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ANNUAL TRAINING CONFERENCE

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How the Weatherization Assistant MulTEA Tool Works to Implement Multifamily Retrofits

"Amplifying Our Impact"

NASCSP

PRESENTERS

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Technical Professional

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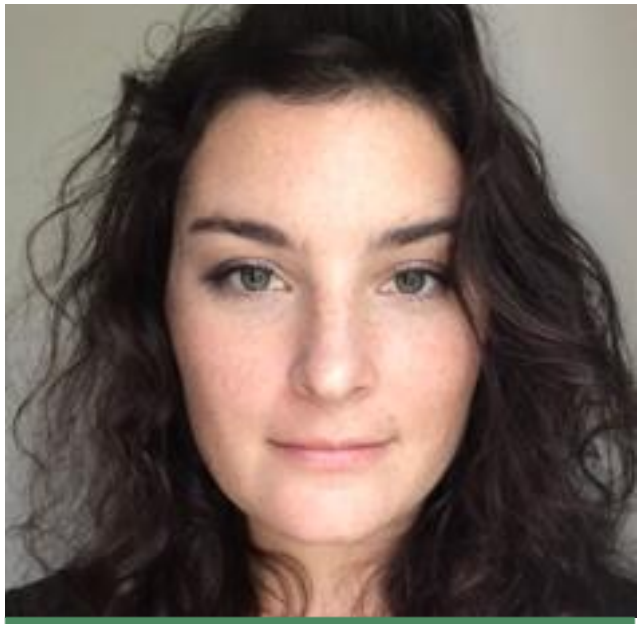

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Deployment and Analysis Group

ACKNOWLEDGMENTS

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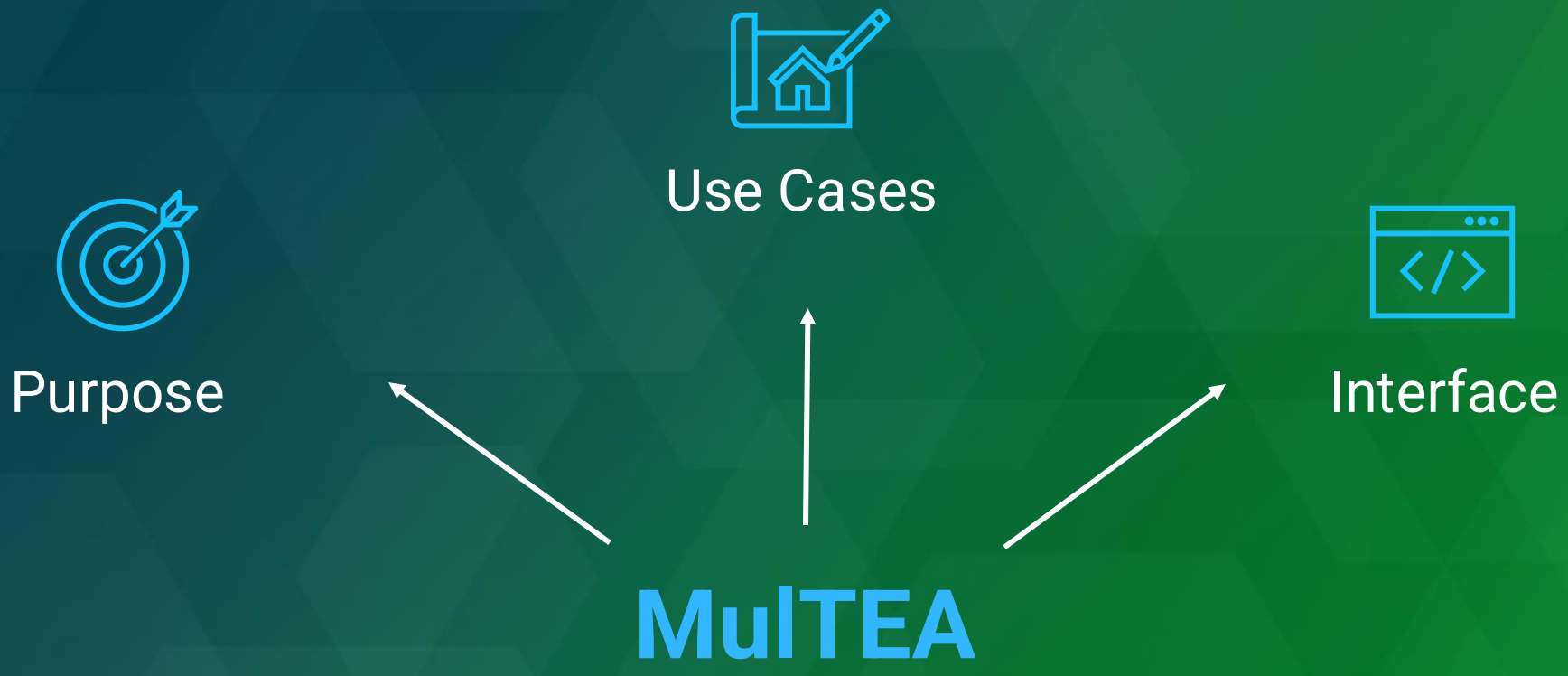
Prepared by OAK RIDGE NATIONAL LABORATORY, Oak Ridge, TN 37831-6283, managed by UT-BATTELLE,LLC for the US DEPARTMENT OF ENERGY under contract DE-AC05-00OR22725.

This presentation introduces MulTEA as a WAP energy audit tool, outlining its purpose, highlighting common use cases, and providing an overview of its user interface.



The Purpose of MulTEA

Purpose

Use Cases

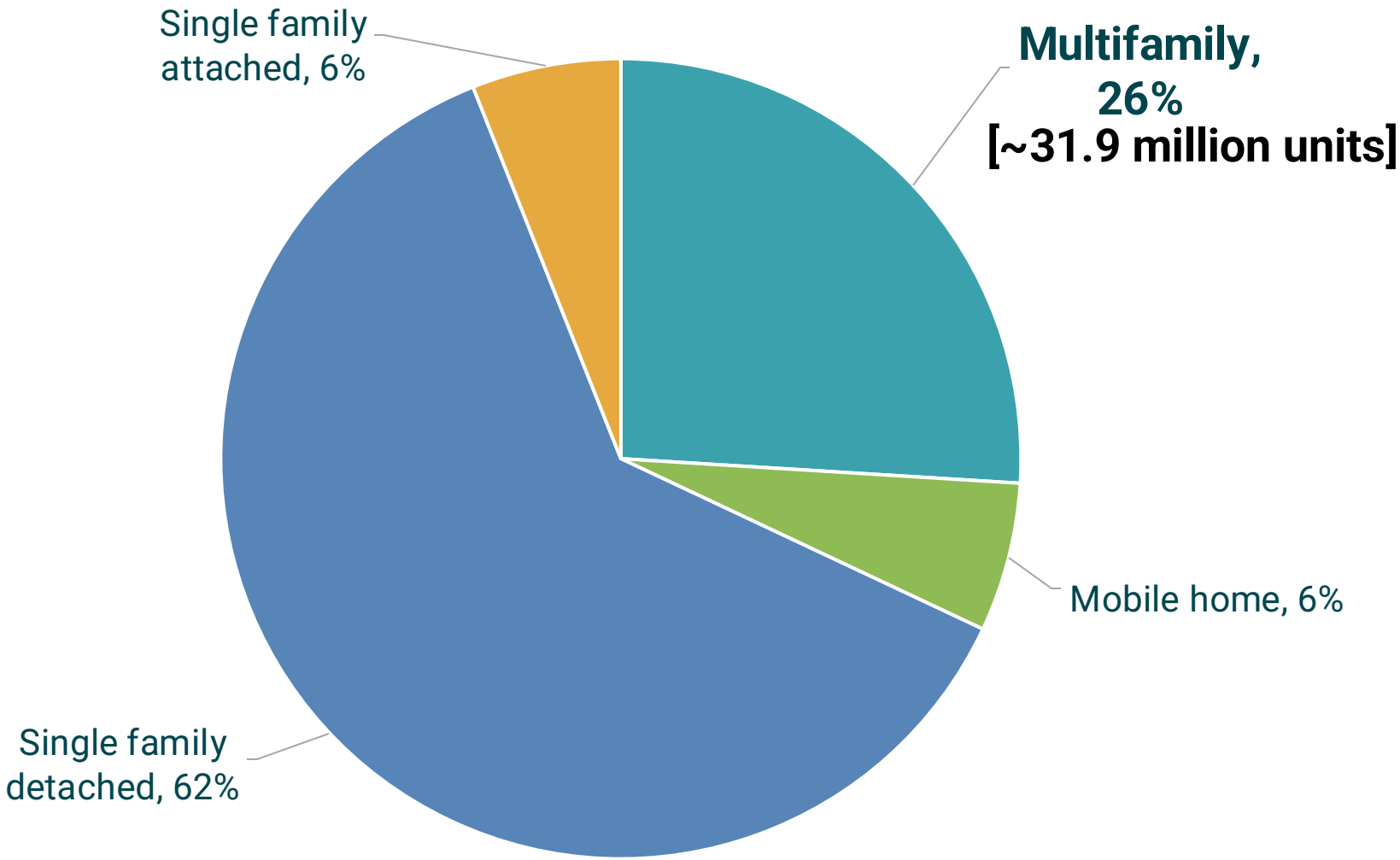
Interface

MulTEA

Multifamily audit tools are needed to meet the retrofit needs of US housing stock.

