

Web-Based Weatherization Assistant Getting Started Guide



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Buildings and Transportation Science Division

WEB-BASED WEATHERIZATION ASSISTANT GETTING STARTED GUIDE

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May 2024

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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 considering 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.

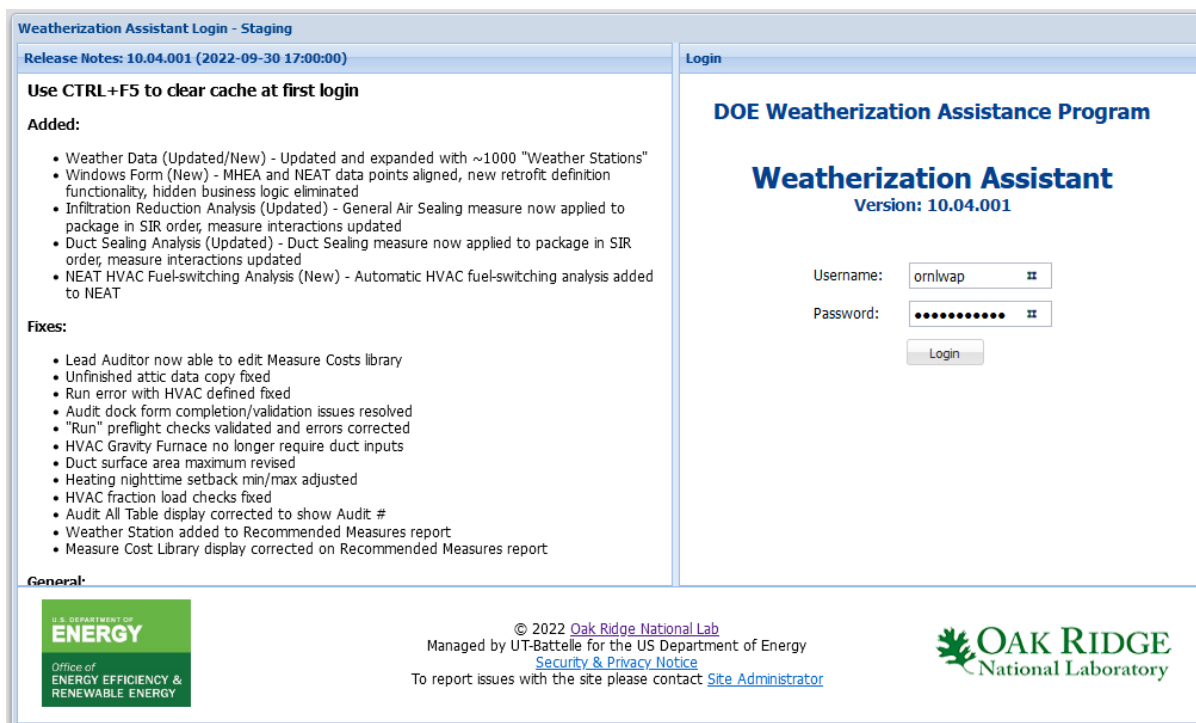


Figure 1.1. Web-based Weatherization Assistant login web page.

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 (see Figure 1.3).

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 1.3). 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 if not relevant in certain contexts or grayed 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.

The All table at the bottom of the form 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 at the top. In addition, the All table of Audit forms also has a pagination bar at the bottom. The column headers show key field names of the form. When you hover over a column header, a drop-down button will appear on the right. Selecting this button will allow you to sort the records in ascending or descending order. In addition, it provides a means to hide or unhide columns of the table (Figure 1.4). 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.

National Energy Audit Tool (NEAT)

Agency: Sample Agency
 Account Name: Sample Account
 Account Number: S001
 Audit Name: Sample Audit

Audit Date: 10-06-2022
 Auditor: John Doe
 City: Denver
 State: CO
 Audit Number: 3596

Building Information
 Occupants: 2
 Conditioned Stories: 1
 Infiltration Height (ft): 8

Floor Area (sq ft): 250
 Number of Bedrooms: 2
 Wind Shielding: Normal Shielding

Libraries
 Weather State: AZ
 Weather Station: Phoenix Sky Harbor Intl Ap
 Economic Parameters: 2020 - Residential US Average Ecor
 Measure Costs: Default (ORNL) NEAT Measure Cost
 Key Parameters: Default NEAT Key Parameters v10
 Supply Library: No Supply Library selected
 Defined Measures: ORNL Initial Defined Measures

Fuel Cost Details
 Electricity: 2020 - Average US Residential Electricity Costs Cost: 0.1309 per kWh
 Natural Gas: 2020 - Average US Residential Natural Gas Costs Cost: 9.85 per Mcf
 Propane/LPG: None Cost: 0 per N/A
 Fuel Oil: None Cost: 0 per N/A
 Kerosene: None Cost: 0 per N/A
 Wood: None Cost: 0 per N/A
 Coal: None Cost: 0 per N/A
 Other: None Cost: 0 per N/A

Account for SCC: (Ghosted field)

Buttons: New Copy Delete OK Apply Cancel

Figure 1.3. NEAT Audit form consisting of the main form and All table.

Mouse-over drop-down button

Column hide/unhide checkbox

Agency	Audit Name	Account Name	Account Number	City	State	Audit Date	Audit #	Auditor	Audit Status	Audit Last Edited
Sample Agency	Sample Audit	Sample Account	S001	Denver	CO	10-06-2022	3596	John Doe	Started	05-23-2024 12:46 AM
Sample Agency	test CCR_all measures	Sample Account_C...	Copy of S001	Denver	CO	01-23-2024	4355	John Doe	Completed	05-23-2024 12:28 AM
Sample Agency	Sample NEAT Audit 4	Sample Account	S001	Denver	CO	02-26-2024	4436	John Doe	Completed	05-23-2024 12:28 AM
Sample Agency	Sample NEAT Audit 0	Sample Account	S001	Denver	CO	02-19-2024	4420	John Doe	Completed	05-23-2024 12:27 AM
Sample Agency	Sample NEAT Audit 3	Sample Account	S001	Denver	CO	02-19-2024	4419	John Doe	Completed	05-22-2024 11:59 PM
Sample Agency	Sample NEAT Audit 2	Sample Account	S001	Denver	CO	02-19-2024	4418	John Doe	Completed	05-22-2024 11:59 PM
Sample Agency	Sample NEAT Audit 1	Sample Account	S001	Denver	CO	02-19-2024	4414	John Doe	Completed	05-22-2024 11:59 PM

Buttons: New Copy Delete OK Apply Cancel

Figure 1.4. The All table displaying sorting and column hide/unhide checkbox options.

In the All table, 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 1.5). To clear all the filters, select the cross below the filter toggle. In addition, in the All table of the Audit form, you may select the buttons on the pagination bar at the bottom to navigate between pages. Fifty audits are displayed per page.

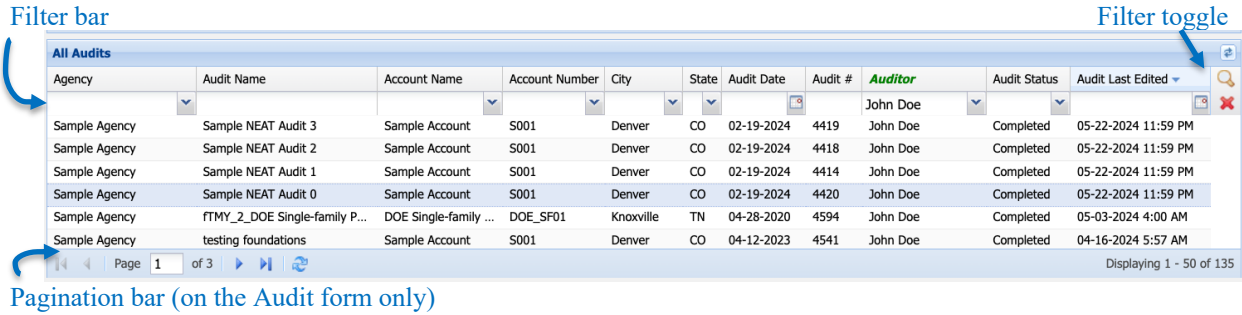


Figure 1.5. All Audits table showing filter bar after selecting the filter toggle.

1.4 USER FORM

Figure 1.6 shows the option to select the User form (Figure 1.7; guests are not allowed access to the User form). Select User → View User on the menu bar to see the user records created by the entity that provided you with your login information. 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. The User Privilege levels and their responsibilities and levels of access are summarized in Table 1.1.

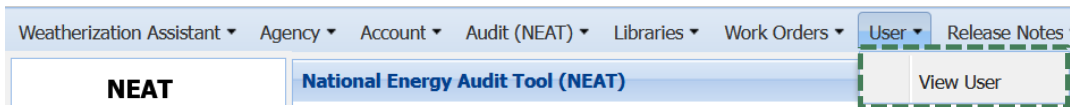


Figure 1.6 Accessing the User form from the menu bar.

User Details

Login Information

Username: johnDOE1

Password: []

Confirm Password: []

Old Password: []

Privilege Level: Lead Auditor

Agency Information

Agency: Sample Agency

Auditor:

Active:

Person Information

Prefix: []

First: John

Middle Init: []

Last: Doe

Suffix: []

Company: []

Title: []

Contact Information

Address: []

Unit Number: []

City: []

State: CO

Zip code: []

Work Phone: []

Cell Phone: []

Home Phone: []

Fax: []

Email: []

Web Page URL: []

Comments

[]

New Assign to Additional Agency Delete OK Apply Cancel

Figure 1.7. User form.

Table 1.1. User privilege

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

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. You can edit own user record except privilege level and agency information. You may want to add, edit, or update the information presented in other fields as needed. When creating a user record, make sure the Active checkbox is selected. Unchecking the Active checkbox will disallow the user to log in, which may be desired for individuals who no longer require access to Weatherization Assistant. Also make sure the Auditor checkbox is selected if the user might create audits in the future. This will list the name of the user 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 for your user account and you are an Auditor or Lead Auditor, then your Agency Administrator may need to make the change.

1.5 AGENCY FORMS

The agency forms—Agency Details, Agency Contact, and Agency Cost Center—can be accessed by selecting Agency on the menu bar (Figure 1.8; guests are not allowed access to the agency forms). Select Agency → Agency Details to see the agency record (Figure 1.9) to which you have been assigned. 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.

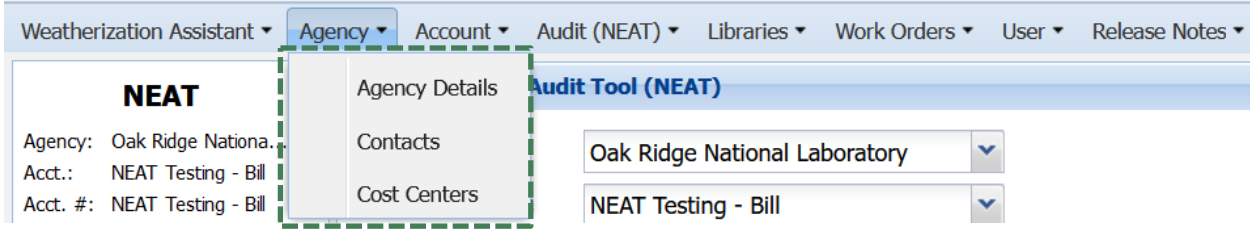


Figure 1.8. Accessing the Agency forms from the menu bar.

Figure 1.9. Agency Details form.

The Agency Contact form (relevant to NEAT and MHEA only) is used to enter information on certain individuals associated with the agency, specifically Contractors, Suppliers, and In-house crew members. The information on the Agency Details form is used to assign recommended measures to contractors and suppliers in the Supply Library and Work Order.

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 LIBRARY FORMS (RELEVANT TO NEAT, MHEA, AND MULTEA ONLY)

Six libraries can be accessed from the menu bar by selecting Libraries → [Library Name], as shown in Figure 1.10 (guests are not allowed access to the library forms). The described libraries are used only by NEAT, MHEA, and MulTEA; they are not used by the Health and Safety Audit.

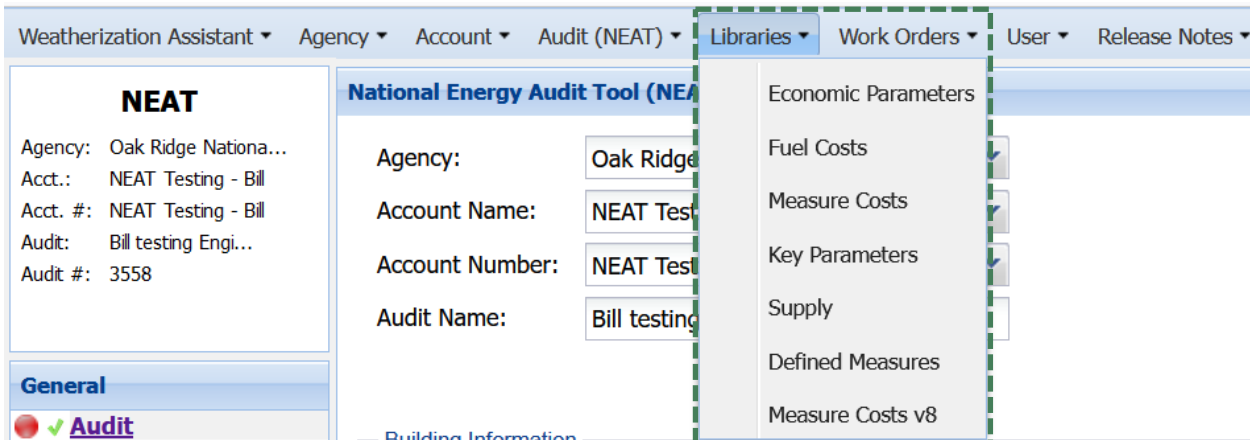


Figure 1.10. Accessing the library forms from the menu bar.

- **Economic Parameter Set** – These libraries (Figure 1.11) 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 1.12) 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 1.13) collect overall measure cost information. They provide access to Retrofit Measure Cost Details forms (Figure 1.14), 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 1.15) provide flexibility to modify some of NEAT’s and MHEA’s inputs and assumptions. The existing values on these forms may be replaced with information for your agency. These forms are provided separately for NEAT and MHEA.
- **Supply (NEAT and MHEA only)** – These libraries (Figure 1.16) 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 1.17) 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.

Economic Parameter Set Library

Economic Parameter Set Name: 2018 - Residential US Average Economic Factors

Agency: Sample Agency

Active for:

NEAT:

MHEA:

MulTEA:

Economic Parameter Set Details

Real Discount Rate (%): 3

Energy Price Escalation Rates			
Fuel Type	Year	Fuel Price Index	Modified UPV Factor
Electricity	0	1	1
Electricity	1	1.02	0.990291
Electricity	2	1.05	1.98002
Electricity	3	1.06	2.95007
Electricity	4	1.07	3.90075
Electricity	5	1.07	4.82374
Electricity	6	1.08	5.72822

Figure 1.11. Economic Parameter Set Library form.

Fuel Cost Library

Fuel Cost Name: 2019 - Average US Residential Coal Costs
 Agency: Simonson Management Services

Active for:
 NEAT:
 MHEA:
 MuITEA:

Fuel Cost Details

Fuel Type: Coal
 Units: Ton
 Unit Cost (\$): 82.97
 Unit Heat Content (MMBtu): 21

Figure 1.12. Fuel Cost Library form.

Measure Cost Set Library

Measure Cost Set Name: ORNL Default MCL with "

Agency: Oak Ridge National Laboratory

Audit Type: NEAT MHEA MuITEA

Is Active:

Index	Measure Type	Measure Name	Lifetime	Is Active
1	Building Insulation	Attic Insulation R11	20	Yes
2	Building Insulation	Attic Insulation R19	20	Yes
3	Building Insulation	Attic Insulation R30	20	Yes
4	Building Insulation	Attic Insulation R38	20	Yes
5	Building Insulation	Attic Insulation R49	20	Yes
6	Building Insulation	Fill Ceiling Cavity	20	Yes
7	Building Insulation	Sillbox Insulation	20	Yes
8	Building Insulation	White Roof Coating	7	Yes
9	Building Insulation	Foundation Wall Insulation	20	Yes

Measure Cost Set Library

Measure Cost Set Name: Copy of Sample MuITEA Measure Cost Library

Agency: AgencyA2

Audit Type: NEAT MHEA MuITEA

Is Active:

Component Type	Component Subtype	Retrofit Measure
✓ Walls	Exterior	Add Cavity Insulation
✓ Walls	Exterior	Add Exterior Insulation
✗ Walls	Exterior	Add Interior Insulation
✗ Walls	Underground	Add Exterior Insulation
✗ Walls	Underground	Add Interior Insulation
✗ Walls	Interior	Add Cavity Insulation
✗ Walls	Interior	Add Exterior Insulation
✗ Walls	Interior	Add Interior Insulation
✓ Windows	Exterior	Replace Window

Figure 1.13. (left) NEAT and (right) MuITEA Measure Cost Set Library forms.

Retrofit Measure Cost Details

Measure Cost Set Name: Test MCL for Josh

Measure Type: Building Insulation

Measure Name: Attic Insulation R11

Lifetime (yr): 20

Is Active:

Measure Description: Blown Cellulose

	Cost	Units
Material:	\$ 0.34	per SqFt
Labor:	\$ 0.22	per SqFt
Other:	\$ 0.00	per Each

Retrofit Measure Cost Details

Measure Cost Set Name: Sample Library for Sample Audits

Component Type: Walls

Component Subtype: Exterior

Retrofit Measure: Add Cavity Insulation

Retrofit Measure Cost Name: Cellulose, 2x4 1-2 stories

Insulation Type: Cellulose Blown - High Density

Lifetime (yr): 20

Is Active:

	Cost	Units
Labor:	\$ 0.75	per Square Foot
Material:	\$ 0.26	per Square Foot
Other 1:	\$	per
Other 2:	\$	per
Other 3:	\$	per

Figure 1.14. (left) NEAT and (right) MuITEA Retrofit Measure Cost Details forms.

NEAT/MHEA Key Parameter Set Library

Key Parameter Set Name: Default NEAT Key Parameters v10
 Agency: Sample Agency
 Audit Type: NEAT: MHEA:
 Active:

Group	Key Parameter	Value	Units
Economics			
Economics	Real discount rate	3.00	%
Economics	Minimum acceptable SIR	1.00	Factor
Equipment			
Equipment	Low flow shower head flow rate	2.50	gal/min
Equipment	Refrigerator defrost cycle energy	0.08	kWh
Insulation			
Insulation	Avg annual outside film coeff	2.25	BTU/hr-sqft-F
Insulation	Uninsulated R-value for "Other" wall type	4.42	F-sqft-hr/Btu

NEAT/MHEA Key Parameter Set Library

Key Parameter Set Name: Default MHEA Key Parameters v10
 Agency: Sample Agency
 Audit Type: NEAT: MHEA:
 Active:

Group	Key Parameter	Value	Units
Base Loads			
Base Loads	MHEA Low flow shower head flow rate	2.50	gal/min
Base Loads	MHEA Water heater wrap added R value	7.00	F-sqft-hr/Btu
Base Loads	MHEA Refrigerator defrost cycle energy	0.08	kWh
Doors			
Doors	Door U-value - wood with hollow core	0.46	Btu/F-sqft-hr
Doors	Door U-value - wood with solid core	0.40	Btu/F-sqft-hr
Doors	Door U-value - standard mfg. home door	0.40	Btu/F-sqft-hr
Doors	U-value of replacement door	0.20	Btu/F-sqft-hr

Figure 1.15. (left) NEAT and (right) MHEA Key Parameter Set Library forms.

Supply Library

Supply Library Name: Sample Supply Library
 Agency: Sample Agency
 Description:
 Is Active:

Supply Library Categories

- Cooling Equipment
- Construction Materials/Hardware
- Doors
- Health and Safety Items
- Heating Equipment
- Hot Water Equipment
- Insulation
- Labor
- Lighting
- Miscellaneous Supplies
- Refrigerators
- Windows
- Other

Cooling Equipment Details

Description: Sample AC
 Manufacturer:
 Model:
 Supplier:
 Units: Each
 Cost (\$/Unit): 1000

Energy Details

Equipment Type: Central Air Conditioner
 Efficiency Units: SEER
 Efficiency: 13
 Capacity (kBtu/hr):
 Lifetime (yr):

Figure 1.16. (left) Supply Library form and (right) Example Supply Library Category Details form.

NEAT/MHEA Defined Measure Set Library

Defined Measure Set Name: issue 1360
 Supply Library: 53
 Agency: Oak Ridge National Laboratory
 Active:

Defined Measure Details

Measures List: linked [New] [Copy] [Delete] Active for: NEAT: MHEA:
 Measure #: Include in SIR: Energy Savings: No Energy Savings
 Measure Type:
 Measure Name: linked
 Default Contractor/Crew:
 Default Cost Center:
 Measure comments:

Materials/Labor Details

#	Type	Copy From Supply	Description	Qty	Units+	\$/Unit	Comment
1	Refrigerators		linked material	1	Each	100.00	

Figure 1.17. NEAT/MHEA Defined Measure Set Library form.

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 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.

Likewise, 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.

Creating and Editing Libraries – The libraries can be created or edited only by Site Administrators, 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 for NEAT, MHEA, or MulTEA checkbox 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 to make the library available to select on the Audit form. Libraries created by ORNL during initial setup and those created on behalf of your state for access by all agencies in your state are read-only and designated as “Is Shared.” Furthermore, libraries in use for an existing audit become read-only. The Is Shared status of a library and the total number of existing NEAT, MHEA, or MulTEA audits using that library can be viewed in the All table, as highlighted by the orange box in Figure 1.18. You cannot modify or delete an existing library that is shared or in use for an existing audit. You can only edit a copy of a shared or in-use library to use it for future audits. Further, you can only uncheck the Active checkbox for a shared or in-use library to make it unavailable for future audits.

Agency	Key Parameter Set Name	Audit Type	Is Active	Is Shared	# Audits	Date Created	Last Edited
ORNL V10	Test UI 580	MHEA	No	No	0	02-20-2023 9:52 AM	02-20-2023 9:53 AM
ORNL V10	MHEA Key Parameters v10_UI-1017	MHEA	Yes	No	0	09-30-2022 11:00 AM	09-30-2022 11:00 AM
ORNL V10	SIRO_Default MHEA Key Parameters v10	MHEA	Yes	No	1	10-03-2023 12:42 PM	10-03-2023 12:42 PM

Figure 1.18. All table showing the Is Shared status and # Audits for library records.

1.7 ACCOUNT FORM

You must access and fill in a new Account form (i.e., set up an account for a house, building, or project) before you run NEAT, MHEA, MulTEA, or the Health and Safety Audit or create a work order. The Account form can be accessed by selecting Account → View Account on the menu bar (Figure 1.19) (guests are not allowed access to the Account form). To create a new account, select the New button on the task bar of the Account form (Figure 1.20). The Copy button on the task bar can also be used to create a new account. 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.

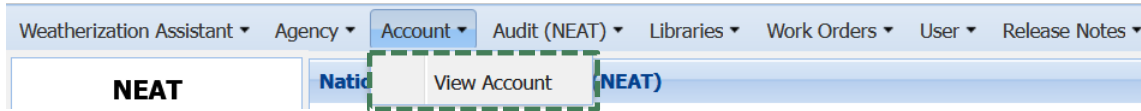


Figure 1.19. Accessing the Account form from the menu bar.

Figure 1.20. Account form.

1.8 WORK ORDER FORMS

The work order forms are used to create, manage, and track the progress of weatherization measures to be completed (state administrators and guests are not allowed to create a work order). The work order includes materials and labor, quantities, and cost details. A work order may be created from scratch or from NEAT or MHEA Audit Recommendations.

To access work orders, select Work Orders → View Work Orders on the menu bar (Figure 1.21). The Work Order Details form (Figure 1.22) is used to enter general information about the work order and to set and track its status. To create a new work order, select the New button on the task bar. You must provide a Work Order name and select either the Account Name or Account Number; this will autofill the Agency and State fields. You may also select an Audit Name, if previously created for the selected account that you intend to link with this work order. You may select a Supply Library containing inventory items from which any materials used by the work order may be taken. You may also select a Contractor/Crew to perform the work described by the work order. Finally, you may select the Work Order Type that best describes the work order. The choices are Weatherization, Re-Weatherization, Emergency Repair or Replacement, Response to Client Request, or Other.

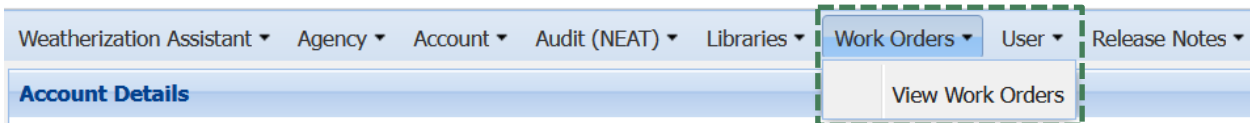


Figure 1.21. Accessing the Work Order forms from the menu bar.

The screenshot shows the 'Work Order Details' form. It has two tabs: 'Work Order Details' (selected) and 'Work Order Measures'. The form is divided into several sections:

- Work Order Information:** Fields for Work Order (Yarnell_Duct_Infiltration_WO_004), Account Name (Yarnell_Charles), Account Number (1362_Yarnell_Station), Agency (Oak Ridge National Laboratory), State (TN), Audit Name (Yarnell_Duct_Infiltration), Supply Library (Test Supply Library), Contractor/Crew (Copy of Lowes), and Work Order Type (Weatherization).
- Account Information:** Fields for Client Name and Alt Id.
- Work Order Economic Summary:** Fields for Number of Active Measures, Cumulative Estimated Cost, and Cumulative Actual Cost.
- Status:** A section titled 'Work Order Status' with a dropdown for 'All Status Types' and a 'Record Count' of 1. Below is a table:

Status Type	Current Status	Updated By	Comments	Date	Revised On
Work Order	Work Order Created from Audit On	Mini Malhotra - AgencyAdmin	Created from Measures form	11-21-2022	11-21-2022 2:06 PM
- Comments:** A large text area for entering comments.

At the bottom, there are buttons for 'New', 'Copy', 'Delete', 'Work Order' (with a printer icon), 'OK', 'Apply', and 'Cancel'.

Figure 1.22. Work Order Details form.

The Work Order Status field set allows you to set and track the status of a work order for three work order status types: Work Order, Inspection, and Payment. The status categories and the available settings for these status types are listed in Table 1.2. Three specific work order status values (“Work Completed On,” “Work Refused by Client On,” and/or “Rework Complete On”) indicate the work as complete and ready for summarized reporting (e.g., the DOE Quarterly Report).

Table 1.2. Work Order Status Type and settings

Status Type	Work Order Status	Inspection Status	Payment Status
Settings¹	Work Order Created from Audit On Work Order Details Completed On Work Order Approved On Work Order Issued On Work Scheduled to Start On Work Started On Work Completed On* Client Signed Off On* Work Refused by Client On* Work Order Canceled On* Work Order Modified On Rework Completed On* Delayed On Other	Scheduled For Passed On* Failed On Not Required* Delayed On Other	Invoice Received On Invoice Approved On Invoice Paid On* Not Required* Delayed On Other

¹Statuses tagged with an asterisk (*) are considered to represent completion.

Select the Work Order Measures tab, to develop detailed task descriptions for weatherization measures for a selected work order. The Work Order Measures form (Figure 1.23) allows you to enter a general description of measures at the top of the form and material and labor components in the Materials/Labor Details subform. You must enter a Measure Name to identify it in the work order. You may select the Measure Type from the drop-down list. The choices are Baseloads, Building Insulation, Client Education, Doors and Windows, General Heat Waste and Air Infiltration, General Repairs, Health and Safety, HVAC Systems, and Other. You may enter the Order # to identify the work order by a unique code. You may enter Components identifying the name or code of all the building components to which the measure will be applied. You may select a Cost Center, which is a funding source to which the actual cost of the measure will be charged. Be sure to select the Active checkbox to include the measure in the work order.

The Materials/Labor Details subform allows you to describe the actual quantities and unit price for different cost components of a measure. You may enter the details of cost components manually or by choosing from the Supply Library in the drop-down under the Copy From Supply column if a Supply Library was selected on the Work Order Details form.

For a work order, multiple Work Order Measures may be created by selecting the New button on the task 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.

#	Type	Copy From Supply	Description	Units+	Est Qty	Est\$/Unit	Est Total	Act Qty	Act\$/Unit	Act Total
1	Hot Water Equipment		Water Heater Tank Insulation Wrap	Each	1	15	15			
2	Labor		Water Heater Tank Insulation Wrap	Each	1	25	25			
3	Other		Water Heater Tank Insulation Wrap	Each	1	5	5			
4	Doors		Solid Core Door	Each	1	200	200			

Figure 1.23 Work Order Measures 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.

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.

NEAT
Agency: Sample Agency
Acct.: Sample Account
Acct. #: S001
Audit: Sample Audit
Audit #: 3596

General
● ✓ Audit

Shell
● ✓ Walls
● ✓ Windows
● Doors
● Unfinished Attics
● Finished Attics
● Foundations

Systems
● ✓ HVAC
● ✓ Ducts
● ✓ Infil./Duct Leakage

Baseloads
● Water Heating
● Refrigerator
● Lighting

Other
● Health and Safety
● Itemized Costs
● Utility Bills

Audit Recommendations
● ✓ Run
● View

Reports

Icon Key
● Form is Required
● Form is Recommended
● Form is Optional
✓ Form is Completed

Figure 2.1. NEAT Audit Dock.

