of leveraged funds needed to make the DOE Weatherization Assistance Program investment cost effective for each selected measure is also provided.

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, especially those undergoing weatherization. When combined with weatherization programs, the audit provides a comprehensive health and safety 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 U.S. Department of Housing and Urban Development's Office of Healthy Homes and Lead Hazard Control and its Healthy Homes Program, and the DOE Weatherization Assistance Program.

The tool utilizes comprehensive checklists together with measured diagnostic data to identify potential health and safety issues in a home and provide recommendations for the prevention and mitigation of identified problems. The tool assesses not only existing health and safety issues, but also the impact of existing conditions on weatherization work and 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 upon the US Environmental Protection Agency's (EPA's) Healthy Indoor Environment Protocols for Home Energy Upgrades (dated October 2011) and incorporates the guidance contained in DOE Weatherization Program Notice 11-6, Weatherization Health and Safety Guidance (dated January 12, 2011).

LOGGING IN TO THE WEB-BASED WEATHERIZATION ASSISTANT

You will log in to the web-based Weatherization Assistant using the following link: http://hyperion.ornl.gov/wx/ (see Figure 1). You will generally obtain the login information (Username and Password) from ORNL, your state, or the agency for which you work.

Figure 1. Log in web page.

Upon logging in, you will see a Menu bar that is located at the top of the user interface (see Figure 2). The Menu bar provides access to the administrative forms (i.e., Agency,

Account, and User), Audits (MulTEA and the Health and Safety Audit), and Libraries needed to run MulTEA (Economic Parameters, Fuel Costs, and Measure Costs). The Menu bar also provides a link to obtain more information about the Weatherization Assistant, your name, and a link to log out. It may also provide access to Options and Help menus in the future.

Figure 2. Menu bar at the top of the user interface.

GENERAL LAYOUT AND NAVIGATION

A typical form has two sections: the main form on the top for data input, and an All table at the bottom for selecting an existing record to be displayed on the main form (see the User form in Figure 3 for an example).

Figure 3. User 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 (e.g., User Details in Figure 3). Data input fields are frequently grouped within a boundary that is called a data set (e.g., Login Information in Figure 3). The task bar contains New, Copy, and Delete buttons to create or delete a record. The Apply button saves the record, and the OK button

saves the record and closes (i.e., exits) the form. The Cancel button exits the form without saving the entries that you just made.

Data input fields are usually ghosted if not relevant in certain context or grayed if read-only. Data input in individual fields may be required or optional. If a required field is left blank or the input is out of range or in an incorrect format, the form cannot be saved; a red border will be provided around the required field and a validation failure message will appear when the OK or Apply buttons are selected. Some data input fields display a tooltip if you hover your mouse over the field that describes the field, the acceptable format, and/or the acceptable range of the input.

The All table at the bottom of the form shows all the records that you can select to be shown on the main form. You should just click on the record in the All table that you want to view.

The All table has a title bar and a table with a header row. The column headers show key field names of the form, each with a mouse over button on the right (the button will appear when you hover your mouse over the header). This button allows sorting 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. 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 columns, drag the column heading to the new location. The magnifying glass on the right of the header row is the filter toggle button to show or hide a filter bar below the header row. To filter the records, click the filter toggle button and enter the filtering criteria in for one or more columns. To clear all the filters, click the cross button that appears below the filter toggle button.

REVIEWING THE USER AND AGENCY FORMS

You should click on User > View User to see the user record (see Figure 3) that was created by the entity that provided you with your login information (Guests are not allowed access to the User form, as described below). You should identify the privilege level that was assigned to you by looking at the entry in the Privilege Level field. Your privilege level determines your access to different forms and records. A user can have one of six privilege levels. These levels and their levels of access are described below.

- **Site Administrators** – Have access to all state-specific databases. They have no restriction to create and edit records.

- **State Administrators** – Have access to all records in the database for their state. They can create new users and agencies in their state. They can view all accounts, audits, libraries, and users for all agencies in their state.

- **Agency Administrators** – Have access to all records for their agency. They can view all users for their agency, create new users for their agency, and can edit their own user record except for Privilege Level and Agency Information. They can view and edit all agency records for their agency. They can view and create new accounts, audits, and libraries for their agency.

- **Lead Auditors** – Have access to all records for their agencies. They can view all users for their agencies and edit their own user record except for Privilege Level and Agency Information, but they cannot create new users. They can view but not edit agency records for their agency. They can view and create new accounts, audits, and libraries for their agencies.

- **Auditors** – Have access to all records for their agencies. They can view all users for their agency and edit their own user information except for Privilege Level and Agency Information, but they cannot create new users. They can view but not edit agency records and all libraries for their agency. They can view and create new accounts and audits for their agency.

- **Guests** – Can only view audits for their agency. They cannot access the Account, Agency, Library, and User forms.

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 (not shown when viewing), Privilege Level, Agency, Last Name, and State. Make sure the Active checkbox is checked. You should also make sure the Auditor checkbox is checked if you might be creating an audit in the future. This will allow your name to be listed on the Auditor dropdown field on the Audit form for MulTEA and the Health and Safety Audit. If these checkboxes need to be updated and you are an Auditor or Lead Auditor, your Agency Administrator may need to make the change.

You should also click on Agency > View Agency to see the agency record that has been created for you (Guests are not allowed access to the Agency 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 (see Figure 4). The only required fields on this form are Agency Name, Agency Type, and State. Make sure the Active checkbox is checked to allow the agency name to be listed on the Agency dropdown field on the Audit form for MulTEA and the Health and Safety Audit.

Figure 4. Data input fields on the Agency form.

LIBRARIES (APPLICABLE TO MULTEA ONLY)

There are three libraries that can be accessed from the Library button on the Menu bar by clicking on Libraries > [Library Name] (Guests are not allowed access to the Library forms):

- **Economic Parameters** – These libraries provide the fuel price indices and modified uniform present worth (UPW) factors required to perform economic calculations in MulTEA. These are provided for eight fuels for 30 years: electricity, natural gas, propane, fuel oil, kerosene, wood, coal, and other.

- **Fuel Costs** – These libraries provide the costs for eight fuels used in MulTEA: electricity, natural gas, propane, fuel oil, kerosene, wood, coal, and other.

- **Measure Costs** – These libraries (see Figure 5) collect overall measure cost information. They provide access to Retrofit Measure Cost Details forms (see Figure 6) which collect material and installation cost details and lifetime for individual retrofit measures programmed into MulTEA for use by energy audits for economic calculations.

Figure 5. Data input fields on the Measure Cost Set Library form.

Figure 6. Data input fields on the Retrofit Measure Cost Details form.

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

ORNL will create a new, read-only economic parameter set applicable to the US each year when new parameters are issued by DOE, usually in May. Thus, you will generally not need to create a new or updated Economic Parameters library unless you want an economic parameter set that is unique to your state or agency.