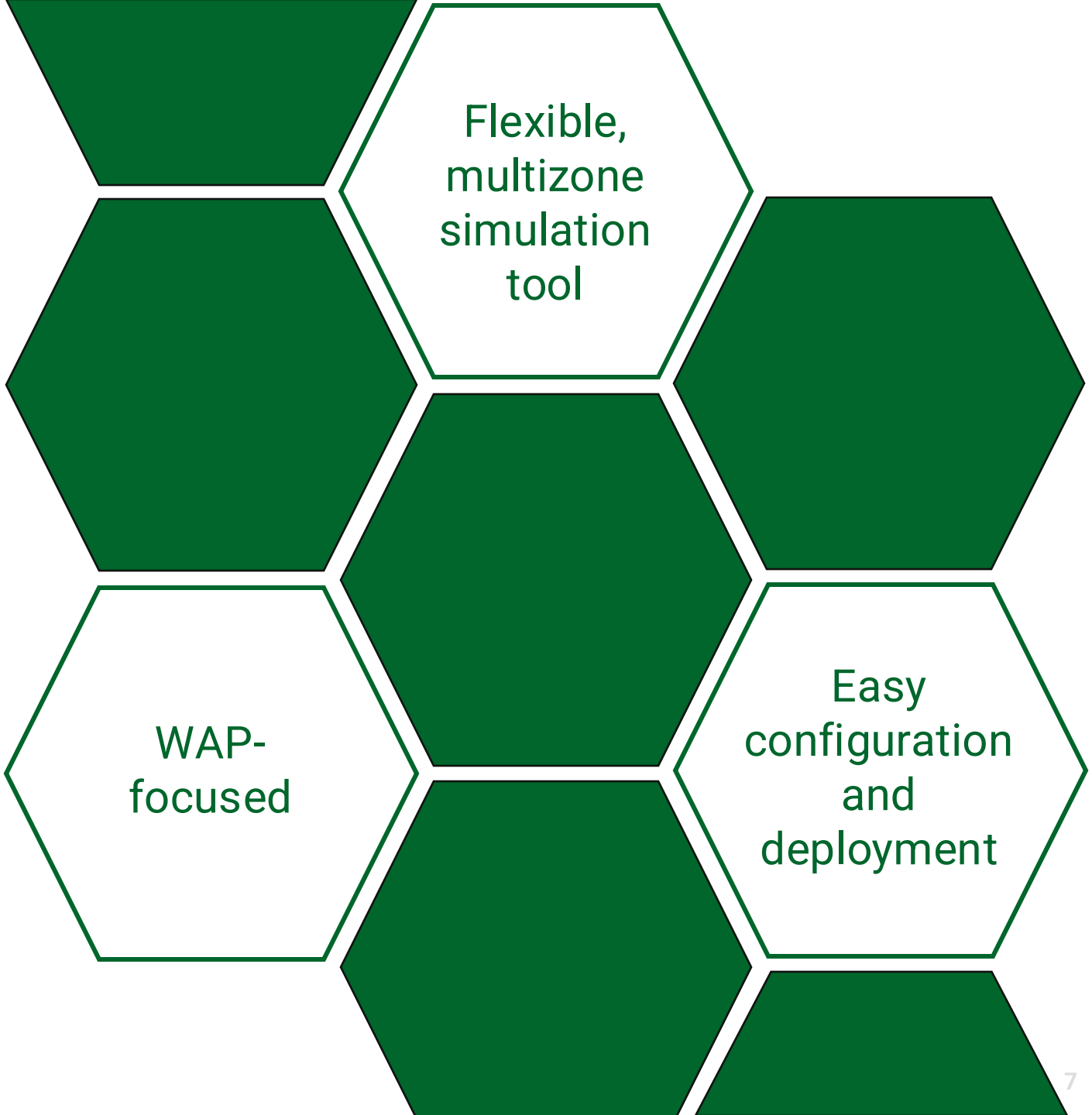
122.8 million housing units

75% of multifamily dwellings units have simpler systems

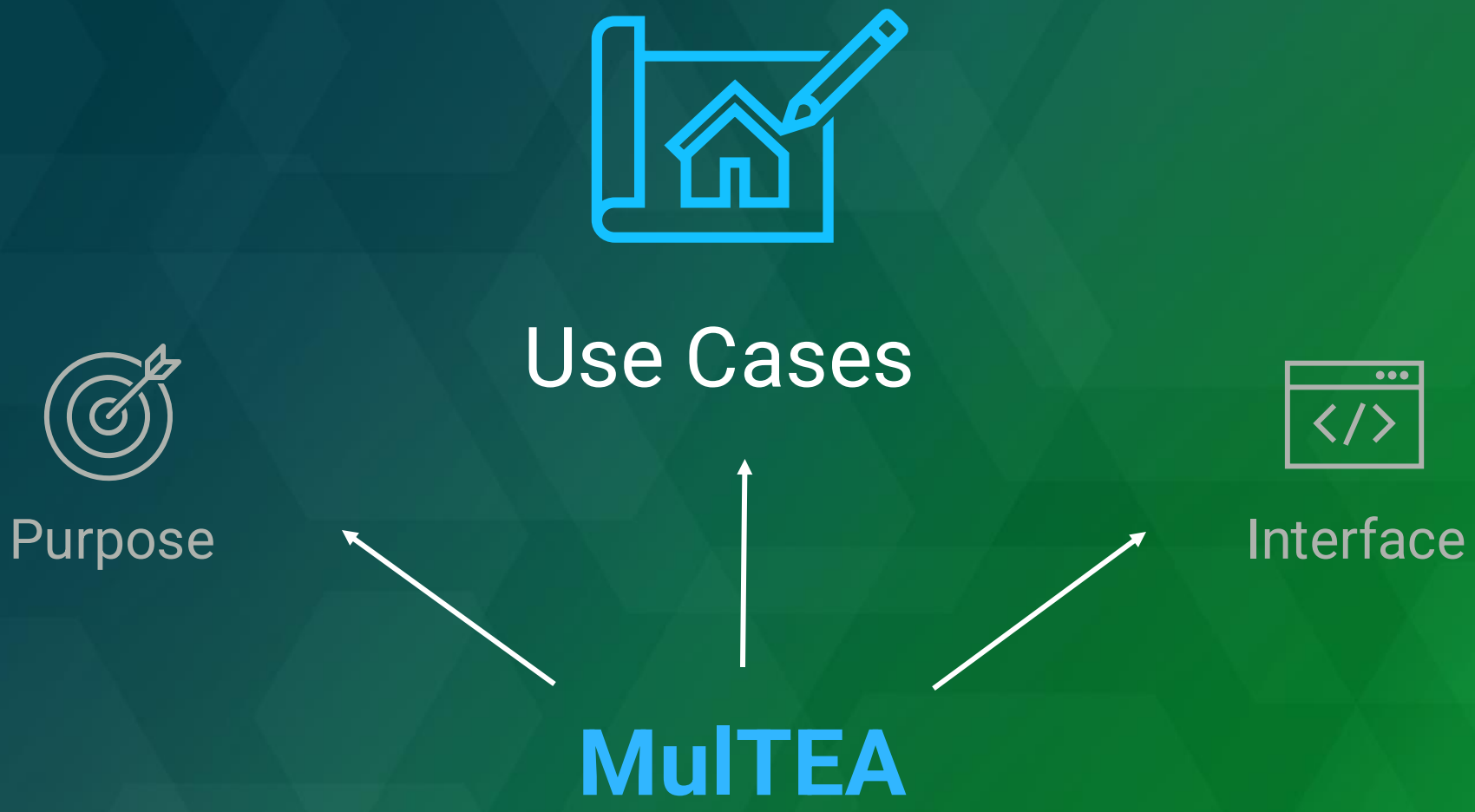


Source: **2019** American Community Survey, US Census Bureau https://data.census.gov/.

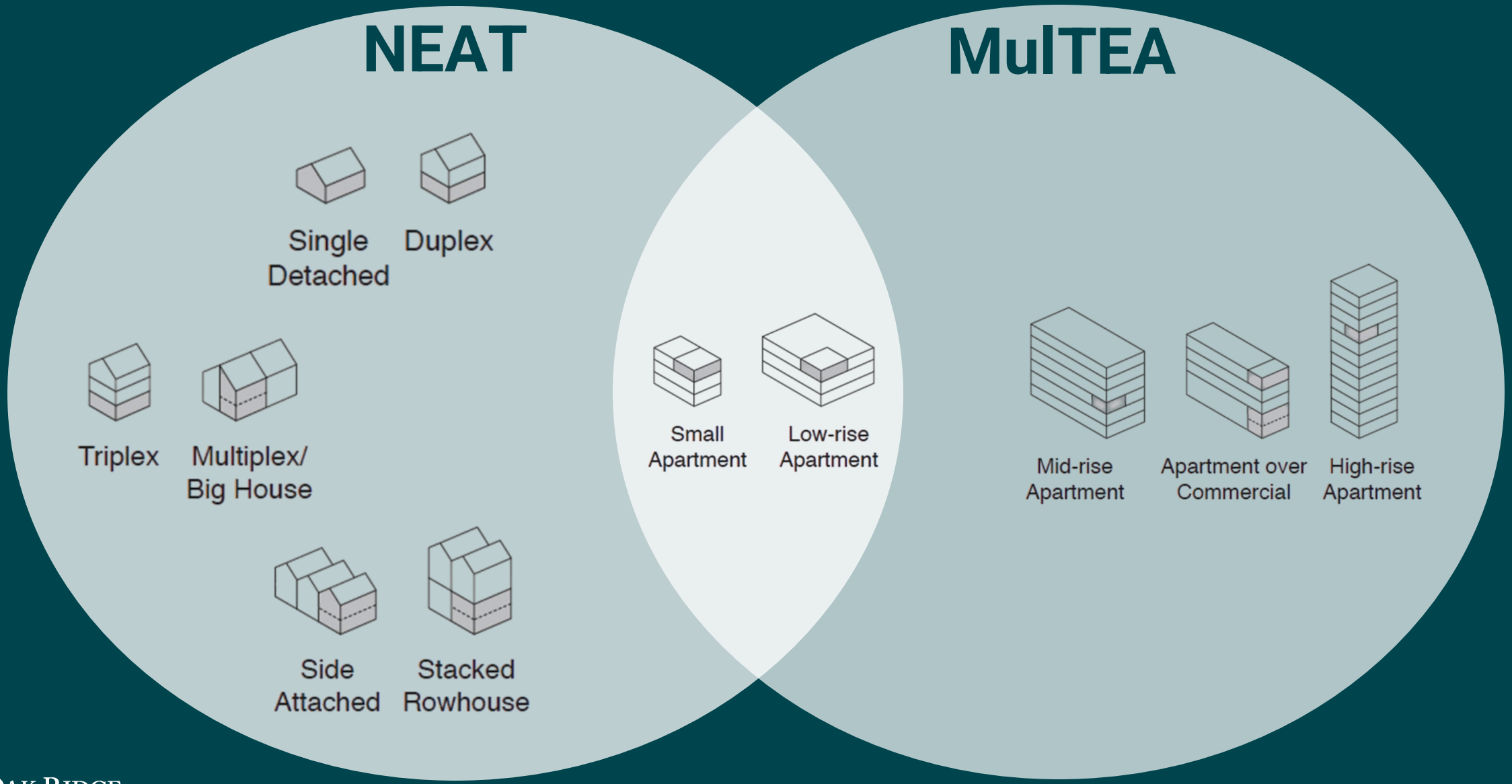
MulTEA allows WAP implementation on common multifamily building types.



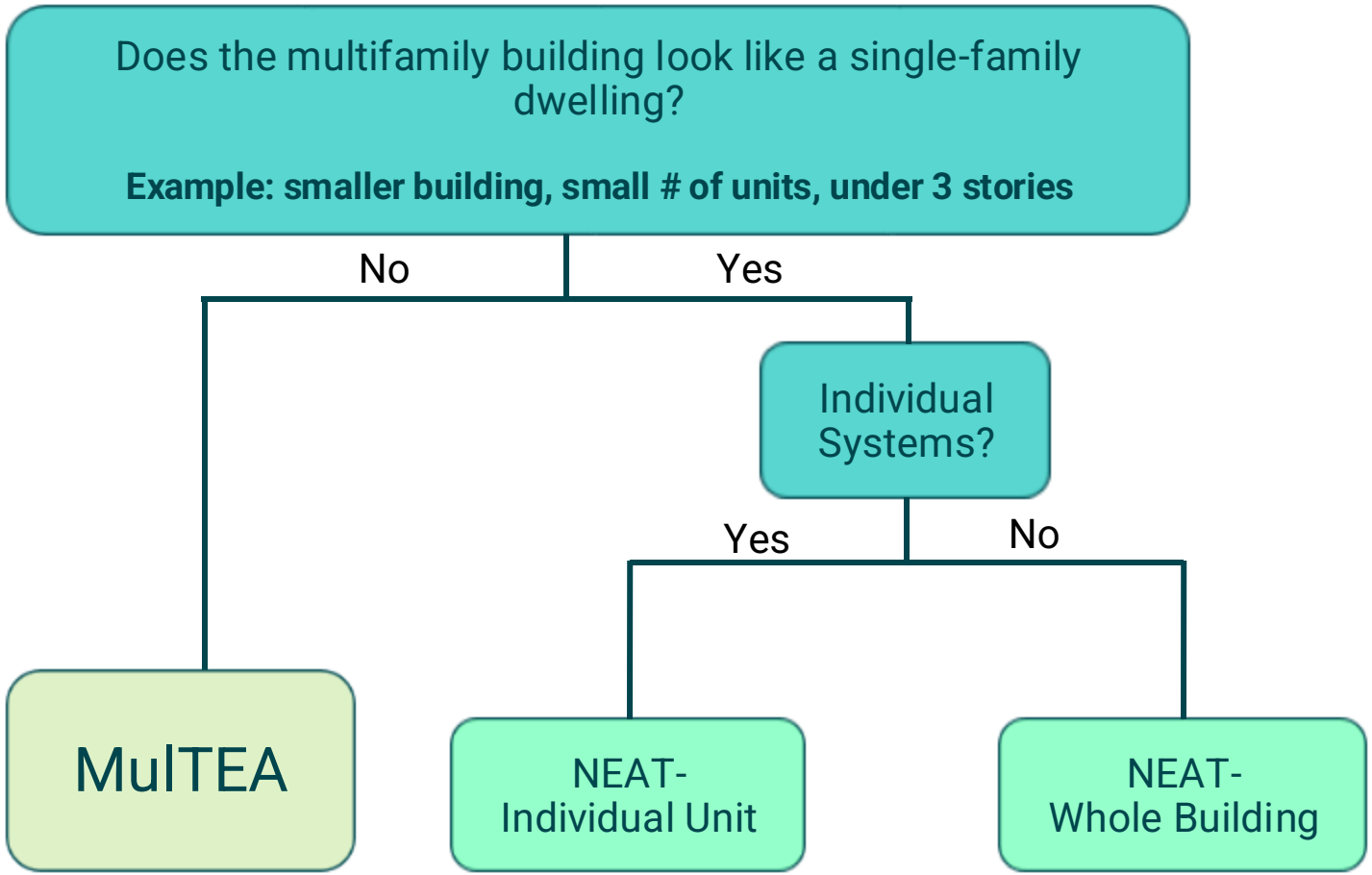
MulTEA Use Cases



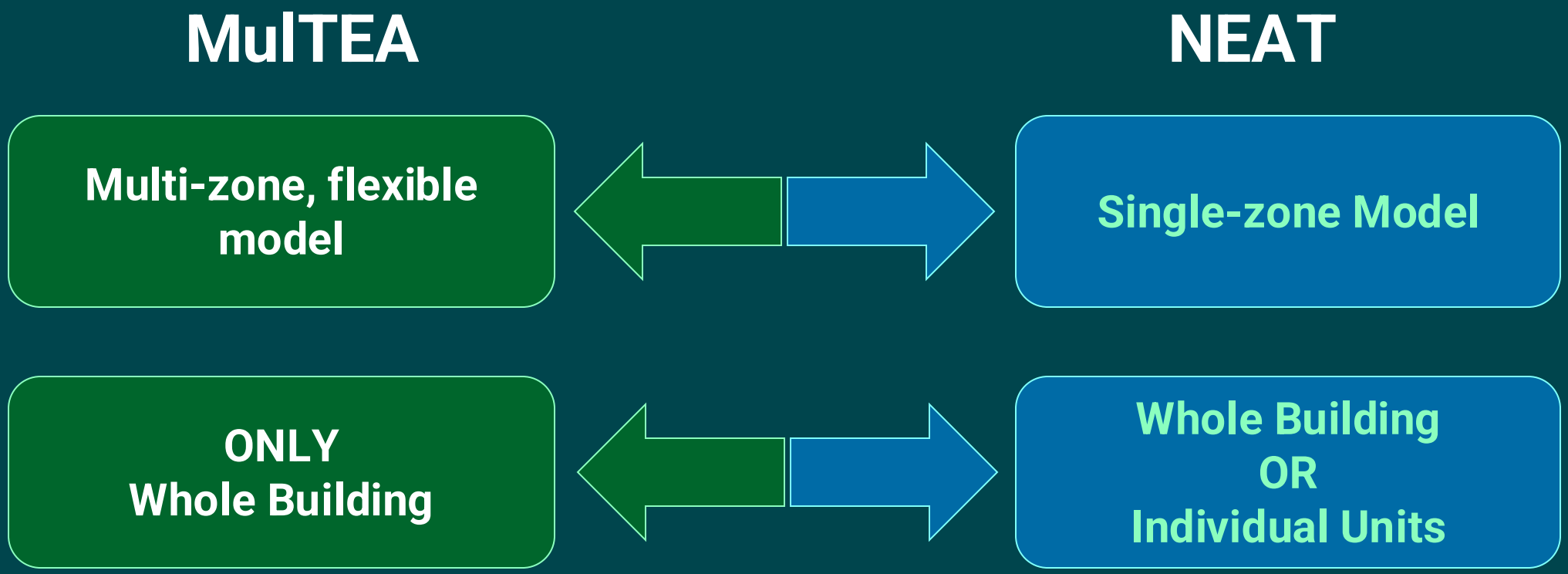
Both NEAT and MulTEA can model multifamily buildings.