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.

National Energy Audit Tool (NEAT)

Agency: Oak Ridge National Laboratory
 Account Name: NEAT Sample Account
 Account Number: Sample 101
 Audit Name: Sample Audit

Audit Date: 11-09-2022
 Auditor: Charles Amoo
 City: Knoxville
 State: TN
 Audit Number: 3511

Building Information

Occupants: 4
 Conditioned Stories: 2
 Infiltration Height (ft): 18
 Floor Area (sq ft): 1800
 Number of Bedrooms: 4
 Wind Shielding: Normal Shielding

Libraries

Weather State: TN
 Weather Station: Knoxville Mcghee Tyson Ap
 Economic Parameters: 2022 - Residential US Average Ec
 Measure Costs: Modified (ORNL) NEAT Measure C
 Key Parameters: Default NEAT Key Parameters v10
 Supply Library: No Supply Library selected
 Defined Measures: ORNL Initial Defined Measures
 Billing Adjustment:

Fuel Cost Details

Electricity:	2020 - Average US Residential Electricity Costs	Cost:	0.1309	per	kWh
Natural Gas:	2020 - Average US Residential Natural Gas Costs	Cost:	9.85	per	Mcf
Propane/LPG:	2020 - Average US Residential Propane Costs	Cost:	1.926	per	Gallon
Fuel Oil:	2020 - Average US Residential No. 2 Heating Oil Costs	Cost:	2.607	per	Gallon
Kerosene:	2020 - Average US Residential Kerosene Costs	Cost:	3.321	per	Gallon
Wood:	2020 - Average US Residential Wood Costs	Cost:	350	per	Cord
Coal:	2020 - Average US Residential Coal Costs	Cost:	86.34	per	Ton
Other:	Other fuel cost	Cost:	106.67	per	MMBtu

New Copy Delete OK Apply Cancel

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.

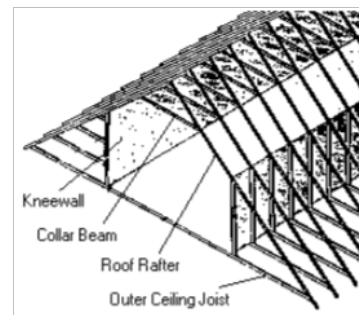


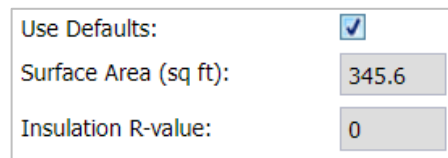
Figure 2.5. Components of a finished attic.

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, selecting a space heater will disable 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 subforms. 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. All existing heating and 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.



Use Defaults:	<input checked="" type="checkbox"/>
Surface Area (sq ft):	345.6
Insulation R-value:	0

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:	20230111.03285538
AUDIT INFORMATION	
Audit Name:	Sample NEAT for manual
Audit Number:	2433
Auditor:	Jyothi Anand
Audit Date:	July 14, 2021
Last Edited On:	January 11, 2023 3:29 PM
Comments:	
Building Information	
Groupings:	3
Conditioned Stories:	1
Floor Area (sq ft):	789
<small>Account Name: Audit Tool Comparisons NEAT Recommended Measures Report Agency: ORNL Account Number: Audit Tool Comparisons Printed On: January 11, 2023 2:34 PM Audit Name: Sample NEAT for manual Other ID Number: Page 1 of 5 Audit Number: 2433</small>	

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	Lighting Retrofits	LT1	0.0	\$0	0	\$0	206	\$30	0.7	\$30
2	Lighting Retrofits	LT2	0.0	\$0	0	\$0	263	\$38	0.9	\$38
3	Low Flow Showerheads	Water Heating	0.0	\$0	0	\$0	421	\$18	1.4	\$18
4	Water Heater Tank Insulation	Water Heating	0.0	\$0	0	\$0	476	\$21	1.6	\$21
5	Insulate and Seal Attic Access	Itemized Cost	0.0	\$0	0	\$0	0	\$0	0.7	\$0
6	Refrigerator Replacement	Refrigerator	0.0	\$0	0	\$0	1,915	\$277	6.5	\$277
7	Water Heater Pipe Insulation	Water Heating	0.0	\$0	0	\$0	260	\$11	0.9	\$11
8	Weatherize Window	WD3,WD1,WD2	6.0	\$77	-46	-\$7	0	\$0	5.9	\$70
9	General Air Sealing	Ducts/Infiltration	9.7	\$123	-22	-\$3	0	\$0	9.7	\$120
10	Water Heater Replacement	Water Heating	0.0	\$0	0	\$0	1,362	\$59	4.7	\$59

Economics					
Index	Recommended Measure	Components	Measure Savings (\$/yr)	Measure Cost (\$)	Measure SIR *
Incidental Repairs					
1	Repair Roof	51	\$0	\$80	0.00
Weatherization Measures					
2	Lighting Retrofits	LT1	\$30	\$24	9.58
3	Lighting Retrofits	LT2	\$38	\$32	9.17
4	Low Flow Showerheads	Water Heating	\$18	\$30	6.71
5	Water Heater Tank Insulation	Water Heating	\$21	\$45	4.48
6	Insulate and Seal Attic Access	Itemized Cost	\$9	\$30	4.17
7	Refrigerator Replacement	Refrigerator	\$277	\$800	4.07
8	Water Heater Pipe Insulation	Water Heating	\$11	\$30	3.68
9	Weatherize Window	WD3,WD1,WD2	\$70	\$300	1.80
10	General Air Sealing	Ducts/Infiltration	\$120	\$600	1.56
11	Water Heater Replacement	Water Heating	\$59	\$450	1.28
Total			\$652	\$2,421	2.67

*Total [Package] SIR excludes Health and Safety measures.

Materials				
Index	Material	Type	Quantity	Units
1	Weatherize Window	Weatherize Window Materials	10	Each Window
2	Water Heater Tank Insulation	Water Heater Tank Insulation Wrap	1	Each
3	Water Heater Pipe Insulation	R-1.85 (1/2") Water Pipe Insulation	1	Each
4	Low Flow Showerheads	Low Flow Showerhead	1	Each
5	General Air Sealing	General Air Sealing	1	Each Measure
6	Replacement Lighting	CFL Lamp 13.0 watts	4	Each
7	Replacement Lighting	CFL Lamp 15.0 watts	4	Each
8	New Refrigerator		1	Each
9	New Water Heater		1	Each
10	R-30 faced batt insylation		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 TMY3 (Typical Meteorological Year 3) 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 loads and energy consumptions (in MMBtu/yr), peak (i.e., design) loads (in kBtu/hr), and output required (in kBtu/hr for heating and tons for cooling) 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)	43.2	30.2	32.6	31.0
Annual Energy (MMBtu/yr)	63.9	8.8	48.1	9.1
Design Day Heat Loss/Gain (kBtu/hr)	37.9	16.1	34.5	15.0
Design Day Output Required (kBtu/hr)(ton)	45.5	1.6	39.7	1.5

Peak Heating Load				
Component Type	Component Name	Area or Volume (Infiltration)	Before Weatherization Load (Btu/h)	After Weatherization Load (Btu/h)
Wall (Btu/h)	WL1-N	348	3,096.3	3,096.3
Wall (Btu/h)	WL2-S	348	3,096.3	3,096.3
Wall (Btu/h)	WL3-E	624	5,552.1	5,552.1
Wall (Btu/h)	WL4-W	640	5,694.4	5,694.4
Window (Btu/h)	WD1	32	2,091.4	2,091.4
Window (Btu/h)	WD2	32	993.1	993.1
Window (Btu/h)	WD3	16	545.0	545.0
Door (Btu/h)	DR1	20	428.2	428.2
Door (Btu/h)	DR2	20	428.2	428.2
Attic (Btu/h)	A1	1,000	3,242.1	3,242.1
Foundation (Btu/h)	Crawlspace1	1,000	3,637.3	3,637.3
Infiltration (Btu/h)	Inf	16,000	9,144.5	5,715.3
Total heat loss (Btu/h)	Tot	0	37,949.1	34,519.9
Duct loss (Btu/h)	Duct	405	7,589.8	5,178.0
Output required (Btu/h)	Output	0	45,538.9	39,697.9

Peak Cooling Load				
Component Type	Component Name	Area or Volume (Infiltration)	Before Weatherization Load (Btu/h)	After Weatherization Load (Btu/h)
Wall (Btu/h)	WL1-N	348	899.8	899.8
Wall (Btu/h)	WL2-S	348	899.8	899.8
Wall (Btu/h)	WL3-E	624	1,613.4	1,613.4
Wall (Btu/h)	WL4-W	640	1,654.8	1,654.8
Window (Btu/h)	WD1	32	980.5	980.5
Window (Btu/h)	WD2	32	940.2	940.2
Window (Btu/h)	WD3	16	1,298.4	1,298.4
Door (Btu/h)	DR1	20	124.4	124.4
Door (Btu/h)	DR2	20	124.4	124.4
Attic (Btu/h)	A1	1,000	1,832.8	1,832.8
Foundation (Btu/h)	Crawlspace1	1,000	623.0	623.0
Infiltration (Btu/h)	Inf	16,000	3,340.8	2,272.8
People (Btu/h)	People	2	552.0	552.0
Appliances (Btu/h)	Appl	1	1,200.0	1,200.0
Total Sensible (Btu/h)	TotS	0	16,084.5	15,016.4
Ducts (Btu/h)	Ducts	0	2,412.7	2,252.5
Total (with ducts) (Btu/h)	TotW	0	18,497.2	17,268.9
Size (tons)	Size	0	1.5	1.4
Latent Load (inf) (Btu/h)	LatentI	0	0.0	0.0
Latent Load (occ) (Btu/h)	LatentO	0	460.0	460.0
Latent Load (tot) (Btu/h)	LatentT	0	460.0	460.0
Total Load (Btu/h)	Total	0	18,957.2	17,728.9
Size (tons)	Size	0	1.6	1.5

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

Reports – The Reports drop-down field on the Audit Dock is used to select two reports associated with the NEAT audit (attached below). The Audit Input report provides a printout of all the inputs 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

A work order is typically created for the measures recommended by running an audit. To create a work order for a previously run NEAT audit, select View at the bottom of the Audit Dock. This will open the Recommended Measures Report in a separate window. Switch to the Weatherization Assistant window and select the View Measures button on the task bar at the bottom of the NEAT Audit Recommendations window (Figure 2.10) to open the Audit Run Measures form.

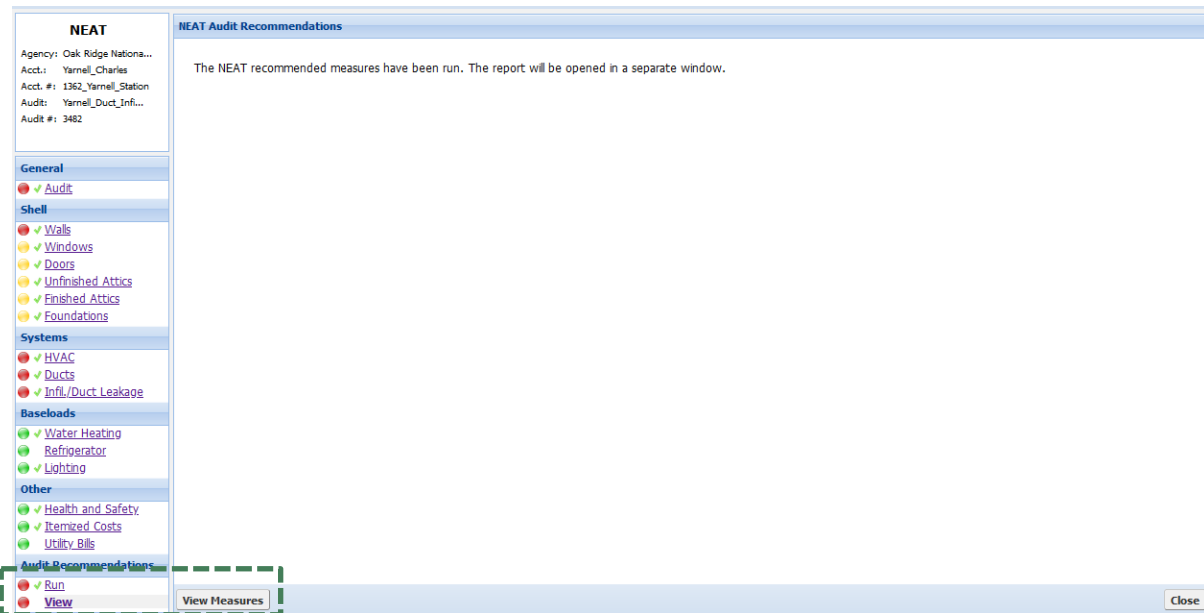


Figure 2.10. NEAT audit showing View and View Measures.

The **Audit Run Measures** form (Figure 2.11) displays seven buttons at the top, the Audit Run Measures subform in the middle, and the Unit Costs for Measure: [Measure Name] table at the bottom. The Select All, Unselect All, Invert Selections, Same Contractor, and Same Cost Center buttons help users complete the Audit Run Measures subform quickly. The Create Work Order button creates work orders based on information provided in the Audit Run Measures subform. The Close button exits the form.

The Audit Run Measures subform displays (a) uneditable fields under columns # (that reflect the order in which measures appear on the Recommended Measures Report), Measure Name, Components (that show the name of component[s] associated with the measure), and Estimated Cost and SIR (that display the measure cost and SIR used by the audits to make their initial recommendations); (b) drop-down fields under Contractor/In-House Crew and Cost Center columns, which allow you to assign each measure to a contractor and the cost of implementing each measure to a funding source or program, respectively; and (c) checkboxes under the Work Order column to indicate which measure to transfer to the work orders.

The Unit Costs for Measure: [Measure Name] table shows a breakdown of Estimated Cost for a measure selected in the Audit Run Measures subform. For a selected measure, the table lists as many cost types as were defined in the Retrofit Cost Details or Defined Measures library forms and in various building description forms. For each cost type, Measure Description, Quantity, Unit, Units\$ (i.e., cost per unit), and Comment specifying the source form for the cost per unit are displayed.

The screenshot shows the 'Audit Run Measures' interface. At the top, there are buttons for 'Select All', 'Unselect All', 'Invert Selections', 'Same Contractor', 'Same Cost Center', 'Create Work Order', and 'Close'. Below this is a table of measures with columns for '#', 'Measure Name', 'Contractor/In-House Crew', 'Cost Center', 'Components', 'Work Order', 'Estimated Cost', and 'SIR'. The table lists 11 measures, with the 'Work Order' column containing checkboxes. Below the main table is a section titled 'Unit Costs for Measure: Water Heater Replacement' with a sub-table showing 'Component', 'Cost Type', 'Measure Description', 'Quantity', 'Units', 'Units\$', and 'Comment'.

#	Measure Name	Contractor/In-House Crew	Cost Center	Components	Work Order	Estimated Cost	SIR
1	Repair Roof			Itemized Cost	<input checked="" type="checkbox"/>	\$80.00	0.0
2	Lighting Retrofits			LT1	<input checked="" type="checkbox"/>	\$24.00	9.6
3	Lighting Retrofits			LT2	<input checked="" type="checkbox"/>	\$32.00	9.2
4	Low Flow Showerheads			Water Heater	<input checked="" type="checkbox"/>	\$30.00	6.7
5	Water Heater Tank Insulation			Water Heater	<input checked="" type="checkbox"/>	\$45.00	4.5
6	Insulate and Seal Attic Access			Itemized Cost	<input checked="" type="checkbox"/>	\$29.60	4.2
7	Refrigerator Replacement			Refrigerator	<input checked="" type="checkbox"/>	\$800.00	4.1
8	Water Heater Pipe Insulation			Water Heater	<input checked="" type="checkbox"/>	\$30.00	3.7
9	Weatherize Window			WD3,WD1,WD2	<input checked="" type="checkbox"/>	\$300.00	1.8
10	General Air Sealing			Ducts/Infiltration	<input checked="" type="checkbox"/>	\$600.00	1.6
11	Water Heater Replacement			Water Heater	<input checked="" type="checkbox"/>	\$450.00	1.3

Component	Cost Type	Measure Description	Quantity	Units	Units\$	Comment
Water Heater	Installation	New Water Heater, 50 gal, Natural Gas, S...	1	Each	\$450.00	Cost from form
Water Heater	Additional	New Water Heater, 50 gal, Natural Gas, S...	1	Each	\$0.00	Cost from form

Figure 2.11. Audit Run Measures form.

To create work orders, you must select the checkbox under the Work Order column for each measure you want transferred to a work order. Measures not selected will not be sent to a work order. You may prefer to not send a specific measure to a work order if a work order already exists that includes the measure or if you do not want to consider certain recommended measures. You may use the Select All, UnSelect All, and Invert Selections buttons to select all recommended measures, unselect all, or invert the current selections.

You may select a Contractor/In-House Crew to assign each measure to a contractor. The selection will determine how many work orders are created from the measure list. All measures assigned the same contractor will be included in the same work order. The choices displayed in the drop-down list will be all agency contacts defined as Contractor or Crew on the Agency Contact form. All measures with an unassigned Contractor that are selected for transfer to a work order will be assigned to the same work order with the contractor undesignated. After assigning one measure to a contractor, you may use the Same Contractor button to assign all additional measures to that contractor.

If you are tracking costs incurred by different funding sources or programs, you may select a Cost Center to assign the cost of implementing each measure to the appropriate Cost Center. The choices available in the drop-down list will be those you have defined on the Agency Cost Center form. If the entry is left unassigned, work orders can still be developed, but total costs over multiple audits will not be tracked. The costs assigned to the various cost centers are not the Estimated Costs. They are the actual costs declared in the work orders themselves. After assigning one measure to a cost center, you may use the Same Cost Center button to assign all measures to that cost center.

When you are ready to create the work orders based on the information provided on the Audit Run Measures subform, select the Create Work Order button. If you have previously created work orders from this specific audit, the Create Work Order pop-up form (Figure 2.12) will be displayed and will ask your preference among three options:

- Save the previously generated Work Order and create new ones,
- Replace the previously generated Work Order with new ones, or
- Cancel the creation of Work Orders.

Select an option and then select OK to save and close the pop-up form. Any work orders not created from this audit will be unaffected by the request to create work orders from the Audit Run Measures form of this audit. Thus, if you used the Work Orders form from the menu bar to create work orders for an account, then you ran an audit for the same account and were asked to create work orders based on the audit recommendations, the two sets of work orders would exist for the same client. This is intended to address situations where agencies may implement some measures outside an audit (such as from a priority list) but use the audit for recommendations on other measures.

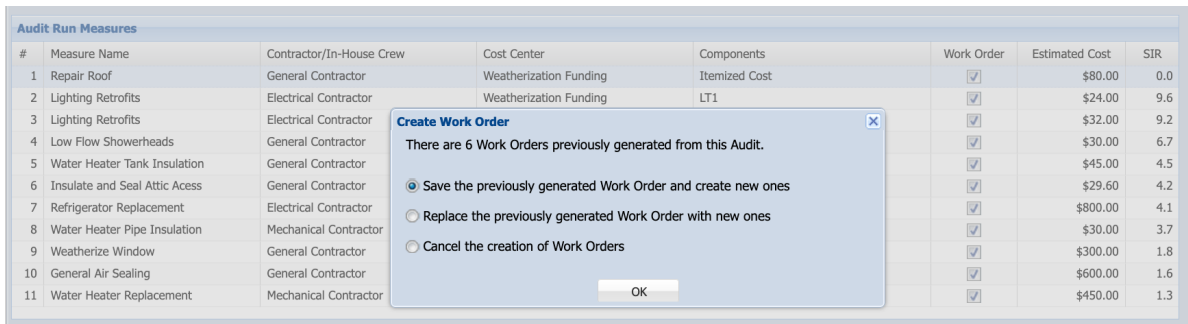


Figure 2.12. Create Work Order pop-up form.

The program will next display the Information pop-up window (Figure 2.13) indicating how many work orders were created as a result of your selections on the Audit Run Measures subform. This should correspond to the number of unique contractors (including undesignated) that you indicated on the Audit Run Measures subform. Select OK to acknowledge and close the pop-up window. Select Close to exit the Audit Run Measures form.

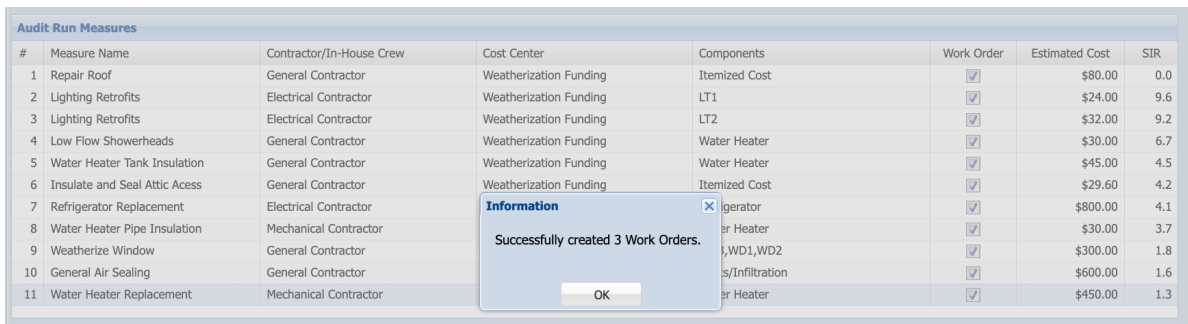


Figure 2.13. Information pop-up window for successfully created work orders.

After creating work orders from the audit recommendations, you may access them from the All table on the Work Order Details form (Figure 2.14) and view measure details on the Work Order Measures form (Figure 2.15). See Section 1.8 for information about making changes to a work order or measure details.

Work Order Details | Work Order Measures

Work Order Information

Work Order: Sample NEAT Audit 0_WO_003

Account Name: Sample Account

Account Number: S001

Agency: Sample Agency

Audit Name: Sample NEAT Audit 0

Supply Library: Sample Supply Library

Contractor/Crew: Mechanical Contractor

Work Order Type: Weatherization

State: TN

Account Information

Client Name: [Redacted]

Alt Id: [Redacted]

Work Order Economic Summary

Number of Active Measures: [Redacted]

Cumulative Estimated Cost: [Redacted]

Cumulative Actual Cost: [Redacted]

Status

Work Order Status

All Status Types | Record Count: 1

Status Type	Current Status	Updated By	Comments	Date	Revised On
Work Order	Work Order Created from Audit On	Mini Malhotra - SiteAdmin	Created from Measures form	03-27-2024	03-27-2024 3:24 AM

Comments

[Redacted]

New Copy Delete **Work Order** OK Apply Cancel

All Work Orders (90)

Agency	Work Order	Account Name	Account Number	Audit Name	Audit #	Audit Type	Last Edited
Sample Agency	Sample NEAT Audit 0_WO_003	Sample Account	S001	Sample NEAT Audit 0	4420	NEAT	03-27-2024 3:24 AM
Sample Agency	Sample NEAT Audit 0_WO_002	Sample Account	S001	Sample NEAT Audit 0	4420	NEAT	03-27-2024 3:24 AM
Sample Agency	Sample NEAT Audit 0_WO_001	Sample Account	S001	Sample NEAT Audit 0	4420	NEAT	03-27-2024 3:24 AM

Figure 2.14. Work orders created for a NEAT audit.

Work Order Details | **Work Order Measures**

Work Order: Sample NEAT Audit 0_WO_003

Order #: [Redacted] Active:

Measure Type: Baseloads

Components: Water Heater Show Components

Measure Name: Water Heater Pipe Insulation

Cost Center: Weatherization Funding

Materials/Labor Details

Materials/Labor Details

Add Detail Delete Detail

#	Type	Copy From Supply	Description	Units+	Est Qty	Est\$/Unit	Est Total	Act Qty	Act\$/Unit	Act Total
1	Hot Water Equipment		R-1.85 (1/2") Water Pipe Insulation	Each	1	5	5			
2	Hot Water Equipment		R-1.85 (1/2") Water Pipe Insulation	Each	1	10	10			
3	Hot Water Equipment		R-1.85 (1/2") Water Pipe Insulation	Each	1	15	15			

Comments

[Redacted]

New Copy Delete **Measure** OK Apply Cancel

All Work Order Measures (2)

Measure Name	Components	Cost Center	Last Edited
Water Heater Pipe Insulation	Water Heater	Weatherization Funding	03-27-2024 3:24 AM
Water Heater Replacement	Water Heater	Health and Safety Funding	03-27-2024 3:24 AM

Figure 2.15. Work order measure details for a NEAT measure.

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.

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.

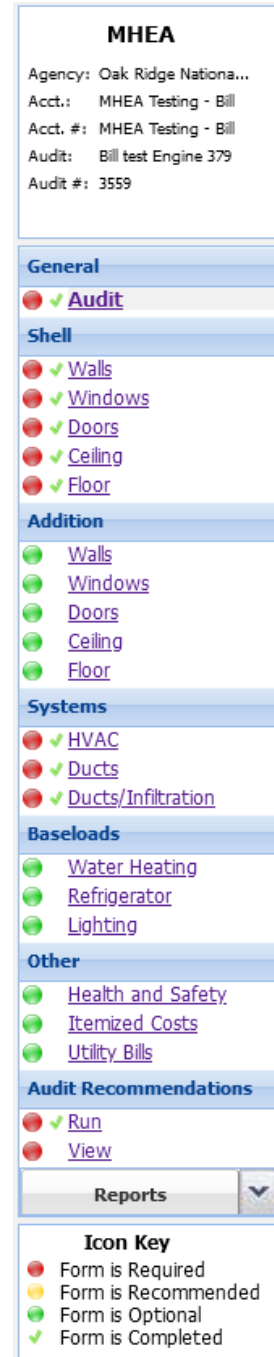


Figure 3.1. MHEA Audit Dock.

The screenshot shows a web interface for window management. At the top, there are two tabs labeled 'Win1' and 'Win2'. Below the tabs, there is a section titled 'Existing Window' with three input fields: 'Window Code:' containing the text 'Win1', 'Window Type:' with a dropdown menu showing 'Awning', and an empty field for 'Window Code:'.

Figure 3.2. Tabs on MHEA’s Window form.

Window Code	Frame Type	Glazing Type	Wall/Roof Code	Leakiness	Width (in.)	Height (in.)	Last Edited
Sliding Door	Vinyl	Double Pane	Wall	Medium	72	80	11-17-2022 12:43 PM
Sliding Door - Max	Vinyl	Double Pane	Wall	Medium	90	90	11-17-2022 12:43 PM
W01	Wood	Single Pane	Wall	Very Loose	34	45	11-17-2022 12:42 PM
W02	Wood	Single Pane	Wall	Very Loose	34	45	11-17-2022 12:42 PM
W03	Wood	Single Pane	Wall	Very Loose	34	45	11-17-2022 12:42 PM
W04	Wood	Single Pane	Wall	Very Loose	34	45	11-17-2022 12:42 PM

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.

Manufactured Home Energy Audit (MHEA)

Agency: Oak Ridge National Laboratory Audit Date: 08-08-2022

Account Name: Duct-Envelope Sealing Tests Auditor: Charles Amoo

Account Number: NEAT-MHEA INF-Ducts-1 City: Anytown

Audit Name: Bill Testing - Engine 495 State: TN

Audit Number: 3534

Building Information

Occupants: 6 Number of Bedrooms: 2

Length (ft): 50 Wind Shielding: Normal Shielding

Width (ft): 12 Outdoor Water Heater Closet:

Exterior Wall Height (ft): 7.5

Infiltration Height (ft): 7.5

Libraries

Weather State: LA

Weather Station: Baton Rouge Metropolitan Airport

Economic Parameters: 2020 - Residential US Average Ec

Measure Costs: Default (ORNL) MHEA Measure Co

Key Parameters: Default MHEA Key Parameters v1C

Supply Library: Test Supply Library

Defined Measures: ORNL Initial Defined Measures

Billing Adjustment:

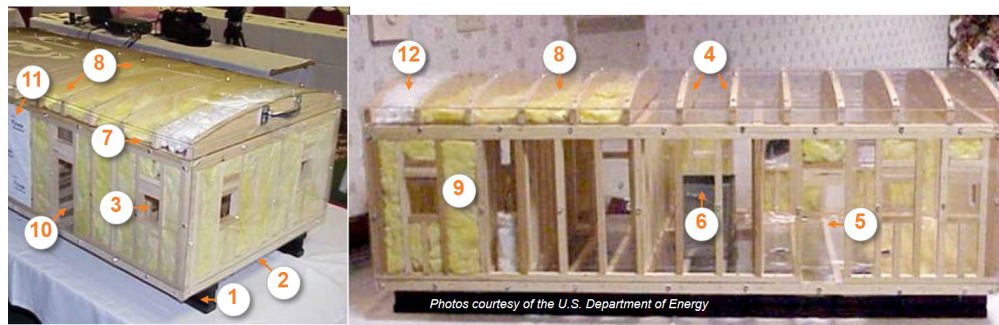
Fuel Cost Details

Electricity:	2020 - Average US Residential Electricity Costs	Cost: 0.1309	per kWh
Natural Gas:	2020 - Average US Residential Natural Gas Costs	Cost: 9.85	per Mcf
Propane/LPG:	2020 - Average US Residential Propane Costs	Cost: 1.926	per Gallon
Fuel Oil:	None	Cost: 0	per N/A
Kerosene:	None	Cost: 0	per N/A
Wood:	None	Cost: 0	per N/A
Coal:	None	Cost: 0	per N/A
Other:	None	Cost: 0	per N/A

New Copy Delete OK Apply Cancel

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 | 7. Top plate |
| 2. Band joist | 8. Ceiling joist cavity |
| 3. Rough window opening | 9. Wall section |
| 4. Bowstring trusses | 10. Rough door opening |
| 5. Floor joists | 11. Vapor barrier |
| 6. Heating/AC duct | 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 3.8 and Figure 3.9 for different cathedral ceiling configurations).