Eventually, you will need to create your own Fuel Costs and Measure Costs libraries to reflect actual costs for your location and agency and, in the case of the Measure Costs library, to make it easier to program a building into MulTEA. ORNL has created a set of read-only Fuel Cost libraries that reflect average costs for the US (to be updated annually) that you can use as you become familiar with MulTEA and before you are ready to run MulTEA for an actual building you are auditing. Similarly, ORNL has created an example read-only Measure Costs library that you can use as you become familiar with MulTEA. Measure costs can be entered into MulTEA manually for each building being audited, so initially an accurate and agency-specific Measure Cost library is not required to run MulTEA, especially as you learn and become familiar with the software. Eventually, however, you will need to develop an agency-specific Measure Costs library to ensure accuracy and ease of use.

To create a new library, you will need to access the library form and then either (a) click the New button on the task bar and complete the form, or (b) select an existing library record from the All [library type] table, click the Copy button on the task bar, and edit the input information as needed. It is recommended that new Economic Parameters libraries be created using the latter approach. Be sure that the Active for MulTEA checkbox is checked for new Economic Parameters and Fuel Costs libraries that you create, and that the Is Active checkbox is checked for new Measure Costs libraries.

ACCOUNT FORM

You will need to access and fill in a new Account form (see Figure 7) before you can run MulTEA or the Health and Safety Audit (i.e., you must first set up an account for a building or project before you can run an audit on a building). The Account form allows you to enter account information about the building or project such as its name, number (e.g., job number), and address. The only required fields are the Agency, Account Name, Account Number, and State. The information in the DOE Quarterly Report section is data used by states in reporting results to DOE and is completely optional, as are the Primary Language and Utility Account fields.

To create a new account, click on Account > View Account on the Menu bar and then click the New button (State Administrators and Guests are not allowed to create an account). The Copy button can also be used to create a new account.

Figure 7. Data input fields on the Accounts form.

MULTEA

Once you have set up an account for a building or project, you can run MulTEA on that building or a building within the project. The forms in MulTEA, in addition to having a main form for data input and possibly an All table for record navigation (see the General Layout and Navigation section), also have an Audit Dock that is a static feature anchored on the left (see Figure 8) and provides you with the 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 8. MulTEA Audit Dock.

At the top of the Audit Dock is an information block that shows key audit information that has been entered on the Audit form for the audit that is currently active (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 and Appliances, 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. The meaning of the icons is shown in the Icon Key at the bottom of the Audit Dock. Three sets of buttons (Calibration, Measures, and Package) are provided to allow you to run MulTEA. The use of these buttons will be described later in the Running MulTEA and Viewing Results section. Finally, there is a Report field with a dropdown box arrow. Clicking on the dropdown arrow provides you with access to various reports available within MulTEA for the audit that is currently being viewed.

Many of the data input forms in MulTEA allow multiple records to be described for a building component. For example, in Figure 9, several different exterior, underground, and interior wall types can be entered on the Wall form. These forms have Tabs presented 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 (see Figure 10).

Figure 9. Tabs on the Wall form.

Figure 10. All table on the Wall form.

To complete one of the 14 building data input forms, you should click on the form in the Audit Dock, click the desired Tab if applicable, and then complete the form. You will need to click Apply to save the form or OK to save and exit the form. Click Cancel if you want to exit the form without saving the entries that you just made. The completed records will be listed in the All table. To view or edit an existing record, click on the Tab or the record in All table.

On the Shell, Systems, and Lighting and Appliance groups of forms, the upper part of the main input form is dedicated to describing a selected component of the existing building, while a data set at the bottom of the main input form is provided to describe possible retrofit measures to this building component. The retrofit measure sections allow you to enter technical details on the retrofit measures. Cost for the measures are entered as part of running the audit as discussed later in the Running MulTEA and Viewing Results section. You should complete these 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 Measure run is performed only if you have checked the Active checkbox in front of the retrofit measure. After the Measure 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 can't 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 Measure run is performed.

Describing a Building in MulTEA

To create a new MulTEA audit, click on Audit > MulTEA on the Menu bar and then click the New button on the Audit form (State Administrators and Guests are not allowed to create an audit). The Copy button can also be used to create a new audit from an existing audit, but 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 the Copy button if you want to make multiple audit runs for a building (e.g., to analyze different packages for a given building) but want to be able to still see the results of previous runs. This is discussed more in the Run 3: Package Run section.

When creating a new audit using the New button, you should always 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. Also, you will need to fill in the Wall form before completing the Window and Door forms.

The Audit and especially the Building forms are described in some detail below because of their uniqueness to MulTEA. Less detail is provided on the other forms because their completion is more straightforward. A separate section below will discuss how to run MulTEA.

Audit Form (Required) – The Audit form allows you to enter general audit information and to select weather files and libraries needed to run the audit (see Figure 11). All of 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 auto-filled 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 dropdown 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 auto-filled using information from the Account form. The Audit Number will be automatically assigned by MulTEA.

You then need to select the Weather State and Weather Station, Economic Parameters and Measure Costs Sets, and Fuel Cost for each fuel type. MulTEA has 1,020 US weather stations which are filtered by

Weather State. You may wish to consider not only those cities in your state, but also cities near you in states that border your own. The Economic Parameter Set names, Measure Cost Set names, and Fuel Cost names that will be listed in the dropdown lists are restricted to those that have been created in the respective libraries for this agency and marked Active for MulTEA. **[Note: Currently, all libraries will be listed whether active or not.]** For the Fuel Cost, you can select None for fuel types that will not be used in the audit. The fuel costs associated with the selected Fuel Cost names will be auto-filled.

Figure 11. Data input fields on the Audit form.

Building Form (Required) – The Building form allows you to enter the overall characteristics of the building and its spaces (see Figure 12). It defines the framework for data inputs on the Shell, Systems, and Lighting & Appliances groups of forms.

Figure 12. Data input fields on the Building form.

Before completing the Building form, you should 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 often dissimilar layouts on different floors. You need to 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). You also need to conceptualize each typical floor as having up to four thermal zones: dwelling units, an unconditioned or conditioned hallway, an other conditioned space, and an other unconditioned space.

A discussion of each of the data fields on the Building form is provided below. All fields on this form that are not disabled or read-only are required. It is imperative that you 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 Data Set** – 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 night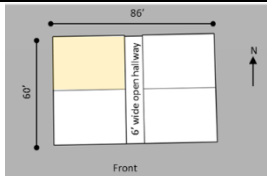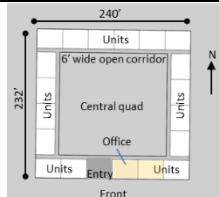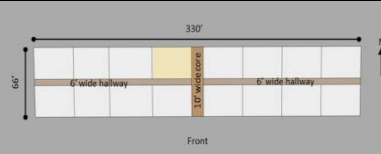time. The number of floors below grade can be two if the site is sloping. MulTEA uses the number of floors above and below grade, the elevation of the first floor above grade, the depth of the building below grade, and the average floor height to determine the z-coordinate of the spaces and shell components on different floors. MulTEA also uses these values with details on the Walls form to model the exterior and underground walls.