While nuanced, what is the basic decision-making process for determining when to use NEAT vs. MulTEA?



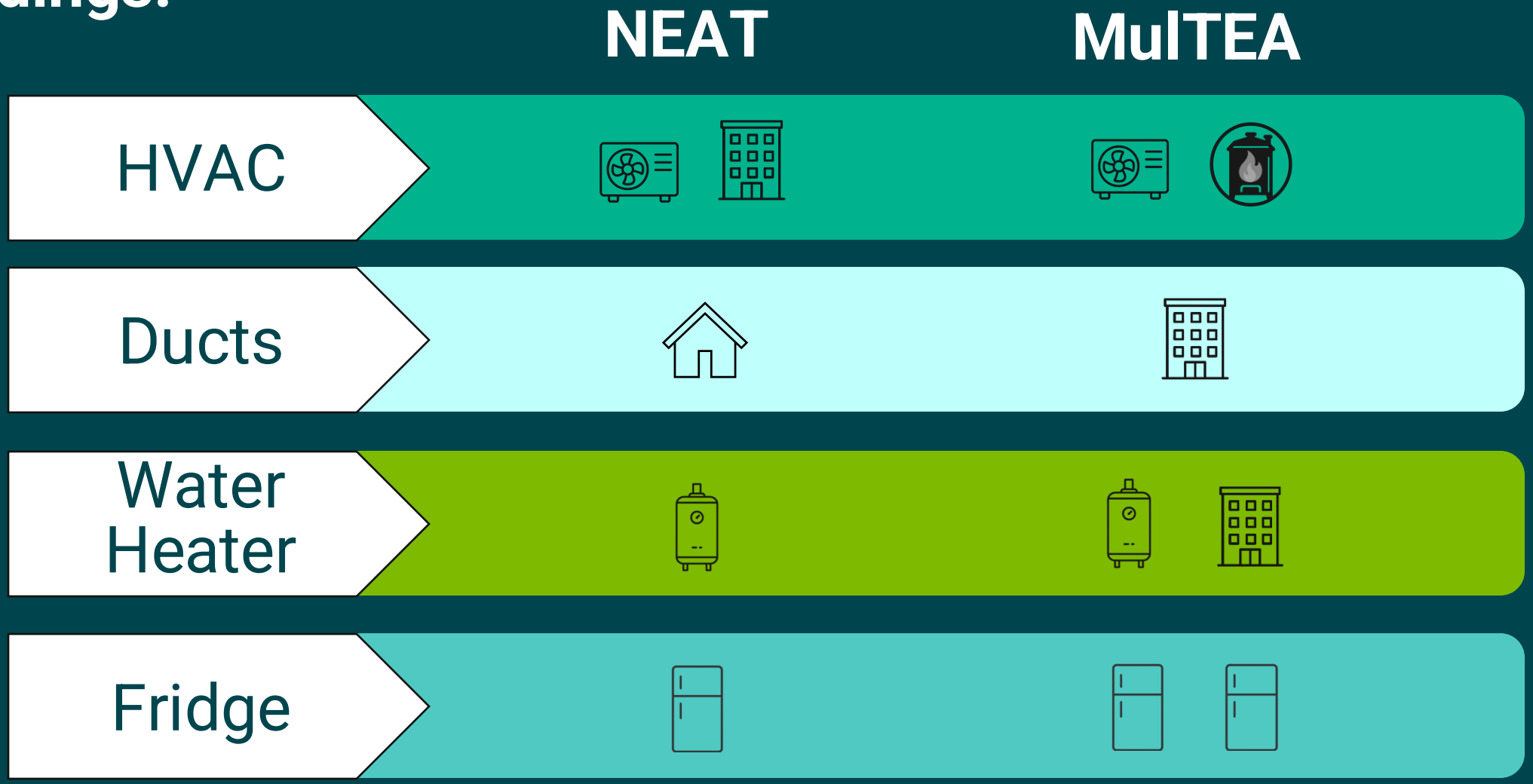
When considering whether to use NEAT or MulTEA, refer to the key modeling differences between NEAT and MulTEA.



Selecting NEAT vs. MulTEA for multifamily buildings requires a case-specific approach.

MulTEA	NEAT-Individual Unit	NEAT-Whole Building
Larger building / large # of units	Smaller building	Smaller building with complex unit configuration
Individual HVAC/DHW and replacements likely	Individual HVAC/DHW replacement likely	HVAC/DHW replacement unlikely
Central HVAC	Varied HVAC/DHW equipment	

NEAT vs. MulTEA systems and equipment modeling differences influence audit tool selection for multifamily buildings.



Duplexes/Triplexes should typically be modeled in NEAT.

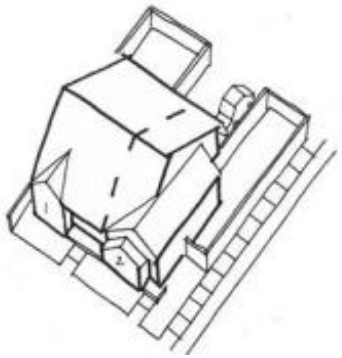
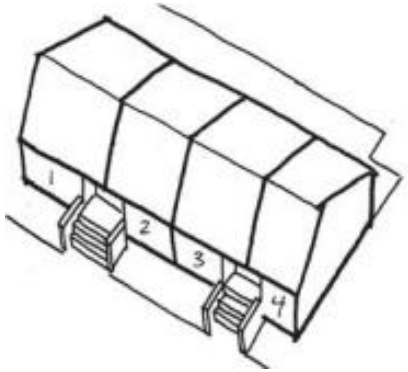


Image sources: The Metropolitan Design Center (University of Minnesota) and Thurston Regional Planning Council

Town Houses/Row Homes could be modeled in NEAT or MulTEA.



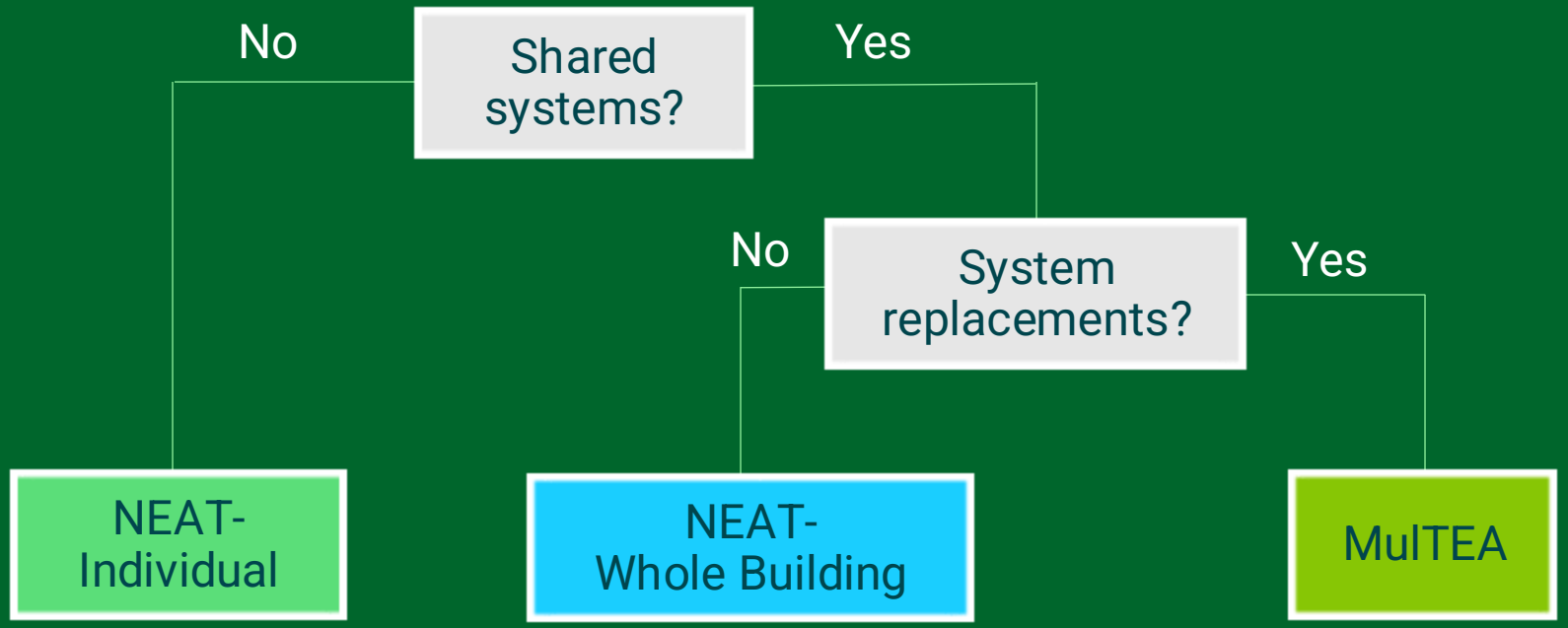


Image sources: The Metropolitan Design Center (University of Minnesota) and Thurston Regional Planning Council

“Mansion” Apartments are best modeled in NEAT.

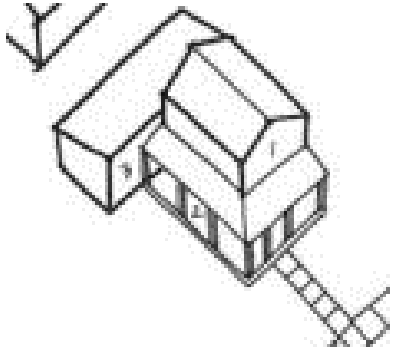
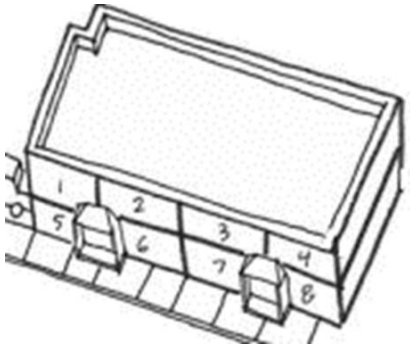


Image sources: The Metropolitan Design Center (University of Minnesota) and Thurston Regional Planning Council

Garden Apartments could be modeled in NEAT or MulTEA.



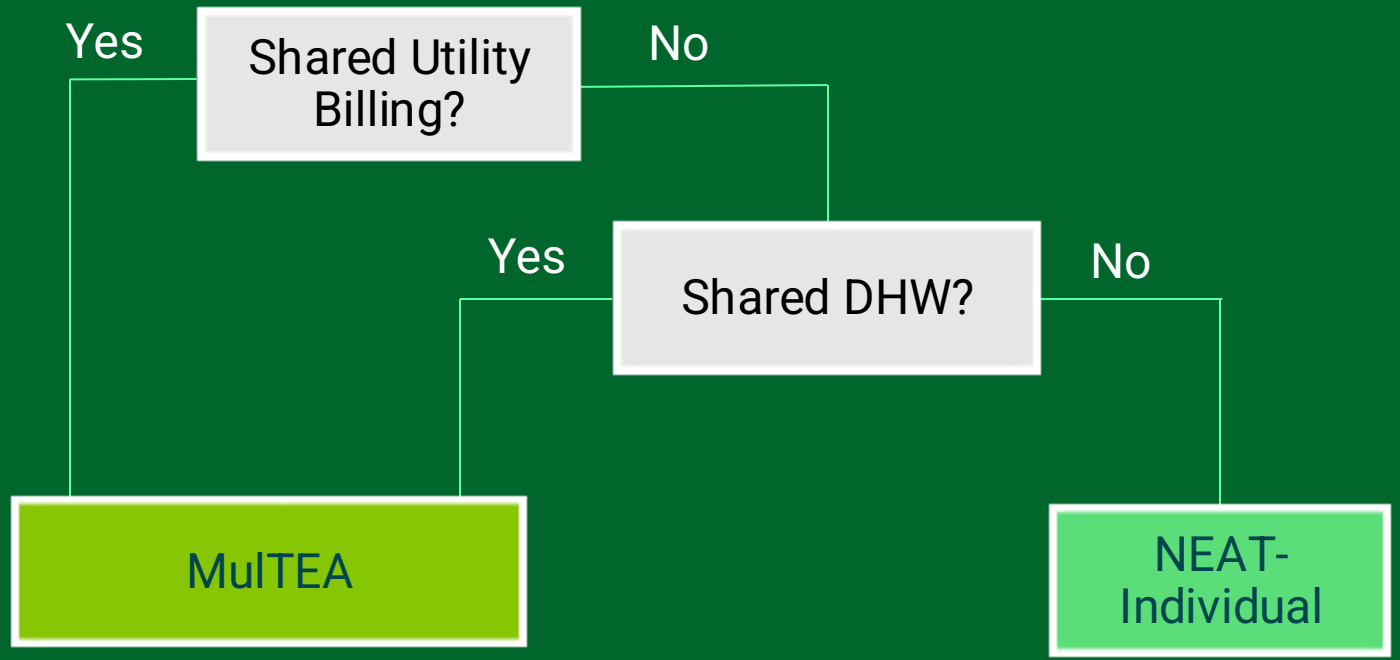


Image sources: The Metropolitan Design Center (University of Minnesota) and Thurston Regional Planning Council