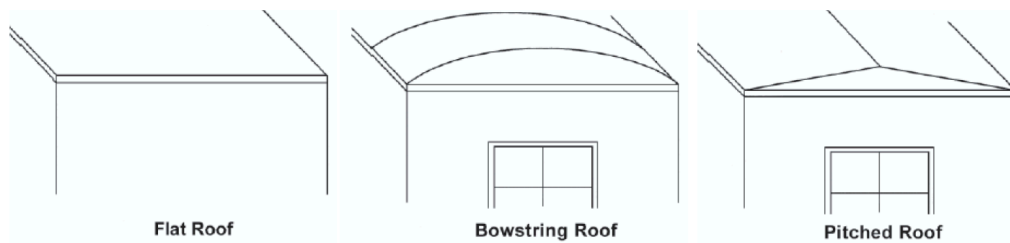


Figure 3.6. Typical manufactured home roof configurations.

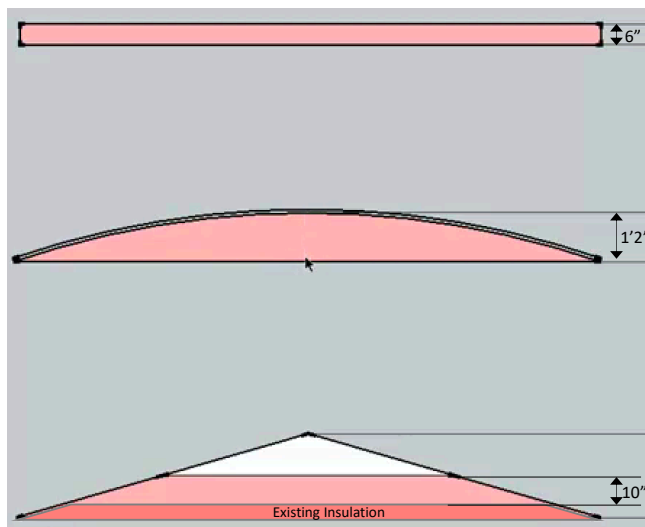


Figure 3.7. Section drawings of manufactured home roof configurations (from top to bottom: flat roof, bowstring roof, pitched roof).

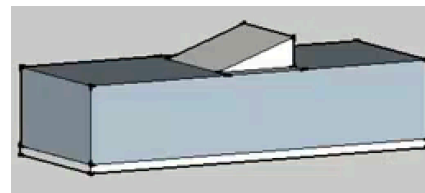


Figure 3.8. Sloped roof cathedral ceiling with step wall, typical with flat roofs.

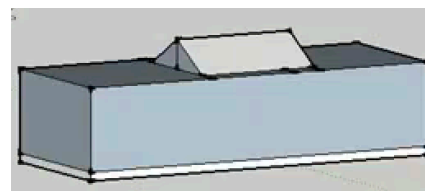


Figure 3.9. Cathedral ceiling configurations with no step wall, typical with pitched roofs.

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).

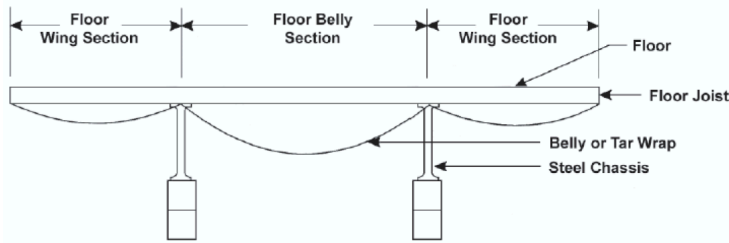


Figure 3.10. Widthwise floor joist direction.

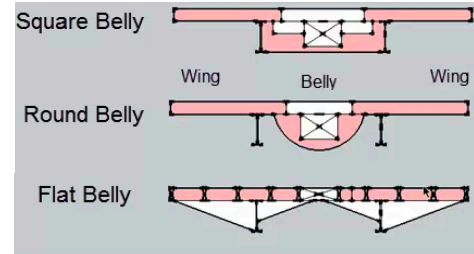


Figure 3.11. Typical manufactured home belly configurations.

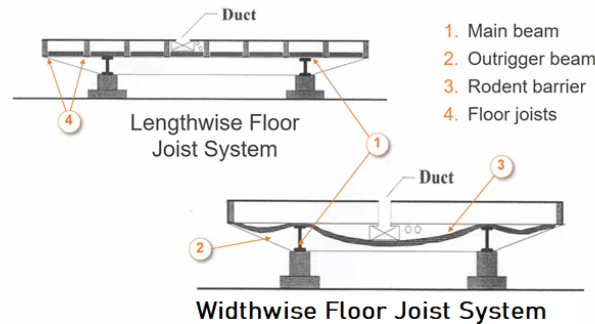


Figure 3.12. Manufactured homes joist spacing and direction.

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.

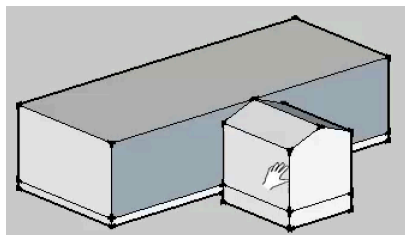


Figure 3.13. Gable roof configuration.

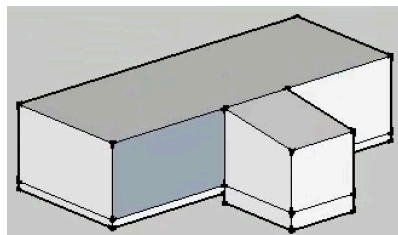


Figure 3.14. Shed roof configuration.

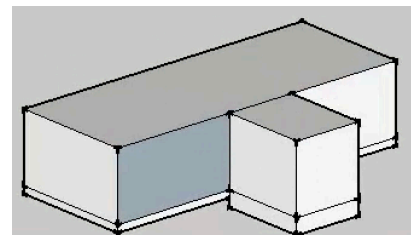


Figure 3.15. Flat roof configuration.

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

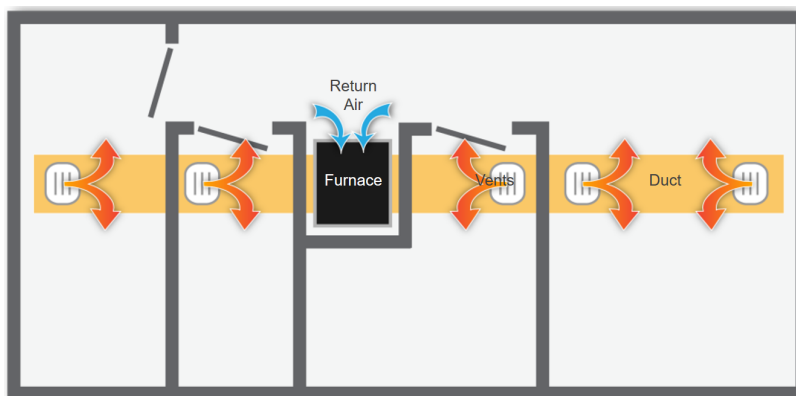
regard to heating, will determine whether the duct form remains optional or becomes required. In most homes, though, both heating and cooling systems will be entered on the HVAC form.

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 disable the retrofit option for installing a smart thermostat, and selecting a space heater will disable 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 subforms. 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.

Use Defaults:	<input checked="" type="checkbox"/>
Surface Area (sq ft):	345.6
Insulation R-value:	0

Figure 3.16. Use Defaults checkbox selected.



Graphic developed for the U.S. DOE WAP Standardized Curricula

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:	865-241-6785
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	MHEA Recommended Measures Report	Agency: ORNL
Account Number: Audit Tool Comparisons	Printed On: January 11, 2023 3:32 PM	Audit Name: Sample test for manual
Other ID Number:	Page 1 of 4	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 would 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 and peak heating load 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 the MHEA audit (attached below). 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).



3.3 CREATING AN MHEA WORK ORDER

The process for creating an MHEA work order is the same as for NEAT. Please refer to Section 2.3, CREATING A NEAT WORK ORDER, for details.

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.

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.

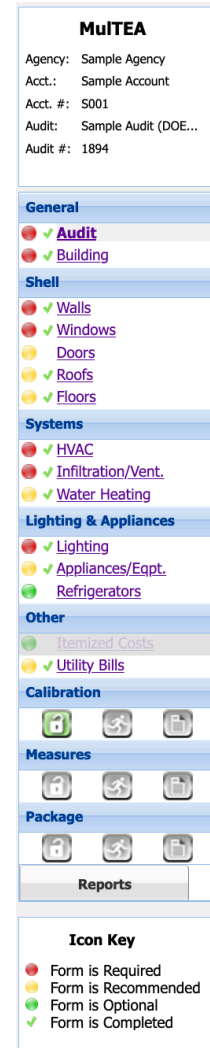


Figure 4.1. MulTEA Audit Dock.

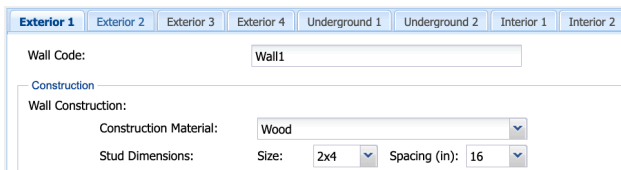


Figure 4.2. Tabs on MulTEA’s Wall form.

All Walls			
Wall Code	Wall Tab	Construction Material	Last Edited
Wall1	Exterior 1	Wood	04-25-2019 5:19 PM
Wall2	Exterior 2	Wood	05-07-2020 3:25 AM

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.

Multifamily Tool for Energy Audits (MulTEA)

Agency: Sample Agency Audit Date: 11-26-2019
 Account Name: Sample Account Auditor: John Doe
 Account Number: S001 City:
 Audit Name: Sample Audit (DOE Mid-rise Prototype) State: CO
 Audit Number: 1894

Libraries
 Weather State: IL
 Weather Station: Chicago Ohare Intl Ap
 Economic Parameters: 2019 - Residential US Average Ecc
 Measure Costs: Sample MulTEA Measure Cost Libr
 Key Parameters:
Fuel Cost Details
 Electricity: 2019 - Average US Residential Electricity Costs Cost: 0.1283 per kWh
 Natural Gas: 2019 - Average US Residential Natural Gas Costs Cost: 9.48 per Mcf
 Propane: None Cost: per
 Fuel Oil: None Cost: per
 Kerosene: None Cost: per

Comments

New Copy Delete OK Apply Cancel

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.

Building Size and Occupancy

Number of Dwelling Units: 31
 Elevation of First Floor Above Grade (ft): 0
 Gross Floor Area of Building (sq ft): 33744
 Depth of Building Below Grade (ft): 0
 Number of Floors Above Grade: 4
 Site Grade Changes:
 Number of Floors Below Grade: 0
 Depth of Building Below Grade:
 Average Floor Height (ft): 10
 On the Back (ft):
 Number of Occupants:
 On the Right (ft):
 During Daytime: 20
 On the Front (ft):
 During Nighttime: 79
 On the Left (ft):

Site Definition

Site Shielding and Terrain: Heavy (Urban, Suburban, Forest Area)
 Ground Surface: Old Asphalt (Light Color)

Building Layout

Building Shape: Linear/Box
 Total Number of Dwelling Units:
 Hallway Configuration: Double-Loaded
 Top Floor: 8
 Hallways Are Conditioned:
 Intermediate Floor(s): 16
 Orientation of Building (deg): 0
 First Floor Above Grade: 7
 First Floor Below Grade: 0

Configuration

Floor Area of Enclosed Spaces

Floor	Area (sq ft)				Floor Sum
	Units	Hallways	Other Conditioned Spaces	Other Unconditioned Spaces	
A3	7600	836	0	0	8436
A2	7600	836	0	0	8436
A1	6650	836	950	0	8436
B1	0	0	0	0	0
B2	NA	0	0	0	0
Bldg Totals: *	29450	3344	950	0	33744

* Bldg totals include a multiplier for two A2 floors

Number of Dwelling Units

Exposed Walls in one orientation (checked)

Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor
<input type="checkbox"/>	2	2	2
<input type="checkbox"/>	2	2	2

Exposed Walls in two adjacent orientations (checked)

Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor
<input type="checkbox"/>	1	1	1
<input type="checkbox"/>	1	1	1
<input type="checkbox"/>	1	1	1

Exposed Walls in two opposite orientations (unchecked)

Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor
<input type="checkbox"/>			
<input type="checkbox"/>			

Exposed Walls in three orientations (unchecked)

Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor
<input type="checkbox"/>			
<input type="checkbox"/>			
<input type="checkbox"/>			

Exposed Walls in all orientations (unchecked)

Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor
<input type="checkbox"/>			
<input type="checkbox"/>			
<input type="checkbox"/>			

Comments

Delete OK Apply Cancel

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.

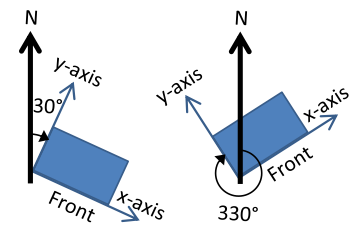





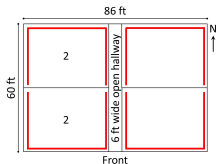
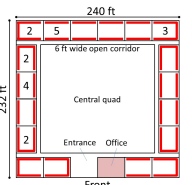
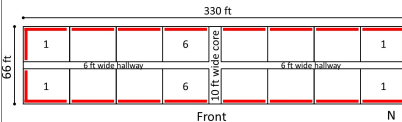
Figure 4.6. Building orientation.

- **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																																																																								
																																																																										
 <ul style="list-style-type: none"> • 4 units on first floor above grade • 4 units on second floor 	 <p>All units on first floor</p>	 <ul style="list-style-type: none"> • 16 units on first floor above grade • 32 units on intermediate floors • 16 units on top floor 																																																																								
<p>Number of Dwelling Units</p> <table border="1"> <thead> <tr> <th>First Floor Below Grade</th> <th>First Floor Above Grade</th> <th>Intermediate Floor(s)</th> <th>Top Floor</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> Exposed Walls in one orientation</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in two adjacent orientations</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in two opposite orientations</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> Exposed Walls in three orientations</td> <td>2</td> <td></td> <td>2</td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in all orientations</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	First Floor Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor	<input type="checkbox"/> Exposed Walls in one orientation				<input type="checkbox"/> Exposed Walls in two adjacent orientations				<input type="checkbox"/> Exposed Walls in two opposite orientations				<input checked="" type="checkbox"/> Exposed Walls in three orientations	2		2	<input type="checkbox"/> Exposed Walls in all orientations				<p>Number of Dwelling Units</p> <table border="1"> <thead> <tr> <th>First Floor Below Grade</th> <th>First Floor Above Grade</th> <th>Intermediate Floor(s)</th> <th>Top Floor</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> Exposed Walls in one orientation</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in two adjacent orientations</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> Exposed Walls in two opposite orientations</td> <td>5</td> <td></td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> Exposed Walls in three orientations</td> <td>4</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in all orientations</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	First Floor Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor	<input type="checkbox"/> Exposed Walls in one orientation				<input type="checkbox"/> Exposed Walls in two adjacent orientations				<input checked="" type="checkbox"/> Exposed Walls in two opposite orientations	5			<input checked="" type="checkbox"/> Exposed Walls in three orientations	4			<input type="checkbox"/> Exposed Walls in all orientations				<p>Number of Dwelling Units</p> <table border="1"> <thead> <tr> <th>First Floor Below Grade</th> <th>First Floor Above Grade</th> <th>Intermediate Floor(s)</th> <th>Top Floor</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> Exposed Walls in one orientation</td> <td>6</td> <td>12</td> <td>6</td> </tr> <tr> <td><input checked="" type="checkbox"/> Exposed Walls in two adjacent orientations</td> <td>1</td> <td>2</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in two opposite orientations</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in three orientations</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> Exposed Walls in all orientations</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	First Floor Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor	<input checked="" type="checkbox"/> Exposed Walls in one orientation	6	12	6	<input checked="" type="checkbox"/> Exposed Walls in two adjacent orientations	1	2	1	<input type="checkbox"/> Exposed Walls in two opposite orientations				<input type="checkbox"/> Exposed Walls in three orientations				<input type="checkbox"/> Exposed Walls in all orientations			
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<input checked="" type="checkbox"/> Exposed Walls in three orientations	2		2																																																																							
<input type="checkbox"/> Exposed Walls in all orientations																																																																										
First Floor Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor																																																																							
<input type="checkbox"/> Exposed Walls in one orientation																																																																										
<input type="checkbox"/> Exposed Walls in two adjacent orientations																																																																										
<input checked="" type="checkbox"/> Exposed Walls in two opposite orientations	5																																																																									
<input checked="" type="checkbox"/> Exposed Walls in three orientations	4																																																																									
<input type="checkbox"/> Exposed Walls in all orientations																																																																										
First Floor Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor																																																																							
<input checked="" type="checkbox"/> Exposed Walls in one orientation	6	12	6																																																																							
<input checked="" type="checkbox"/> Exposed Walls in two adjacent orientations	1	2	1																																																																							
<input type="checkbox"/> Exposed Walls in two opposite orientations																																																																										
<input type="checkbox"/> Exposed Walls in three orientations																																																																										
<input type="checkbox"/> Exposed Walls in all orientations																																																																										

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.

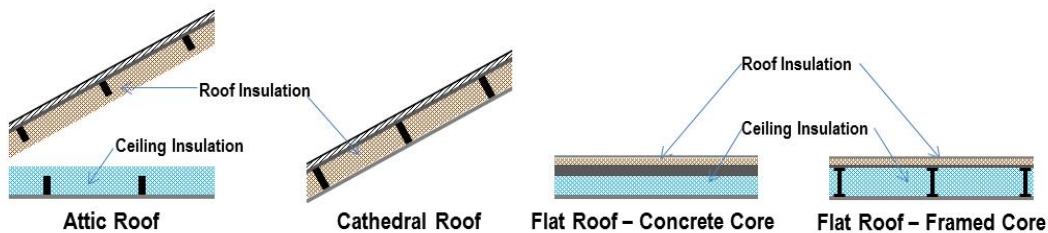
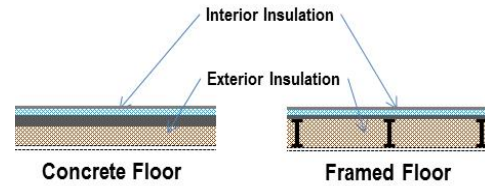
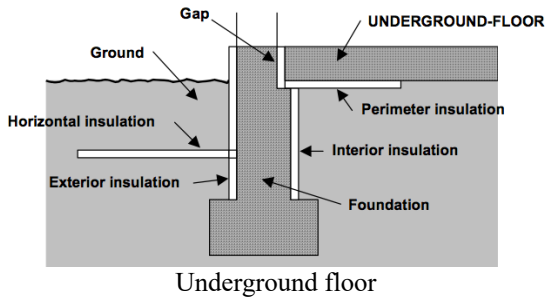


Figure 4.7. Roof insulation locations.

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.



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
	<p>Describe on-grade slab as underground floor</p>	<p>Describe above grade portion of the wall as an exterior wall</p> <p>Describe below grade portion of the wall as an underground wall</p> <p>Describe below-grade slab as underground floor</p>	<p>Describe above grade portion of the wall as an exterior wall</p> <p>Describe below grade portion of the wall as an underground wall</p>
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 subform** (required) 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 subforms** (optional) 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 subform 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 subform 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 subforms** or a central water heater using the **Central System subform**. 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 subform cannot be accessed. Conversely, if a central system has been entered, then the Individual System subforms 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 Performance¹ 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.

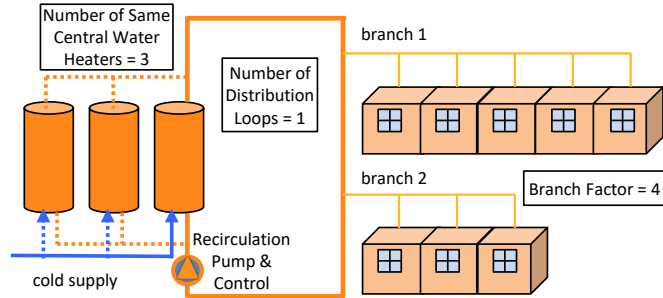


Figure 4.9. Central water heater distribution loops.

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 ft² room, the lighting power density would be 180/360 = 0.5 W/ft². 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/ft²)

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 Base Case 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.
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

Table 4.4. Fuel heat capacities

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

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):

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.

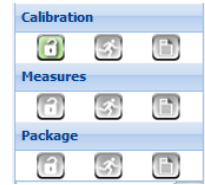


Figure 4.10. Run control buttons.

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.

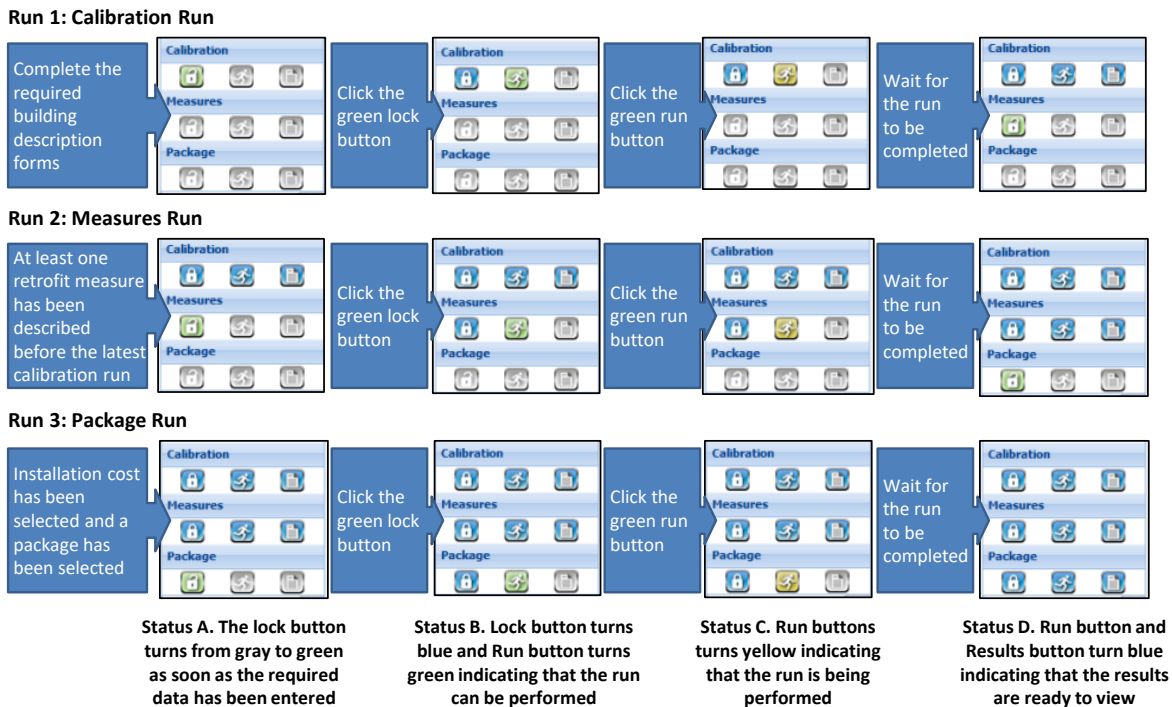


Figure 4.11. Status of run control buttons during the Calibration, Measures, and Package Runs.

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.

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.

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

Account Name: Sample Account	MulTEA Building Calibration Report	Agency: Sample Agency
Account Number: S001	Printed On: May 7, 2020 2:33 AM	Audit Name: Sample Audit (DOE Mid-rise Pro
Other ID Number:	Page 1 of 5	Audit Number: 1894

Figure 4.12. MulTEA Building Calibration Report: title page.

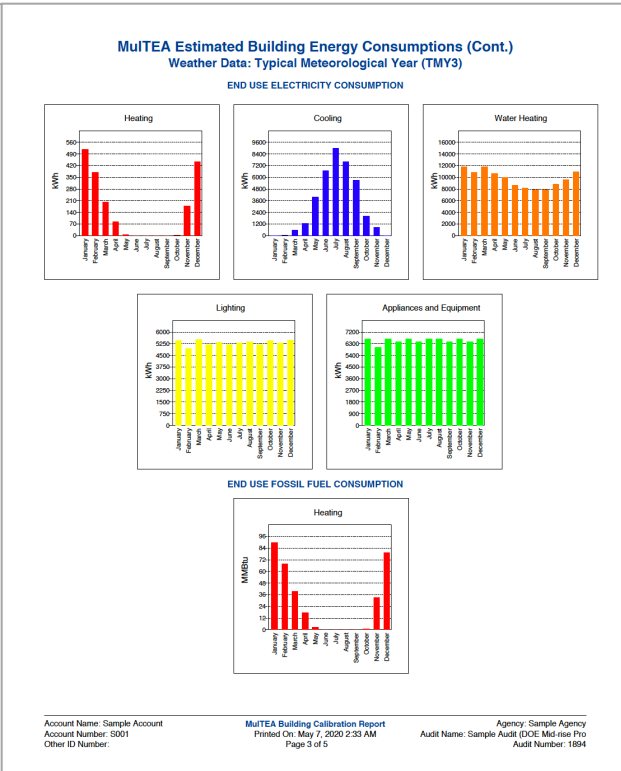
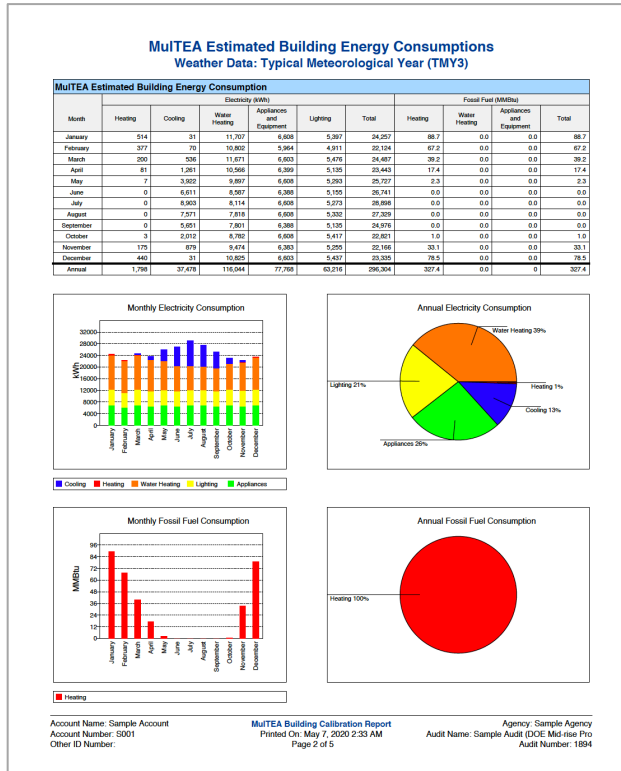


Figure 4.13. MuTEA Calibration Report: estimated energy consumptions by end use.

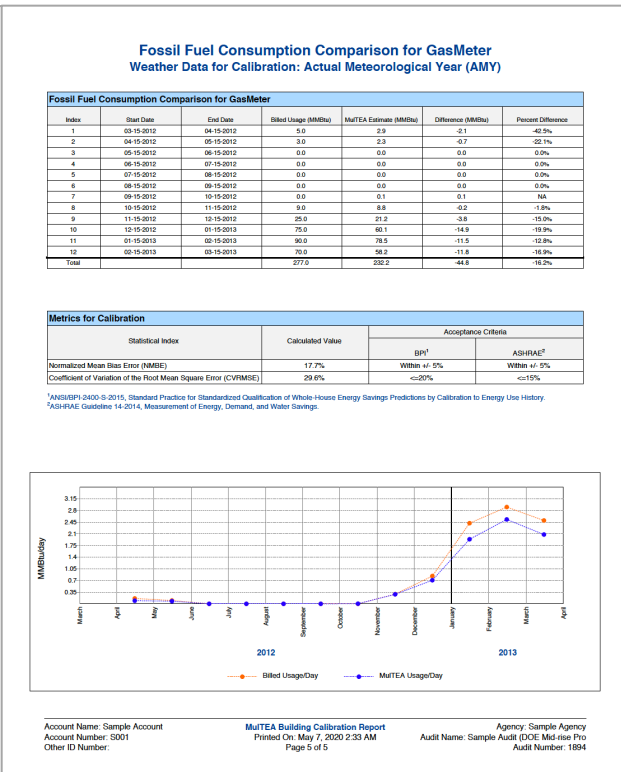
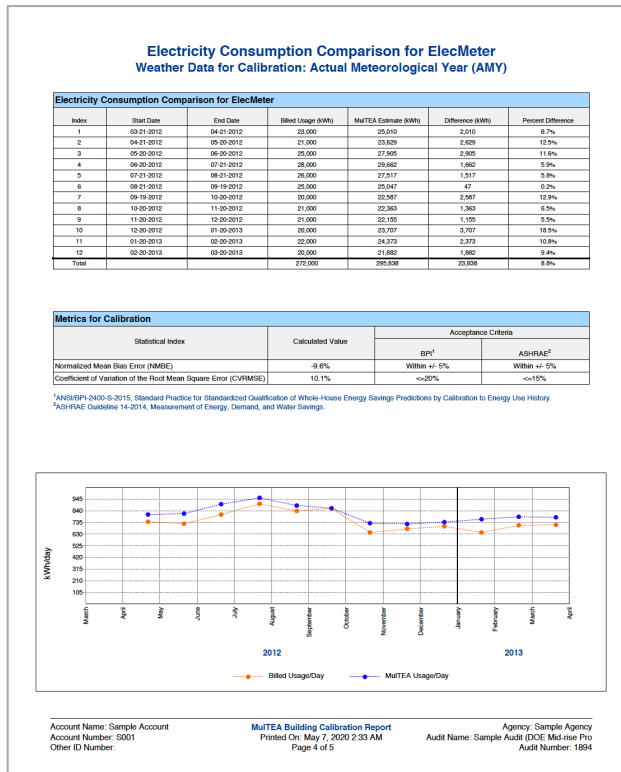


Figure 4.14. MuTEA Calibration Report: comparison of energy consumptions to utility bills.