- **Site Definition Data Set** – 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 at the airport at a height of 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 Data Set** – Select the building shape that best represents your building. Also select the hallway configuration and check the checkbox if the hallways are conditioned. If there are no hallways, the checkbox will be disabled. These selections have no impact on MulTEA's energy use calculations, but they are provided to help you focus on 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 13, this is the clockwise

Figure 13. Building orientation.

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 data set on the right. The value for the intermediate floor is the sum of dwelling units on all intermediate floors.

- **Number of Dwelling Units Data Set** – This data set allow you to enter the number of dwelling units on each floor with exposure to the outside in different configurations. The 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 non-orthogonal walls needs to be simplified to assume 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 1 shows examples of how the Number of Dwelling Units for multifamily buildings of different configurations should be described.

Table 1. Describing Dwelling Units for Different Multifamily Building Configurations

- **Configuration Data Set** – This data set allows you to enter the floor area of the building space on each floor by dwelling units, hallways, other conditioned space, and other unconditioned space. The floor sums and building totals are calculated automatically.

Shell Forms – The group of Shell forms includes forms to describe the walls, windows, doors, roofs, and floors of a building. You will use these forms to describe all the surfaces in the building through which heat flows and the retrofit measures that you want to evaluate for these surfaces. You must enter one wall description on the Wall form to meet the minimum requirements of MulTEA. The remaining forms are optional. This allows you to describe 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 Windows, Doors, Roofs, and Floors forms.

The **Wall form** 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 unconditioned and conditioned 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** are used to describe all the windows and doors on the exterior walls. You can 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 their parent walls (e.g., Exterior 1, Exterior 3), thermal zone, and orientation.

The **Roof form** 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 14, 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 insulation that is installed in the roof cavity. For a flat roof, ceiling insulation is the insulation on the underside of the roof and roof insulation is insulation over the roof. A radiant barrier is applicable only to an attic roof.
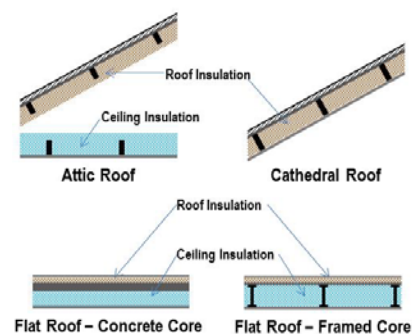
Figure 14. Roof insulation locations.

The **Floor form** 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 being installed in four configurations: exterior, interior, perimeter, and horizontal (see Figure 15). Exterior insulation and interior insulation can be described for an exposed floor, interior

Underground Floor
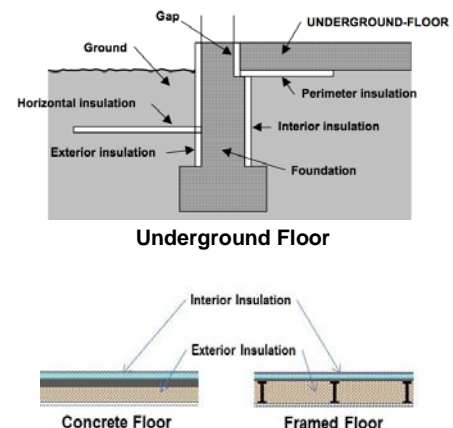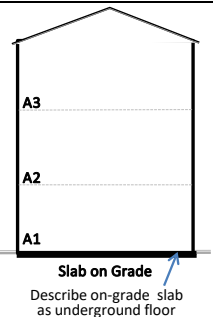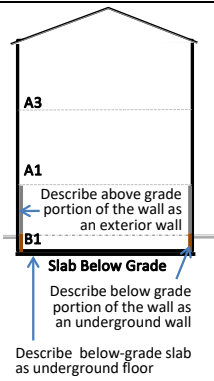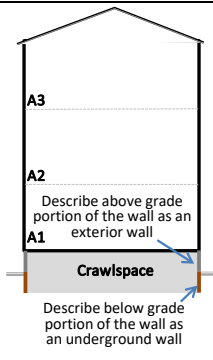
Exposed, Interior or Above-Crawlspace Floor

Figure 15. Floor insulation locations.

floor, or a floor above a crawlspace as shown in Figure 15. Exterior insulation is insulation below the floor deck (within and below the floor joists), whereas interior insulation is insulation above the floor (below the floor finish). Sill box insulation can also be described for an interior floor and an above-crawlspace floor. Sill box insulation is insulation in the sill box of the wood frame or metal frame floor.

Describing the different types of floor situations in MulTEA can be a little confusing, especially for crawlspaces and below grade floors. A correct description requires consistent entries on the Building, Floor, and Wall forms. The examples provided in Table 2 are meant to clarify the entries for three primary foundation types: slab-on-grade floor, below grade floor, and crawlspace.

Table 2. Describing 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
Walls Form Tab		**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 wall area on B1 for all zones applicable	Enter wall area in "Crawlspace" row
Walls Form Tab		**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 wall area in "Crawlspace" row
Floor Form Tab	**Underground**	**Underground**	**Above Crawlspace**
Construction	Describe slab floor of A1	Describe slab floor of B1	Describe floor of A1
Area and Exposed Perimeter	Enter floor area and exposed perimeter for A1	Enter floor area and exposed perimeter for B1	Enter floor area and exposed perimeter for A1

Systems Forms – The group of Systems forms includes forms 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 form to meet the minimum requirements of MulTEA. The remaining forms are 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** allows modeling of HVAC systems serving individual dwelling units and individual common spaces on each floor. The System tabs allow you to describe up to six HVAC system types and specify the number of same systems and the thermal zones they serve. The system configuration field allows you to specify if the system you are describing 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 same systems applies to both.

The Thermostat tabs 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 will 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, you will have to come up with 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 impact the savings-to-investment ratio of the retrofit measure.

The **Infiltration/Ventilation form** allows you to enter infiltration and mechanical ventilation data. The Infiltration tab allows you to enter infiltration as estimated air-changes per hour for the whole building or for individual units. Alternatively, you can enter blower door readings at 50 Pa. The Mechanical Ventilation tab is not activated yet. **[Note: Currently, the Mechanical Ventilation tab can be accessed, but no entries should be made on this form.]** When activated, it will allow you to enter space-specific or whole-building ventilation rates.

The **Water Heater form** allows modeling of either individual water heaters serving individual dwelling units or a central water heater serving all dwelling units in the building. You can describe up to four individual water heaters using the Individual System tabs or a central water heater using the Central System tab. Both individual and central water heating systems cannot be entered into MulTEA. If an individual system has been entered and saved by clicking the "OK" or "Apply" buttons, then the Central System tab will not be able to be accessed. Conversely, if a central system has been entered, then the Individual System tabs will not be able to be accessed.