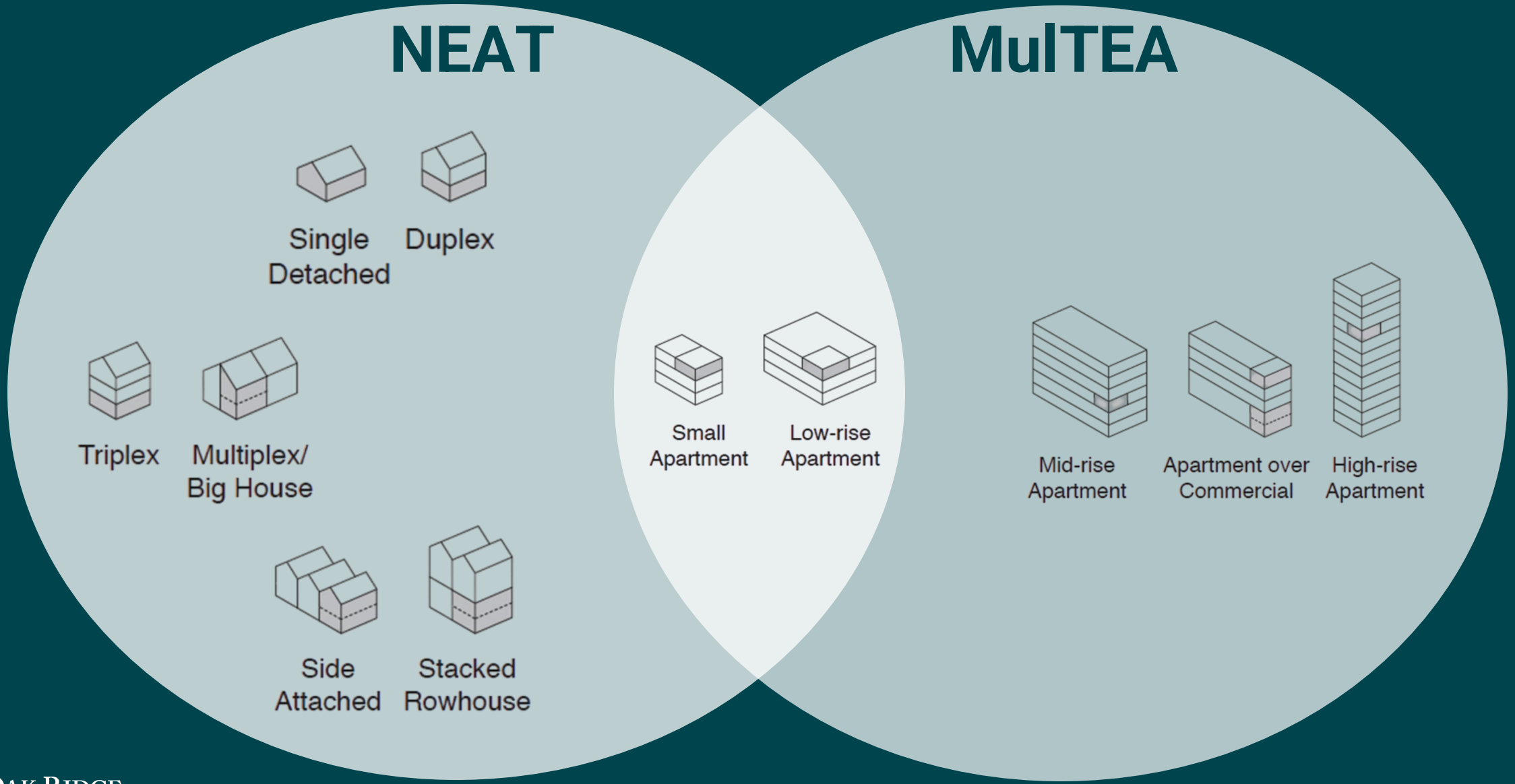
Midrise Apartment Buildings are best modeled in MulTEA.

>25 units!

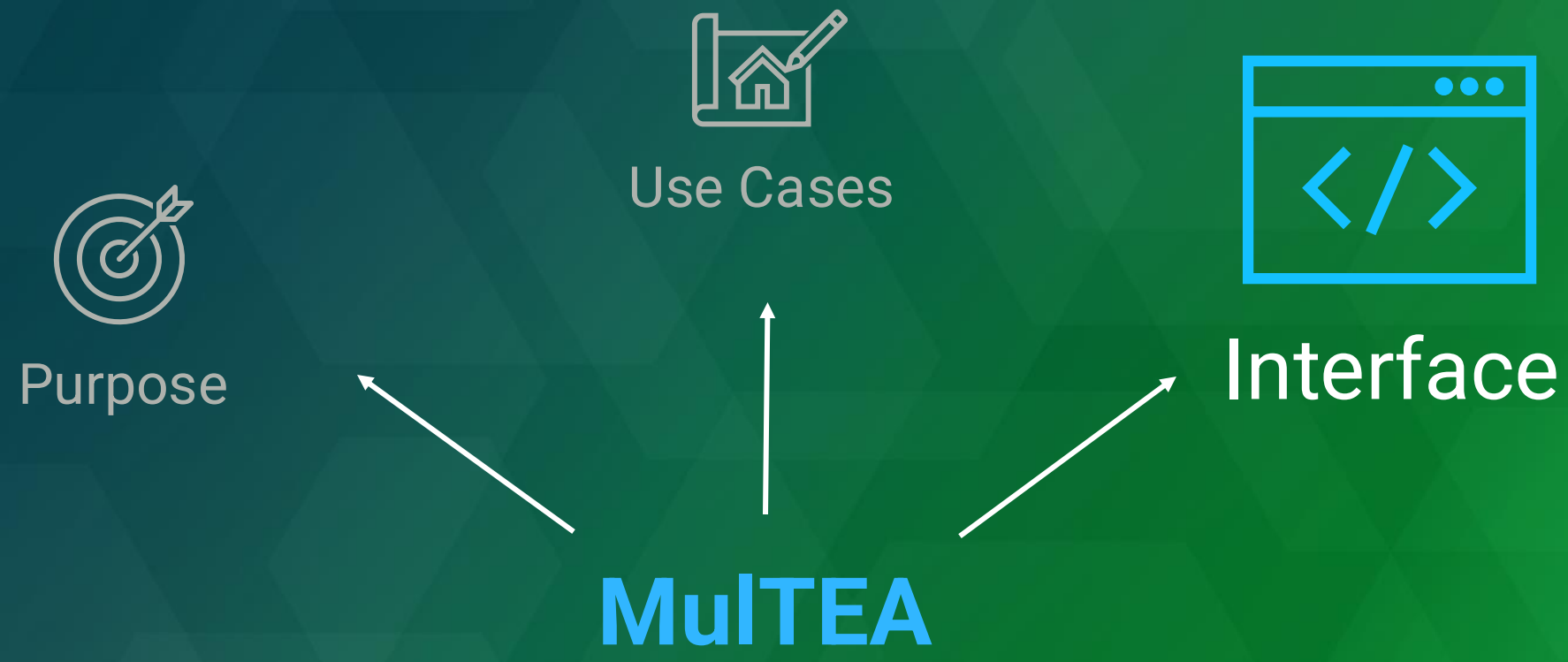
Multiple thermal zones

Image source: Web-based Weatherization Assistant Getting Started Guideline (ORNL)

Both NEAT and MulTEA can model multifamily buildings.



MulTEA User Interface



The Weatherization Assistant (WA) interface provides access to all audit tools in one location. Existing WA users can access MulTEA by using the same dropdown menu used to access NEAT, MHEA, and the Health & Safety Audit.

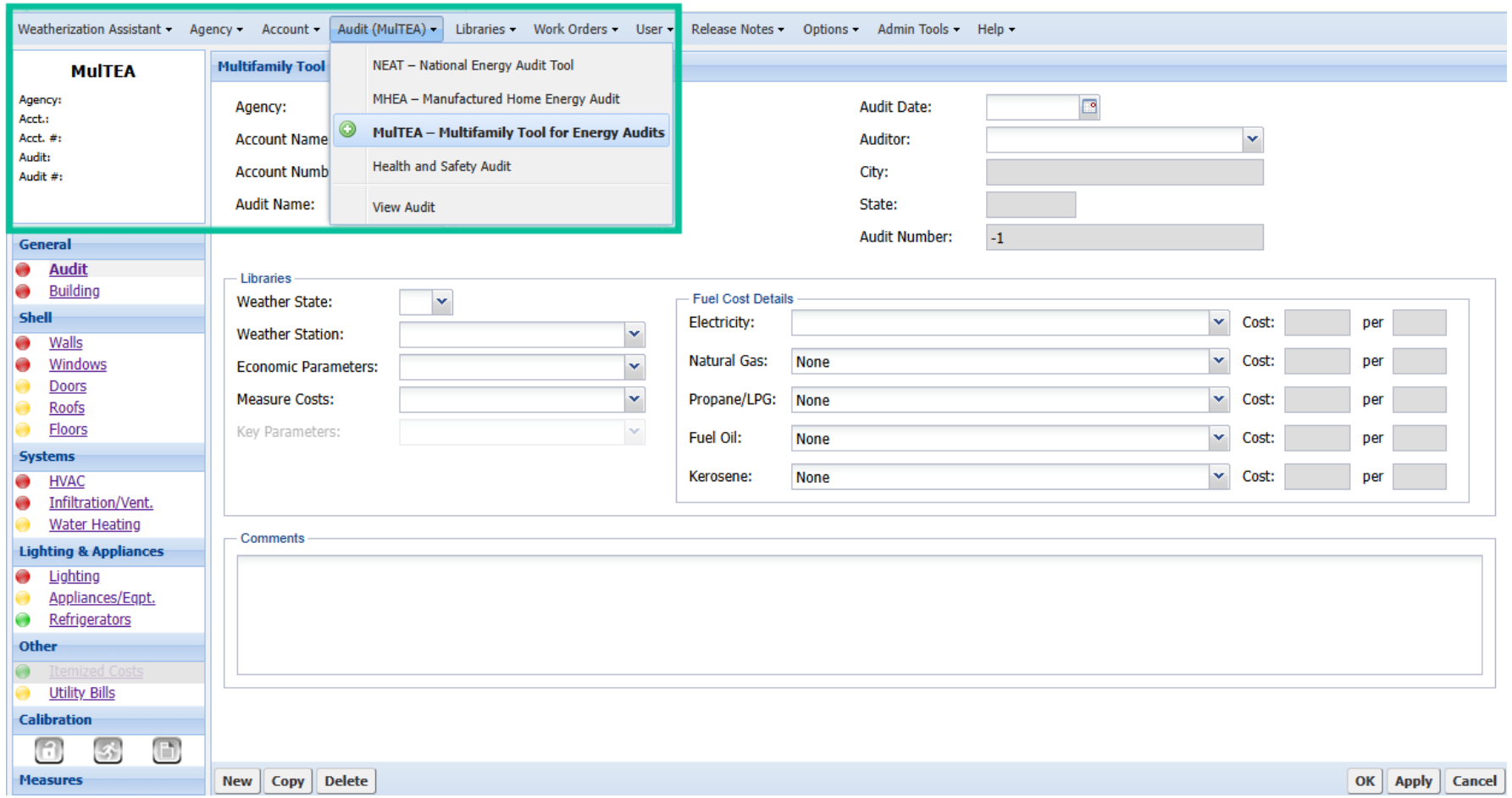
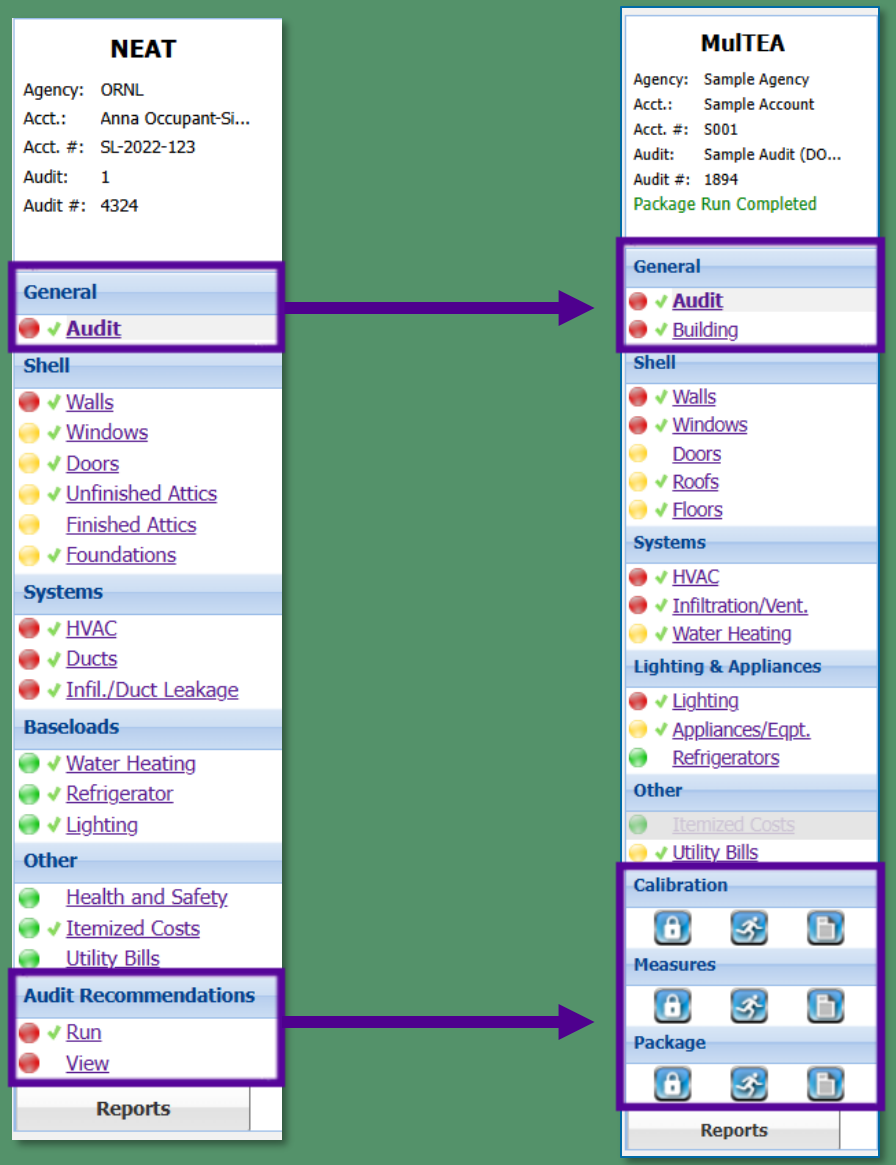