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, subform (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: 999999999			
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	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)
<input checked="" type="checkbox"/>	1	Replace Window	Windows	Window 1	WIN1	1,472	16,000	20.0	1.6	10.9
<input checked="" type="checkbox"/>	2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	203	3,601	25.0	1.2	17.7
<input type="checkbox"/>	3	Replace the System	HVAC	System 1	HEAT1	798	0	15.0	0.0	0.0
<input type="checkbox"/>	4	Air Sealing	Infiltration/Ventilation	Infiltration	Infiltration	614	0	10.0	0.0	0.0
<input type="checkbox"/>	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, subform (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: Northern Test														
Account Number: 999999999														
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	0	1,472		
2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	217	-18	0	0	0	0	199		
3	Package				1,696	-25	0	0	0	0	1,671		

(b) Package: Cost Savings form

Retrofit Package Economics (Includes Interaction Among Measures)													
<input type="checkbox"/> Add repair cost <input type="checkbox"/> 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	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 (attached below) can also be accessed from the Reports field.



Sample MulTEA Calibration Report



Sample MulTEA Retrofit Measures



Sample MulTEA Retrofit Package

5. HEALTH AND SAFETY AUDIT

Health and Safety
 Agency: Oak Ridge Nationa...
 Acct.: WPN 17-7 Testing
 Acct. #: 17-7
 Audit: Sample Audit
 Audit #: 1294

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
 ● View

Reports

Icon Key
 ● Form is Required
 ● Form is Recommended
 ● Form is Optional
 ● Form is Not Applicable
 ● Form is Completed

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).

Mold and Moisture
 Evidence of Issue | Source Identification

Observations

Space/Component	Visible Mold	Moisture Damage, Water, or Dampness
Attic	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Bathrooms	<input type="checkbox"/>	<input type="checkbox"/>

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.

Health and Safety Audit

Audit

Agency: Oak Ridge National Laboratory Audit Date: 08-03-2018
Account Name: WPN 17-7 Testing Auditor: Mini Malhotra - AgencyAdmin
Account Number: 17-7 City: Knoxville
Audit Name: Sample Audit State: TN
Audit Number: 1294

Dwelling Location

State: TN Weather State: TN
County: Anderson Weather Station: Knoxville MCGhee Tyson Ap

Dwelling Characteristics

Conditioned Floor Area (sq ft): 1800 Number of Floors: 1
Average Ceiling Height (ft): 8 Number of Bedrooms: 2
Attached Garage: Number of Bathrooms: 2
Year Built: 1992

Dwelling Occupancy

Number of Daytime Occupants: 0 Number of Elderly (over 65 years): 0
Number of Nighttime Occupants: 1 Number of Disabled: 0
Number of Children (under 6 years): 0

Housing Type and Weatherization Funding Sources

Check all that apply:

Housing unit is a HUD program home (i.e., federally owned or assisted housing, including HUD Section 8 vouchered housing)
 Housing unit will be weatherized with HUD funds
 Housing unit will be weatherized under the DOE Weatherization Assistance Program

Comments

New Copy Delete OK Apply Cancel

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. You may have to scroll down to see the latter two field sets.

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 5.5). 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.

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	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 5.5. 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 subforms. First, indicate the evidence of mold and moisture in different spaces and components on the Evidence of Issue subform (Figure 5.2). Then, on

the Source Identification subform, 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 subform.

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 subforms. Complete the Safety Inspection subform 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 subform after the Safety Inspection subform has been completed. All the vented combustion appliances identified on the Safety Inspection subform will be listed automatically in the Measurements table in the CAZ Measurements field set of the Performance Testing subform.

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

Safety related questions are grouped under four subforms of the **Safety form**. In the General Safety subform, hazards are categorized as injury prevention, hazards for people who are elderly and disabled, and child safety hazards. Hazards in the Structural Safety subform are grouped by structural components, including roof, walls, windows, doors, stairs, floor, and porch, patio, or balcony. In the Fire Safety subform, 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 subform, 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 5.6). 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.

Health and Safety Audit Recommendations

Mold and Moisture (3) | Lead (0) | Radon (0) | Asbestos (0) | Formaldehyde and VOCs (0) | Combustion (13) | Pest Infestation (0) | Safety (0) | Ventilation (0)

Recommended Measures

Recommendation	Must be Performed Before Weatherization	Intended Action			
		Implement	Refer	Recommend to Client	Defer
Install a kitchen exhaust fan that is vented to outdoors.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Provide adequate ventilation in the crawlspace if it is not sealed or conditioned.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Replace missing shingles on roof.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Factors to Consider in Determining if Recommendation Required Before or as Part of Weatherization

- Necessary to install weatherization measure or perform weatherization work.
- Ensure the long term stability and durability of weatherization measures to be installed.
- Ensure weatherization work does not cause a health and safety problem.
- Provide a healthy and safe working environment for weatherization crews.

General Notes Regarding Interaction with Weatherization Measures

- Do not install weatherization measures that will reduce the home's infiltration rate if any mold and moisture recommendation required for weatherization must be deferred.
- Repair roof leaks before air sealing or insulating the attic.
- Address drainage issues before insulating basement or crawlspace walls.
- Manage rainwater in wall and window assemblies receiving retrofits (e.g., drainage plans, flashings).

Mold Cleanup Guidance

Notes Applicable to the Weatherization Assistance Program

- Limited water damage repairs that can be addressed by weatherization workers are allowed when necessary in order to weatherize the home and ensure the long-term stability and durability of the measures.
- Source control (i.e., correction of moisture and mold creating conditions) is allowed when necessary in order to weatherize the home and to ensure the long-term stability and durability of the measures. Source control is independent of latent damage and related repairs.
- Mold cleanup is not an allowable health and safety cost.
- Surface preparation where weatherization measures are being installed (e.g., cleaning mold off window trim in order to apply caulk) must be charged as part of the energy conservation measure, not to a health and safety budget category.
- Deferral is required when severe mold and moisture issues cannot be addressed.
- When deferral is necessary, provide the client with information in writing describing the conditions that must be met in order for weatherization to commence.

Comments

OK Apply Cancel

Figure 5.6. Health and Safety Audit Recommendations form.

Reports – The Reports drop-down field on the Audit Dock is used to select Audit Results, which 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. These reports are attached below.



APPENDIX A. GENERAL FORMS

APPENDIX A. GENERAL FORMS

A.1 User Details Form

The **User Details** form (Figure A-1) is used by State Administrators and Agency Administrators to create user accounts and assign privilege levels. Users can view and edit their login information and their personal and contact information.

The screenshot shows the 'User Details' form with the following sections and fields:

- Login Information:** Username (johnDOE1), Password, Confirm Password, and Privilege Level (Lead Auditor).
- Agency Information:** Agency (Sample Agency), Auditor (checked), and Active (checked).
- Person Information:** Prefix, First (John), Middle Init, Last (Doe), Suffix, Company, and Title.
- Contact Information:** Address, Unit Number, City, State (CO), Zip code, Work Phone, Cell Phone, Home Phone, Fax, Email, and Web Page URL.

At the bottom, there are buttons for 'New', 'Assign to Additional Agency', 'Delete', 'OK', 'Apply', and 'Cancel'.

Figure A-1. User Details form.

A.2 Agency Forms

The **Agency Details** form (Figure A-2) is used by State Administrators to create agency records in their state. Agency Administrators can edit and other agency users can view information about their agency.

The **Agency Contacts** form (Figure A-3; relevant to NEAT and MHEA only) can be used to enter information on any person associated with the agency, including contractors, suppliers, and in-house crew members. This allows for creating separate work orders by contractor and adding suppliers to supply libraries.

The **Agency Cost Center** form (Figure A-4; relevant to NEAT and MHEA only) can be used to set up cost centers (i.e., funding sources or programs) to which the cost for individual measures can be assigned. This allows for tracking the cost of implementing measures over multiple audits.

Agency Details

Agency Name:	<input type="text" value="Sample Agency"/>	Address:	<input type="text"/>
Agency Type:	<input type="text" value="Community Action Agency"/>	Unit Number:	<input type="text"/>
Active:	<input checked="" type="checkbox"/>	City:	<input type="text"/>
EIN:	<input type="text"/>	State:	<input type="text" value="TN"/>
Contract Number:	<input type="text"/>	Zip Code:	<input type="text"/>
Other ID Number:	<input type="text"/>	Work Phone:	<input type="text"/>
		Fax Number:	<input type="text"/>
		Email:	<input type="text"/>
		Web Page URL:	<input type="text"/>

Comments

New Copy Delete DOE Quarterly Report OK Apply Cancel

Figure A-2. Agency Details form.

Agency Contact

Contact		Contact Information	
Agency:	<input type="text" value="Sample Agency"/>	Contact Name:	<input type="text" value="John Smith"/>
Company Name:	<input type="text" value="General Contractor"/>	Address:	<input type="text"/>
Active:	<input checked="" type="checkbox"/>	Unit Number:	<input type="text"/>
Contractor:	<input checked="" type="checkbox"/>	City:	<input type="text"/>
Supplier:	<input type="checkbox"/>	State:	<input type="text" value="TN"/>
In-house Crew:	<input type="checkbox"/>	Zip Code:	<input type="text"/>
EIN:	<input type="text"/>	Work Phone:	<input type="text"/>
Title:	<input type="text"/>	Cell Phone:	<input type="text"/>
		Fax Number:	<input type="text"/>
		Email:	<input type="text"/>
		Web Page URL:	<input type="text"/>

Comments

New Copy Delete OK Apply Cancel

Figure A-3. Agency Contact form.

Agency Cost Center

Cost Center Details

Agency: Sample Agency

Cost Center Name: Health and Safety Funding

Cost Center Type: Other Federal

Active:

Program Year:

Description:

Comments

Figure A-4. Agency Cost Center form.

A.3 Economic Parameter Set Library Form

The **Economic Parameter Set Library** form (Figure A-5) provides the fuel price indices and modified uniform present value (UPV) factors required to perform economic calculations in NEAT, MHEA, and MuITEA. The information is provided for the following eight fuels for 30 years: electricity, natural gas, propane, fuel oil, kerosene, wood, coal, and other.

Economic Parameter Set Library

Economic Parameter Set Name: 2023 - Residential US Average Economic Factors

Agency: Sample Agency

Active for:

NEAT:

MHEA:

MuITEA:

Economic Parameter Set Details

Real Discount Rate (%):

Energy Price Escalation Rates			
Fuel Type	Year	Fuel Price Index	Modified UPV Factor
Electricity	0	1	1
Electricity	1	0.976835	0.948383
Electricity	2	0.949744	1.84361
Electricity	3	0.929859	2.69456
Electricity	4	0.915988	3.5084
Electricity	5	0.906272	4.29016
Electricity	6	0.897242	5.04586

Comments

Figure A-5. Economics Parameter Set Library form.

A.4 Fuel Cost Library Form

The **Fuel Cost Library** form (Figure A-6) provides the costs for eight fuels used in NEAT, MHEA, and MulTEA: electricity, natural gas, propane, fuel oil, kerosene, wood, coal, and other.

Fuel Cost Library

Fuel Cost Name: 2023 - Average US Residential Natural Gas Costs

Agency: Sample Agency

Active for:

- NEAT:
- MHEA:
- MulTEA:

Fuel Cost Details

Fuel Type: Natural Gas

Units: Mcf

Unit Cost (\$): 12.98

Unit Heat Content (MMBtu): 1.025

Comments

New Copy Delete

Figure A-6. Fuel Cost Library form.

A.5 Measure Cost Set Library Forms

The **Measure Cost Set Library** forms (Figure A-7) collect overall measure cost information. They provide access to **Retrofit Measure Cost Details** forms (Figure A-8), which collect material and installation cost details for individual retrofit measures programmed into NEAT, MHEA, and MulTEA. 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 rather than in the Measure Cost Set Library form.

The NEAT Measure Cost Set Library form also provides access to the **NEAT Insulation Types** form (Figure A-9), which can be used to view or edit the R-value or R/inch of default insulation types and define additional insulation types to be considered when insulating the walls, unfinished attics, finished attics, and foundations.

Measure Cost Set Library

Measure Cost Set Name:

Agency:

Audit Type: NEAT MHEA MultiTEA

Is Active: **NEAT Insulation Types (0)**

Retrofit Measure List				
Index	Measure Type	Measure Name	Lifetime	Is Active
1	Baseloads	Lighting Retrofits	...	Yes
2	Baseloads	Refrigerator Replacement	15	Yes
3	Baseloads	Water Heater Tank Insulation	13	Yes
4	Baseloads	Water Heater Pipe Insulation	13	Yes
5	Baseloads	Low Flow Showerheads	15	Yes
6	Baseloads	Water Heater Replacement	13	Yes
7	Building Insulation	Attic Insulation R11	20	Yes
8	Building Insulation	Attic Insulation R19	20	Yes
9	Building Insulation	Attic Insulation R30	20	Yes

Comments

(a) NEAT Measure Cost Set Library form

Measure Cost Set Library

Measure Cost Set Name:

Agency:

Audit Type: NEAT MHEA MultiTEA

Is Active:

Retrofit Measure List				
Index	Measure Type	Measure Name	Lifetime	Is Active
1	Baseloads	Lighting Retrofits	...	Yes
2	Baseloads	Refrigerator Replacement	15	Yes
3	Baseloads	Water Heater Tank Insulation	13	Yes
4	Baseloads	Water Heater Pipe Insulation	13	Yes
5	Baseloads	Low Flow Showerheads	15	Yes
6	Baseloads	Water Heater Replacement	13	Yes
7	Building Insulation	Wall Fiberglass Batt Insulation	20	Yes
8	Building Insulation	Wall Fiberglass Batt Insulation in Addition	20	Yes
9	Building Insulation	Wall Cellulose Loose Insulation	20	Yes

Comments

(b) MHEA Measure Cost Set Library form.

Measure Cost Set Library

Measure Cost Set Name:

Agency:

Audit Type: NEAT MHEA MulTEA

Is Active:

Retrofit Measure List		
Component Type	Component Subtype	Retrofit Measure
<input checked="" type="checkbox"/> Walls	Exterior	Add Interior Insulation
<input checked="" type="checkbox"/> Walls	Underground	Add Exterior Insulation
<input checked="" type="checkbox"/> Walls	Underground	Add Interior Insulation
<input checked="" type="checkbox"/> Walls	Interior	Add Cavity Insulation
<input checked="" type="checkbox"/> Walls	Interior	Add Exterior Insulation
<input checked="" type="checkbox"/> Walls	Interior	Add Interior Insulation
<input checked="" type="checkbox"/> Windows	Exterior	Replace Window
<input checked="" type="checkbox"/> Windows	Exterior	Add Storm Window
<input checked="" type="checkbox"/> Windows	Exterior	Add Shading

Comments

(c) MulTEA Measure Cost Set Library form
Figure A-7. Measure Cost Set Library forms.

Retrofit Measure Cost Details - V10

Measure Cost Set Name:

Measure Type:

Measure Name:

Lifetime (yr):

Is Active:

Measure Description:

Cost Details		Units	Comment
Material:	Cost: \$	76.00 per SqFt	<input type="text"/>
Labor:	Cost: \$	55.00 per SqFt	<input type="text"/>
Other:	Cost: \$	125.00 per Each	<input type="text"/>

Comments

(a) NEAT/MHEA Retrofit Measure Cost Details form

Retrofit Measure Cost Details - v10

Measure Cost Set Name:

Component Type:

Component Subtype:

Retrofit Measure:

Retrofit Measure Cost Name:

Glazing Assembly:

Glass Type:

Lifetime (yr):

Is Active:

Cost Details

				Units	Comment
Labor:	Clear Entry	Cost: \$	<input type="text" value="55"/>	per	<input type="text" value="Square Foot"/>
Material:	Clear Entry	Cost: \$	<input type="text" value="76"/>	per	<input type="text" value="Square Foot"/>
Other 1:	Clear Entry	Cost: \$	<input type="text" value="125"/>	per	<input type="text" value="Each"/>
Other 2:	Clear Entry	Cost: \$	<input type="text"/>	per	<input type="text"/>
Other 3:	Clear Entry	Cost: \$	<input type="text"/>	per	<input type="text"/>

Comments

(b) MulTEA Retrofit Measure Cost Details form
Figure A-8. Retrofit Measure Cost Details forms.

NEAT Insulation Types v10

Attic			Kneewall*		Wall*		
	Name	Rs/Inch	Name	R-Value	Name	Value	Units
Type 1	Blown Cellulose	3.75	Fiberglass Batts	13	Blown Cellulose	3.71	R/in
Type 2	Blown Fiberglass	3.09					
Type 3							
Type 4							
Type 5							
Type 6							
Floor			Sill*		Foundation Wall*		
	Name	Rs/Inch	Name	R-Value	Name	R-Value	
Type 1	Fiberglass Batts	3.33	Fiberglass Batts	19	Rigid Foam Board	12	
Type 2	Blown Cellulose	3.71					
Type 3	Blown Fiberglass	3.05					
Type 4							
Type 5							
Type 6							

Insulation type names can be up to 30 characters in length
 *Note: If you change an R-value, check the installation costs for that measure.

Ok Apply Cancel

Figure A-9. NEAT Insulation Types form.

A.6 Key Parameter Set Library Forms (NEAT and MHEA only)

The **Key Parameter Set Library** form (Figure A-10) provides 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. The key parameters are provided separately for NEAT and MHEA.

NEAT/MHEA Key Parameter Set Library

Key Parameter Set Name: Default NEAT Key Parameters v10

Agency: Sample Agency

Audit Type: NEAT: MHEA:

Active:

Group	Key Parameter	Value	Units
Economics			
Economics	Real discount rate	3.00	%
Economics	Minimum acceptable SIR	1.00	Factor
Equipment			
Equipment	Low flow shower head flow rate	2.50	gal/min
Equipment	Refrigerator defrost cycle energy	0.08	kWh
Insulation			
Insulation	Avg annual outside film coeff	2.25	BTU/hr-sqft-F
Insulation	Uninsulated R-value for 'Other' wall type	4.42	F-sqft-hr/Btu

Comments

New Copy Delete OK Apply Cancel

Figure A-10. Key Parameter Set Library form (NEAT and MHEA only).

A.7 Supply Library Forms (NEAT and MHEA only)

The Supply Library form (Figure A-11) provides the ability to identify materials used within your program and their costs. 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 on the **Supply Library Category Details** form (Figure A-12).

Supply Library

Supply Library Name:

Agency:

Description:

Is Active:

Supply Library Categories	
<input checked="" type="checkbox"/>	Cooling Equipment
<input checked="" type="checkbox"/>	Construction Materials/Hardware
<input checked="" type="checkbox"/>	Doors
<input checked="" type="checkbox"/>	Health and Safety Items
<input checked="" type="checkbox"/>	Heating Equipment
<input checked="" type="checkbox"/>	Hot Water Equipment
<input checked="" type="checkbox"/>	Insulation
<input checked="" type="checkbox"/>	Labor
<input checked="" type="checkbox"/>	Lighting
<input checked="" type="checkbox"/>	Miscellaneous Supplies
<input checked="" type="checkbox"/>	Refrigerators
<input checked="" type="checkbox"/>	Windows
<input checked="" type="checkbox"/>	Other

Comments

New Copy Delete OK Apply Cancel

Figure A-11. Supply Library form.

Cooling Equipment Details

Description:

Manufacturer:

Model:

Supplier:

Units:

Cost (\$/Unit):

Energy Details

Equipment Type:

Efficiency Units:

Efficiency:

Capacity (kBtu/hr):

Lifetime (yr):

Comments

New Copy Delete Ok Apply Cancel

Figure A-12. Example Supply Library Category Details form.

A.8 Defined Measure Set Library Form (NEAT and MHEA only)

The **Defined Measure Library** form (Figure A-13) provides the ability to predefine weatherization activities, including 50 predefined health and safety measures, which are not addressed within the NEAT and MHEA library measures but that are commonly encountered during an audit. Defining the measures on this form enables copying them to any audit as an itemized cost.

NEAT/MHEA Defined Measure Set Library

Defined Measure Set Name: Sample Defined Measures Supply Library: Sample Supply Library

Agency: Sample Agency Active:

Defined Measure Details

Measures List: 101 - Fix Other Venting Related Problems (Heating System) New Copy Delete Active for: NEAT: MHEA:

Measure #: 101 Include in SIR: Energy Savings: No Energy Savings

Measure Type: Health and Safety

Measure Name: Fix Other Venting Related Problems (Heating System) **H&S Measure**

Default Contractor/Crew: 1162

Default Cost Center: Health and Safety Funding

Measure comments: sample comment

Materials/Labor Details

+ Add Detail - Delete Detail

#	Type	Copy From Supply	Description	Qty	Units+	\$/Unit	Comment
1	Health and Safety Items		Equipment	1	Each	900.00	
2	Labor		Labor	1	Hour	88.00	

Comments

New Copy Delete OK Apply Cancel

Figure A-13. NEAT/MHEA Defined Measures Set Library form.

A.9 Account Details Form

The **Account Details** form (Figure A-14) is used to set up an account for a house, building, or project before a NEAT, MHEA, MulTEA, Health and Safety Audit, or work order can be created. The information in the DOE Quarterly Report field set is used by Weatherization Assistance Program Grantees in reporting results to DOE.

Account Details

Account Information

Agency: Sample Agency Address: State: CO

Account Name: Sample Account Unit: Zip Code:

Account Number: S001 City: Denver Geographic Identifier:

Other ID Number:

DOE Quarterly Report

Building Type: Primary Heating Fuel: Number of Occupants:

Number of Units: High Energy User: Total:

Rentals: High Energy Burden: Elderly:

Owner Occupied: Previously Weatherized: Disabled:

Leveraged: Year Weatherized: Native American:

Children:

Other Information

Primary Language:

Utility Account 1:

Utility Account 2:

Comments

New Copy Delete Client Completion Report OK Apply Cancel

Figure A-14. Account Details form.

A.10 Work Order Forms

The Work Order forms can be used to create, manage, and track the progress of weatherization measures to be completed. The **Work Order Details** form (Figure A-15) is used to enter general information about the work order, to identify the client and contractor, to specify a supply library from which inventoried items can be selected, and to view the current status settings associated with the current work order for three work order status categories: Work Order, Inspection, and Payment. For a selected work order, the **Work Order Measures** form (Figure A-16) is used to develop detailed task descriptions for weatherization measures to be installed in a home.

Work Order Details | Work Order Measures

Work Order Information

Work Order: Sample Work Order 1

Account Name: Sample Account

Account Number: S001

Agency: Sample Agency State: TN

Audit Name: Sample Audit

Supply Library: Sample Supply Library

Contractor/Crew: General Contractor

Work Order Type: Weatherization

Account Information

Client Name: []

Alt Id: []

Work Order Economic Summary

Number of Active Measures: []

Cumulative Estimated Cost: []

Cumulative Actual Cost: []

Status

Work Order Status

All Status Types [] Record Count: 3

Status Type	Current Status	Updated By	Comments	Date	Revised On
Work Order	Work Completed On	Mini Malhotra - SiteAdmin		02-23-2024	02-26-2024 5:11 PM
Work Order	Work Order Created from Audit On	Mini Malhotra - SiteAdmin		02-19-2024	02-26-2024 5:09 PM
Inspection	Passed On	Mini Malhotra - SiteAdmin		02-26-2024	02-26-2024 5:11 PM

Comments

[]

New Copy Delete Work Order [] OK Apply Cancel

Figure A-15. Work Order Details form.

Work Order Details | **Work Order Measures**

Work Order: Sample Work Order 1

Measure Type: HVAC Systems

Measure Name: Replace HVAC

Order #: [] Active:

Components: Furnace1 Show Components

Cost Center: Weatherization Funding

Materials/Labor Details

Materials/Labor Details

+ Add Detail - Delete Detail

#	Type	Copy From Supply	Description	Units+	Est Qty	Est\$/Unit	Est Total	Act Qty	Act\$/Unit	Act Total
1	Heating Equipment		Heat Pump, 3 ton	Each	1	4000	4000	1	5000	5000
2	Labor		Installation	Hour	4	200	800	4	200	800

Comments

[]

New Copy Delete Measure [] OK Apply Cancel

Figure A-16. Work Order Measures form.

APPENDIX B. NEAT AND MHEA FORMS

APPENDIX B. NEAT AND MHEA FORMS

B.1 Audit Form

The NEAT and MHEA **Audit** forms (Figure B-1 and Figure B-2, respectively; required) are used to enter overall audit and building information about the house and to select weather files and libraries that NEAT and MHEA will reference for non-house-specific data when running the audit. NEAT and MHEA Audit forms are identical except for some of the Building Information fields, as follows:

- The NEAT Audit form requires inputs for conditioned stories and floor area to determine the overall building configuration. The area of walls, roof/ceiling, and floor are determined from the inputs in the respective shell forms.
- MHEA assumes that the house has a rectangular shape and may have a 30" × 30" outdoor water heater closet. To calculate the area of exterior walls, roof/ceiling, and floor, the MHEA Audit form requires inputs for the length, width, and exterior wall height of the house, along with information on the presence of the outdoor water heater closet.

National Energy Audit Tool (NEAT)

Agency: Oak Ridge National Laboratory Audit Date: 11-09-2022
Account Name: NEAT Sample Account Auditor: Charles Amoo
Account Number: Sample 101 City: Knoxville
Audit Name: Sample Audit State: TN
Audit Number: 3511

Building Information

Occupants: 4 Floor Area (sq ft): 1800
Conditioned Stories: 2 Number of Bedrooms: 4
Infiltration Height (ft): 18 Wind Shielding: Normal Shielding

Libraries

Weather State: TN
Weather Station: Knoxville Mcghee Tyson Ap
Economic Parameters: 2022 - Residential US Average Ec
Measure Costs: Modified (ORNL) NEAT Measure C
Key Parameters: Default NEAT Key Parameters v10
Supply Library: No Supply Library selected
Defined Measures: ORNL Initial Defined Measures
Billing Adjustment:

Fuel Cost Details

Fuel Type	Cost	Unit
Electricity: 2020 - Average US Residential Electricity Costs	0.1309	per kWh
Natural Gas: 2020 - Average US Residential Natural Gas Costs	9.85	per Mcf
Propane/LPG: 2020 - Average US Residential Propane Costs	1.926	per Gallon
Fuel Oil: 2020 - Average US Residential No. 2 Heating Oil Costs	2.607	per Gallon
Kerosene: 2020 - Average US Residential Kerosene Costs	3.321	per Gallon
Wood: 2020 - Average US Residential Wood Costs	350	per Cord
Coal: 2020 - Average US Residential Coal Costs	86.34	per Ton
Other: Other fuel cost	106.67	per MMBtu

New Copy Delete OK Apply Cancel

Figure B-1. NEAT Audit form.

Manufactured Home Energy Audit (MHEA)

Agency: Oak Ridge National Laboratory Audit Date: 08-08-2022

Account Name: Duct-Envelope Sealing Tests Auditor: Charles Amoo

Account Number: NEAT-MHEA INF-Ducts-1 City: Anytown

Audit Name: Bill Testing - Engine 495 State: TN

Audit Number: 3534

Building Information

Occupants: 6 Number of Bedrooms: 2

Length (ft): 50 Wind Shielding: Normal Shielding

Width (ft): 12 Outdoor Water Heater Closet:

Exterior Wall Height (ft): 7.5

Infiltration Height (ft): 7.5

Libraries

Weather State: LA

Weather Station: Baton Rouge Metropolitan Airport

Economic Parameters: 2020 - Residential US Average Ec

Measure Costs: Default (ORNL) MHEA Measure Co

Key Parameters: Default MHEA Key Parameters v1C

Supply Library: Test Supply Library

Defined Measures: ORNL Initial Defined Measures

Billing Adjustment:

Fuel Cost Details

Electricity:	2020 - Average US Residential Electricity Costs	Cost:	0.1309	per	kWh
Natural Gas:	2020 - Average US Residential Natural Gas Costs	Cost:	9.85	per	Mcf
Propane/LPG:	2020 - Average US Residential Propane Costs	Cost:	1.926	per	Gallon
Fuel Oil:	None	Cost:	0	per	N/A
Kerosene:	None	Cost:	0	per	N/A
Wood:	None	Cost:	0	per	N/A
Coal:	None	Cost:	0	per	N/A
Other:	None	Cost:	0	per	N/A

New Copy Delete OK Apply Cancel

Figure B-2. MHEA Audit form.