For commercial type 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 in units of either Btu/hr or % per hr. The AHRI Directory of Certified Product Performance (http://www.ahridirectory.org/ahriDirectory/pages/home.aspx) 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 data base, the data base may be useful to help determine

reasonable estimates for specifications for older units. In general, typical standby losses appear to be on the order of 0.5-2% per hr (divide rated standby loss by rated input).

Two entries that must be provided in the Distribution System – Central data set on the Central System form are the Number of Distribution Loops and the Branch Factor (i.e., average units per branch). Figure 16 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.
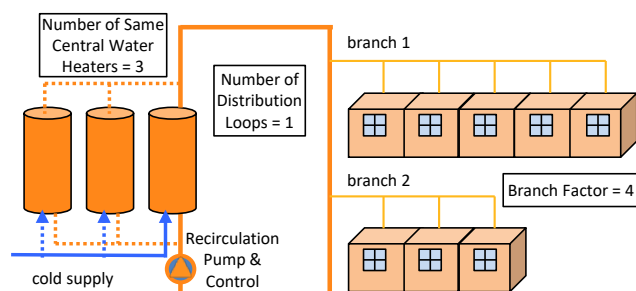
Figure 16. Central water heater distribution loops.

Lighting and Appliances – The group of Lighting and Appliances forms include forms to describe the lighting loads and lighting retrofits, appliance loads, and replacement refrigerators. You must enter the lighting and appliance loads to meet the minimum requirements of MulTEA. Refrigerator replacements need to be entered only if you want to evaluate a refrigerator retrofit measure.

On the **Lighting form** and the **Appliances form**, you need to enter the loads as a power density in the Loads data set of each form. The power density can be calculated by adding up the

Table 3. Typical Power Density Ranges (W/sq-ft)

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

wattages 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 sq ft room, the lighting power density would be 180/360 = 0.5 W/sq-ft. Table 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). **[Note: The report will be published in the near future.]**

You also need to choose the Usage Schedule for lighting and appliances in the Loads data set on each of the Lighting and Appliance 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.

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

The Lighting Systems data set on the Lighting form is used to describe lighting retrofit measures. **[Note: The data set will be renamed to Retrofit Measures in the future to be clearer.]** You do not need to fill in any information in the Lighting Systems data set unless you want 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 data set. In the Lighting Systems data set, you must describe both the existing lighting system to be retrofit and the

retrofit lighting system itself. Click Add on the Lighting Systems Dock on the left of the Lighting Systems data 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** is used to enter information necessary to evaluate the refrigerator replacement measure. If this measure is not going to be evaluated for a specific audit, the Refrigerator form does not need to be filled out. 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 data set on the Appliance form. You can evaluate up to eight types of refrigerator replacements. You will need to specify the location and number of refrigerators to be replaced, select your preferred 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 – Under the Other group, the **Utility Bills form** allows you to enter pre-retrofit utility bills for electricity and a fossil fuel if you want to calibrate the building inputs against these utility bills. The energy consumption of the building as predicted by MulTEA will be compared to 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 uncertainly in the building description data and assumptions associated with multifamily buildings than say 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 better 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, MulTEA only allows you to enter Whole Building utility bills as indicated by the read only field for Coverage. To enter utility bills:

- Enter a Meter Code to identify the meter.

- Select the [Weather] Data Entry Type. This field allows you to select the type of weather parameter that you will enter with the utility bills (HDD Only, CDD Only, HDD and CDD, or Average Temperature). Select None if this information is unavailable. Your selection will add columns to the Utility Bill Information table where you can enter the values. MulTEA will show these values on the Calibration Report and compare them to values taken from the weather file used to predict the energy use of the building. This allows you to determine the degree that differences between predicted energy consumptions and the utility bills might be due to weather differences. The Degree Day Base Temp. (°F) field is relevant only if HDD or CDD are being entered. Currently, this is a read only field with 65 °F set as the degree day base temperature.

- Select the units of energy for the billing data: kWh or MWh for electricity, and MMBtu (millions of Btu), MCF (thousand cubic feet), CCF (hundred cubic feet), or Therms for fossil fuels. Propane, fuel oil, and kerosene are usually metered in gallons. Convert the gallons of fuel into MMBtu by multiplying gallons by the heat content as shown in Table 4.

Table 4. Fuel Heat Capacities

Fuel	Heat Capacity (MMBtu)	Per Unit
Propane	0.0915	Gallon
Oil	0.139	Gallon
Kerosene	0.135	Gallon

- In the Utility Bill Information data set, enter the billing dates, metered energy usage during the billing period, and weather parameter (HDD, CDD, or Average Temperature depending on your selection in the Data Entry Type field). 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 a 365-day period is recommended. Examples of entries are twelve consecutive monthly readings, one annual consumption, or any number of consecutive periods spanning more than a year. **[Note: Currently, the utility bills must be from the same calendar year. A software glitch is causing utility bills that extend from one year into the next year to work incorrectly.]**

- You should 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. You may select or deselect all the bills at once using the buttons at the top of the table.

Running MulTEA and Viewing Results

A MulTEA audit is comprised of three runs:

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 is the only measure applied to the building, so there are no interactive effects between measures. This run provides the auditor with information to help in the selection of 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 between measures are accounted for.

These runs are performed sequentially using three sets of three run control buttons (see Figure 17) that are provided on the Audit Dock. Each set of buttons includes a Lock button, a Run button, and a Results button. The color of the buttons indicates the status of the audit run. The initial status of all buttons is gray. Figure 18 shows the status of the run control buttons during these runs. The steps for performing the three runs are described next.

Figure 17. Run control buttons.

Run 1: Calibration Run

| | Click the green lock button | | Click the green run button | | Wait for the run to be completed |

Run 2: Measures Run

| | Click the green lock button | | Click the green run button | | Wait for the run to be completed |