Image source: Web-based Weatherization Assistant (ORNL)

The primary differences between the MulTEA and NEAT audit docks are MulTEA's building form and iterative audit run process.



Images sourced from the Web-based Weatherization Assistant (ORNL)

MulTEA's Building Form sets key features of the shell forms.

Define dwelling units and orientations

General Building Details

Building Configuration

Define Areas of Building Spaces

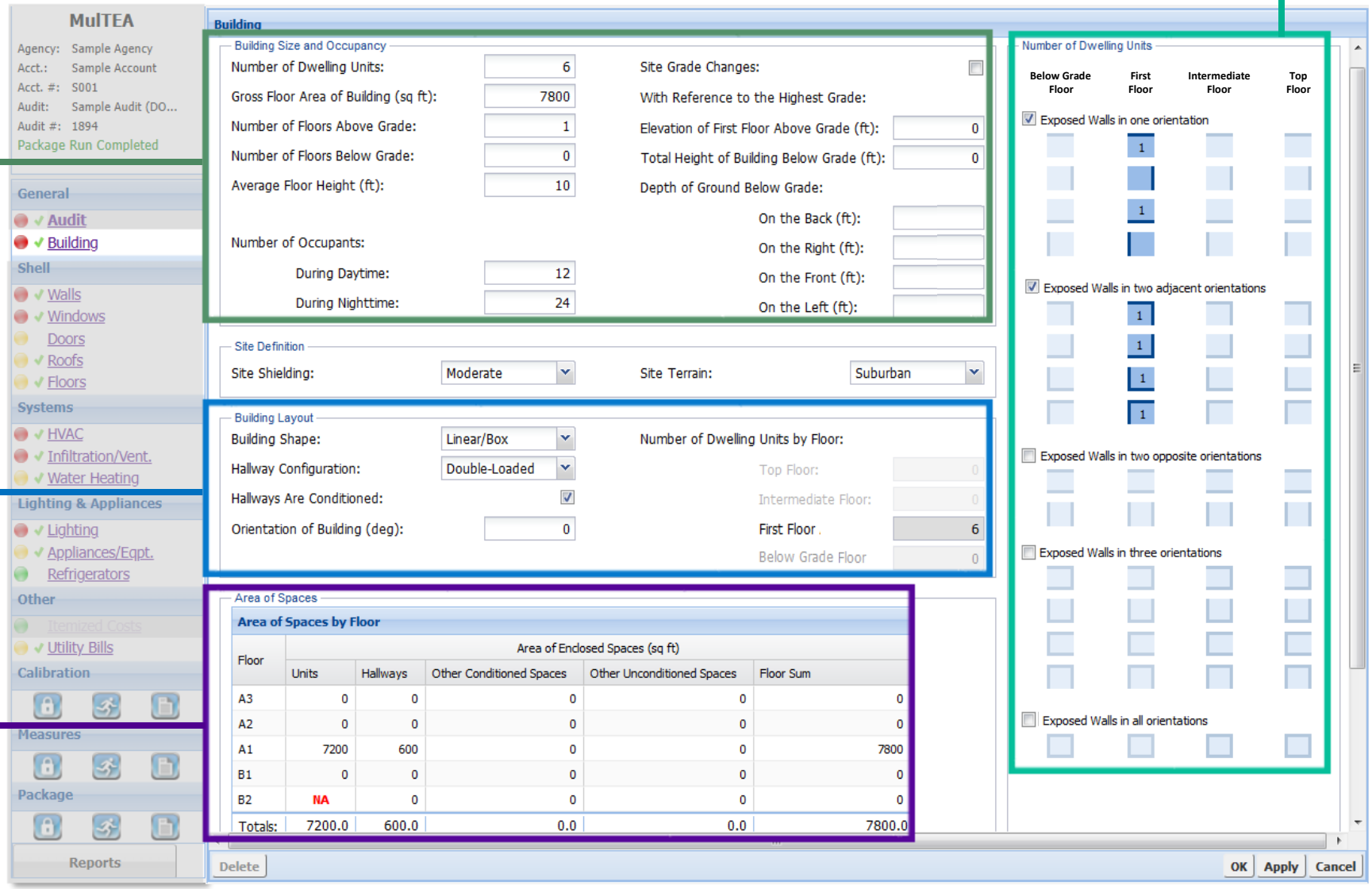


Image source: Web-based Weatherization Assistant (ORNL)

MulTEA's tabbed interface streamlines data entry while preserving user flexibility.

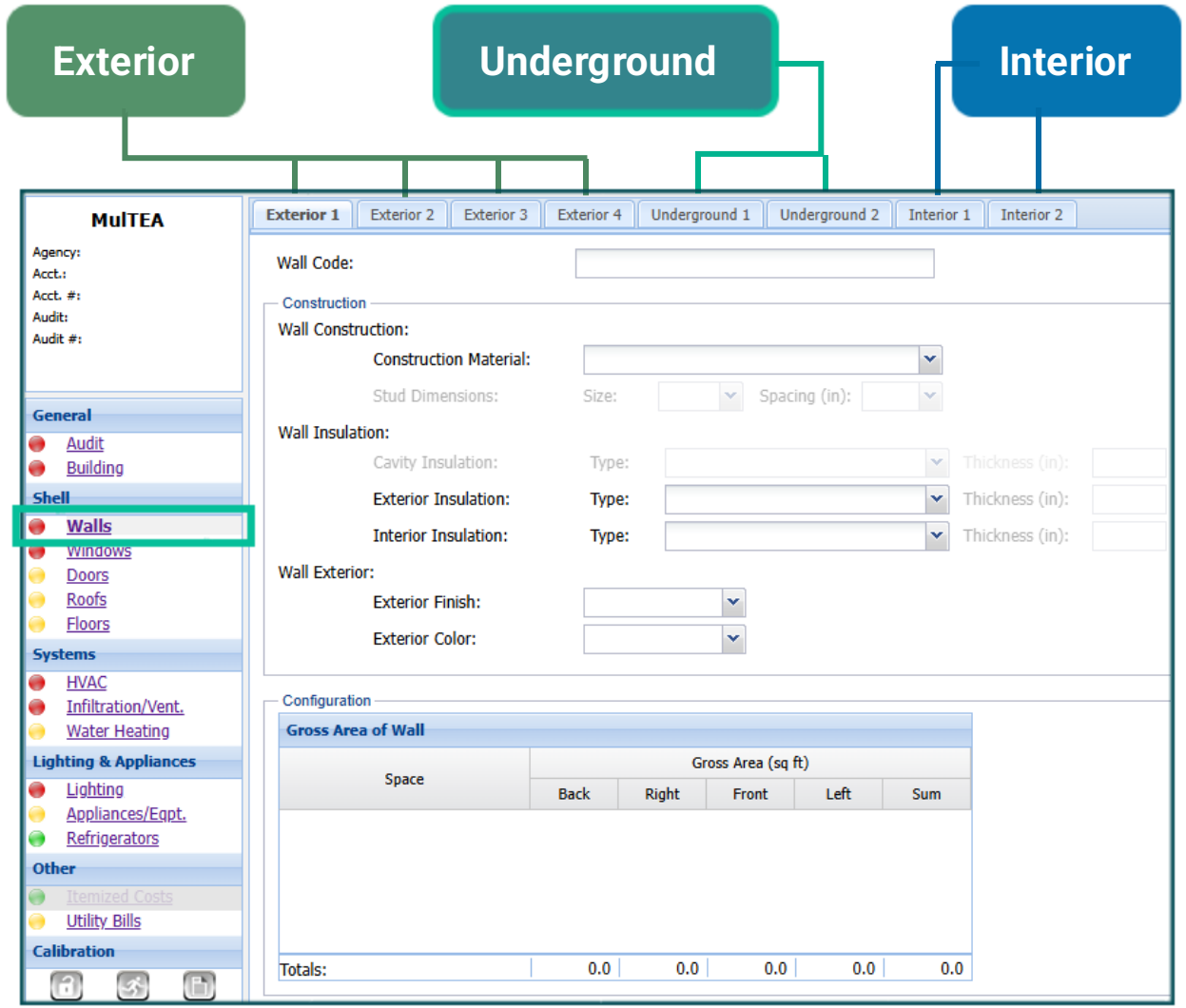
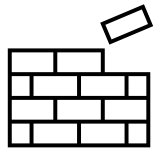


Image source: Web-based Weatherization Assistant (ORNL)

In MulTEA, the Shell, Systems, and Appliances forms use the tabbed interface similar to the Walls form.



Walls

Windows

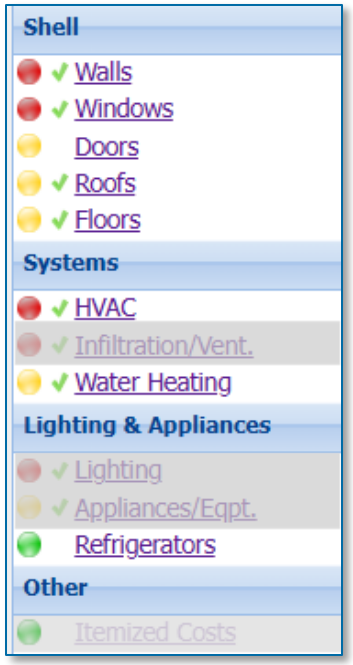
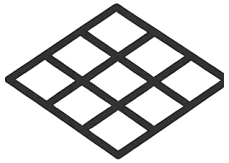


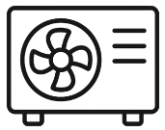
Image source:
Web-based Weatherization Assistant
(ORNL)

Doors

Attic/Roof

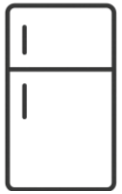


Floors



HVAC

Water Heating



Refrigerators

Shell forms in MulTEA, NEAT, and MHEA share similar structure and inputs.