B.2 Walls Form

The NEAT and MHEA **Walls** forms (required) are used to describe the walls of a house. The NEAT Walls form (Figure B-3) requires inputs for the construction type, orientation, area, existing insulation, and type of added insulation to be evaluated. In NEAT, at least one wall must be described to run the audit. Multiple forms can be used to describe walls that differ by orientation and other specified inputs.

On the other hand, MHEA assumes that the house is rectangular in shape with wood-frame construction and that the walls facing different orientations have identical construction characteristics. Therefore, MHEA uses only one Shell – Walls form (Figure B-4) to describe the characteristics of all walls, including a few additional inputs relevant to construction and orientation, inputs for existing insulation, and information on carport/porch to determine the degree of shading and orientation of the shaded wall. The area of walls is determined from the length, width, and exterior wall height entered on the Audit form. The types of added insulation to be evaluated are fixed in the MHEA Measure Cost Set library.

Furthermore, if there is an addition attached to the mobile home, MHEA assumes that the addition is rectangular in shape with wood-frame construction and that the three exposed walls of the addition have identical construction characteristics. Therefore, MHEA uses only one Addition – Walls form (Figure B-5) to describe the characteristics of all walls of the addition, including a few additional inputs relevant to construction, orientation and area, and inputs for existing insulation. The area of the addition's walls is determined from the wall height entered on this form and the length and width of addition entered on the Addition – Floor form. The types of added insulation to be evaluated are fixed in the MHEA Measure Cost Set library.

The screenshot shows the NEAT Walls form with the following data:

Section	Field	Value
Wall Information	Wall Code	WL1-N
	Wall Type	Platform Frame
	Stud Size	2 X 4
	Exterior Type	Wood
	Exposed To	Outside (Ambient)
	Orientation	North
	Gross Area (sq ft)	400
Existing Insulation	Type	Fiberglass Batts
	R Value	3.5
Added Insulation	Measure Number	1
	Type	None
	Additional Cost (\$)	

Figure B-3. NEAT Walls form.

Walls

Wall Information

Wall Stud Size: 2 X 4

Orientation of Long Wall: East

Wall Ventilation: Not Vented

Uninsulatable Wall Area (sq ft): 0

Additional Cost (\$): 100

Existing Insulation

Batt/Blanket (in): 0

Loose Fill (in): 0

Foam Core (in): 0

Carport/Porch Roof

Carport/Porch Present:

Length (ft):

Width (ft):

Orientation:

Comments

Delete OK Apply Cancel

Figure B-4. MHEA Shell – Walls form.

Addition - Walls

Wall Information

Wall Stud Size: 2 X 6

Addition Orientation: East

Wall Ventilation: Not Vented

Additional Cost (\$): -100

Existing Insulation

Batt/Blanket (in): 0

Loose Fill (in): 0

Foam Core (in): 0

Configuration Information

Wall Configuration: All Addition Walls the Same Height

Maximum Wall Height (ft): 10

Minimum Wall Height (ft): 10

Comments

Delete OK Apply Cancel

Figure B-5. MHEA Addition – Walls form.

B.3 Windows Form

The NEAT and MHEA **Windows** forms (Figure B-6 and Figure B-7, respectively) are used to enter information on all the windows installed in the house and describe retrofit measures. The NEAT Windows form (optional) and MHEA Windows form (required for shell; optional for addition) are identical except for information on the number of windows in different orientations.

- In NEAT, the number of windows is entered by parent wall segment; the orientation of the parent wall segment determines the orientation of the window. Multiple windows installed on the same wall segment and with the same characteristics may be entered as a single window description by indicating the number of windows having this description.
- On the other hand, in MHEA, the number of windows is entered by orientations on the same form. Multiple windows with the same characteristics facing any orientation may be entered as a single window description by indicating the number of windows facing different orientations having this description. However, similar windows considered for different retrofit measures should be described separately.

The screenshot shows the NEAT Windows form interface. It features a title bar 'Windows' and three tabs: 'WD1', 'WD2', and 'WD3'. The 'WD1' tab is selected. The form is organized into several sections:

- Existing Window:** Fields for Window Code (WD1), Window Type (Slider), Frame Type (Wood), Glazing Type (Single Pane), Storm Window (None), Interior Shading (None), Exterior Shading (None), Overhang/Awning (Horizontal Projection and Distance from Lintel), Leakiness (Medium), Width (24), Height (48), Wall Code (WL1-N), and Number on This Wall (4).
- Retrofits:** A table with columns for 'Evaluate All', 'Required', 'Include in SIR', and 'Additional Cost (\$/Window)'. The table includes rows for 'Weatherize Window', 'Replace Window', 'Add Storm Window', 'Add Awning', and 'Add Exterior Shading'.
- Comments:** A large text area for entering comments.
- Buttons:** 'New', 'Copy', and 'Delete' buttons on the left; 'OK', 'Apply', and 'Cancel' buttons on the right.

Figure B-6. NEAT Windows form.

Windows

WD1 | WD2 | WD3 | WD4

Existing Window

Window Code:

Window Type:

Frame Type:

Glazing Type:

Storm Window:

Interior Shading:

Exterior Shading:

Overhang/Awning

Horizontal Projection (in):

Distance from Lintel (in):

Leakiness:

Width (in):

Height (in):

of Windows on

North:

South:

East:

West:

Roof:

Retrofits

Evaluate All: [Clear All](#) Additional Cost (\$/Window)

Weatherize Window: Required Include in SIR

Replace Window: Required Include in SIR

Glazing Type:

U-value: SHGC:

Add Storm Window: Required Include in SIR

Storm Window:

Add Awning:

Horizontal Projection (in):

Distance from Lintel (in):

Add Exterior Shading:

Type:

Comments

New Copy Delete OK Apply Cancel

Figure B-7. MHEA Shell/Addition – Windows form.

B.4 Doors Form

The NEAT and MHEA **Doors** forms (Figure B-8 and Figure B-9, respectively) are used to enter information on all the doors installed in the house. The NEAT Doors form (optional) and MHEA Doors form (required for shell; optional for addition) are identical except for information on the number of doors in different orientations.

- In NEAT, the number of doors is entered by parent wall segment; the orientation of the parent wall segment determines the orientation of the door. Multiple doors installed on the same wall segment and with the same characteristics may be entered as a single door description by indicating the number of doors having this description.
- On the other hand, in MHEA, the number of doors is entered by orientations on the same form. Multiple doors with the same characteristics facing any orientation may be entered as a single door description by indicating the number of doors facing different orientations having this description. However, similar doors considered for different retrofit measures should be described separately.

The screenshot shows the 'Doors' form with the following data entered:

- Existing Door:**
 - Door Code: DR1
 - Door Type: Solid Core Wood
 - Area (sq ft): 20
 - Storm Door Condition: Adequate
 - Leakiness: Medium
 - Optional Dimensions:
 - Width (in):
 - Height (in):
 - Wall Code: WL1-N
 - Number on This Wall: 1
- Retrofits:**
 - Replacement Door Required:
 - Include in SIR:
 - Additional Cost (\$/door): 0
- Comments:** (Empty text area)

Buttons at the bottom: New, Copy, Delete, OK, Apply, Cancel.

Figure B-8. NEAT Doors form.

Addition - Doors

DA1 DA2

Existing Door

Door Code: DA1

Door Type: Hollow Core Wood

Width (in): 36

Height (in): 80

Storm Door Present:

Leakiness: Tight

Number of Doors Facing

North: 1

South: 0

East: 0

West:

Retrofits

Replacement Door Required:

Include in SIR:

Additional Cost (\$/door):

Comments

New Copy Delete OK Apply Cancel

Figure B-9. MHEA Shell/Addition – Doors form.

B.5 Attics (NEAT) and Ceiling (MHEA) Forms

The NEAT **Unfinished Attics** form (Figure B-10; optional) is used to describe unfinished attics in the house (i.e., attic areas that are not conditioned). Many houses will require only one unfinished attic description, but homes with separate unfinished attic areas may require two or more unfinished attic descriptions, especially if the attic areas differ in their characteristics. This occurs especially in homes that have had additions built onto them, where the attics in the additions differ in characteristics from the attic in the original home.

The NEAT **Finished Attics** form (Figure B-11; optional) is used to describe finished attics in the house (i.e., attic areas that are included in the conditioned area of the home). Four types of finished attic components are characterized to fully describe a finished attic: outer ceiling joist, collar beam, knee wall, and roof rafter.

The MHEA **Shell – Ceiling** form (Figure B-12; required) is used to enter information on the roof/ceiling in the house. Unlike NEAT, MHEA uses only one form to describe the roof/ceiling of the house. The roof type options are flat, bowstring, and pitched, which are the typical roof configurations found in mobile homes.

The MHEA **Addition – Ceiling** form (Figure B-13; conditionally required) is used to enter information on the ceiling of the mobile home addition. MHEA uses only one form to describe the roof/ceiling of the addition. MHEA models the roof of the addition as flat, shed, and gable roof based on the Wall Configuration information entered on the Addition – Walls form.

The screenshot shows the 'Unfinished Attics' form with the following data entered:

Section	Field	Value
Attic Information	Attic Code	A1
	Attic Type	Unfloored
	Joist Spacing (in)	24
	Area (sq ft)	1000
	Roof Color	Normal or Weathered
Existing Insulation	Type	Blown Cellulose
	Depth (in)	6
Added Insulation	Measure Number	1
	Type	Blown Cellulose
	Added R Value	
	OR	
	Maximum Depth (in)	
Additional Cost (\$)	500	

Figure B-10. NEAT Unfinished Attics form.

Finished Attics

FA1

Attic Information

Attic Code: FA1

Attic Type: Roof Rafter

Floor Type:

Area (sq ft): 1200

Roof Color: Normal or Weathered

Existing Insulation

Type: Fiberglass Batts

Depth (in): 3

Added Insulation

Measure Number: 1

Type: None

Added R Value:

OR

Maximum Depth (in):

Additional Cost (\$):

Comments

New Copy Delete OK Apply Cancel

Figure B-11. NEAT Finished Attics form.

Ceiling

Ceiling Information

Roof Type: Flat

Roof Color: Normal or Weathered

Joist Size: 2 X 6

Height of Roof at Center (in):

Insulation to Add at Center (in):

Additional Cost (\$): -100

Existing Insulation

Batt/Blanket (in): 0

Loose Fill (in): 0

Foam Core (in): 0

Cathedral Ceiling Information

Cathedral Ceiling (%): 0

Step Wall Orientation:

Comments

Delete OK Apply Cancel

Figure B-12. MHEA Shell – Ceiling form.

Addition - Ceiling

Ceiling Information		Existing Insulation	
Joist Size:	2 X 8	Batt/Blanket (in):	0
Roof Color:	Normal or Weathered	Loose Fill (in):	0
Additional Cost (\$):	-100	Foam Core (in):	0

Comments

Delete **OK** **Apply** **Cancel**

Figure B-13. MHEA Addition – Ceiling form.

B.6 Foundations (NEAT) and Floor (MHEA) Forms

The NEAT **Foundations** form (Figure B-14; optional) is used to describe the foundations of the house, including basements and crawl spaces (i.e., enclosed foundation space), slab-on-grade foundations, and floors exposed to 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 any 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.

The MHEA **Shell – Floor** form (Figure B-15; required) is used to describe the floor of a mobile home. Unlike NEAT, MHEA uses only one form to describe the floor of the house. The floor description includes the wing and belly sections and information on the presence of skirting installed around the perimeter of the floor.

The MHEA **Addition – Floor** form (Figure B-16; conditionally required) is used to describe the floor of the mobile home addition. MHEA uses only one form to describe the floor of the addition. The floor type options include crawlspace, slab-on-grade foundation, and floor exposed to outside air. The floor can be retrofitted by adding insulation, depending on the floor type and space available for adding insulation.

The screenshot shows the 'Foundations' form with the 'Crawlspace1' tab selected. The form is organized into several sections:

- Foundation Code:** Crawlspace1
- Foundation Type:** Vented Non Conditioned
- Measure Number:** 1
- Floor Section:**
 - Area (sq ft): 1000
 - Existing Insulation R Value: 19
 - Added Insulation Type: None
 - Additional Cost (\$):
- Sill Section:**
 - Floor Joist Size (in): 6
 - Perimeter (ft): 130
 - Existing Insulation R value: 0
 - Added Insulation Type:
 - Additional Cost (\$):
- Foundation Wall Section:**
 - Height (ft): 4
 - Height Exposed (%): 100
 - Perimeter (ft): 130
 - Existing Insulation R Value: 0
 - Added Insulation Type:
 - Additional Cost (\$):
- Comments:** A large empty text area for notes.

At the bottom of the form are buttons for 'New', 'Copy', 'Delete', 'OK', 'Apply', and 'Cancel'.

Figure B-14. NEAT Foundations form.

Floor

<p>Floor Information</p> <p>Floor Joist Direction: Widthwise</p> <p>Skirt Present: <input type="checkbox"/></p> <p>Additional Cost (\$): -100</p>	<p>Wing Description</p> <p>Floor Joist Size: 2 X 8</p> <p>Batt/Blanket Insulation Location: None</p> <p>Batt/Blanket Insulation Thickness (in):</p> <p>Loose Insulation Thickness (in): 0</p>	<p>Belly (Center) Description</p> <p>Floor Joist Size: 2 X 8</p> <p>Belly Cavity Configuration: Flat</p> <p>Condition of Belly: Poor</p> <p>Maximum Depth of Belly Cavity (in): 8</p> <p>Batt/Blanket Insulation Location: None</p> <p>Batt/Blanket Insulation Thickness (in):</p> <p>Loose Insulation Thickness (in): 0</p>
--	--	---

Comments

Delete OK Apply Cancel

Figure B-15. MHEA Shell – Floor form.

Addition - Floor

<p>Floor Information</p> <p>Floor Type: Crawspace</p> <p>Length (ft): 10</p> <p>Width (ft): 10</p> <p>Floor Joist Size: 2 X 8</p>	<p>Insulation</p> <p>Batt/Blanket Insulation Location: None</p> <p>Batt/Blanket Insulation Thickness (in):</p> <p>Loose Insulation Thickness (in): 2</p> <p>Depth Available for Added Insulation (in): 0</p>
--	---

Comments

Delete OK Apply Cancel

Figure B-16. MHEA Addition – Floor form.

B.7 HVAC Systems Forms

The NEAT and MHEA **HVAC Systems** form (Figure B-17; required) is used to describe the heating and cooling equipment installed in the house and select retrofit options. The selected equipment may provide heating, cooling, or both. You can describe as many pieces of equipment as are required to describe the heating and cooling sources in the house. At least one unit of equipment that provides heating must be described to run an audit.

The HVAC – Optional forms (Figure B-18) can be used to document an extensive number of heating system measurements and observations made while auditing a house. Some of these data items help to identify potential health and safety hazards. Not all forms will be applicable to the system described on the HVAC Systems form.

The screenshot shows the 'HVAC Systems' form with the following details:

- Existing Equipment:**
 - HVAC System Code: Furnace1
 - Equipment: Furnace - Forced Air
 - Location: Conditioned Space
 - Fuel: Primary: Natural Gas, Backup:
 - Efficiency Input Method: Name Plate Efficiency
 - Year Manufactured:
 - Efficiency: Heating: 75%, Cooling:
 - Output Capacity: 80 kBtu/hr
 - Fraction of Load Served: 1, Estimate checked
 - Equipment Features: Atmospheric Burner, Automatic Vent Damper, IID, Pilot Light, On in Summer
 - Year Installed: 2020
 - Maintenance Status: Annual Professional Maintenance
 - Heating Setback Used:
- Retrofit Options to Evaluate:**
 - Install Smart Thermostat: Required, Include in SIR
 - Heating Nighttime Setback (°F):, Daily Setback Hours:, Additional Cost (\$):
 - Tune Up: Required, Include in SIR
 - Efficiency Improvements (%): Heating:, Cooling:, Additional Cost (\$): 0
 - Replace the Equipment: Required, Include in SIR
 - Material Cost (\$):, Labor Cost (\$):, Other Cost (\$):
 - Equipment:, Fuel: Primary:, Backup:
 - Efficiency: Heating:, Cooling:
 - Output Capacity: Heating:, Cooling:
 - Fraction of Load Served: Heating:, Cooling:
 - Also Replaces:
- Comments:** (Empty text area)
- Buttons:** New, Copy, Delete, Optional: Operational Tests, Vent Tests, Furnace Components, Boiler Components, Inspections, Thermostat, OK, Apply, Cancel

Figure B-17. NEAT/MHEA HVAC Systems form.

Operational Tests for Furnace1

Flue Gas Analysis (Average Values if Multiple Burners)

Conducted During	Audit	Inspection
Combustion Air Inlet Temperature (°F):	70	70
Flue Gas Temperature (°F):	570	470
Net Stack Temperature (°F):	500	400
Percent Oxygen (%):	10	9
Percent Carbon Dioxide (%):	6	7
Smoke Number:		
Steady State Efficiency (%):	74	78

Carbon Monoxide

As-Measured Reading In Flue (ppm):	30	10
Air-Free Reading In Flue (ppm):	58	18

Heat Rise

Return Temperature (°F):	68	68
Supply Temperature (°F):	120	125
Temperature Rise (°F):	52	57
Listed/Rated Temperature Rise (°F):		

Comments

Tune-up performed.

Delete OK Apply Cancel

(a) Operational Tests form

Vent Tests for Furnace1

Venting Information

Damper Type:	None Found
Damper Condition:	Not Applicable
Chimney Type:	Masonry-Lined
Chimney Condition:	Fair
Flue Type:	Metal Single Wall
Flue Condition:	Fair
Flue/Damper Diameter (in):	6
Combustion System Type:	Unsealed
Combustion Air Intake:	Adequate
Other Venting Related Problems:	<input type="checkbox"/> ...

Normal Operating Conditions Draft Measurements

Conducted During	Audit	Inspection
Outdoor Temperature (°F):	31	25
Draft (Pa or Inches of Water):	6	8
Spillage Time (sec):	30	15

Comments

Delete OK Apply Cancel

(b) Vent Tests form

Furnace Components for Furnace1

Fan Limit Controls

Control Settings are Adjustable:

Limit Control Not Working: ...

Burner and Pilot

Burner Type: Ribbon Pilot Type: Standing Pilot (on in Summer)

Burner Condition: Fair Pilot Condition: Fair

Blower

Blower Type: Belt Drive Belt Condition: Poor (but Working)

Blower Condition: Dirty Belt Size: 14

Motor Current (amps): Belt Play (in): 0.5

Accessories

Humidifier Condition: None

Electronic Air Cleaner Condition: None

Air Conditioner Coil Condition: Fair

Air Filter

Filter Location: In Furnace

Filter Size (length x width, in): 24x30

Filter Condition: Dirty

Comments

Adjust fan limit control settings.

Delete OK Apply Cancel

(c) Furnace Components form

Boiler Components for

Distribution System

System Type:

Pump Location:

Asbestos Present: ...

Asbestos Condition:

Expansion Tank Condition:

Drain Valve Condition:

General Condition:

Controls

Temperature-Pressure Valve Present:

Pressure Reading (psi):

Low Water Cut-Off Present:

AquaStat Setting (°F):

Convectors

Convectors Type:

Client Knows How to Use Radiator Key:

Operable Convectors in Each Room:

Operable Convectors in Unconditioned Space:

Zone Valves Present:

Zone Valve Type/Model:

Zone Valve Condition:

Comments

Delete OK Apply Cancel

(d) Boiler Components form

Inspections for Furnace1

Inspection Items

Cracked Heat Exchanger: ...

Insufficient Clearance from Combustibles: ...

Electric Service Switch: Good

Gas Leak Present: ...

Fuel Shutoff Valve Not Present: ...

Drip Leg Not Present: ...

Any Other Heating System Problems: ...

Comments

tell occupants to move clothes away from furnace.

Delete OK Apply Cancel

(e) Inspections form

Thermostat Details for Furnace1

Thermostat Type: Mechanical (mercury Bulb)

Daytime Thermostat Setting (°F): 72

Nighttime Thermostat Setting (°F): 85

Relocate Thermostat: ...

Anticipator Current (amps): 0.2

Anticipator Setting (0-1): 0.4

Anticipator Adjustment Needed: ...

Comments

Delete OK Apply Cancel

(f) Thermostat Details form

Figure B-18. NEAT/MHEA HVAC Systems – Optional forms.

B.8 Duct Systems Form

The NEAT and MHEA **Duct Systems** form (Figure B-19; conditionally required) is used to describe the supply and return ducts of ducted HVAC equipment in the house and to evaluate duct insulation. Multiple supply and return duct segments can be described. At least one supply duct serving each ducted HVAC system must be described to run an audit.

Duct Systems

DS1

Existing Equipment

Duct System Code: DS1

Duct Type: Supply Return

HVAC Systems Served: Heating: Furnace1 Cooling: CAC

Duct Location: Unconditioned Attic/Ceiling

Duct Insulation: Around Duct or Ductboard

Use Defaults:

Surface Area (sq ft): 270

Insulation R-value: 7

Number of Return Registers:

Add Insulation

Measure Number:

Added R-value:

Additional Cost (\$):

Comments

New Copy Delete OK Apply Cancel

Figure B-19. NEAT/MHEA Duct Systems form.

B.9 Infiltration and Duct Leakage Form

The NEAT and MHEA **Infiltration and Duct Leakage** form (required) is used to characterize air leakage of the house and evaluate the effectiveness of air and duct sealing. If duct sealing is not evaluated, only the whole-house blower door measurements before and after weatherization are entered (Figure B-20). If duct sealing is evaluated, additional measurements related to duct leakage are required, depending on the Duct Leakage Method selected on the form (Figure B-21).

The Infiltration and Duct Leakage – Optional Measurements forms (Figure B-22) can be used to document additional air and duct leakage measurements that may be taken during the audit for diagnostic purposes. These measurements are entered on three sets of forms: the Blower Door Measurements and Zonal Pressure Measurements forms, the Pressure Pan Measurements form, and the Room Pressure Balance Measurements form.

	Before Weatherization (Existing)	After Weatherization (Target or Actual)
Air Leakage Rate (cfm)	4000	2500
at House Pressure Difference (Pa)	50	50

Costs
Infiltration Reduction (\$): 600

Comments

Optional Measurements: Blower Doors Zonal Pressures Pressure Pans Room Pressure Balances

Figure B-20. NEAT/MHEA Infiltration and Duct Leakage form (with Evaluate Duct Sealing unchecked).

Ducts and Infiltration

Evaluate Duct Sealing: Duct Leakage Method: Whole House Blower Door Measurements

Whole House Blower Door Measurements

	Before Weatherization (Existing)	After Duct Sealing and Before Other Weatherization (Target or Actual)	After Weatherization (Target or Actual)
Air Leakage Rate (cfm)	4000	3000	2500
at House Pressure Difference (Pa)	50	50	50

Duct Operating Pressures

	Before Duct Sealing	After Duct Sealing
Supply (Pa)	35	35
Return (Pa)	25	25

Costs

Infiltration Reduction (\$): 600
Duct Sealing (\$): 100

(a) Duct Leakage Method: Whole House Blower Door Measurements

Ducts and Infiltration

Evaluate Duct Sealing: Duct Leakage Method: Blower Door Subtraction Measurements

Whole House Blower Door Measurements

	Before Weatherization (Existing)	After Duct Sealing and Before Other Weatherization (Target or Actual)	After Weatherization (Target or Actual)
With Registers/Grills Open:			
Air Leakage Rate (cfm)	6000	5700	2000
at House Pressure Difference (Pa)	50	50	50
With Registers/Grills Sealed:			
Air Leakage Rate (cfm)	5400	5400	
at House Pressure Difference (Pa)	50	50	
Duct to House Pressure Difference (Pa)	50	50	

Duct Operating Pressures

	Before Duct Sealing	After Duct Sealing
Supply (Pa)	35	40
Return (Pa)	35	40

Costs

Infiltration Reduction (\$): 600
Duct Sealing (\$): 100

(b) Duct Leakage Method: Blower Door Subtraction Measurements

Ducts and Infiltration

Evaluate Duct Sealing: Duct Leakage Method: Duct Blower Measurements

Whole House Blower Door Measurements

	Before Weatherization (Existing)	After Weatherization (Target or Actual)
Air Leakage Rate (cfm)	6000	2000
at House Pressure Difference (Pa)	50	50

Duct Blower Measurements

	Before Duct Sealing (Existing)		After Duct Sealing (Target or Actual)	
	Total	Outside *	Total	Outside *
Fan Flow (cfm)	400	300	200	100
at Duct Pressure (Pa)	25	25	25	25
House Pressure WRT Outside (Pa)	25		25	

*'Outside' readings are taken while the house to outdoor pressure difference provided by a blower door is maintained at the same level as the duct to outdoor pressure difference created by the duct blower. Thus, the 'Duct Pressure' and the 'House Pressure With Respect To Outside' should be equal.

Costs

Infiltration Reduction (\$): 600
Duct Sealing (\$): 100

(c) Duct Leakage Method: Duct Blower Measurements

Ducts and Infiltration

Evaluate Duct Sealing: Duct Leakage Method: Pressure Pan Measurements

Whole House Blower Door Measurements

	Before Weatherization (Existing)	After Weatherization (Target or Actual)
Air Leakage Rate (cfm)	3000	1500
at House Pressure Difference (Pa)	50	50

Pressure Pan Measurements

	Before Duct Sealing (Existing)	After Duct Sealing (Target or Actual)
Sum of Pressure Pan Measurements (Pa)	20	6

Duct Operating Pressures

	Before Duct Sealing	After Duct Sealing
Supply (Pa)	35	40

Costs

Infiltration Reduction (\$): 600
Duct Sealing (\$): 100

(d) Duct Leakage Method: Pressure Pan Measurements (MHEA only)

Figure B-21. NEAT/MHEA Infiltration and Duct Leakage form (with Evaluate Duct Sealing checked).

Blower Door Measurements

Test Information

Date Conducted: 2024-02-21

Conducted During: Audit

Equipment Used:

Blower Door Measurements

Air Leakage Rate (CFM): 4000

Building Pressure Differential (Pa): 50

Corrected CFM at 50 Pa: 4000

Comments

New Copy Delete OK Apply Cancel

All Blower Door Measurements				
Date Conducted	Conducted During	Air Leakage Rate (CFM)	Building Pressure Differential (Pa)	Last Edited
02-20-2024 7:00 PM	Audit	4000	50	02-21-2024 12:09 AM
02-20-2024 7:00 PM	During Installation	3200	55	02-21-2024 12:09 AM

Zonal Pressure Measurements

Zonal Pressure Measurements

Blower Door Test: 2024-02-21-During Installation

Location: Crawlspace

Pressure (Pa): 38

Ducts Present:

Comments

New Copy Delete OK Apply Cancel

All Zonal Pressure Measurements				
Blower Door Test	Location	Pressure (Pa)	Ducts Present	Last Edited
2024-02-21-During Installation	Attic	48	No	02-21-2024 12:23 AM
2024-02-21-During Installation	Interior Wall	43	No	02-21-2024 12:23 AM
2024-02-21-During Installation	Crawlspace	38	Yes	02-21-2024 12:23 AM

(a) Blower Door Measurements and Zonal Pressure Measurements forms

Pressure Pan Measurements

Pressure Pan Measurements

Blower Door Test: 2024-02-21-During Installation

Location: Dining Room

Register Number: 4

Register Type: Supply

Initial Pressure (Pa): 2

Final Pressure (Pa): 0

Comments

New Copy Delete OK Apply Cancel

All Pressure Pan Measurements				
Blower Door Test	Location	Register Number	Register Type	Last Edited
2024-02-21-During Installation	Dining Room	4	Supply	02-21-2024 12:19 AM
2024-02-21-During Installation	Kitchen	3	Supply	02-21-2024 12:19 AM
2024-02-21-During Installation	Family Room	2	Supply	02-21-2024 12:19 AM
2024-02-21-During Installation	Family Room	1	Supply	02-21-2024 12:18 AM

Room Pressure Balance Measurements

Room Pressure Balance Measurements

Location: Bedroom 2

Initial Pressure Difference (Pa): 15

Final Pressure Difference (Pa): 15

Comments

New Copy Delete OK Apply Cancel

All Room Pressure Balance Measurements			
Location	Initial Pressure Difference (Pa)	Final Pressure Difference (Pa)	Last Edited
Bedroom 2	15	15	02-21-2024 12:22 AM
Bathroom 1	10	4	02-21-2024 12:21 AM
Bedroom 1	5	5	02-21-2024 12:21 AM

(b) Pressure Pan Measurements form

(c) Room Pressure Balance Measurements form

Figure B-22. NEAT/MHEA Infiltration and Duct Leakage – Optional Measurements forms.

B.10 Water Heating Forms

The **Water Heating** form (Figure B-23; optional) is used to enter information necessary to evaluate four water heating measures: tank insulation, pipe insulation, low-flow showerheads, and water heater replacement. If none of the four water heating measures is to be evaluated for a specific audit, the Water Heating form need not be accessed.

The **Optional Water Heating Details** forms (Figure B-24) can be used to document an extensive number of water heater measurements and observations made while auditing a dwelling. Some of these data items help to identify potential health and safety hazards. You must complete the description of the water heater before accessing these forms. Not all forms will be applicable to the water heater described on the Water Heating form.