Run 3: Package Run

| | Click the green lock button | | Click the green run button | | Wait for the run to be completed |
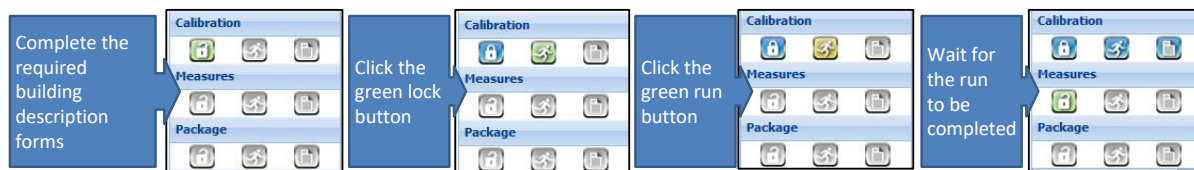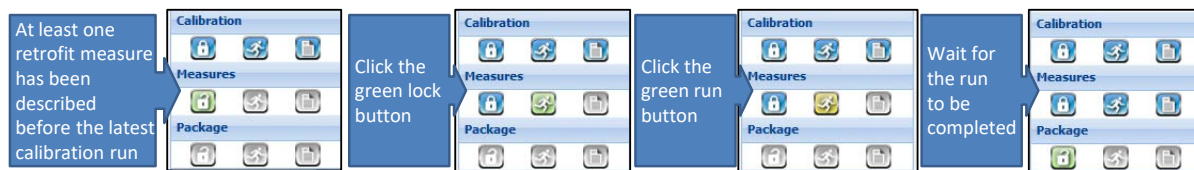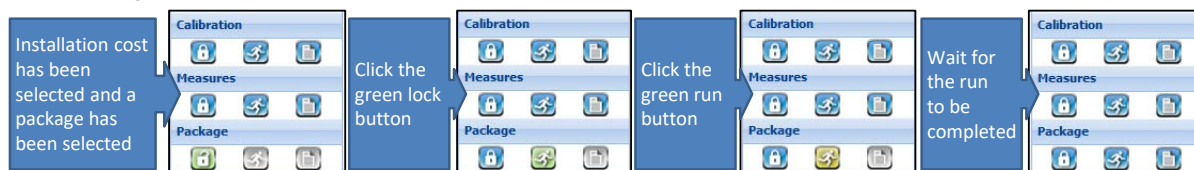
Status A. The lock button turns from gray to green as soon as the required data has been entered

Status B. Lock button turns blue and Run button turns green indicating that the run can be performed

Status C. Run buttons turns yellow indicating that the run is being performed

Status D. Run button and Results button turn blue indicating that the results are ready to view

Figure 18. Status of run control buttons during the Calibration, Measures, and Package Runs.

Run 1: Calibration Run – You can perform a Calibration Run after you have entered all the information for the building on the building description forms. It is recommended that you also enter the desired retrofit measures on the building description forms and make them active. They can be described and activated later; however, in that case, the calibration run will have to be performed again. Be sure to enter utility bills if you want to calibrate the building inputs. You can still perform a Calibration Run without entering utility bills, but in this case only MulTEA's estimates of the building's current energy consumptions will be provided. The Calibration Lock button will turn from gray to green as soon as all of the required buildings forms have been completed (see Status 1A in Figure 18).

To start a Calibration Run, click the green Calibration Lock button. The Calibration Lock button will turn blue indicating that the building forms are locked to prevent you from making 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 the OK and Apply buttons will be deactivated). Also, the Calibration Run button will turn from gray to green indicating that the run can now be performed (Status 1B). Now click the green Calibration Run button. The Calibration Run button will turn yellow (Status 1C) indicating that the Calibration Run has started. After the run is complete, the Calibration Run button will turn blue and the Calibration Results button will turn from gray to blue (Status 1D) indicating that the run is complete and the results are ready to view.

To view the Calibration Report, click the blue Calibration Results button. Figure 19 shows the title page of the Calibration Report. The title page identifies your Agency, Account, Audit, and Audit Run; provides key information you have entered on the Agency form, Account form, and Audit form; and provides additional information about the audit run for the purpose of tracking 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 (see Figure 20). These results are based on typical meteorological year (TMY3) weather data.

If you entered utility bills on the Utility Bills form, MulTEA's estimates of the building's total electricity and fossil fuel consumptions will be compared to the utility bills (see Figure 21). Data will be shown only for those months for which utility bills were entered. Months with partial bills will be excluded. Keep in mind when comparing MulTEA's estimated energy consumptions to the utility bills that MulTEA'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 weather data associated with the utility bills, it will be compared to the TMY3 weather data used to make the building energy estimates (see Figure 22) so that you can determine the degree that differences between predicted energy consumptions and utility bills might be due to weather differences.

MulTEA Building Audit Calibration Report

Agency Information

Agency:	Oak Ridge National Laboratory
Agency Code:	
Agency State:	TN

Client Information

Job Number:	228
Other ID Number:	
Client Name:	Ternes, Mark
Client Address:	One Bethel Valley Road

Audit Information

Audit Name:	Ternes - Demonstration Building (NG)
Audit Number:	1172
Auditor Name:	Ternes, Mark
Audit Date:	Tue Jan 15 00:00:00 EST 2013
Audit Created Date:	Tue Jan 15 12:37:00 EST 2013

Audit Run Details

Version:	0.9
Weather State:	IL
Weather Station:	Chicago Ohare Intl Ap
Setup Library:	Default Setup Library
Fuel Library:	Default Fuel Library

Figure 19. Calibration Report: Title Page.

MulTEA Estimated Electricity Consumption (kWh)

Month	Heating	Cooling	Hot Water	Appliances	Lighting	Building Total
January	220	307	0	356	568	1,451
February	186	251	0	310	495	1,242
March	197	307	0	356	568	1,428
April	163	373	0	344	550	1,430
May	129	414	0	356	568	1,467
June	103	613	0	344	550	1,610
July	86	1,102	0	356	568	2,112
August	75	951	0	356	568	1,950
September	98	664	0	344	550	1,656
October	121	394	0	356	568	1,439
November	146	315	0	344	550	1,355
December	190	300	0	356	568	1,414
Annual	1,714	5,990	0	4,178	6,671	18,553

MulTEA Estimated Natural Gas Consumption (MBtu)

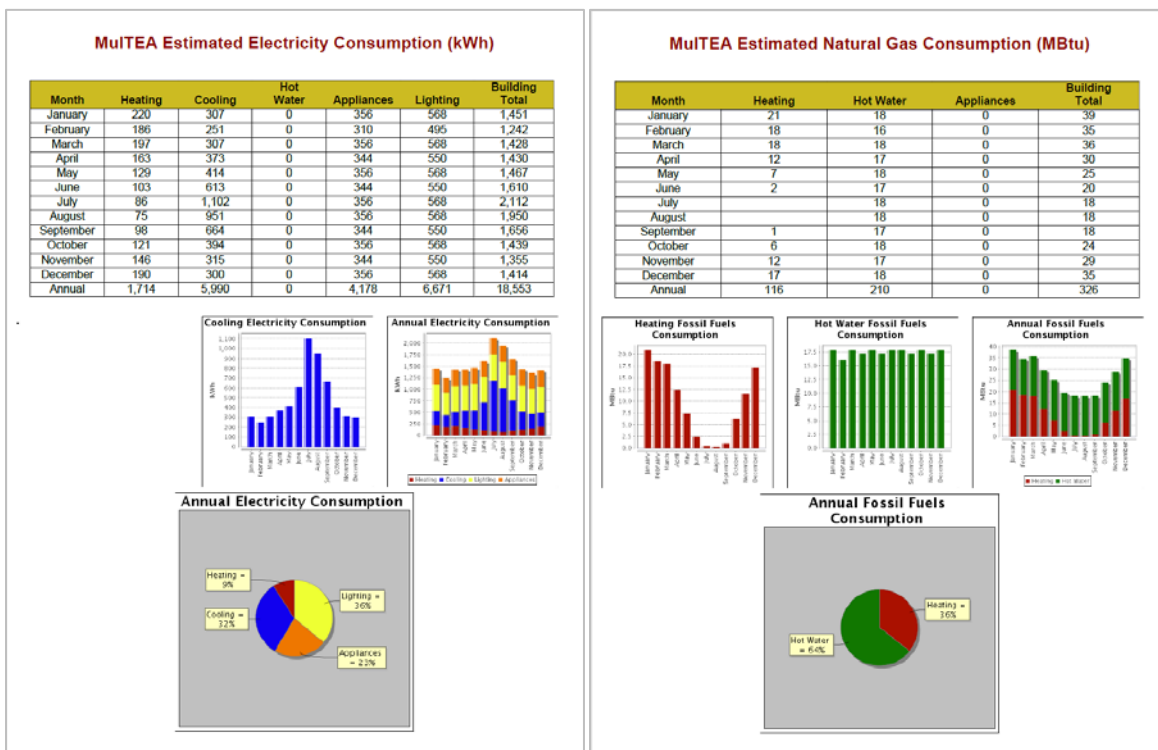| Month	Heating	Hot Water	Appliances	Building Total
January	21	18	0	39
February	18	16	0	35
March	18	18	0	36
April	12	17	0	30
May	7	18	0	25
June	2	17	0	20
July		18	0	18
August		18	0	18
September	1	17	0	18
October	6	18	0	24
November	12	17	0	29
December	17	18	0	35
Annual	116	210	0	326