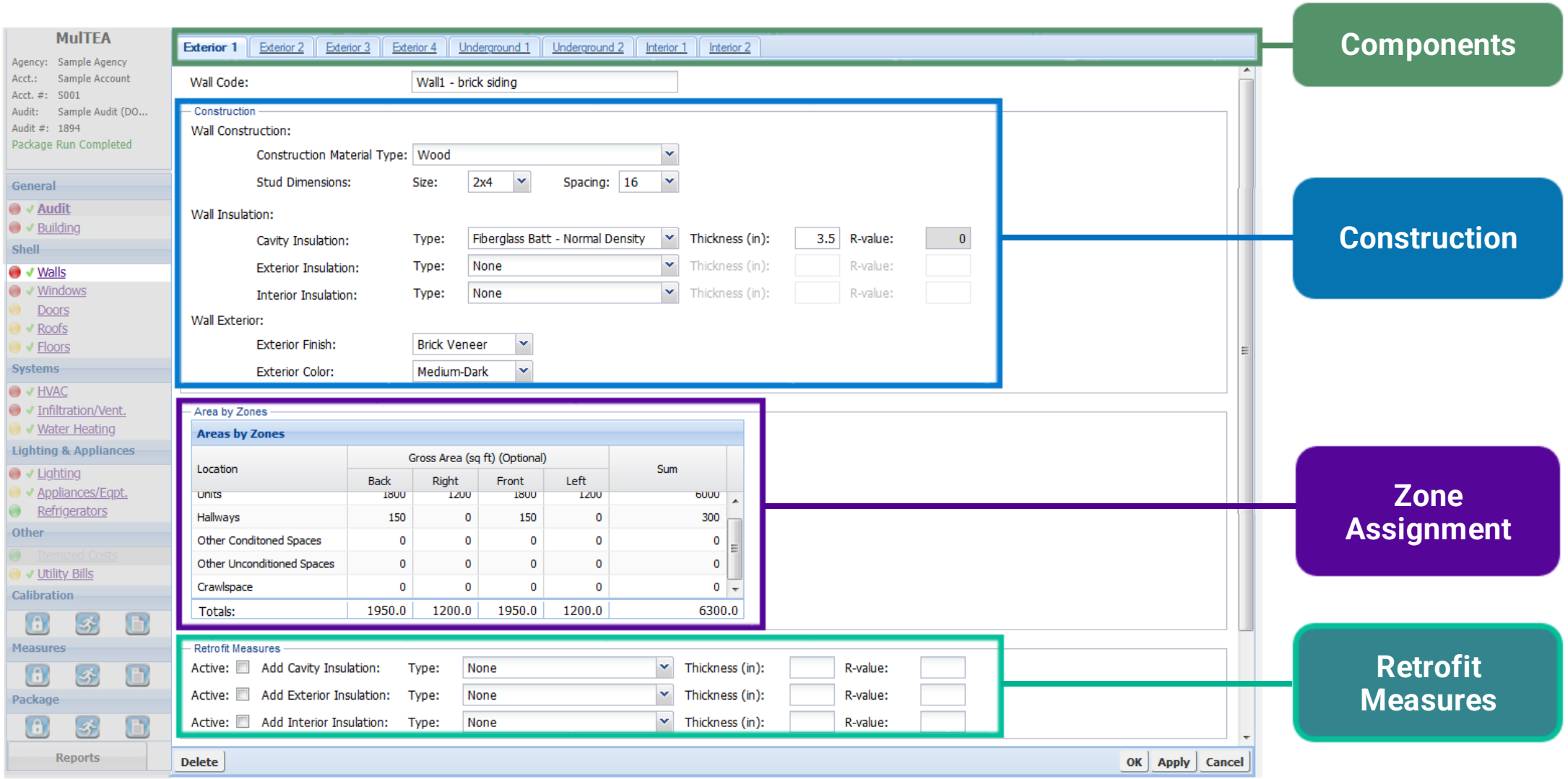


Image source: Web-based Weatherization Assistant (ORNL)

Systems forms in MulTEA, NEAT, and MHEA share similar structure and inputs.

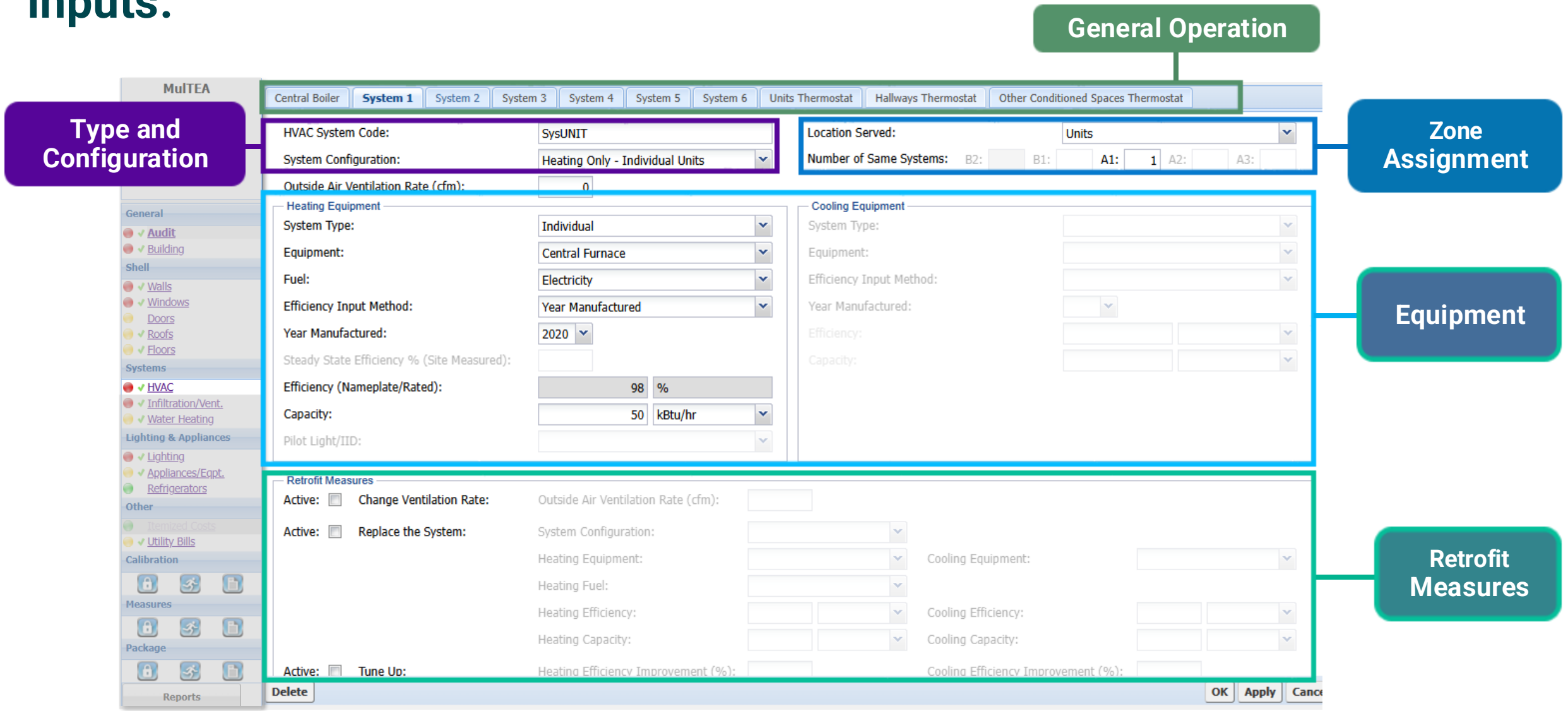
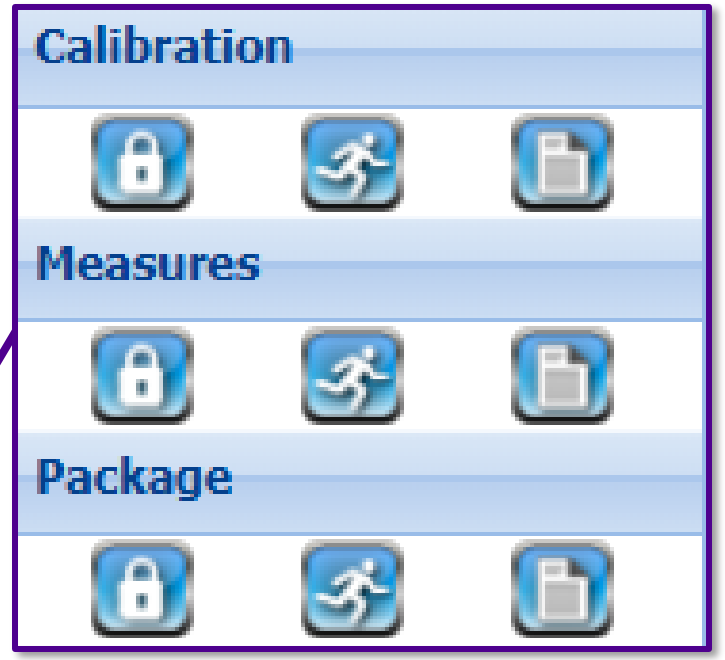


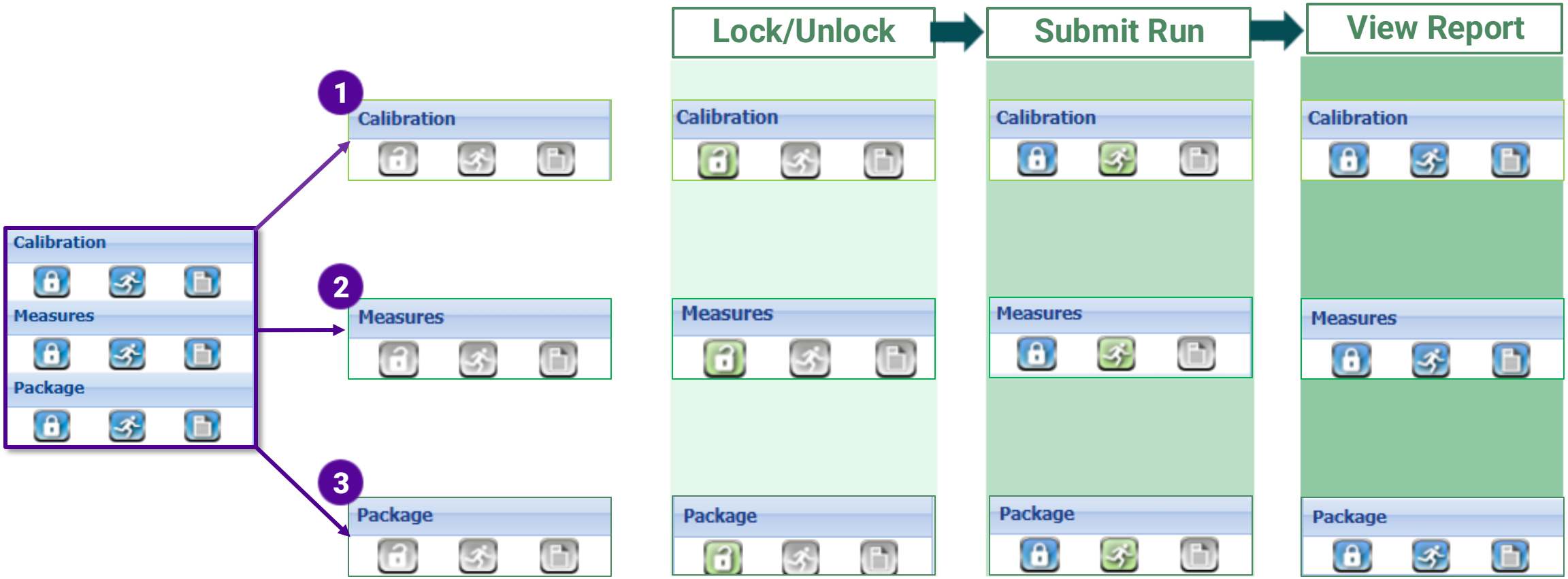
Image source: Web-based Weatherization Assistant (ORNL)

Three-step MulTEA audit run provides improved input and control for auditors.



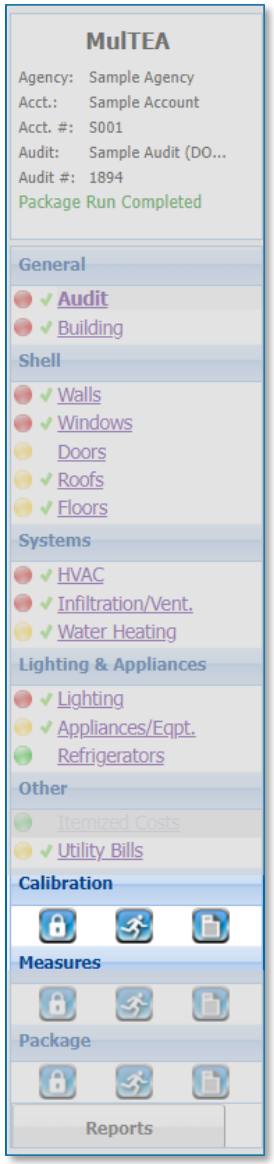
Images sourced from the Web-based Weatherization Assistant (ORNL)

MulTEA's iterative run process allows fine tuning of the model, measure modification, and package customization.