Water Heating

Existing Equipment

Manufacturer: Fuel: Natural Gas

Model: Input Units: KBtu Per Hour

Equipment Type: Storage Rated Input: 50

Location: Conditioned Space Rated Storage Capacity (gal): 50

Energy Factor: 0.53

Uniform Energy Factor:

Water Heater Wrap Present: First-Hour Rating (gal):

Water Heater Pipe Insulation Present: Recovery Efficiency: 0.76 Estimate

Original Tank Insulation

R Value: Thickness (in): 1.5 Type: Fiberglass

Replacement

Pick from Supply Library:

Manufacturer:

Model:

Equipment Type: Storage

Fuel: Natural Gas

Input Units: KBtu Per Hour

Rated Input: 40

Rated Storage Capacity (gal): 50

Uniform Energy Factor: 0.65

First-Hour Rating (gal):

Recovery Efficiency: 0.8 Estimate

Installation Cost (\$): 450

Additional Cost (\$):

Replacement Required:

Include in SIR:

Water heater specifications may be available from the AHRI Directory of Certified Product Performance (www.ahridirectory.org).

Showerheads

Number of Showerheads: 1 Flow Rate (gpm): 3.2

Shower Use (min/day): 10

Comments

Delete **Optional Water Heating Details:** Operational Tests Vent Tests Inspections OK Apply Cancel

Figure B-23. NEAT/MHEA Water Heating form.

Operational Tests for Water Heating

Flue Gas Analysis

Conducted During	Audit	Inspection
Combustion Air Inlet Temperature (°F):	70	
Flue Gas Temperature (°F):	470	
Net Stack Temperature (°F):	400	
Percent Oxygen (%):	8	
Percent Carbon Dioxide (%):	7	
Smoke Number:		
Steady State Efficiency (%):	79	

Carbon Monoxide

As-Measured Reading In Flue (ppm): 15

Air-Free Reading In Flue (ppm): 24

Comments

Delete OK Apply Cancel

(a) Operational Tests form

Vent Tests for Water Heating

Venting Information

Damper Type: None Found

Damper Condition: Not Applicable

Chimney Type: Masonry-Lined

Chimney Condition: Fair

Flue Type: Metal Single Wall

Flue Condition: Fair

Flue/Damper Diameter (in): 6

Combustion Air Intake: Adequate

Other Venting Related Problems: ...

Normal Operating Conditions Draft Measurements

Conducted During	Audit	Inspection
Outdoor Temperature (°F):	30	
Draft (Pa or Inches of Water):	6	
Spillage Time (sec):	20	

Comments

Delete OK Apply Cancel

(b) Vent tests form

Inspections for Water Heating

Fuel Related

Insufficient Clearance from Combustibles:

Electric Service Switch: Not Applicable

Gas Leak Present:

Fuel Shutoff Valve Not Present:

Drip Leg Not Present:

Water Related

Hot Water Temperature (°F): 120

Supply Temperature Adjustment Needed: ...

Pressure Relief Piping Needed: ...

Water Leak Present: ...

Other Water Heating Problems: ...

Comments

Delete OK Apply Cancel

(c) Inspections form

Figure B-24. NEAT/MHEA Optional Water Heating Details forms.

B.11 Refrigerator Form

The **Refrigerator** form (Figure B-25; optional) is used to enter information necessary to evaluate the refrigerator replacement measure. If this measure is not to be evaluated for a specific audit, the Refrigerator form need not be accessed.

Refrigerator

Existing Equipment

Manufacturer: Admiral Model: AS1ND205

Style: Bottom Freezer Defrost: Automatic

Size (cu ft): 20.1 Location: Conditioned Space

Consumption

Source: Nameplate or Database Metered

Nameplate or Database

Rated Consumption (kWh/yr): 1980 Age: 15 or More Years

Door Seal Condition: Fair - Some Wear

Metered

Metering Minutes: Manual Defrost:

Meter Reading (kWh): Includes Defrost Cycle:

Space Temperature (°F):

Replacement

Pick from Supply Library:

Manufacturer:

Model:

Style: Side by Side

Defrost: Automatic

Rated Consumption (kWh/yr): 600 Size (cu ft): 21.7

Height (in): Width (in): Depth (in):

Installation Cost (\$): 700

Additional Cost (\$): 100

Adjusted Consumptions

Existing Refrigerator (kWh/yr): 2574

Replacement Refrigerator (kWh/yr): 660

Annual Savings (kWh/yr): 1914

Adjusted consumptions and savings reported on this form assume that the refrigerators are in heated spaces. Final calculations will be based on the actual location.

Available Space Dimensions

Height (in): Width (in): Depth (in):

Comments

Delete OK Apply Cancel

Figure B-25. NEAT/MHEA Refrigerator form.

B.12 Lighting Form

The **Lighting** form (Figure B-26; optional) is used to describe the existing lighting systems for which you want to evaluate the replacement measure. If this measure is not to be evaluated for a specific audit, the Lighting form need not be accessed.

Lighting

LT1

Lighting Information

Lighting Code:

Room:

Location:

Existing Lighting System

Pick from Supply Library:

Lamp Type:

Number of Lamps:

Size (watts):

Usage (hr/day):

Brightness (lumens):

Color Temperature (K):

Retrofit Lighting System

Retrofit Options:

Pick from Supply Library:

Lamp Type:

Number of Lamps:

Size (watts):

Usage (hr/day):

Brightness (lumens):

Color Temperature (K):

Installation Cost (\$/bulb):

Additional Cost (\$/bulb):

Additional Cost (\$):

Comments

New Copy Delete OK Apply Cancel

Figure B-26. NEAT/MHEA Lighting form.

B.13 Health and Safety Forms

The **Health and Safety** forms (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 **Whole House** form (Figure B-27) can be used to identify the need for smoke detectors and carbon monoxide monitors and to record the carbon monoxide concentrations in various rooms of the house. The carbon monoxide concentration should be recorded for rooms having combustion-based space heating or water heating, a kitchen having a gas/propane cook stove, and the living area.

The **Equipment** form (Figure B-28) can be used to identify health and safety issues related to equipment in the house. Improper venting is a concern for wood stoves, fireplaces, clothes dryers, and exhaust fans. Wood stoves and fireplaces may also have inadequate combustion air, and bathroom or kitchen exhaust fans may be missing or not operational. Individual burner and oven carbon monoxide measurements can be recorded for a gas cook stove and a gas leak associated with the gas stove may also be identified. The existence of an air-to-air heat exchanger may be indicated.

The **Building Shell** form (Figure B-29) can be used to identify health and safety issues in the attics, walls, and basement/crawlspace of the house. These issues include wiring problems, water leaks, plumbing leaks, moisture/mold problems, the presence of lead-based paint in walls, asbestos in vermiculite attic insulation or wall siding, recessed lighting, problems associated with the ventilation and the chimney/flue, and the need of a vapor barrier in the basement. All areas can also be described as having Other Problems, which could be explained in the comments.

The **Space Heating Worst Case Draft Measurements** form (Figure B-30) and the **Water Heater Worst Case Draft Measurements** form (Figure B-31) can be used to record worst-case condition draft measurements for any combustion-based heating systems described on the HVAC Systems form and the water heater described on the Water Heating form, respectively.

The **ASHRAE 62.2 Ventilation Calculation** form (Figure B-32) can be used to determine ventilation requirements to comply with ASHRAE Standard 62.2. The calculations use the building information entered on the Audit form and require the kitchen and bath exhaust information and blower door measurements before weatherization, targeted, and/or after weatherization to estimate the continuous ventilation needed. For NEAT, fields for entering blower door measurements are activated only when an infiltration credit can be taken (i.e., when the type of dwelling unit is detached or horizontally attached).

Health and Safety

Whole House | Equipment | Building Shell | Space Heating Worst Case Draft Measurements | Water Heater Worst Case Draft Measurements | ASHRAE 62.2 Ventilation Calculation

Health and Safety Devices

Smoke Detector is Needed: ...

Carbon Monoxide (CO) Monitor is Needed: ...

Carbon Monoxide Measurements

Room with Heating System (ppm):

Room with Water Heater (ppm):

Living Area (ppm):

Kitchen (ppm):

Comments

Delete OK Apply Cancel

Figure B-27. NEAT/MHEA Health and Safety – Whole House form.

Health and Safety

Whole House | **Equipment** | Building Shell | Space Heating Worst Case Draft Measurements | Water Heater Worst Case Draft Measurements | ASHRAE 62.2 Ventilation Calculation

Wood Stoves/Fireplaces

Wood Stove/Fireplace is Present: ...

Improper Venting: ...

Combustion Air is Inadequate: ...

Clothes Dryer

Improper Venting: ...

Cook Stove

CO Measurement Oven (ppm):

CO Measurement Burner 1 (ppm):

CO Measurement Burner 2 (ppm):

CO Measurement Burner 3 (ppm):

CO Measurement Burner 4 (ppm):

Gas Leak Present: ...

Exhaust Fans

<p>Bathrooms</p> <p>Missing: <input checked="" type="checkbox"/> ...</p> <p>Not Operational: <input type="checkbox"/> ...</p> <p>Improper Venting: <input type="checkbox"/> ...</p>	<p>Kitchen</p> <p>Missing: <input type="checkbox"/> ...</p> <p>Not Operational: <input type="checkbox"/> ...</p> <p>Improper Venting: <input type="checkbox"/> ...</p>	<p>Air-to-Air Heat</p> <p>Exists: <input type="checkbox"/></p> <p>Not Operational: <input type="checkbox"/> ...</p>
--	---	--

Comments

Delete OK Apply Cancel

Figure B-28. NEAT/MHEA Health and Safety – Equipment form.

Health and Safety

Whole House | Equipment | **Building Shell** | Space Heating Worst Case Draft Measurements | Water Heater Worst Case Draft Measurements | ASHRAE 62.2 Ventilation Calculation

Attics

Recessed Lights Present: ...

Chimney/Flue Shielding Incorrect: ...

Wiring Problems: ...

Ventilation Inadequate: ...

Water Leaks Present: ...

Moisture/Mold Problems Evident: ...

Vermiculite Present: ...

Other Problems: ...

Walls

Wiring Problems: ...

Water Leaks Present: ...

Moisture/Mold Problems Evident: ...

Lead Based Paint is Likely: ...

Asbestos in Siding is Likely: ...

Other Problems: ...

Basements/Crawlspaces

Vapor Barrier Needed: ...

Wiring Problems: ...

Water Leaks Present: ...

Plumbing Leaks Present: ...

Moisture/Mold Problems Evident: ...

Other Problems: ...

Comments

Delete OK Apply Cancel

Figure B-29. NEAT/MHEA Health and Safety – Building Shell form.

Health and Safety

Whole House | Equipment | Building Shell | **Space Heating Worst Case Draft Measurements** | Water Heater Worst Case Draft Measurements | ASHRAE 62.2 Ventilation Calculation

Date Conducted: 2024-02-21 *** THIS IS A COPY ***

Conducted During: Audit

On Heating System: HS1

Outdoor Temperature (F): 30

Draft (Pa or Inches of Water): 6

Spillage Time (sec): 35

Comments

All Worst Case Condition Draft Measurements

Date Conducted	Conducted During	Heating System	Outdoor Temperature (F)	Draft (Pa or Inches of Water)	Spillage Time (sec)	Last Edited
2024-02-21	Audit	HS1	30	6	35	02-21-2024 2:31 AM

New Copy Delete OK Apply Cancel

Figure B-30. NEAT/MHEA Health and Safety – Space Heating Worst-Case Draft Measurements form.

Health and Safety

Whole House | Equipment | Building Shell | Space Heating Worst Case Draft Measurements | **Water Heater Worst Case Draft Measurements** | ASHRAE 62.2 Ventilation Calculation

Date Conducted: 2024-02-21 ***** THIS IS A COPY *****

Conducted During: Audit

Outdoor Temperature (F): 30

Draft (Pa or Inches of Water): 6

Spillage Time (sec): 35

Comments

All Worst Case Condition Draft Measurements

Date Conducted	Conducted During	Outdoor Temperature (F)	Draft (Pa or Inches of Water)	Spillage Time (sec)	Last Edited
2024-02-21	Audit	30	6	35	02-21-2024 3:04 AM

New Copy Delete OK Apply Cancel

Figure B-31. NEAT/MHEA Health and Safety – Water Heater Worst-Case Draft Measurements form.

Health and Safety

Whole House | Equipment | Building Shell | Space Heating Worst Case Draft Measurements | Water Heater Worst Case Draft Measurements | **ASHRAE 62.2 Ventilation Calculation**

ASHRAE Standard 62.2 Version: 2016 2019

Weather State: CO

Weather Station: Denver Intl Ap

Floor Area (sqft): 2000

Infiltration Height (ft): 8

Number of Bedrooms: 4

Number of Occupants: 2

Use number of occupants for ventilation calculation (i.e., if exception to ASHRAE 62.2 occupant density calculation applies)

Dwelling Unit Type: Detached

Common Wall Area (sqft):

Exterior Envelope Area (sqft):

Comments

ASHRAE 62.2 Ventilation Calculation

Space	Operable Window	PreWx		Target		PostWx	
		CFM	Deficit	CFM	Deficit	CFM	Deficit
<input checked="" type="checkbox"/> Bathroom 1	<input type="checkbox"/>	40	10	40	10	40	10
<input checked="" type="checkbox"/> Bathroom 2	<input type="checkbox"/>	60	0	60	0	60	0
<input type="checkbox"/> Bathroom 3	<input type="checkbox"/>						
<input type="checkbox"/> Bathroom 4	<input type="checkbox"/>						
<input type="checkbox"/> Bathroom 5	<input type="checkbox"/>						
<input checked="" type="checkbox"/> Kitchen 1	<input checked="" type="checkbox"/>	0	80	0	80	0	80
<input type="checkbox"/> Kitchen 2	<input type="checkbox"/>						

Blower Door Measurements

Air Leakage Rate (cfm): 4000 3000 2500

House Pressure Difference (Pa): 50 50 50

Continuous Ventilation Needed (cfm): 120 120 120

Delete OK Apply Cancel

Figure B-32. NEAT/MHEA Health and Safety – ASHRAE 62.2 Ventilation Calculation form.

B.14 Itemized Costs Form

The **Itemized Costs** form (Figure B-33) can be used to enter necessary repair and health and safety measures associated with recommended energy measures and their costs. This form can also be used to enter your own energy saving measures (that you define) not addressed under the Measure Cost Set Library.

Itemized Costs

Repair Roof **Insulate and...**

Itemized Cost Measure

Measure Name: Insulate and Seal Attic Access

Cost (\$): 29.6 Include in SIR:

Material: R-30 faced batt insylation

Annual Energy Savings: 0.7 Units: MMBtu

Life (yr): 20

Fuel Saved: Natural Gas

Defined Measures

Copy from Defined Measures, including Health and Safety Measures (101-150)

Select a measure to copy

Referenced Defined Measure

Clear Reference to Defined Measure

Comments

New Copy Delete OK Apply Cancel

Figure B-33. NEAT/MHEA Itemized Costs form.

B.15 Utility Bills Form

The NEAT and MHEA **Utility Bills** form (Figure B-34) (optional) can be used to enter pre-retrofit utility bills associated with heating and cooling. This form is used if you want NEAT or MHEA to compare the bills with the home's heating and cooling energy consumption estimates as part of an audit calibration process and to adjust energy savings estimates for the recommended measures.

Utility Bills

Pre-Retrofit Heating Pre-Retrofit Cooling

Utility Units

Usage Units: Therms

Days in First Period: 30

Degree Days Base Temperature (°F): 65

Monthly Baseload: 28.9

NOTE: The maximum number of utility bills that can be entered is 12. The utility bills must be entered in chronological order and must be consecutive (i.e., no missing periods). The utility bills may span over two calendar years, but they cannot span more than 365 days (e.g., March 17, 2017 to March 16, 2018). If desired, one annual consumption can be entered.

Index	Billing Date	Usage	Degree Days
1	1/15/2023	381	1631
2	2/17/2023	424	1380
3	3/14/2023	276	1166
4	4/16/2023	129	621
5	5/13/2023	162	288
6	6/15/2023	98	81
7	7/15/2023	30	22
8	8/14/2023	28	31
9	9/16/2023	86	189
10	10/17/2023	148	505
11	11/13/2023	194	1014
12	12/12/2023	298	1454

Comments

Delete OK Apply Cancel

Figure B-34. NEAT/MHEA Utility Bills form.

B.16 Audit Run Measures Form

The **Audit Run Measures** form (Figure B-35; optional) can be used to create work orders based on the results from running NEAT or MHEA. Following execution of either NEAT or MHEA, the Audit Run Measures form lists all measure recommendations, similar to the listing in the Recommended Measures report. This form can be used to select measures you want transferred to a work order and assign each measure to a contractor/in-house crew (optional) and a cost center (optional) defined on the Agency Contact and Agency Cost Center forms, respectively. All selected measures assigned to the same contractor (or not assigned to any contractor) will be included in the same work order. Cost center assignment allows you to track the cost of implementing measures over multiple audits.

Audit Run Measures

Audit Run Measures							
#	Measure Name	Contractor/In-House Crew	Cost Center	Components	Work Order	Estimated Cost	SIR
1	Repair Roof			Itemized Cost	<input checked="" type="checkbox"/>	\$80.00	0.0
2	Lighting Retrofits			LT1	<input checked="" type="checkbox"/>	\$24.00	9.6
3	Lighting Retrofits			LT2	<input checked="" type="checkbox"/>	\$32.00	9.2
4	Low Flow Showerheads			Water Heater	<input checked="" type="checkbox"/>	\$30.00	6.7
5	Water Heater Tank Insulation			Water Heater	<input checked="" type="checkbox"/>	\$45.00	4.5
6	Insulate and Seal Attic Access			Itemized Cost	<input checked="" type="checkbox"/>	\$29.60	4.2
7	Refrigerator Replacement			Refrigerator	<input checked="" type="checkbox"/>	\$800.00	4.1
8	Water Heater Pipe Insulation			Water Heater	<input checked="" type="checkbox"/>	\$30.00	3.7
9	Weatherize Window			WD3,WD1,WD2	<input checked="" type="checkbox"/>	\$300.00	1.8
10	General Air Sealing			Ducts/Infiltration	<input checked="" type="checkbox"/>	\$600.00	1.6
11	Water Heater Replacement			Water Heater	<input checked="" type="checkbox"/>	\$450.00	1.3

Unit Costs for Measure: Water Heater Replacement

Component	Cost Type	Measure Description	Quantity	Units	Units\$	Comment
Water Heater	Installation	New Water Heater, 50 gal, Natural Gas, S...	1	Each	\$450.00	Cost from form
Water Heater	Additional	New Water Heater, 50 gal, Natural Gas, S...	1	Each	\$0.00	Cost from form

Figure B-35. NEAT/MHEA Audit Run Measures form.

APPENDIX C. MULTEA FORMS

APPENDIX C. MULTEA FORMS

The descriptions of all MulTEA forms can be found in Section 4 and are not included here.

Multifamily Tool for Energy Audits (MulTEA)

Agency: Sample Agency
Account Name: Sample Account
Account Number: S001
Audit Name: Sample Audit (DOE Mid-rise Prototype)

Audit Date: 11-26-2019
Auditor: John Doe
City:
State: CO
Audit Number: 1894

Libraries

Weather State: IL
Weather Station: Chicago Ohare Intl Ap
Economic Parameters: 2019 - Residential US Average Ecc
Measure Costs: Sample MulTEA Measure Cost Libr
Key Parameters:

Fuel Cost Details

Electricity:	2019 - Average US Residential Electricity Costs	Cost:	0.1283	per	kWh
Natural Gas:	2019 - Average US Residential Natural Gas Costs	Cost:	9.48	per	Mcf
Propane:	None	Cost:		per	
Fuel Oil:	None	Cost:		per	
Kerosene:	None	Cost:		per	

Comments

Figure C-1. MulTEA Audit form.

Building

Building Size and Occupancy

Number of Dwelling Units: Elevation of First Floor Above Grade (ft):

Gross Floor Area of Building (sq ft): Site Grade Changes:

Number of Floors Above Grade: Depth of Building Below Grade:

Number of Floors Below Grade: All Sides (ft):

Average Floor Height (ft): On the Back (ft):

Number of Occupants:

During Daytime: On the Right (ft):

During Nighttime: On the Front (ft):

On the Left (ft):

Site Definition

Site Shielding and Terrain:

Ground Surface:

Building Layout

Building Shape: Total Number of Dwelling Units:

Hallway Configuration: Top Floor:

Hallways Are Conditioned: Intermediate Floor(s):

Orientation of Building (deg): First Floor Above Grade:

First Floor Below Grade:

Configuration

Floor Area of Enclosed Spaces

Floor	Area (sq ft)				Floor Sum
	Units	Hallways	Other Conditioned Spaces	Other Unconditioned Spaces	
A3	7600	836	0	0	8436
A2	7600	836	0	0	8436
A1	6650	836	950	0	8436
B1	0	0	0	0	0
B2	NA	0	0	0	0
Bldg Totals: *	29450	3344	950	0	33744

* Bldg totals include a multiplier for two A2 floors

Number of Dwelling Units by Orientation

Orientation	First Floor Below Grade	First Floor Above Grade	Intermediate Floor(s)	Top Floor
<input checked="" type="checkbox"/> Exposed Walls in one orientation	0	2	2	2
<input checked="" type="checkbox"/> Exposed Walls in two adjacent orientations	0	1	1	1
<input type="checkbox"/> Exposed Walls in two opposite orientations	0	0	0	0
<input type="checkbox"/> Exposed Walls in three orientations	0	0	0	0
<input type="checkbox"/> Exposed Walls in all orientations	0	0	0	0

Comments

Delete

Figure C-2. MulTEA Building form.

Exterior 1 Exterior 2 Exterior 3 Exterior 4 Underground 1 Underground 2 Interior 1 Interior 2

Wall Code:

Construction

Wall Construction:

Construction Material:

Stud Dimensions: Size: Spacing (in):

Wall Insulation:

Cavity Insulation: Type: Thickness (in): R-value:

Exterior Insulation: Type: Thickness (in): R-value:

Interior Insulation: Type: Thickness (in): R-value:

Wall Exterior:

Exterior Finish:

Exterior Color:

Configuration

Gross Area of Wall

Space	Gross Area (sq ft)				
	Back	Right	Front	Left	Sum
Units	6080	1750	5700	2000	15530
Hallways	0	220	0	220	440
Other Conditioned Spaces	0	250	380	0	630
Crawlspace	0	0	0	0	0
Totals:	6080.0	2220.0	6080.0	2220.0	16600.0

Retrofit Measures

Active: Add Cavity Insulation: Type: Thickness (in): R-value:

Active: Add Exterior Insulation: Type: Thickness (in): R-value:

Active: Add Interior Insulation: Type: Thickness (in): R-value:

Comments

Figure C-3. MulTEA Exterior Wall form.

Exterior 1 Exterior 2 Exterior 3 Exterior 4 **Underground 1** Underground 2 Interior 1 Interior 2

Wall Code:

Construction

Wall Construction:

Construction Material:

Stud Dimensions: Size: Spacing (in):

Wall Insulation:

Cavity Insulation: Type: Thickness (in): R-value:

Exterior Insulation: Type: Thickness (in): R-value:

Interior Insulation: Type: Thickness (in): R-value:

Wall Exterior:

Exterior Finish:

Exterior Color:

Configuration

Gross Area and Exposed Perimeter of Wall

Space	Gross Area (sq ft)					Exposed Perimeter (ft)				
	Back	Right	Front	Left	Sum	Back	Right	Front	Left	Sum
Units	0	0	0	0	0	0	0	0	0	0
Hallways	0	0	0	0	0	0	0	0	0	0
Other Conditioned Spaces	0	0	0	0	0	0	0	0	0	0
Crawlspace	304	111	304	111	830	152	55.5	152	55.5	415
Totals:	304.0	111.0	304.0	111.0	830.0	152.0	55.5	152.0	55.5	415.0

Retrofit Measures

Active: Add Cavity Insulation: Type: Thickness (in): R-value:

Active: Add Exterior Insulation: Type: Thickness (in): R-value:

Active: Add Interior Insulation: Type: Thickness (in): R-value:

Comments

Figure C-4. MulTEA Underground Wall form.

Exterior 1 Exterior 2 Exterior 3 Exterior 4 Underground 1 Underground 2 **Interior 1** Interior 2

Wall Code:

Construction

Wall Construction:

Construction Material:

Stud Dimensions: Size: Spacing (in):

Wall Insulation:

Cavity Insulation: Type: Thickness (in): R-value:

Exterior Insulation: Type: Thickness (in): R-value:

Interior Insulation: Type: Thickness (in): R-value:

Wall Exterior:

Exterior Finish:

Exterior Color:

Configuration

Gross Area of Wall

Conditioned Space	Unconditioned Attached Space	Gross Area (sq ft)
Units	Hallways	11780
Units	Attic	0
Units	Crawlspace	0
Other Conditioned Spaces	Hallways	380
Other Conditioned Spaces	Attic	0
Other Conditioned Spaces	Crawlspace	0
Totals:		12160.0

Retrofit Measures

Active: Add Cavity Insulation: Type: Thickness (in): R-value:

Active: Add Exterior Insulation: Type: Thickness (in): R-value:

Active: Add Interior Insulation: Type: Thickness (in): R-value:

Comments

Figure C-5. MulTEA Interior Wall form.

Window 1 Window 2 Window 3 Window 4 Window 5 Window 6 Window 7 Window 8

Window Code:

Width (in): Height (in):

Construction

Window Type:

Default Leakiness:

Input NFRC Ratings: U-value: SHGC:

Glazing Assembly:

Glass Type:

Frame Type:

Installed Characteristics

Installed Leakiness:

Storm Window:

Interior Shading:

Exterior Shading:

Overhang/Awning: Horizontal Projection (in): Distance from Lintel (in):

Configuration

Number of Windows

Wall Tab	Wall Code	Space	Number				
			Back	Right	Front	Left	Sum
Exterior 1	Wall1	Units	32	0	30	0	62
Exterior 1	Wall1	Hallways	0	0	0	0	0
Exterior 1	Wall1	Other Conditioned Spaces	0	0	2	0	2
Totals:			32	0	32	0	64

Retrofit Measures

Active: **Replace Window:** Input NFRC Ratings: U-value: SHGC:
 Glazing Assembly:
 Glass Type:

Active: **Add Storm Window:** Storm Window Type:

Active: **Add Shading:** Shading Type:

Active: **Add Awning:** Horizontal Projection (in): Distance from Lintel (in):

Comments

Figure C-6. MulTEA Window form.

Attic 1 Attic 2 Attic 3 Attic 4 Cathedral 1 Cathedral 2 Flat 1 Flat 2

Roof Code: Attic

Construction

Roof Construction:

Construction Material: Wood Frame

Truss / Joist: Size: 2x6 Spacing (in): 24

Roof Insulation:

Ceiling Insulation: Type: Cellulose Blown - Normal Density Thickness (in): 5.5 R-value: 20.37

Roof Insulation: Type: None Thickness (in): R-value:

Radiant Barrier: None

Roof Exterior:

Roofing Material: Asphalt Shingles

Roof Color: Medium Absorptance: 0.65

Configuration

Area of Roof		
Floor	Space	Area (sq ft)
A3	Units	7600
A3	Hallways	836
A2	Units	0
A2	Hallways	0
Totals:		8436.0

Roof Slope (x/12): 3

Attic Height (ft): 6.88

Attic Volume (cu ft): 25546

Retrofit Measures

Active: Add Ceiling Insulation: Type: Thickness (in): R-value:

Active: Add Roof Insulation: Type: Thickness (in): R-value:

Active: Add Radiant Barrier:

Active: White Roof Coating: Absorptance: 0.25

Comments

Delete OK Apply Cancel

Figure C-8. MulTEA Attic Roof form.

Attic 1 Attic 2 Attic 3 Attic 4 **Cathedral 1** Cathedral 2 Flat 1 Flat 2

Roof Code: Cathedral

Construction

Roof Construction:

Construction Material: Wood Frame

Truss / Joist: Depth (in): 6 Spacing (in): 24

Roof Insulation:

Ceiling Insulation: Type: Thickness (in): R-value:

Roof Insulation: Type: Cellulose Blown - Normal Density Thickness (in): 5.5 R-value: 20.37

Radiant Barrier:

Roof Exterior:

Roofing Material: Asphalt Shingles

Roof Color: Medium Absorptance: 0.65

Configuration

Area of Roof		
Floor	Space	Area (sq ft)
A3	Units	7600
A3	Hallways	836
A2	Units	0
A2	Hallways	0
Totals:		8436.0

Roof Slope (x/12): 3

Attic Height (ft): 0

Attic Volume (cu ft):

Retrofit Measures

Active: Add Ceiling Insulation: Type: Thickness (in): R-value:

Active: Add Roof Insulation: Type: Thickness (in): R-value:

Active: Add Radiant Barrier:

Active: White Roof Coating: Absorptance: 0.25

Comments

Delete OK Apply Cancel

Figure C-9. MulTEA Cathedral Roof form.