Figure 20. Calibration Report: MulTEA's estimated energy consumptions by end use.

Building Total Electricity Consumption Comparison (kWh)

Month	MulTEA Estimate	Utility Bill	Difference	Percent Difference
January	10,300	13,562	-3,262	-24.1%
February	9,095	11,918	-2,823	-23.7%
March	9,187	12,071	-2,884	-23.9%
April	7,480	9,779	-2,299	-23.5%
May	6,611	8,191	-1,579	-19.3%
June	6,253	6,673	-420	-6.3%
July	6,784	6,541	244	3.7%
August	6,572	6,634	-62	-.9%
September	6,168	6,382	-215	-3.4%
October	6,587	6,631	-44	-.7%
November	7,658	7,836	-178	-2.3%
December	9,438	9,967	-528	-5.3%
Annual	92,135	106,185	-14,050	-13.2%

Usage Comparison (kWh)
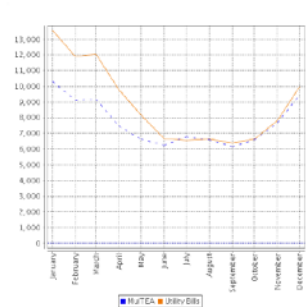
Building Total Natural Gas Consumption Comparison (MBtu)

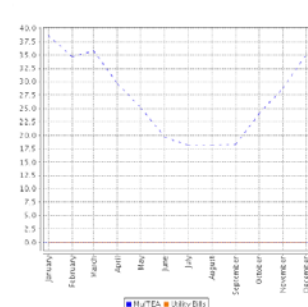| Month	MulTEA Estimate	Utility Bill	Difference	Percent Difference
January	39		39	72,465,421.9%
February	35		35	76,344,098.6%
March	36		36	83,500,540.5%
April	30		30	77,846,589.0%
May	25		25	68,262,035.9%
June	20		20	70,953,817.9%
July	18		18	70,062,654.5%
August	18		18	75,954,973.8%
September	18		18	87,123,011.6%
October	24		24	89,814,850.3%
November	29		29	84,280,201.3%
December	35		35	80,686,662.3%
Annual	326		326	77,736,968.4%

Usage Comparison (MBtu)

Figure 21. Calibration Report: Comparison of MulTEA's energy consumptions to utility bills.

Month	MulTEA HDD Estimate	Utility Bill HDD	Difference	Percent Difference	MulTEA CDD Estimate	Utility Bill CDD	Difference	Percent Difference
January	1,282	1,316	-33	-2.5%	0	0	0	NaN
February	1,051	1,114	-63	-5.6%	0	0	0	NaN
March	810	995	-185	-18.6%	0	0	0	NaN
April	498	653	-155	-23.7%	46	1	45	4,601.7%
May	201	369	-168	-45.6%	32	30	2	7.6%
June	25	133	-108	-81.3%	175	107	67	62.6%
July	3	25	-22	-88.2%	326	211	116	54.8%
August	6	14	-9	-60.7%	197	236	-38	-16.3%
September	76	63	13	21.5%	65	136	-71	-52.1%
October	411	254	156	61.4%	1	39	-39	-98.7%
November	734	570	164	28.7%	0	5	-5	-100.0%
December	1,229	980	249	25.4%	0	0	0	NaN
Annual	6,325	6,486	-161	-2.5%	842	766	76	9.9%

Heating and Cooling Degree Days Comparison
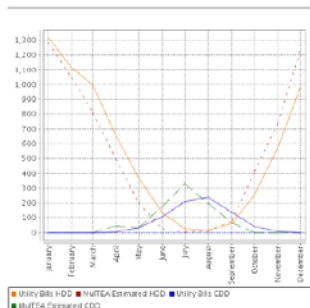
Figure 22. Calibration Report: Comparison of MulTEA and utility bill weather data.

You should review the calibration results carefully. You may want to refer to Sections 4.3 and 4.5.7 of the Technical Guidelines for Multifamily Building Energy Audits (ORNL/TM-2014/0297) for some guidance on how to do this. **[Note: The report will be published in the near future.]** If the results are not satisfactory, you may want to make adjustments to the building description inputs and rerun the calibration. To do so, click the blue Calibration Lock button. The button will turn green indicating that the building description forms are unlocked and you can make changes to them. Also, the Calibration Run and Calibration Report buttons will turn gray indicating that the previous run and results are now unavailable (Status 1A). Then, modify the building inputs, lock the forms, perform the Calibration Run again, and view the results. If the calibration results are satisfactory, you can now perform a Measures Run.

Run 2: Measures Run – If at least one retrofit measure has been described and activated on the building forms before the last Calibration Run, the Measures Lock button will turn from gray to 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., the Measures Lock button is still gray) or they need to be modified, click the blue Calibration Lock button to unlock the building description forms. The Calibration Lock button will turn green indicating that the building description forms are unlocked and you can make changes to them. Also, the Calibration Run and Calibration Report buttons will turn gray indicating 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 Calibration Results will not have changed if the base case building inputs were not modified.

To start a Measures Run, click the green Measure Lock button. The Measure Lock button will turn blue indicating that the building forms are locked to prevent you from making any changes on the building description forms. Also, the Measures Run button will turn from gray to green indicating that the run can now be performed (Status 2B). Now click the green Measure Run button. The Measure Run button will turn yellow (Status 2C) indicating that the Measures Run has started. After the run is complete, the Measure Run button will turn blue and the Measures Results button will turn from gray to blue (Status 2D) indicating that the run is completed and the results are ready to view.