Images sourced from the Web-based Weatherization Assistant (ORNL)

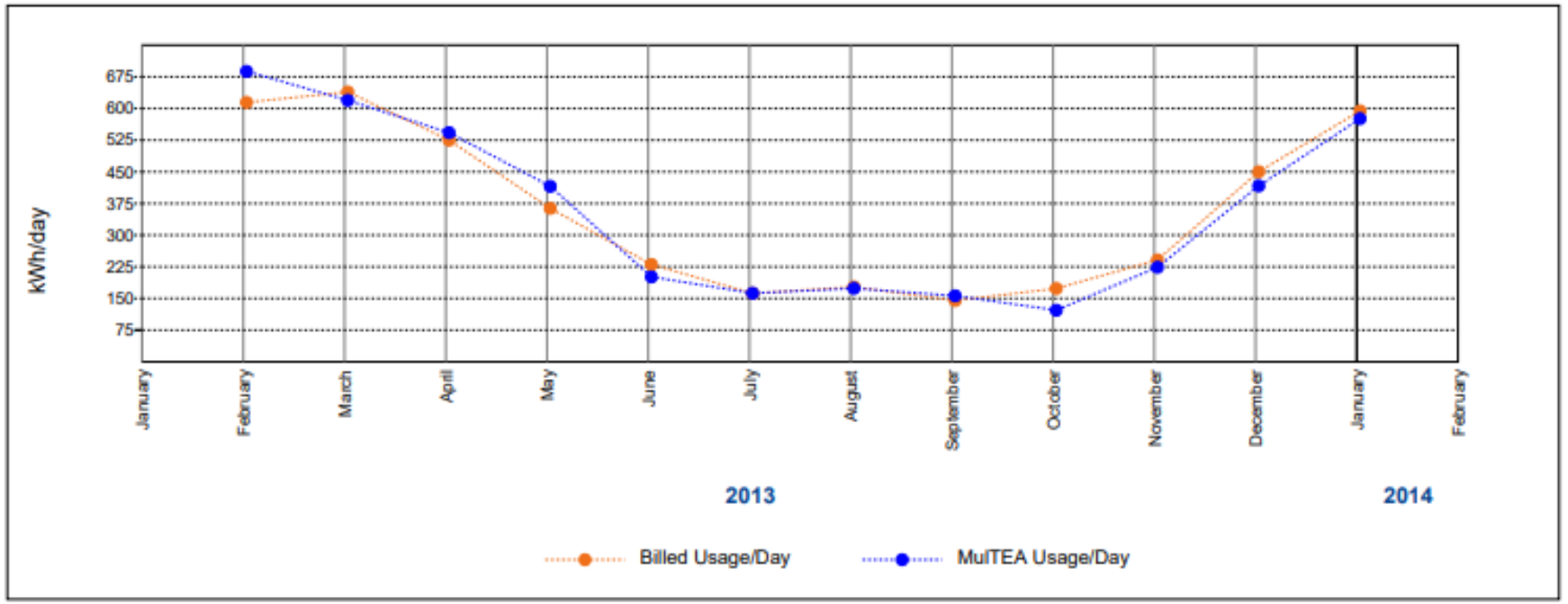
Calibration run report shows utility bill comparison and acceptance criteria.



Metrics for Calibration			
Statistical Index	Calculated Value	Acceptance Criteria	
		BPI[1]	ASHRAE[2]
Normalized Mean Bias Error (NMBE)	0.4%	Within +/- 5%	Within +/- 5%
Coefficient of Variation of the Root Mean Square Error (CVRMSE)	10.1%	<=20%	<=15%

[1]BPI-2400-S-2015 v.2, Standard Practice for Standardized Qualification of Whole-House Energy Savings Predictions by Calibration to Energy Use History.
[2]ASHRAE Guideline 14-2023, Measurement of Energy, Demand, and Water Savings.

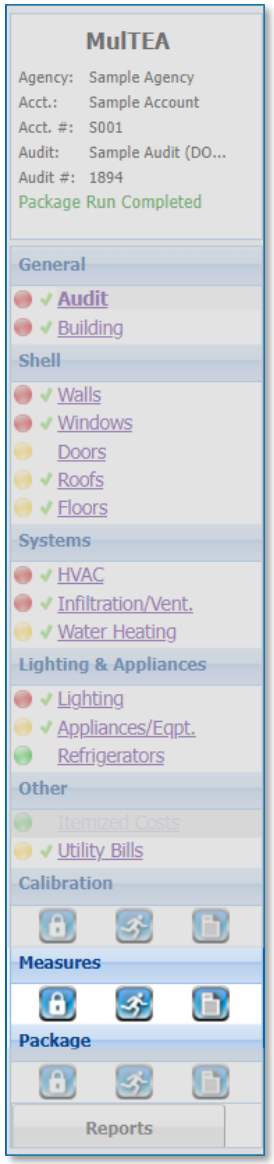
Meets acceptance criteria



Utility bill comparison with model

Image source: Web-based Weatherization Assistant (ORNL)

The Economics tab within the Measures Run report allows auditors to select appropriate measures, including potential buy down measures.



Weatherization Assistant ▾ | Agency ▾ | Account ▾ | Audit (MulTEA) ▾ | Libraries ▾ | Work Orders ▾ | User ▾ | Release Notes ▾ | Options ▾ | Admin Tools ▾ | Help ▾

Energy Savings | Cost Savings | Installation Costs | **Economics**

Agency: ORNL
Account Name: MulTEA Examples - TtT
Account Number: none provided
Audit Name: Sample Bldg 0 - Calibrated
Audit Number: 6175

Retrofit Measure Economics (No Interaction Among Measures)

Include in Package	#	Retrofit Measure	Component	Tab	Code	Predicted Annual Cost Savings ($)	Estimated Installation Cost ($)	Lifetime (years)	Savings-to-Investment Ratio (SIR)	Simple Payback Period (years)
☑	1	Replace Window	Windows	Window 1	W1	$524	$6,000	20.0	1.35	11.4
☑	2	Replace Window	Windows	Window 2	W2	$362	$4,500	20.0	1.24	12.4
☐	3	Replace Door	Doors	Door 1	Building entrance	$10	$500	20.0	0.29	52.4
☑	4	Add Ceiling Insulation	Roofs	Attic 1	Roof 1	$489	$3,000	20.0	2.51	6.1
☑	5	Air Sealing	Infiltration/Ventilati...	Infiltration	Infiltration	$484	$2,500	10.0	1.70	5.2
☑	6	Replace Lamps	Lighting	System	L1_units	$232	$1,000	6.8	1.44	4.3
☑	7	Install Motion Sensors	Lighting	System	L2_hallways	$101	$500	12.0	2.08	4.9
☑	8	Replace the Refrigerator	Refrigerator	Refrigerator 1	R1	$180	$3,600	15.0	0.92	13.4

Auditor selects measures…

…based on SIR, buydown potential

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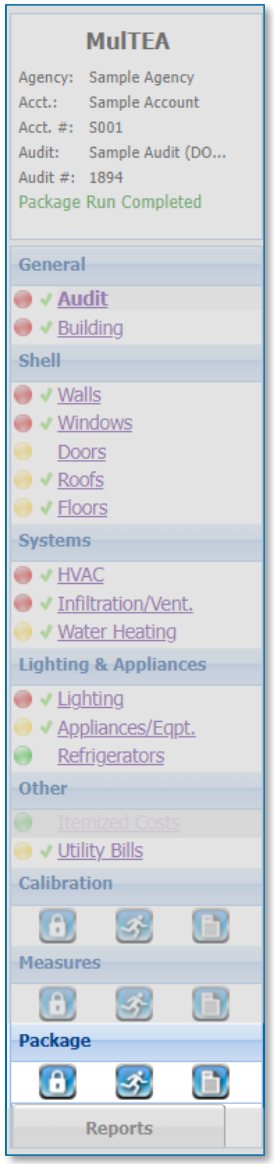
Image source: Web-based Weatherization Assistant (ORNL)

Package run shows opportunity for measure buydown.



Energy Savings | Cost Savings | Economics | **Leveraging**

Agency: ORNL
Account Name: MulTEA Examples - TtT
Account Number: none provided
Audit Name: Sample Bldg 0 - Calibrated
Audit Number: 6175

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	Add Ceiling Insulation	Roofs	Attic 1	Roof 1	$3,000	2.51	$0	$0	$3,000	2.51
2	Install Motion Sensors	Lighting	System	L2_hallways	$500	1.75	$0	$0	$500	1.75
3	Air Sealing	Infiltration/Ventilation	Infiltration	Infiltration	$2,500	1.96	$0	$0	$2,500	1.96
4	Replace Lamps	Lighting	System	L1_units	$1,000	1.71	$0	$0	$1,000	1.71
5	Replace Window	Windows	Window 1	W1	$6,000	1.18	$0	$0	$6,000	1.18
6	Replace Window	Windows	Window 2	W2	$4,500	1.03	$0	$0	$4,500	1.03
7	Replace the Refrigerator	Refrigerator	Refrigerator 1	R1	$3,600	0.75	$916	$950	$2,650	1.01
	Package				$21,100	1.39		$950	$20,150	1.46

Buydown opportunity

SIR > 1

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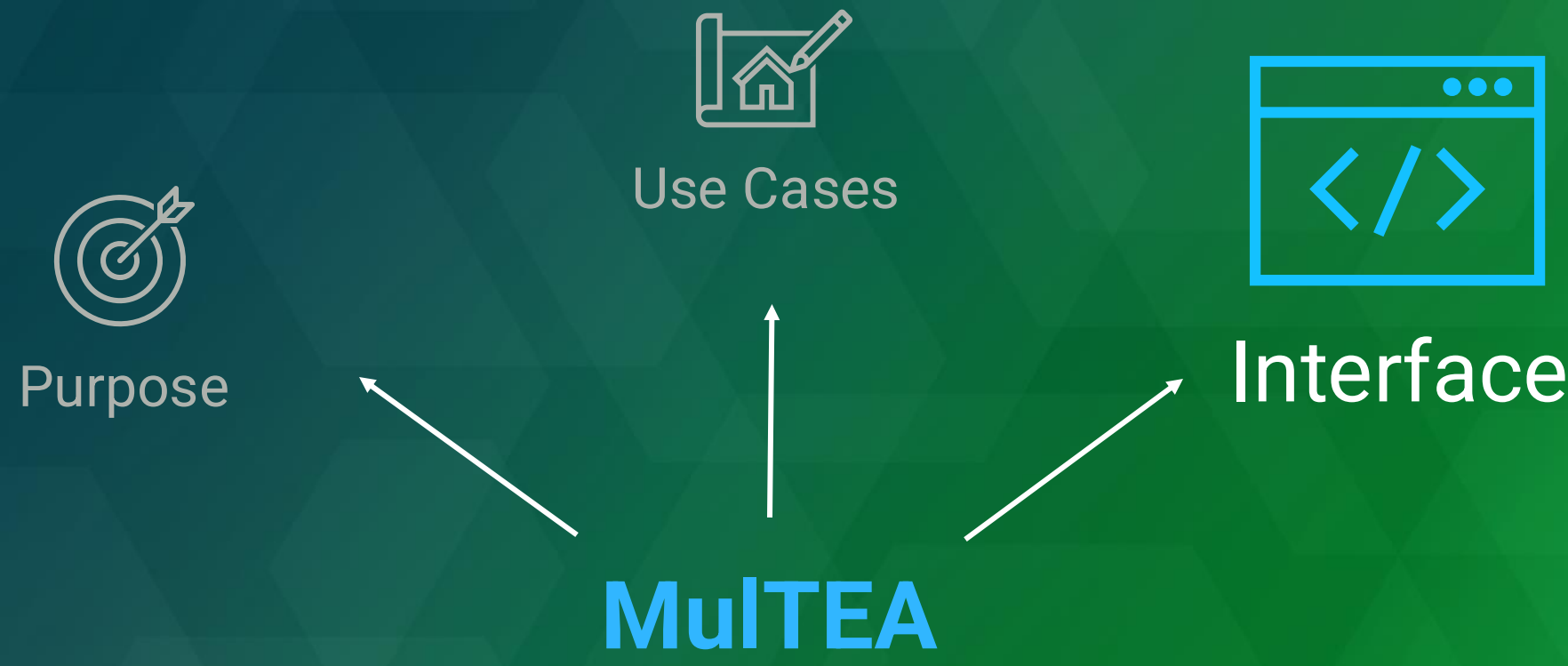
Image source: Web-based Weatherization Assistant (ORNL)

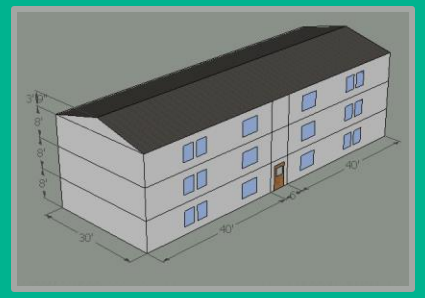
MulTEA User Interface



- Questions?

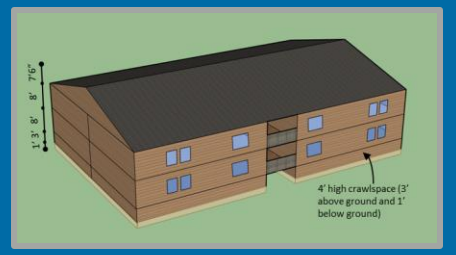
These sample buildings represent the 5 typical buildings commonly used in testing and training for MulTEA.

Walkup- Slab



Basement

Garden with crawlspace



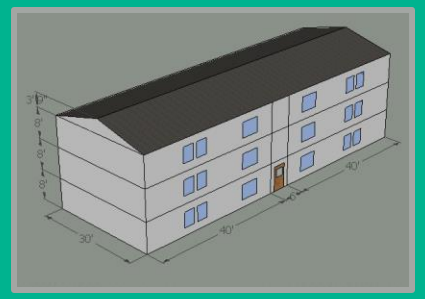
Open parking ground floor

Row housing- slab floor

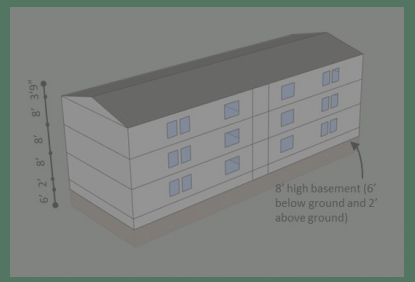
Images sourced from the 1) Web-based Weatherization Assistant Getting Started Guideline (ORNL) and the 2) Manuals and Training Material page on weatherization.ornl.gov

We will walk through how to input a three-story walkup with slab-on-grade floor in MulTEA.