Attic 1 Attic 2 Attic 3 Attic 4 Cathedral 1 Cathedral 2 **Flat 1** Flat 2

Roof Code: Built-up roof

Construction

Roof Construction:

Construction Material: Concrete

Truss / Joist: Depth (in): Spacing (in):

Roof Insulation:

Ceiling Insulation: Type: None Thickness (in): R-value:

Roof Insulation: Type: Extruded Polystyrene Thickness (in): 3 R-value: 12.5

Radiant Barrier:

Roof Exterior:

Roofing Material: Built-up Roofing

Roof Color: Medium Absorptance: 0.65

Configuration

Area of Roof		
Floor	Space	Area (sq ft)
A3	Units	7600
A3	Hallways	836
A2	Units	0
A2	Hallways	0
Totals:		8436.0

Roof Slope (x/12): 0

Attic Height (ft): 0

Attic Volume (cu ft):

Retrofit Measures

Active: Add Ceiling Insulation: Type: Thickness (in): R-value:

Active: Add Roof Insulation: Type: Thickness (in): R-value:

Active: Add Radiant Barrier:

Active: White Roof Coating: Absorptance: 0.25

Comments

Delete OK Apply Cancel

Figure C-10. MulTEA Flat Roof form.

Underground 1
 Underground 2
 Exposed 1
 Exposed 2
 Interior 1
 Interior 2
 Above Crawlspace 1
 Above Crawlspace 2

Floor Code:

Construction

Floor Construction:

Construction Material:

Truss / Joist: Depth (in): Spacing (in):

Floor Insulation:

Slab Insulation: Location: Thickness (in): Width/Depth (ft): [Show Slab Insulation Diagram](#)

Exterior Insulation: Type: Thickness (in): R-value:

Interior Insulation: Type: Thickness (in): R-value:

Sill Box Insulation: Type: Thickness (in): R-value:

Floor Covering:

Carpet Area (%):

Configuration

Area and Exposed Perimeter of Floor

Floor	Space	Area (sq ft)	Exposed Perimeter (ft)
A1	Units	6650	341
A1	Hallways	836	11
A1	Other Conditioned Spaces	950	63
Totals:		8436.0	415.0

Retrofit Measures

Active: Add Slab Insulation: Location: Thickness (in): Width/Depth (ft):

Active: Add Exterior Insulation: Type: Thickness (in): R-value:

Active: Add Sill Box Insulation: Type: Thickness (in): R-value:

Comments

Figure C-11. MulTEA Underground Floor form.

Underground 1 | Underground 2 | Exposed 1 | Exposed 2 | **Interior 1** | Interior 2 | Above Crawlspace 1 | Above Crawlspace 2

Floor Code: IntFlr to UNCD

Construction

Floor Construction:
 Construction Material: Metal
 Truss / Joist: Depth (in): 8 Spacing (in): 24

Floor Insulation:
 Slab Insulation: Location: Thickness (in): 1 Width/Depth (ft): Show Slab Insulation Diagram
 Exterior Insulation: Type: Fiberglass Batt - Normal Density Thickness (in): 6 R-value: 20
 Interior Insulation: Type: None Thickness (in): R-value:
 Sill Box Insulation: Type: None Thickness (in): R-value:

Floor Covering:
 Carpet Area (%): 0

Configuration

Area of Floor				
Floor	Space	Attached Space Below	Area (sq ft)	Exposed Perimeter (ft)
A3	Units	Hallways	0	0
A3	Hallways	Units	0	0
A2	Units	Hallways	0	0
A2	Hallways	Units	0	0
A2	Hallways	Other Conditioned Spaces	0	0
A1	Units	Other Unconditioned Spaces	6650	341
A1	Other Conditioned Spaces	Other Unconditioned Spaces	050	63
Totals:			7600.0	404.0

Retrofit Measures

Active: Add Slab Insulation: Location: Thickness (in): 1 Width/Depth (ft):
 Active: Add Exterior Insulation: Type: Thickness (in): R-value:
 Active: Add Sill Box Insulation: Type: Thickness (in): R-value:

Comments

Delete OK Apply Cancel

Figure C-13. MulTEA Interior Floor form.

Underground 1 | Underground 2 | Exposed 1 | Exposed 2 | Interior 1 | Interior 2 | **Above Crawlspace 1** | Above Crawlspace 2

Floor Code:

Construction

Floor Construction:

Construction Material:

Truss / Joist: Depth (in): Spacing (in):

Floor Insulation:

Slab Insulation: Location: Thickness (in): Width/Depth (ft): [Show Slab Insulation Diagram](#)

Exterior Insulation: Type: Thickness (in): R-value:

Interior Insulation: Type: Thickness (in): R-value:

Sill Box Insulation: Type: Thickness (in): R-value:

Floor Covering:

Carpet Area (%):

Configuration

Area of Floor			
Floor	Space	Area (sq ft)	Exposed Perimeter (ft)
A1	Units	6650	341
A1	Hallways	836	11
A1	Other Conditioned Spaces	950	63
Totals:		8436.0	415.0

Retrofit Measures

Active: Add Slab Insulation: Location: Thickness (in): Width/Depth (ft):

Active: Add Exterior Insulation: Type: Thickness (in): R-value:

Active: Add Sill Box Insulation: Type: Thickness (in): R-value:

Comments

Figure C-14. MulTEA Above Crawlspace Floor form.

System 1		System 2	System 3	System 4	System 5	System 6	Units Thermostat	Halfways Thermostat	Other Conditioned Spaces Thermostat
HVAC System Code:	NG Furnace and Room AC							Location Served:	Units
System Configuration:	Combined - Individual Units							Number of Same Systems:	B2: <input type="text"/> B1: <input type="text"/> A1: <input type="text"/> A2: <input type="text"/> A3: <input type="text"/>
Outside Air Ventilation Rate (cfm):	<input type="text"/> 0								
Heating Equipment					Cooling Equipment				
System Type:	Individual							System Type:	Individual
Equipment:	Central Furnace							Equipment:	Room (Wall) Air Conditioner
Fuel:	Natural Gas							Efficiency Input Method:	Year Manufactured
Efficiency Input Method:	Year Manufactured							Year Manufactured:	1998
Year Manufactured:	1998							Efficiency:	9.08 EER
Steady State Efficiency % (Site Measured):	<input type="text"/> 0							Capacity:	2 Tons
Efficiency (Nameplate/Rated):	82.6 AFUE								
Capacity:	24 kBtu/hr								
Pilot Light/IID:	Pilot Light								
Retrofit Measures									
Active:	<input type="checkbox"/>	Change Ventilation Rate:	Outside Air Ventilation Rate (cfm):	<input type="text"/>					
Active:	<input type="checkbox"/>	Replace the System:	System Configuration:	<input type="text"/>					
			Heating Equipment:	<input type="text"/>					
			Heating Fuel:	<input type="text"/>					
			Heating Efficiency:	<input type="text"/>					
			Heating Capacity:	<input type="text"/>					
Active:	<input type="checkbox"/>	Tune Up:	Heating Efficiency Improvement (%):	<input type="text"/>					
Active:	<input checked="" type="checkbox"/>	Pilot Light:	Replace Pilot Light with IID						
Comments									
<input type="text"/>									
Delete								OK Apply Cancel	

Figure C-15. MulTEA HVAC System form.

System 1	System 2	System 3	System 4	System 5	System 6	Units Thermostat	Hallways Thermostat	Other Conditioned Spaces Thermostat																														
Current Schedule																																						
Thermostat Schedule <input type="radio"/> Custom <input checked="" type="radio"/> Default Heating: temp 24-Hour 68°F Cooling: temp 24-Hour 76°F																																						
Weekdays																																						
<table border="0" style="width:100%"> <tr> <td></td> <td></td> <td colspan="4" style="text-align:center">Daytime</td> <td colspan="3"></td> <td style="text-align:right">Nighttime</td> </tr> <tr> <td>Heating:</td> <td>24 hour schedule: <input type="checkbox"/></td> <td>From:</td> <td><input type="text"/></td> <td>To:</td> <td><input type="text"/></td> <td>Temperature (°F):</td> <td><input type="text"/></td> <td></td> <td>Temperature (°F): <input type="text"/></td> </tr> <tr> <td>Cooling:</td> <td>24 hour schedule: <input type="checkbox"/></td> <td>From:</td> <td><input type="text"/></td> <td>To:</td> <td><input type="text"/></td> <td>Temperature (°F):</td> <td><input type="text"/></td> <td></td> <td>Temperature (°F): <input type="text"/></td> </tr> </table>											Daytime							Nighttime	Heating:	24 hour schedule: <input type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	<input type="text"/>		Temperature (°F): <input type="text"/>	Cooling:	24 hour schedule: <input type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	<input type="text"/>		Temperature (°F): <input type="text"/>
		Daytime							Nighttime																													
Heating:	24 hour schedule: <input type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	<input type="text"/>		Temperature (°F): <input type="text"/>																													
Cooling:	24 hour schedule: <input type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	<input type="text"/>		Temperature (°F): <input type="text"/>																													
Different Weekday and Weekends/Holidays Schedules: <input type="checkbox"/>																																						
Weekends and Holidays																																						
Retrofit Measures																																						
Active: <input checked="" type="checkbox"/> New Thermostat Schedule: <input checked="" type="radio"/> Programmable Thermostat <input type="radio"/> Client Education																																						
Weekdays																																						
<table border="0" style="width:100%"> <tr> <td></td> <td></td> <td colspan="4" style="text-align:center">Daytime</td> <td colspan="3"></td> <td style="text-align:right">Nighttime</td> </tr> <tr> <td>Heating:</td> <td>24 hour schedule: <input type="checkbox"/></td> <td>From:</td> <td>8:00 AM</td> <td>To:</td> <td>5:00 AM</td> <td>Temperature (°F):</td> <td>72</td> <td></td> <td>Temperature (°F): 80</td> </tr> <tr> <td>Cooling:</td> <td>24 hour schedule: <input type="checkbox"/></td> <td>From:</td> <td>8:00 AM</td> <td>To:</td> <td>5:00 AM</td> <td>Temperature (°F):</td> <td>76</td> <td></td> <td>Temperature (°F): 65</td> </tr> </table>											Daytime							Nighttime	Heating:	24 hour schedule: <input type="checkbox"/>	From:	8:00 AM	To:	5:00 AM	Temperature (°F):	72		Temperature (°F): 80	Cooling:	24 hour schedule: <input type="checkbox"/>	From:	8:00 AM	To:	5:00 AM	Temperature (°F):	76		Temperature (°F): 65
		Daytime							Nighttime																													
Heating:	24 hour schedule: <input type="checkbox"/>	From:	8:00 AM	To:	5:00 AM	Temperature (°F):	72		Temperature (°F): 80																													
Cooling:	24 hour schedule: <input type="checkbox"/>	From:	8:00 AM	To:	5:00 AM	Temperature (°F):	76		Temperature (°F): 65																													
Different Weekday and Weekends/Holidays Schedules: <input checked="" type="checkbox"/>																																						
Weekends and Holidays																																						
<table border="0" style="width:100%"> <tr> <td></td> <td></td> <td colspan="4" style="text-align:center">Daytime</td> <td colspan="3"></td> <td style="text-align:right">Nighttime</td> </tr> <tr> <td>Heating:</td> <td>24 hour schedule: <input checked="" type="checkbox"/></td> <td>From:</td> <td><input type="text"/></td> <td>To:</td> <td><input type="text"/></td> <td>Temperature (°F):</td> <td>65</td> <td></td> <td>Temperature (°F): <input type="text"/></td> </tr> <tr> <td>Cooling:</td> <td>24 hour schedule: <input checked="" type="checkbox"/></td> <td>From:</td> <td><input type="text"/></td> <td>To:</td> <td><input type="text"/></td> <td>Temperature (°F):</td> <td>80</td> <td></td> <td>Temperature (°F): <input type="text"/></td> </tr> </table>											Daytime							Nighttime	Heating:	24 hour schedule: <input checked="" type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	65		Temperature (°F): <input type="text"/>	Cooling:	24 hour schedule: <input checked="" type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	80		Temperature (°F): <input type="text"/>
		Daytime							Nighttime																													
Heating:	24 hour schedule: <input checked="" type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	65		Temperature (°F): <input type="text"/>																													
Cooling:	24 hour schedule: <input checked="" type="checkbox"/>	From:	<input type="text"/>	To:	<input type="text"/>	Temperature (°F):	80		Temperature (°F): <input type="text"/>																													
Comments																																						
<input type="button" value="Delete"/> <input type="button" value="OK"/> <input type="button" value="Apply"/> <input type="button" value="Cancel"/>																																						

Figure C-16. MulTEA Thermostat form.

Infiltration Mechanical Ventilation

Infiltration Data
 Data Input Method: Space Specific Whole Building
 Type of Measurement: Natural Air Changes per Hour (ACH) Blower Door Data

Space Specific Infiltration

Floor	Space	Natural ACH
A3	Units	0.44
A3	Hallways	0.44
A2	Units	0.44
A2	Hallways	0.44
A1	Units	0.44
A1	Hallways	0.44

Whole Building Infiltration:
 Natural ACH:
 Blower Door Reading (CFM50):

Retrofit Building
 Airsealing Measures Planned:

Space Specific Infiltration

Floor	Space	Natural ACH
A3	Units	0
A3	Hallways	0
A2	Units	0
A2	Hallways	0
A1	Units	0
A1	Hallways	0

Whole Building Infiltration:
 Natural ACH:
 Blower Door Reading (CFM50):

Comments

Delete

Figure C-17. MulTEA Infiltration form.

Individual System 1		Individual System 2	Individual System 3	Individual System 4	Central System
DHW Individual System Code:		DHW units		Water Use Calibration Factor: 1	
Water Heating Equipment - Individual					
Equipment Type:	Storage	Rated Storage Capacity (gal):	50		
Location:	Conditioned Space	Rated Input:	15	kW	
Number of Same Water Heaters:	31	Efficiency Input Method:	Energy Factor		
Set-Point Temperature (°F):	140	Year Manufactured:			
Fuel:	Electricity	Energy Factor:	0.9		
Water Heater Wrap R-value:	0	First-Hour Rating (gal):			
Insulated Pipe Length (ft):	0	Recovery Efficiency:	0.98	<input type="checkbox"/> Estimate	
Retrofit Measures - Individual					
Active:	<input type="checkbox"/> Replace the System:	Equipment Type:		Rated Storage Capacity (gal):	
		Number of Same Water Heaters:		Rated Input:	
		Fuel:		Uniform Energy Factor:	
				First-Hour Rating (gal):	
				Recovery Efficiency:	<input type="checkbox"/> Estimate
Active:	<input type="checkbox"/> Change Set-Point Temperature:	Set-Point Temperature (°F):			
Active:	<input type="checkbox"/> Install Water Heater Wrap:	Water Heater Wrap R-value:			
Active:	<input type="checkbox"/> Add Insulation on Water Heater Pipes:	Insulation Thickness (in):		Length of Pipe to Insulate (ft):	
Comments - Individual					
Delete				OK Apply Cancel	

Figure C-18. MulTEA Individual Water Heating System form.

Individual System 1	Individual System 2	Individual System 3	Individual System 4	Central System	
DHW Central System Code:		DHW Central		Water Use Calibration Factor:	1
Water Heating Equipment - Central					
System Category:	Separate		Fuel:	Natural Gas	
Equipment Type:	Storage		Rated Storage Capacity (gal):	200	
Location:	Unconditioned Space		Rated Input:	500 kBtu/hr	
Number of Same Central Water Heaters:	1		Steady-State Efficiency (%):	80	
Set-Point Temperature (°F):	140		Standby Loss:	1 % per hr	
Distribution System - Central					
Number of Distribution Loops:	1		Recirculation Control Type:	Demand	
Branch Factor (units per branch):	8		Pump Power (hp):	10	
Pipe Location:	Conditioned Space		Flow Rate (gpm):	60	
Pipe Insulation Thickness (in):	1		Pump Motor Efficiency (%):	60	
Retrofit Measures - Central					
Active:	<input type="checkbox"/> Replace the System:	System Category:		Rated Storage Capacity (gal):	
		Equipment Type:		Rated Input:	
		Number of Central Water Heaters:		Steady-State Efficiency (%):	
		Fuel:		Standby Loss:	
Active:	<input type="checkbox"/> Change Set-Point Temperature:	Set-Point Temperature (°F):			
Active:	<input type="checkbox"/> Add Insulation on Distribution Pipes:	Insulation Thickness (in):			
Active:	<input type="checkbox"/> Replace Circulation Pump:	Pump Power (hp):		Flow Rate (gpm):	
		Pump Motor Efficiency (%):			
Comments - Central					
Delete		OK Apply Cancel			

Figure C-19. MulTEA Central Water Heating System form.

Basecase

Data Input Method: Space Specific Wattage Space Specific Power Density Whole Building Power Density

Whole Building Power Density (W/sq ft):

Usage Schedule: High Medium Low

Exterior Installed Wattage (W):

Space Specific Lighting Loads			
Floor	Space	Wattage	Power Density (W/sq ft)
A3	Units	3420	0.45
A3	Hallways	660.44	0.79
A2	Units	3420	0.45
A2	Hallways	660.44	0.79
A1	Units	2992.5	0.45
A1	Hallways	660.44	0.79

Comments

Retrofit Measures

Lighting Retrofit 1

Lighting Retrofit Code: Location:

Existing Lighting System

Lamp Type: Wattage (W):

Usage (hr/day): Number of Lamps:

Retrofit Lighting System

Retrofit Measure Action: Number of New Ballasts, Sensors, or Controls:

Lamp Type: Wattage (W):

Usage (hr/day): Number of Lamps:

Comments

Figure C-20. MulTEA Lighting form.

Appliance Basecase

Basecase Appliance Loads

Data Input Method: Space Specific Whole Building

Whole Building Power Density (W/sq ft):

Usage Schedule: High Medium Low

Space Specific Appliance Loads		
Floor	Space	Power Density (W/sq ft)
A3	Units	0.62
A3	Hallways	0
A2	Units	0.62
A2	Hallways	0
A1	Units	0.62
A1	Hallways	0

Comments

Figure C-21. MulTEA Appliances form.

Refrigerator 1	Refrigerator 2	Refrigerator 3	Refrigerator 4	Refrigerator 5	Refrigerator 6	Refrigerator 7	Refrigerator 8
Refrigerator Code: <input type="text" value="Refrigerator 1"/>		Number of Units to be Replaced: <input type="text" value="18"/>		<small>NOTE: You must enter a non-zero power density for a space on the Appliances form in order to select that Location.</small>			
Location: <input type="text" value="Units"/>							
Existing Refrigerator							
Preferred Input Method: <input type="text" value="Enter Metering Data"/>		Metering Data:		Minutes: <input type="text" value="60"/>		Wh: <input type="text" value="100"/>	
Manufacturer: <input type="text"/>		Defrost Cycle During Metering: <input type="text" value="Did Not Defrost"/>					
Model: <input type="text"/>		Year Made: <input type="text"/>					
Label or Database (kWh/year): <input type="text"/>		Door Seal Condition: <input type="text"/>					
Size (cu ft): <input type="text" value="0"/>		Calculated Consumption (kWh/year):		<input type="text" value="1040.69"/>			
Style: <input type="text"/>							
Defrost Type: <input type="text"/>							
Replacement Refrigerator							
Preferred Input Method: <input type="text" value="Enter kWh/year from Label"/>		Refrigerator Dimensions:		Height (in): <input type="text"/>		Width (in): <input type="text"/>	
Manufacturer: <input type="text"/>		Adjusted Consumption (kWh/year):		Depth (in): <input type="text"/>		<input type="text" value="550"/>	
Model: <input type="text"/>							
Label or Database (kWh/year): <input type="text" value="500"/>							
Size (cu ft): <input type="text"/>							
Style: <input type="text"/>							
Defrost Type: <input type="text"/>							
Comments							
<input type="text"/>							
<input type="button" value="Delete"/>						<input type="button" value="OK"/> <input type="button" value="Apply"/> <input type="button" value="Cancel"/>	

Figure C-22. MulTEA Refrigerator form.

Utility Bills

Weather Information
 Weather Data for Calibration: **NOTE:** AMY weather data for the selected weather location (Houston Bush Intercontinental, TX) is available for 2007, 2008, 2009, 2010, 2011, 2012, and 2013. Please enter utility bills that fall within these periods. If utility bills cannot be obtained for available AMY periods, consider another weather location on the Audit Form or select TMY3 for Weather Data for Calibration
 Billing Period Weather Metrics:
 Degree Days Base Temp. (°F):

Electricity Fossil Fuels

Meter Code:
 Energy End Uses:
 Usage Units:

Utility Bill Information

Use	Index	Start Date	End Date	Usage	HDD	CDD
<input checked="" type="checkbox"/>	1	01-01-2013	01-31-2013	47548	326.0	46.0
<input checked="" type="checkbox"/>	2	02-01-2013	02-28-2013	43004	171.0	31.0
<input checked="" type="checkbox"/>	3	03-01-2013	03-31-2013	42254	164.0	82.0
<input checked="" type="checkbox"/>	4	04-01-2013	04-30-2013	44213	88.0	136.0
<input checked="" type="checkbox"/>	5	05-01-2013	05-31-2013	48256	26.0	332.0
<input checked="" type="checkbox"/>	6	06-01-2013	06-30-2013	52368	0.0	563.0
<input checked="" type="checkbox"/>	7	07-01-2013	07-31-2013	55687	0.0	583.0
<input checked="" type="checkbox"/>	8	08-01-2013	08-31-2013	55468	0.0	585.0
<input checked="" type="checkbox"/>	9	09-01-2013	09-30-2013	52574	0.0	506.0
<input checked="" type="checkbox"/>	10	10-01-2013	10-31-2013	48428	28.0	245.0
<input checked="" type="checkbox"/>	11	11-01-2013	11-30-2013	44758	253.0	79.0
<input checked="" type="checkbox"/>	12	12-01-2013	12-31-2013	37125	422.0	35.0
<input type="checkbox"/>	13			0	0.0	0.0
<input type="checkbox"/>	14			0	0.0	0.0
<input type="checkbox"/>	15			0	0.0	0.0
<input type="checkbox"/>	16			0	0.0	0.0
<input type="checkbox"/>	17			0	0.0	0.0

NOTE: The maximum number of utility bills that can be entered is 30. The utility bills must be entered in chronological order and can have missing periods. The utility bills may span over three calendar years. If desired, one annual consumption can be entered.

Comments:

Delete OK Apply Cancel

Figure C-23. MulTEA 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 O'hare Intl Ap
 Weather State: IL

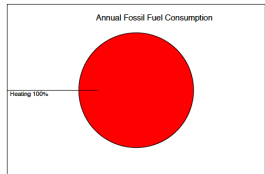
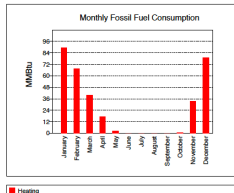
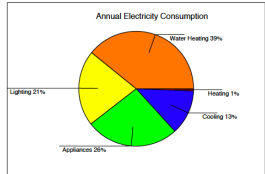
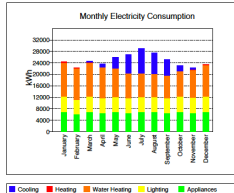
Account Name: Sample Account MulTEA Building Calibration Report Agency: Sample Agency
 Account Number: S001 Printed On: May 7, 2020 2:33 AM Audit Name: Sample Audit (DOE Mid-rise Pro
 Other ID Number: Page 1 of 5 Audit Number: 1894

(a) Title page

Figure C-24. MulTEA Calibration Report.

MuTEA Estimated Building Energy Consumptions
Weather Data: Typical Meteorological Year (TMY3)

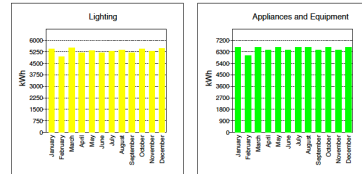
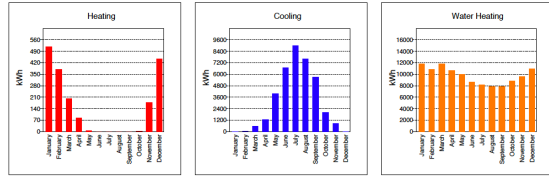
Month	Electricity (kWh)				Fossil Fuel (MMBtu)					
	Heating	Cooling	Water Heating	Appliances and Equipment	Heating	Water Heating	Appliances and Equipment	Total		
January	514	31	11,707	6,608	5,387	24,257	88.7	0.0	0.0	88.7
February	377	70	10,862	5,584	4,911	20,144	87.2	0.0	0.0	87.2
March	355	356	11,071	6,023	5,478	24,487	28.5	0.0	0.0	28.5
April	81	1,281	10,568	6,399	5,150	23,443	17.4	0.0	0.0	17.4
May	7	3,822	9,897	6,608	5,293	25,727	2.3	0.0	0.0	2.3
June	0	6,811	8,287	6,388	5,150	28,741	0.0	0.0	0.0	0.0
July	0	8,903	8,114	6,608	5,273	28,898	0.0	0.0	0.0	0.0
August	0	7,571	7,918	6,608	5,333	27,209	0.0	0.0	0.0	0.0
September	0	6,951	7,901	6,388	5,129	24,978	0.0	0.0	0.0	0.0
October	3	2,012	8,782	6,608	5,417	22,621	1.0	0.0	0.0	1.0
November	175	879	9,474	6,383	5,255	22,166	38.1	0.0	0.0	38.1
December	440	31	10,829	6,603	5,427	23,329	79.5	0.0	0.0	79.5
Annual	1,798	37,478	116,044	77,798	63,216	296,304	307.4	0.0	0.0	307.4



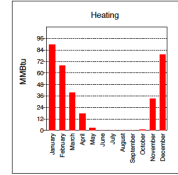
Account Name: Sample Account
Account Number: 5001
Other ID Number:
MuTEA Building Calibration Report
Printed On: May 7, 2020 2:33 AM
Page 2 of 5
Agency: Sample Agency
Sample Audit (DOE Mid-rise Pro)
Audit Number: 1894

MuTEA Estimated Building Energy Consumptions (Cont.)
Weather Data: Typical Meteorological Year (TMY3)

END USE ELECTRICITY CONSUMPTION



END USE FOSSIL FUEL CONSUMPTION



Account Name: Sample Account
Account Number: 5001
Other ID Number:
MuTEA Building Calibration Report
Printed On: May 7, 2020 2:33 AM
Page 3 of 5
Agency: Sample Agency
Sample Audit (DOE Mid-rise Pro)
Audit Number: 1894

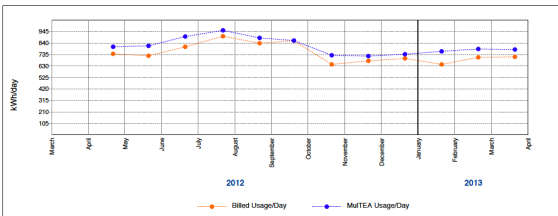
(b) Estimated energy consumptions by end use

Electricity Consumption Comparison for ElecMeter
Weather Data for Calibration: Actual Meteorological Year (AMY)

Index	Start Date	End Date	Billed Usage (kWh)	MuTEA Estimate (kWh)	Difference (kWh)	Percent Difference
1	03-21-2012	04-21-2012	25,010	25,010	0.0	0.0%
2	04-21-2012	05-20-2012	21,000	23,629	2,629	12.5%
3	05-20-2012	06-19-2012	29,000	27,609	-1,391	-4.8%
4	06-19-2012	07-18-2012	38,000	39,662	1,662	4.4%
5	07-18-2012	08-17-2012	26,000	27,517	1,517	5.8%
6	08-17-2012	09-16-2012	25,000	25,647	647	2.6%
7	09-16-2012	10-15-2012	30,000	22,587	-7,413	-24.7%
8	10-15-2012	11-14-2012	21,000	22,263	1,263	6.0%
9	11-14-2012	12-13-2012	31,000	22,146	-8,854	-28.6%
10	12-13-2012	01-11-2013	30,000	33,707	3,707	12.4%
11	01-11-2013	02-09-2013	22,000	24,373	2,373	10.8%
12	02-09-2013	03-08-2013	20,000	21,680	1,680	8.4%
Total			272,000	295,938	23,938	8.8%

Statistical Index	Calculated Value	Acceptance Criteria	
		BPI ¹	ASHRAE ²
Normalized Mean Bias Error (NMBE)	-9.6%	Within +/- 5%	Within +/- 5%
Coefficient of Variation of the Root Mean Square Error (CVRMSE)	10.1%	<=20%	<=15%

¹ANSI/BSIP 1400-5-2015, Standard Practice for Standardized Qualification of Whole-House Energy Savings Predictions by Calibration to Energy Use History
²ASHRAE Guidelines 14-2014, Measurement of Energy, Demand, and Water Savings



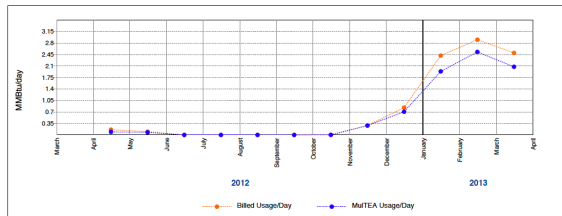
Account Name: Sample Account
Account Number: 5001
Other ID Number:
MuTEA Building Calibration Report
Printed On: May 7, 2020 2:33 AM
Page 4 of 5
Agency: Sample Agency
Sample Audit (DOE Mid-rise Pro)
Audit Number: 1894

Fossil Fuel Consumption Comparison for GasMeter
Weather Data for Calibration: Actual Meteorological Year (AMY)

Index	Start Date	End Date	Billed Usage (MMBtu)	MuTEA Estimate (MMBtu)	Difference (MMBtu)	Percent Difference
1	03-15-2012	04-15-2012	5.0	2.9	-2.1	-42.0%
2	04-15-2012	05-15-2012	3.0	2.3	-0.7	-23.3%
3	05-15-2012	06-15-2012	0.0	0.0	0.0	0.0%
4	06-15-2012	07-15-2012	0.0	0.0	0.0	0.0%
5	07-15-2012	08-15-2012	0.0	0.0	0.0	0.0%
6	08-15-2012	09-15-2012	0.0	0.0	0.0	0.0%
7	09-15-2012	10-15-2012	0.0	0.1	0.1	NA
8	10-15-2012	11-15-2012	0.0	6.8	6.8	-0.2%
9	11-15-2012	12-15-2012	0.0	31.2	31.2	-0.8%
10	12-15-2012	01-15-2013	60.1	60.1	-14.9	-19.9%
11	01-15-2013	02-15-2013	90.0	78.5	-11.5	-12.8%
12	02-15-2013	03-15-2013	70.0	68.2	-1.8	-2.6%
Total			277.0	252.2	-24.8	-8.9%

Statistical Index	Calculated Value	Acceptance Criteria	
		BPI ¹	ASHRAE ²
Normalized Mean Bias Error (NMBE)	17.7%	Within +/- 5%	Within +/- 5%
Coefficient of Variation of the Root Mean Square Error (CVRMSE)	29.6%	<=20%	<=15%

¹ANSI/BSIP 1400-5-2015, Standard Practice for Standardized Qualification of Whole-House Energy Savings Predictions by Calibration to Energy Use History
²ASHRAE Guidelines 14-2014, Measurement of Energy, Demand, and Water Savings



Account Name: Sample Account
Account Number: 5001
Other ID Number:
MuTEA Building Calibration Report
Printed On: May 7, 2020 2:33 AM
Page 5 of 5
Agency: Sample Agency
Sample Audit (DOE Mid-rise Pro)
Audit Number: 1894

(c) Comparison of energy consumptions to utility bills

Figure C-24. MuTEA Calibration Report (continued).