To view the Measures Results, click the blue Measure Results button. The Measures Results consist of four forms to allow you 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 (see Figure 23). Each form has two sections: audit information on the top and results in tabular format on the bottom. All of the tables show the name of the retrofit measure and the component, tab (if applicable), and code with which the retrofit is associated (e.g., replace the windows associated with the window that you called WIN 1 on the Window 1 tab on the Window form).

Once you have reviewed MulTEA's predicted annual energy savings and cost savings for each individual measure on the Energy Savings and Cost Savings tabs, respectively, you should enter the installation cost (materials plus labor) for each measure on the Installation Costs tab. If the Retrofit Measure Cost Name for a measure shows None Defined (indicating that no Retrofit Measure Cost Name for this measure has been defined in the Measure Costs Library that you selected to use with this audit), then you must enter an installation cost manually in the Adjustment column. Otherwise, you can use costs that have been entered in the Measure Cost Library selected for this audit to calculate the installation cost for the measure. To do this, select a name from the Retrofit Measure Cost Name dropdown list. This list will include all the Retrofit Measure Cost Names that have been created for that measure in the Measure Cost Library that you selected for this audit. Selecting a name will calculate an installation cost that is entered in the Default Estimated Installation Cost column. You can fine tune this cost by entering a cost adjustment in the Adjustment column. 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 clicking the OK or Apply button.

Finally, you should review the economics of each measure on the Economics tab. The Economics tab shows the savings-to-investment ratio (SIR) and simple payback period (SPP) for each individual measure based on the predicted annual cost savings, estimated installation cost, measure lifetime, and economic parameters contained in the Economic Parameters library that you selected to use with this audit.

Click on the print icon provided in the upper right corner of each of the four forms to obtain a printable report of the measure results. This same report can be accessed from the Report field on the Audit Dock.

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 and package selection form.

Figure 23. Measures Results forms.

Once the Measure Run is complete and satisfactory (e.g., installation costs are final, all desired measures analyzed), you will be ready to perform a Package Run. 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 Measure Runs again. To do so, click the blue Calibration Lock button. The button will turn green, indicating that the building description forms are unlocked and you can make changes to them. In addition, all other Calibration and Measure buttons will turn gray, indicating that the previous runs and results are now unavailable (Status 1A). Then, modify the retrofit measures, lock the Calibration Lock button, perform the Calibration Run again, lock the Measures Lock button, 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 that you want to analyze as a package. To do so, click the blue Measures Results button, go to the Economics tab, select the Include in Package checkboxes for the retrofit measures you want to analyze in a package, and then save the form by clicking the OK or Apply button. After you have saved the Retrofit Measures > Economics tab with at least one retrofit measure selected to be analyzed in the package, the Package Lock button will turn from gray to green (Status 3A). To start a Package Run, click the green Package Lock button. The Package Lock button will turn blue indicating that the Measures Results are locked to prevent making any changes to the installation costs and package selection. Also, the Package Run button will turn from gray to green indicating that the run can now be performed (Status 3B). Now click the green Package Run button. The Package Run button will turn yellow (Status 3C) indicating that the Package Run has started. After the run is complete, the Package Run button will turn blue and the Package Results button will turn from gray to blue (Status 3D) indicating that the run is complete and results are ready to view.

To view the Package Results, click the blue Package Results button. The first three Package Results forms allow you to view the interacted energy savings, cost savings, and cost effectiveness of the individual measures in the package and the package as a whole, and to enter repair and health and safety measures (see Figure 24). A fourth form allows you to enter cost sharing/leveraging and to see its impact on SIRs as viewed for 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 of the tables show the name of the retrofit measure and the component, tab (if applicable), and code with which the retrofit is associated (e.g., replace the windows associated with the window that you called WIN 1 on the Window 1 tab on the Window form). The last row in the tables shows the package results.

The Energy Savings, Cost Saving, and Economics tabs 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 tab shows the SIR and SPP for the measures in the package based on the interacted cost savings predicted for each measure, estimated installation cost, measure lifetime, and economic parameters contained in the Economic Parameters library that you selected to use with this audit. You also use the Economics form to describe and enter the costs of repair items and health and safety items. To do this, click on Add Repair Cost and fill in the information in the blank row that is provided.

The Leveraging tab allows you 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 buy down amount needed to achieve an SIR of exactly 1.0. You will enter the actual buy down 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), click the blue Package Lock button. The button will turn green, indicating that the Retrofit Measure > Economic tab is again accessible. Also, the Package Run and Package Results buttons will turn gray (Status 3A), indicating that the package runs and results are now unavailable. Modify the package selection on the Retrofit Measure > Economics tab, save the form, and then perform the Package Run again.

Click on the print icon provided in the upper right corner of each of the four forms to obtain a printable report of the package results. This same report can be accessed from the Report field on the Audit Dock.

If you want to save the results of several different Package Runs, you can 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.

(a) Package: Energy Savings form

(b) Package: Cost Savings form

(c) Package: Economics form

(d) Package: Leveraging form

Figure 24. Package Results forms.

HEALTH AND SAFETY AUDIT

Health and Safety

Agency: AgencyA1
Acct.: A1AccountName2
Acct. #: A1AccountNumber2
Audit: GKA
Audit #: 1193

General Survey
- 🔴 Audit
- 🔴 Health Concerns
- 🟢 Observations

Detailed Form Guidance
- 🔴 View Guidance

Detailed Survey
- 🟢 Mold and Moisture
- 🟢 Lead
- 🟡 Radon
- 🟡 Asbestos
- 🟢 Formaldehyde/VOCs
- 🟡 Combustion
- 🟢 Pest Infestation
- 🟡 Safety
- 🟡 Ventilation

Audit Recommendations
- 🔴 Create Report

Icon Key
- 🔴 Form is Required
- 🟡 Form is Recommended
- 🟢 Form is Optional
- ⚪ Form is Not Applicable

Figure 25. Health and Safety Audit Dock.

Once you have set up an account for a building or project, you can run the Health and Safety Audit on a house or individual dwelling unit of a multifamily building within the 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 (see Figure 25) and provides you with the means of accessing the Health and Safety Audit'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.

At the top of the Audit Dock is an information block that shows key audit information that has been 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. The meaning of the icons is shown in the Icon Key at the bottom of the Audit Dock.

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., see the Radon form). Several forms have Tabs presented at the top of the form to provide access to different data input sections (see Figure 26).

Figure 26. Tabs on the Mold and Moisture form.

To access one of the 14 forms, you should click on the form in the Audit Dock, click the desired Tab if applicable, and then complete the form (unless read-only). You will need to click Apply to save the form or OK to save and exit the form. Click Cancel if you want to exit the form without saving the entries that you just made.

To use the Health and Safety Audit, you should first complete the group of General Survey forms which include audit information and preliminary screening questions on health and safety issues (see Figure 27). You will then view the Detailed Form Guidance which will provide 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. You may choose to follow the guidance and complete only the recommended Detailed Survey forms, or you may complete any of the optional forms to further investigate those health and safety issues. The audit uses your inputs on the Detailed Survey forms to generate its Audit Recommendations.

Figure 27. Schematic of Health and Safety Audit

Describing a Building in the Health and Safety Audit

To create a new Health and Safety audit, click on Audit > Health and Safety Audit on the Menu bar and then click the New button on the Audit form (State Administrators and Guests are not allowed to create an audit). The Copy button can also be used to create a new audit from an existing audit. When creating a new audit using the New button, you should always 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 below because of its uniqueness to the Health and Safety Audit. Less detail is provided on the other forms because their completion is more straightforward. A separate section below will discuss how to run the Health and Safety Audit.

Audit Form (Required) – The Audit form allows you to enter general audit information and to select a weather file needed to run the audit (see Figure 28). All of the fields on this form that are not disabled or read-only are required.

Figure 28. Data input fields on the Audit form.

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 auto-filled using information from the Account form). Enter an Audit Name and the Audit Date, and then enter the name of the auditor (currently there is no dropdown list of auditor names as provided in MulTEA based on users for the Agency that are marked as Active and Auditor on the Users form). The City and State fields will be auto-filled using information from the Account form. The Audit Number will be automatically assigned by MulTEA.

You then need to 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 1,020 US weather stations which are filtered by Weather State. You may wish to consider not only those cities in your state, but also 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 data sets. You may have to use the scroll bar on the right to see the Dwelling Occupancy data set.

General Survey – The group of General Survey forms consists of three data input forms. The **Audit** form, which was already discussed above, allows you to enter general audit information and details about the house or dwelling unit. The **Health Concerns** form allows you to identify specific occupant health symptoms that may indicate the presence of existing health and safety issues in the dwelling. The **Observations** form allows you to identify general observations regarding the dwelling that also may indicate the presence of existing or potential problems. Observations related to mold and moisture, lead, radon, formaldehyde and VOCs, combustion appliances, pest infestation, and planned weatherization work can be identified.

Detailed Form Guidance – Based on your inputs on the General Survey forms, the audit generates Detailed Form Guidance to provide you with the status of existing or potential health and safety issues and recommendations regarding which issues warrant a detailed survey. Click 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 (see Figure 29). The audit will always recommend completion of the Safety and Ventilation forms.

Recommendations

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	Recommended	Asbestos may be present in insulation or other building materials, either from the original construction of the house in 1930-1989 or renovations performed between 1930 and 1989.
Formaldehyde and VOCs	Optional	There is no evidence of existing or future formaldehyde or VOC.
Combustion	Not Applicable	There are no combustion appliances present.
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 29. Detailed Form Guidance.

Detailed Survey – The group of Detailed Survey forms consists of 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 allow you to visually determine the existence and severity of problems, make quantifying measurements, and pinpoint the sources of existing or potential problems. Each of the nine forms is discussed below.

Data on the **Mold and Moisture** form is entered on two tabs. First, indicate the evidence of mold and moisture in different spaces and components on the Evidence of Issue tab (see Figure 26). Then, on the Source Identification tab, 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 tab. Finally, return to the Evidence of Issue tab and check the applicable checkboxes in the All Sources Identified on Source Identification Form column. The form will show the Source Identification Warning (see Figure 30) if you try to save the form before at least one source is identified for the space/component where you have indicated the evidence of mold and moisture.

Source Identification Warning

Additional moisture sources need to be identified on the Source Identification form that are causing visible mold, moisture damage, water issues, high humidity, condensation, or musty odor in the following spaces or components:

Other Interior Spaces
House Exterior

Figure 30. Source Identification Warning for the Mold and Moisture form.

On the **Lead** form, check the applicable checkboxes in the Housing Type/Funding Sources data set. Then, provide details about interior and exterior painted surfaces that may be disturbed by weatherization

and indicate the results of lead testing, if performed. You should refer to the notes provided on the form for guidance on completing the form.

The **Radon** form allows you to indicate if 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. Enter the testing information in the Indoor Radon Measurements table as applicable. Indicate if the house has an existing radon reduction system, and then identify potential radon entryways in the Source Identification data set.

The **Asbestos** form allows you to indicate if asbestos containing materials (ACMs) may be present on different building and system components. For those components where asbestos may be present, indicate the condition of the ACM. You should refer to the notes provided on the form for guidance on completing the form.

The **Formaldehyde and VOCs** form allows you 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 unit.

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 tabs. The Safety Inspection tab should be completed first. Identify all the combustion appliances in the dwelling unit on this form, and then enter safety inspection observations for each appliance. Enter combustion-related measurements on the Performance Testing tab after the Safety Inspection tab has been filled in. All of the vented combustion appliances identified on the Safety Inspection tab will be listed automatically in the Measurements table in the CAZ Measurements data set of the Performance Testing tab.

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

Safety related questions are grouped under four tabs on the **Safety** form. On the General Safety tab**,** hazards are categorized as injury prevention, hazards for elderly and disabled, and child safety hazards. The Hazards for Elderly and Disabled data set will appear only if the number of elderly or disabled entered on the Audit form is non-zero. Similarly, the Child Safety Hazards data set will appear only if the number of children entered on the Audit form is non-zero. Hazards on the Structural Safety tab are grouped by structural components, including roof, walls, windows, doors, stairs, floor, and porch, patio, or balcony. Under the Fire Safety tab, 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. Under the Electrical Safety tab, hazards are grouped to identify issues related to knob and tube wiring and other electrical hazards.

The **Ventilation** form allows you to check compliance with ASHRAE 62.2 and provides recommendations to achieve compliance. You should indicate if the exception to the ASHRAE Standard 62.2 whole-building mechanical ventilation requirement applies to your dwelling unit. Then select the ASHRAE Standard 62.2 version that you want to check compliance with. The current options are 2010 and 2013. Read-only fields pertinent to the ventilation calculations are displayed that you have already entered on the Audit form. 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 post-weatherization blower door measurements. You must select the blower door measurements to use in calculating the required whole-building mechanical ventilation rate.

Running the Health and Safety Audit and Viewing Results

Based on your 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.
- Allow measure selection and identification of responsible organization.

To view the audit recommendations, click Create Report. Audit recommendations are provided on different tabs corresponding to each of the nine health and safety issues (see Figure 31). Each tab shows a list of recommendations for each Detailed Survey form completed. For each recommendation, checkboxes are provided to allow you to indicate if 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 you determine your intended action, guidance based on WPN 11-6 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.
- Notes Applicable to the Weatherization Assistance Program.
- Mold Cleanup Guidance and Radon Mitigation Guidance under respective forms.

Click the dropdown box in front of each category to view the guidance.

Figure 31. Audit Recommendations form.