Agency: SMS
 Account Name: NorthernTest
 Account Number: 999999999
 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	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)
<input checked="" type="checkbox"/>	1	Replace Window	Windows	Window 1	WIN1	1,472	16,000	20.0	1.6	10.9
<input checked="" type="checkbox"/>	2	Add Ceiling Insulation	Roofs	Attic 1	Roof1	203	3,601	25.0	1.2	17.7
<input type="checkbox"/>	3	Replace the System	HVAC	System 1	HEAT1	798	0	15.0	0.0	0.0
<input type="checkbox"/>	4	Air Sealing	Infiltration/Ventilation	Infiltration	Infiltration	614	0	10.0	0.0	0.0
<input type="checkbox"/>	5	Replace the Refrigerator	Refrigerator	Refrigerator 1	Refrig1	15,675	0	15.0	0.0	0.0

(d) Measures: Economics form

Figure C-25. MulTEA Measures Results form.

Agency: SMS
 Account Name: NorthernTest
 Account Number: 999999999
 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	0	19,600	1.5

(d) Package: Leveraging form

Figure C-26. MulTEA Package Results form.

APPENDIX D. HEALTH AND SAFETY AUDIT FORMS

APPENDIX D. HEALTH AND SAFETY AUDIT FORMS

The descriptions of all Health and Safety Audit forms can be found in Section 5 and are not included here.

Health and Safety Audit

Audit

Agency: <input type="text" value="Oak Ridge National Laboratory"/>	Audit Date: <input type="text" value="08-03-2018"/>
Account Name: <input type="text" value="WPN 17-7 Testing"/>	Auditor: <input type="text" value="Mini Malhotra - AgencyAdmin"/>
Account Number: <input type="text" value="17-7"/>	City: <input type="text" value="Knoxville"/>
Audit Name: <input type="text" value="Sample Audit"/>	State: <input type="text" value="TN"/>
	Audit Number: <input type="text" value="1294"/>

Dwelling Location

State: <input type="text" value="TN"/>	Weather State: <input type="text" value="TN"/>
County: <input type="text" value="Anderson"/>	Weather Station: <input type="text" value="Knoxville Mcghee Tyson Ap"/>

Dwelling Characteristics

Conditioned Floor Area (sq ft): <input type="text" value="1800"/>	Number of Floors: <input type="text" value="1"/>
Average Ceiling Height (ft): <input type="text" value="8"/>	Number of Bedrooms: <input type="text" value="2"/>
Attached Garage: <input type="checkbox"/>	Number of Bathrooms: <input type="text" value="2"/>
	Year Built: <input type="text" value="1992"/>

Dwelling Occupancy

Number of Daytime Occupants: <input type="text" value="0"/>	Number of Elderly (over 65 years): <input type="text" value="0"/>
Number of Nighttime Occupants: <input type="text" value="1"/>	Number of Disabled: <input type="text" value="0"/>
	Number of Children (under 6 years): <input type="text" value="0"/>

Housing Type and Weatherization Funding Sources

Check all that apply:

- Housing unit is a HUD program home (i.e., federally owned or assisted housing, including HUD Section 8 vouchered housing)
- Housing unit will be weatherized with HUD funds
- Housing unit will be weatherized under the DOE Weatherization Assistance Program

Comments

New Copy Delete OK Apply Cancel

Figure D-1. Health and Safety Audit form.

Health Concerns

Occupant Feedback						
Symptom is Present	Symptoms	Long-term Illness	Children/Elderly	Worse at Home	Worse in Winter	Comments
<input checked="" type="checkbox"/>	Allergic skin reactions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Allergy-type symptoms					
<input type="checkbox"/>	Asthma/bronchitis-type symptoms					
<input checked="" type="checkbox"/>	Breathing difficulties	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Burning or watery eyes					
<input type="checkbox"/>	Dizziness					
<input type="checkbox"/>	Eye, nose, or throat irritations					
<input type="checkbox"/>	Fatigue					
<input type="checkbox"/>	Headaches					
<input type="checkbox"/>	Irritability					
<input type="checkbox"/>	Nausea					

OK Apply Cancel

Figure D-2. Health and Safety Audit Health Concerns form.

Observations

Mold and Moisture

- Evidence of indoor mold, dampness, water damage, or any moisture-related problem
- Detection or occupant reports of musty odor inside the home
- Evidence or occupant reports of high indoor humidity
- Evidence of exterior mold or moisture problems or drainage issues

Lead

- Planned weatherization work will disturb paint on interior or exterior surfaces
- Housing unit is designated for elderly or disabled persons (unless children under age 6 live there or are expected to live there)
- Housing unit is a zero-bedroom dwelling (e.g., studio apartment, dormitory)

Radon

- Radon detected in the neighborhood
- Radon previously detected in the house

Formaldehyde and VOCs

- Evidence of smoking inside the house (cigarette butts or ashes, tobacco odor)
- Odors or occupant complaints indicate possible presence of formaldehyde or VOCs
- Remodeling within last year involving possible VOC sources such as composite wood products, plywood, paints and finishes, carpeting, flooring, furniture, or cabinets
- Evidence of unsafe use or storage of VOC-emitting products such as paints, fuel and automotive products, pesticides, and cleaning supplies

Combustion

- Combustion space heating, water heating, or cooking appliance present

Pest Infestation

- Evidence or occupant reports of pest infestation (rodents, birds, bats, cockroaches, termites, bedbugs, fleas, or other pests)
- Evidence of pest harborage conditions, food or water sources, or entryways

Planned Weatherization Work

- Planned weatherization work will decrease house infiltration rate
- Planned weatherization work could use or install VOC-emitting products such as spray polyurethane foam insulation, sealants, plywood or composite wood products, or paints and finishes

Figure D-3. Health and Safety Audit Observations form.

Detailed Survey Form Guidance

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	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.

OK Apply

Figure D-4. Health and Safety Audit Detailed Survey Form Guidance.

Mold and Moisture

Evidence of Issue | Source Identification

Observations

Space/Component	Visible Mold ¹	Moisture Damage, Water, or Dampness ²	Condensation or High Humidity	Musty Odor	All Sources Identified on Source Identification Form	Comment
Attic	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Bathrooms	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Kitchen	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Laundry Room	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Mechanical Room	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other Interior Spaces	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Crawlspace/Basement	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
House Exterior	<input type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	
Site Drainage		<input type="checkbox"/>			<input type="checkbox"/>	
Heating System	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	
Cooling System	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	
Forced-Air Ducts	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	
Dehumidifier	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	
Appliances	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	
Humidifier/Vaporizer	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	

¹Mold testing is not an allowable cost under the Weatherization Assistance Program.

²Diagnostics such as moisture meters are recommended under the Weatherization Assistance Program.

Figure D-5. Health and Safety Audit Mold and Moisture – Evidence of Issue form.

Mold and Moisture

Evidence of Issue | Source Identification

Attic

- Roof leaks
- Ice dams occur during winter
- Voids present in attic insulation
- Exhaust fans (e.g., bathroom, kitchen, dryer) vented into attic
- Air leakage through attic access door and other attic bypasses
- Recessed lighting fixtures present
- Attic ventilation inadequate
- Other

Bathrooms

- Exhaust fan not present in each bathroom
- Bathroom exhaust fan not operating properly
- Bathroom exhaust fan not used while showering
- Tub or shower enclosure not properly caulked
- Tile grouting around tub or shower enclosure deteriorated
- Other

Kitchen

- Kitchen exhaust fan not present or is a recirculating model
- Kitchen exhaust fan not operating properly
- Kitchen exhaust fan not used while cooking
- Lids not used while cooking
- Kitchen sink or splash plate not properly sealed or caulked
- Tile grouting around kitchen sink deteriorated
- Sink and garbage disposal unclean
- Dishwasher unclean
- Refrigerator drip tray dirty
- Other

Figure D-6. Health and Safety Audit Mold and Moisture – Source Identification form.

Lead

Evidence of Issue

Painted Surfaces Disturbed by Weatherization or Assessment						Comments
Surface	Will be Disturbed	Disturbance Exceeds Area Limits ¹	Involves Demolition or Window Replacement	Involves Prohibited Paint Removal Practices ²	Lead Testing Results ^{3,4,5}	
Interior	<input type="checkbox"/>					
Exterior	<input type="checkbox"/>					

¹Area limits (applies to area being disturbed, not total painted surface area):
 Interior room: > 6 sq. ft for any interior room or, for HUD only, > 2 sq. ft for any interior room
 Exterior: > 20 sq. ft
 Component: > 10% of a small building component (e.g., window) (HUD only)

²Prohibited paint removal practices:
 Open flame burning or torching
 Use of heat guns at temperatures greater than 1,100 degrees Fahrenheit
 Use of heat guns that char paint (HUD only)
 Use of power tools without high-efficiency particulate air (HEPA) exhaust control to collect dust
 Abrasive blasting or sandblasting without HEPA local exhaust control (HUD only)
 Dry sanding or dry scraping unless done with heat guns, within 1 ft of electrical outlets, or to treat < 2 sq. ft in any one interior room or < 20 sq. ft on exterior surfaces (HUD only)
 Paint stripping in a poorly ventilated space using a volatile paint stripper (HUD only)

³Testing methods (positive test indicates that lead is present):
 EPA-recognized on-site test kit (not recognized by HUD)
 X-Ray Fluorescence (XRF) testing
 Laboratory analysis of paint samples

⁴Determining if lead testing should be performed:
 Compare the cost of lead testing to the cost of implementing lead protocols. The expense of testing may be greater than the cost of implementing lead protocols when only small areas of paint will be disturbed.
 In houses built before 1930, it is logical and usually more cost effective to assume lead-based paint is present.
 NOTE: Lead testing and evaluation may already have been done on HUD Program housing.

⁵For homes to be weatherized under the Weatherization Assistance Program:
 Testing to determine the presence of lead in paint that will be disturbed by the installation of a WAP measure is allowed with EPA-approved testing methods.
 Testing methods must be economically feasible and justified.

Figure D-7. Health and Safety Audit Lead form.

Radon

Evidence of Issue

Radon Assessment Approach

Test in/test out (i.e., before and after weatherization)
 Post-weatherization test only (i.e., also appropriate if the house is not being weatherized)
 None

Note: For homes to be weatherized under the Weatherization Assistance Program, Grantees may allow testing at their discretion in areas with high radon potential.

Testing

Indoor Radon Measurements					
	Testing Performed	Radon Level (pCi/l)	Sampling Device	Date Installed	Sampling Duration (Days)
Pre-weatherization ¹					
Post-weatherization					

¹Pre-weatherization measurement, if available, should be within last 2 years.

Existing radon reduction system:

Source Identification

Earthen floor not covered in basement or crawlspace
 Covers on sump pump crock or collecting basin not airtight
 Foundation floor drain traps not present or are dry
 Penetrations, openings, or cracks in foundation walls
 Penetrations, openings, or cracks in concrete foundation floor
 Top course of hollow foundation block walls not capped
 Pores in face of hollow foundation block wall or along mortar joints
 Other

Figure D-8. Health and Safety Audit Radon form.

Asbestos

Evidence of Issue

Source of Asbestos	Presence of Asbestos ^{3,4}	Condition of Asbestos Containing Material		Comments
		Damaged ²	Will be Disturbed During Weatherization or Other Activity	
Attic and Walls				
Attic insulation ¹				
Wall insulation ¹				
Wall siding				
Heating System Components²				
Insulation around heating equipment				
Heating equipment door gaskets				
Insulation on steam pipes				
Insulation on boiler and furnace ducts				
Transite (cement and asbestos) combustion vent or flue				
Artificial ashes and embers in fireplace				
Building Materials				
Roofing and shingles				
Plaster				
Materials sprayed on walls and ceilings				
Textured paint on walls and ceilings				
Patching and joint compounds on walls and ceilings				
Vinyl floors				

¹ Assume that any vermiculite insulation found in attics or walls contains asbestos unless testing determines otherwise. For homes to be weatherized under the Weatherization Assistance Program, baseline vermiculite sampling is an allowable health and safety cost if authorized in the Grantee's Health and Safety Plan.

² For homes to be weatherized under the Weatherization Assistance Program, assume asbestos is present in suspect covering materials unless testing determines otherwise. Costs directly associated with testing is an allowable health and safety cost.

³ For all sources currently identified as Unsure, the presence of asbestos will be assumed to be Yes in homes built prior to 1990 because of the original construction of the house or possible renovations performed between 1930 and 1989. If these sources are also damaged or will be disturbed during weatherization or other activity, testing or assessment by a qualified asbestos professional to verify that asbestos is not present can be less expensive than abatement.

Figure D-9. Health and Safety Audit Asbestos form.

Formaldehyde and VOCs

Evidence of Issue

Formaldehyde sampling has been performed

Measured Formaldehyde Concentration (ppm):

Source Identification

VOC Sources in House or Attached Garage

Identify products that are stored incorrectly and/or may be contributing to the presence of formaldehyde or other VOCs:

Paints, varnishes or lacquers

Wood preservatives

Paint strippers or other solvents

Glue or adhesives

Hobby or craft materials

Fuel or automotive products

Pesticides

Air-fresheners, potpourri, incense, candles, etc.

Cleaners, disinfectants and degreasers

Other

Other VOC Sources or Conditions

Composite or engineered wood products installed during remodeling within last year are not low VOC-emitting and were not sealed to reduce VOC emissions

Evidence of smoking inside the house

Air cleaning equipment designed to produce ozone in the house

Existing Conditions in Attached Garage

Leaks in HVAC system return ducts or air handler in garage

Supply diffusers or return grilles in garage

Leaks through the shared walls, doors, floor, or ceiling between garage and living space

Vehicle left idling in garage

Weatherization Related VOC-Emitting Sources

Identify products that will be used or installed during weatherization that emit formaldehyde or other VOCs:

Spray polyurethane foam insulation

Figure D-10. Health and Safety Audit Formaldehyde and VOCs form.

Combustion					
Safety Inspection		Performance Testing			
Observations					
Appliance					
Fuel					
Vented					
Expected Post-Retrofit Status: 2					
General Safety					
Not compliant with applicable codes or standards ^{3, 4}					
Proper clearance to combustibles not maintained					
Fuel leaks, especially at fuel line connections ^{5, 6}					
Electrical connections unsafe					
Other general safety problem: <input type="text"/>					
Vented Combustion Appliance					
Venting system damaged or has leaks, cracks or faulty connections					
Venting system inadequately sized, not venting to outside or otherwise inadequate ⁷					
Other venting problem: <input type="text"/>					
Solid Fuel Combustion Appliance					
Soot on walls, ceiling, or mantel					
Creosote staining near flue pipe					
Inside of house smells like wood or coal smoke					
Occupant reports regular (i.e., daily) wood or coal smoke smell indoors during heating season					
Opacity of smoke leaving chimney > 20 % (if being used) ⁸					
Size or materials of floor protection inadequate					
Not EPA-certified ⁹					
Is or will be oversized					
Unvented or Vent-Free Combustion Appliance					
Primary source of heating					

Figure D-11. Health and Safety Audit Combustion – Safety Inspection form.

Combustion

Safety Inspection | **Performance Testing**

Background Measurements

Outdoor temperature (°F):

CO outside the house (ppm)¹:

CO in the living space (ppm)²:

¹Avoid testing near obvious sources of CO (e.g., motor vehicles, lawn equipment).

²Avoid testing near combustion equipment that has already undergone CO testing.

Oven Measurements

CO in undiluted flue gases in the oven vent¹:

Measurement type:

Stove 1 (ppm):

Stove 2 (ppm):

¹For homes to be weatherized under the Weatherization Assistance Program, testing is required.

CAZ Measurements

Measurements ¹					
Vented Combustion Appliance					
Fuel					
CAZ Measurements					
Combustion appliance zone					
CAZ depressurization limit (Pa) ²					
CAZ baseline pressure with reference to outdoors (Pa)					
CAZ worst-case pressure with reference to outdoors (Pa) ³					
CAZ net worst-case depressurization (Pa)					

Figure D-12. Health and Safety Audit Combustion – Performance Testing form.

Pest Infestation

Evidence of Issue | Source Identification

Observations

Pest	Degree of Infestation ¹	Degree of Pest Contaminated Materials ²	All Sources Identified on the Source Identification Form ³	Harmful Rodenticides or Pesticides Being Used ⁴	Comments
Rodents		Moderate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Termites				<input type="checkbox"/>	
Birds or Bats				<input type="checkbox"/>	
Cockroaches				<input type="checkbox"/>	
Bedbugs		Severe	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Fleas				<input type="checkbox"/>	
Other Insects		Moderate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Other Animals				<input type="checkbox"/>	

- ¹ Occupant reported, live or dead pests, body parts, droppings (feces), nests, or other indications.
- ² Droppings (feces), nests, dead pests, body parts, and the harborage materials listed on the Source Identification form.
- ³ Sources of pest harborages, food and water, and entryways.
- ⁴ Sprays, foggers, bombs, Chinese Chalk, Tres Pasitos, Tempo, or other harmful chemicals.

Figure D-13. Health and Safety Audit Pest Infestation – Evidence of Issue form.

Pest Infestation

Evidence of Issue **Source Identification**

Pest Harborage

- Appliances (e.g., toaster, microwave, countertop grilles, clocks) not clean
- Indoor clutter (clothes, boxes, paper, bottles, etc.)
- Bushes, trees or other vegetation closer than two feet from the home
- Wood piles near house
- Other

Food and Water Sources

- Boxed, loose, or pet food not properly stored
- Open food packages, pet food, food debris or dirty dishes left out overnight.
- Indoor waste containers not tightly closed or not emptied every night
- Outside garbage cans not sealable or not used properly by occupants
- Leaky faucets or water pipes
- Other

Pest Entryways

- Large exterior holes and gaps in areas with evidence of rodent infestations
- Window or door screens loose, torn or missing
- Air intake screens or dampers missing, broken, or dirty
- Exhaust vent screens or dampers missing, broken, or dirty
- Other

Figure D-14. Health and Safety Audit Pest Infestation – Source Identification form.

Safety

General Structural Fire Electrical

Observations

Presence of Hazard	Hazard	Comments
Injury Prevention		
<input type="checkbox"/>	Clutter on the floor, stairs, or landings	
<input type="checkbox"/>	Cables or cords lying in the traffic area	
<input type="checkbox"/>	Flooring, carpet or rugs damaged or worn-out	
<input type="checkbox"/>	Throw-rugs without non-skid backing	
<input type="checkbox"/>	Hazardous chemicals (e.g., strong cleaners and pesticides) not stored in appropriate and controlled locations	
<input type="checkbox"/>	Hot water supply temperature > 120 degrees Fahrenheit	
Hazards for Elderly and Disabled		
<input type="checkbox"/>	Door thresholds raised or deteriorated	
<input type="checkbox"/>	Bathroom wall fittings loose	
<input type="checkbox"/>	Grab bars by the bathtub and toilet not present	
<input type="checkbox"/>	Non-skid mat or strips on tub bottom not present	
<input type="checkbox"/>	Night lamps in hallway and stair not present or burned out	
<input type="checkbox"/>	Lighting level in hallway and stair inadequate	
<input type="checkbox"/>	Light switches in hallway and stair improperly located (e.g., not present at the top and bottom of stairs)	
Child Safety Hazards		
<input type="checkbox"/>	Window guards missing	
<input type="checkbox"/>	Window blinds with looped cords present	
<input type="checkbox"/>	Infant sleep environment unsafe	
<input type="checkbox"/>	Necessary safety gates missing at the top of stairs	
<input type="checkbox"/>	Flammable products or igniters within children's reach	
<input type="checkbox"/>	Medicines and vitamins within children's reach	
<input type="checkbox"/>	Cleaning supplies within children's reach	

Figure D-15. Health and Safety Audit General Safety form.

Safety		
General Structural Fire Electrical		
Observations1		
Presence of Hazard	Hazard	Comments
Roof		
<input type="checkbox"/>	Sagging or damaged	
Walls		
<input type="checkbox"/>	Bulging, buckling or sagging	
<input type="checkbox"/>	Surface finish damaged or missing	
Windows		
<input type="checkbox"/>	Window pane broken or missing	
<input type="checkbox"/>	Window sill damaged	
<input type="checkbox"/>	Window frame loose or damaged	
<input type="checkbox"/>	Hardware or lock loose, damaged, or jammed (window inoperable or not lockable)	
<input type="checkbox"/>	Security bars prevent egress (for windows designed for fire exist)	
Doors		
<input type="checkbox"/>	Door panel damaged or missing	
<input type="checkbox"/>	Threshold or frame loose or damaged	
<input type="checkbox"/>	Hardware or lock loose, damaged, or jammed (door inoperable or not lockable)	
<input type="checkbox"/>	Necessary security door damaged or missing	
Stairs		
<input type="checkbox"/>	Supports or frame damaged	
<input type="checkbox"/>	Banister or handrail loose, damaged or missing	
<input type="checkbox"/>	Steps non-intact, damaged or missing	
<input type="checkbox"/>	Bulging, buckling or sagging	
<input type="checkbox"/>	Tiles or panels damaged or missing	
Floor		

Figure D-16. Health and Safety Audit Structural Safety form.

Safety		
General Structural Fire Electrical		
Observations		
Presence of Hazard	Hazard	Comments
Smoke Alarms		
<input type="checkbox"/>	Not installed on all floors and in vicinity of all bedroom doors	
<input type="checkbox"/>	Not working -- broken	
<input type="checkbox"/>	Not working -- dead battery	
CO Alarms		
<input type="checkbox"/>	Not installed on all floors and in vicinity of all bedroom doors	
<input type="checkbox"/>	Not working -- broken	
<input type="checkbox"/>	Not working -- dead battery	
Fire Extinguisher		
<input type="checkbox"/>	Fire extinguisher inaccessible or improperly located	
<input type="checkbox"/>	Fire extinguisher not present or not working	
<input type="checkbox"/>	Fire extinguisher operation unfamiliar to occupants	
Fire Hazards (see Electrical form for specific electricity-related hazards)		
<input type="checkbox"/>	Flammable products improperly stored or stored near ignition sources	
<input type="checkbox"/>	Insufficient clearance around heating systems	
<input type="checkbox"/>	Any other fire hazard/code-compliance issue present	

Figure D-17. Health and Safety Audit Fire Safety form.

Safety

General Structural Fire **Electrical**

Knob and Tube Wiring

Observations					
Present		Unsafe ^{1,2}	Installation of Insulation Planned	Code Allows Insulating Over Knob and Tube Wiring	Comments
<input type="checkbox"/>	Attic				
<input type="checkbox"/>	Basement/Crawlspace				
<input type="checkbox"/>	Exterior Walls				
<input type="checkbox"/>	Other				

¹ Damaged wiring insulation, inadequately sized, alterations performed that may have created an electrical hazard, circuits overloaded, or otherwise unsafe.
² For homes to be weatherized under the Weatherization Assistance Program, voltage drop and voltage detection testing are allowed.

Other Electrical Hazards

Observations		
Presence of Hazard	Hazard ^{1,2}	Comments
<input type="checkbox"/>	Electric space heater present	
<input type="checkbox"/>	Electrical wiring or components damaged or exposed	
<input type="checkbox"/>	Extension cords used unsafely	
<input type="checkbox"/>	Electrical circuits overloaded	
<input type="checkbox"/>	Nonpolarized cords or plugs used for polarized appliances	
<input type="checkbox"/>	Electrical outlet or switch cover plates missing or broken	
<input type="checkbox"/>	Working GFIs in kitchen, bathrooms, or laundry not present	
<input type="checkbox"/>	Water leaks or puddling near electrical equipment	
<input type="checkbox"/>	Wiring in attic unsafe	
<input type="checkbox"/>	Voltage drop detected at electrical outlets	
<input type="checkbox"/>	Faulty wiring	
<input type="checkbox"/>	Other hazards/code compliance issues	

¹ Especially check for alterations performed that may have created an electrical hazard.
² For homes to be weatherized under the Weatherization Assistance Program, voltage drop and voltage detection testing are allowed.

Figure D-18. Health and Safety Audit Electrical Safety form.

Ventilation: ASHRAE 62.2 Ventilation Requirement

General Information

Exception to ASHRAE Standard 62.2 whole-building mechanical system requirement applies.

For a housing unit that will not be weatherized under the DOE Weatherization Assistance Program: If the authority having jurisdiction determines that window operation is a locally permissible method of providing ventilation and at least one of the following conditions is met: (a) the building has no mechanical cooling and is in [zone 1](#) or [zone 2](#) of the ASHRAE Climate Zone Map, or (b) the building is thermally conditioned for human occupancy for less than 876 h per year.

For a housing unit that will be weatherized under the DOE Weatherization Assistance Program: If (a) the housing unit is in Climate [Zone 1](#) of the ASHRAE Climate Zone Map, (b) the housing unit is designed to have free movement of air between the indoors and outdoors where no effect will be made through weatherization to establish an air barrier, and (c) there is no room that may be enclosed and contains a source of water or combustion.

ASHRAE Standard 62.2 version!: 2010 2013 2016 Not Applicable

¹2010 and 2013 versions are not approved if the housing unit will be weatherized under the DOE Weatherization Assistance Program.

Exception to ASHRAE Standard 62.2 occupant density calculation applies if the authority having jurisdiction approves. In this case, the density will be equal to the number of occupants when this is less than the number of bedrooms plus one.

Fields entered on the Audit form:

Weather State:	AK
Weather Station:	Adak Nas
Conditioned Floor Area (sq. ft.):	1000
Average Ceiling Height (ft):	8
Number of Floors:	1
Number of Bedrooms:	1
Number of Bathrooms:	3
Number of Occupants:	1

Figure D-19. Health and Safety Audit Ventilation form.

Health and Safety Audit Recommendations

Mold and Moisture (3) | Lead (0) | Radon (0) | Asbestos (0) | Formaldehyde and VOCs (0) | Combustion (13) | Pest Infestation (0) | Safety (0) | Ventilation (0)

Recommended Measures

Recommendation	Must be Performed Before Weatherization	Intended Action			
		Implement	Refer	Recommend to Client	Defer
Install a kitchen exhaust fan that is vented to outdoors.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Provide adequate ventilation in the crawlspace if it is not sealed or conditioned.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Replace missing shingles on roof.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Factors to Consider in Determining if Recommendation Required Before or as Part of Weatherization

- Necessary to install weatherization measure or perform weatherization work.
- Ensure the long term stability and durability of weatherization measures to be installed.
- Ensure weatherization work does not cause a health and safety problem.
- Provide a healthy and safe working environment for weatherization crews.

General Notes Regarding Interaction with Weatherization Measures

- Do not install weatherization measures that will reduce the home's infiltration rate if any mold and moisture recommendation required for weatherization must be deferred.
- Repair roof leaks before air sealing or insulating the attic.
- Address drainage issues before insulating basement or crawlspace walls.
- Manage rainwater in wall and window assemblies receiving retrofits (e.g., drainage plans, flashings).

Mold Cleanup Guidance

Notes Applicable to the Weatherization Assistance Program

- Limited water damage repairs that can be addressed by weatherization workers are allowed when necessary in order to weatherize the home and ensure the long-term stability and durability of the measures.
- Source control (i.e., correction of moisture and mold creating conditions) is allowed when necessary in order to weatherize the home and to ensure the long-term stability and durability of the measures. Source control is independent of latent damage and related repairs.
- Mold cleanup is not an allowable health and safety cost.
- Surface preparation where weatherization measures are being installed (e.g., cleaning mold off window trim in order to apply caulk) must be charged as part of the energy conservation measure, not to a health and safety budget category.
- Deferral is required when severe mold and moisture issues cannot be addressed.
- When deferral is necessary, provide the client with information in writing describing the conditions that must be met in order for weatherization to commence.

Comments

OK Apply Cancel

Figure D-20. Example Health and Safety Audit Recommendations form.