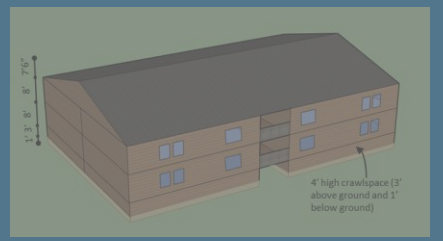
Walkup- Slab



Basement



Garden with crawlspace

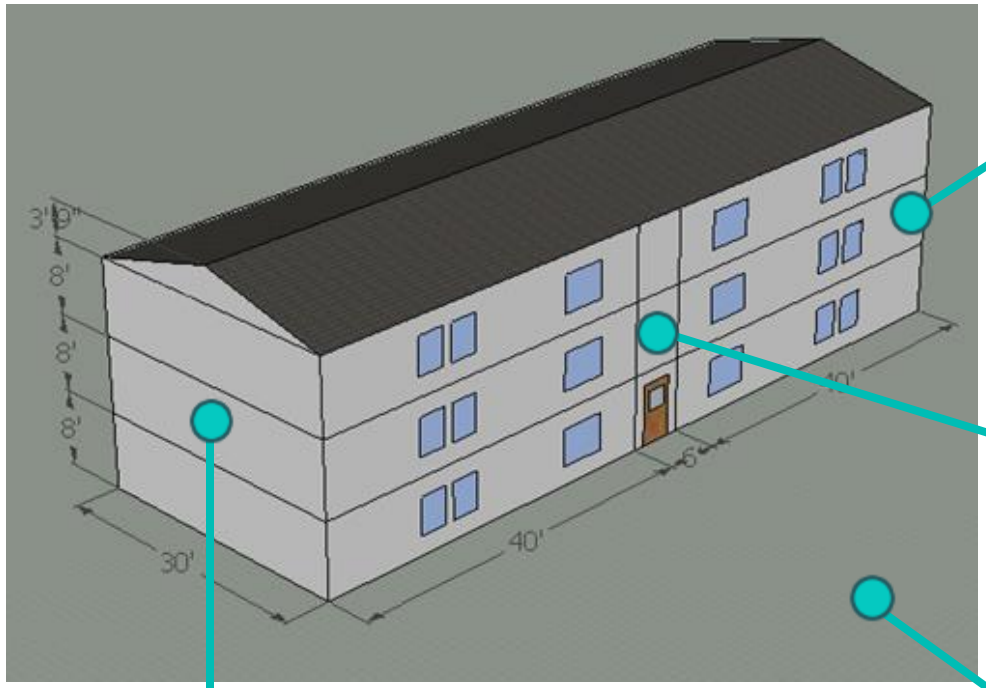


Open parking ground floor

Row housing- slab floor

Images sourced from the 1) Web-based Weatherization Assistant Getting Started Guideline (ORNL) and the 2) Manuals and Training Material page on weatherization.ornl.gov

Our sample building is a three-story walkup with slab-on-grade floor



3-stories

(2 units per floor)

Double-loaded, enclosed, unconditioned hallways & stairwells

Old asphalt ground surface lot

Walls

8” hollow concrete blocks (exterior and partition)

Stucco finish with medium-dark color (exterior)

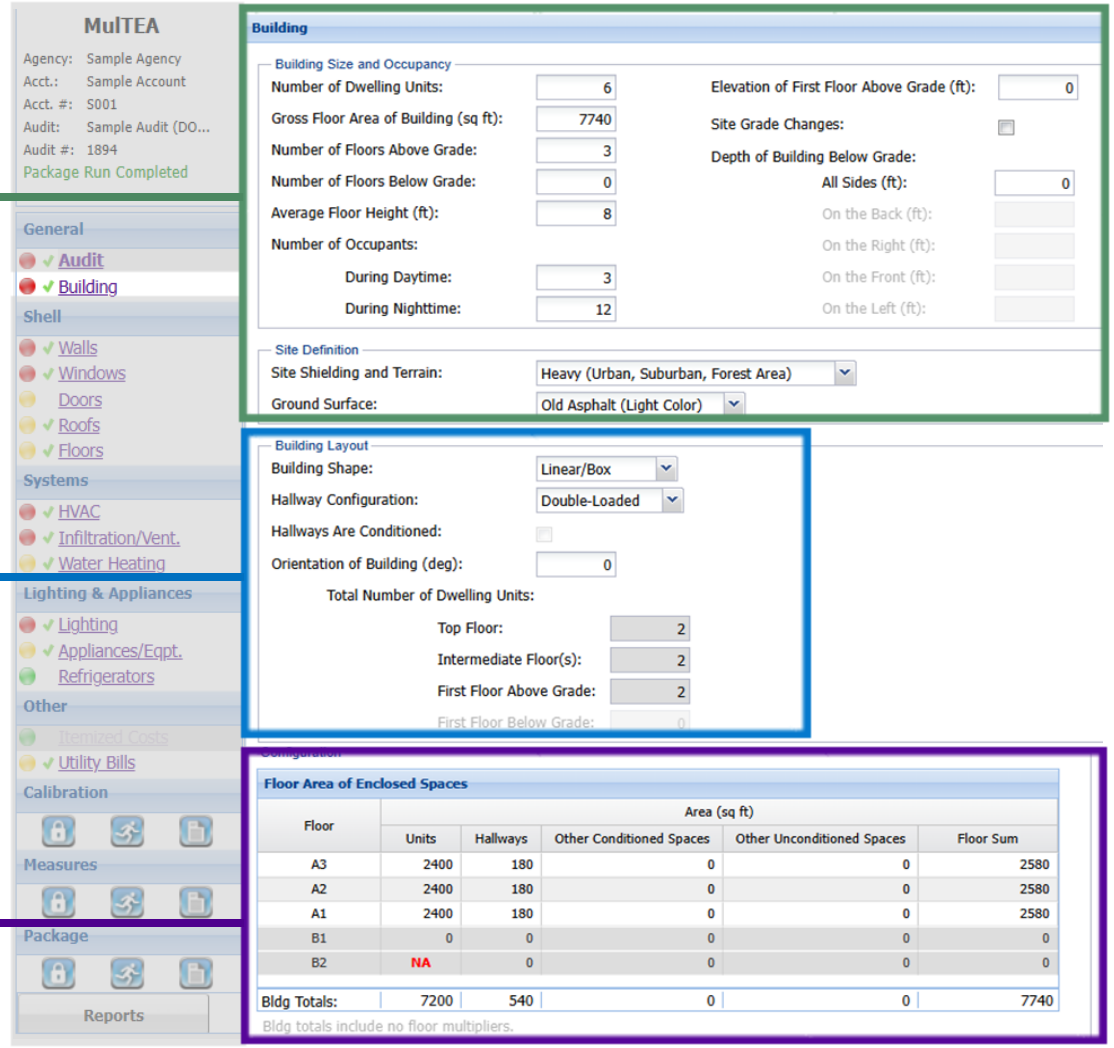
Image source: Manuals and Training Material page on weatherization.ornl.gov

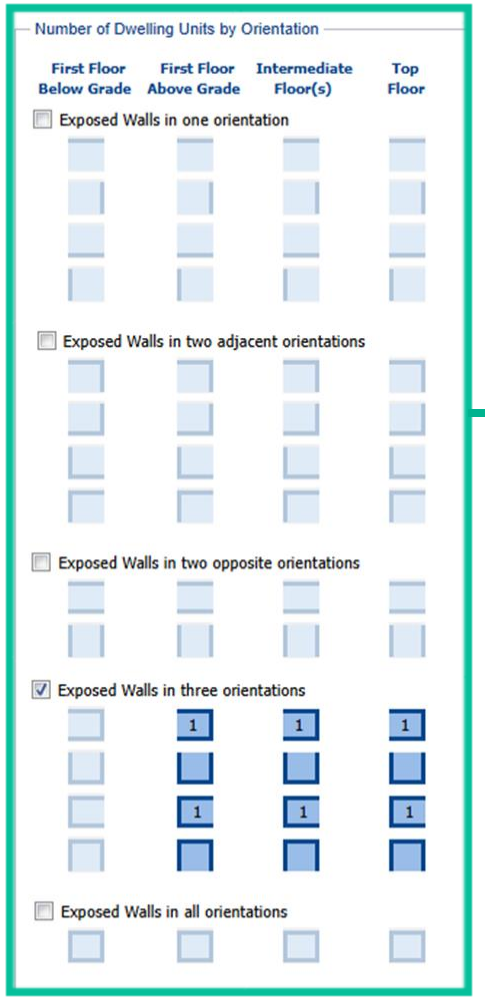
This represents the sample building's completed Building Form, and we will cover each field in detail.

General Building Details

Building Configuration

Define Areas of Building Spaces





Define dwelling units and orientations

Image source: Web-based Weatherization Assistant (ORNL)

OAK RIDGE National Laboratory

First, general building details are entered about its size, occupancy, and layout, as well as site information.

2 units per floor

3-stories

Old asphalt ground surface lot

Double-loaded, enclosed, unconditioned hallways

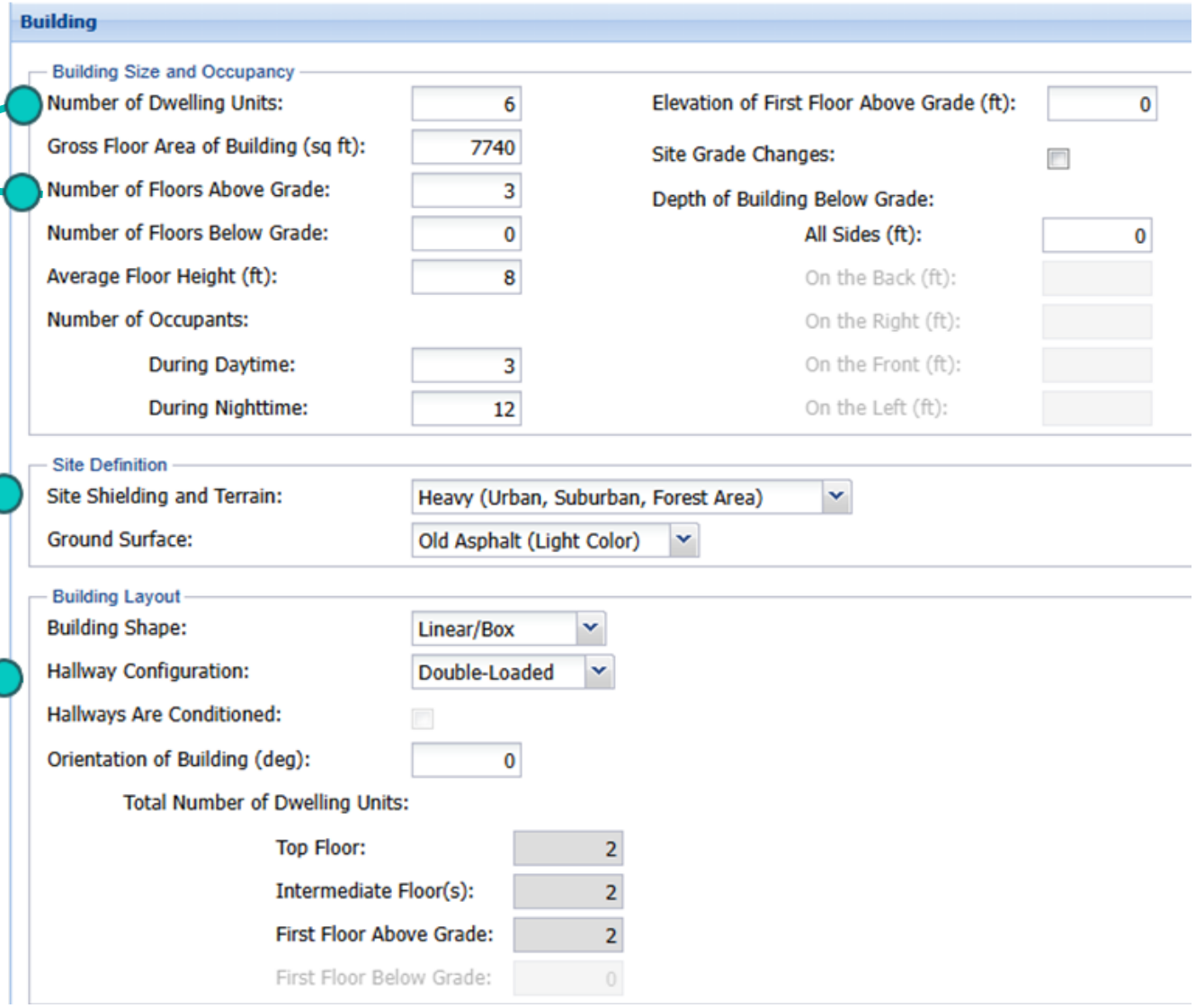


Image source: Web-based Weatherization Assistant (ORNL)

To input the number of dwelling units by orientation on the Building Form, we will determine the configuration of walls exposed to ambient conditions for the top floor of the building.

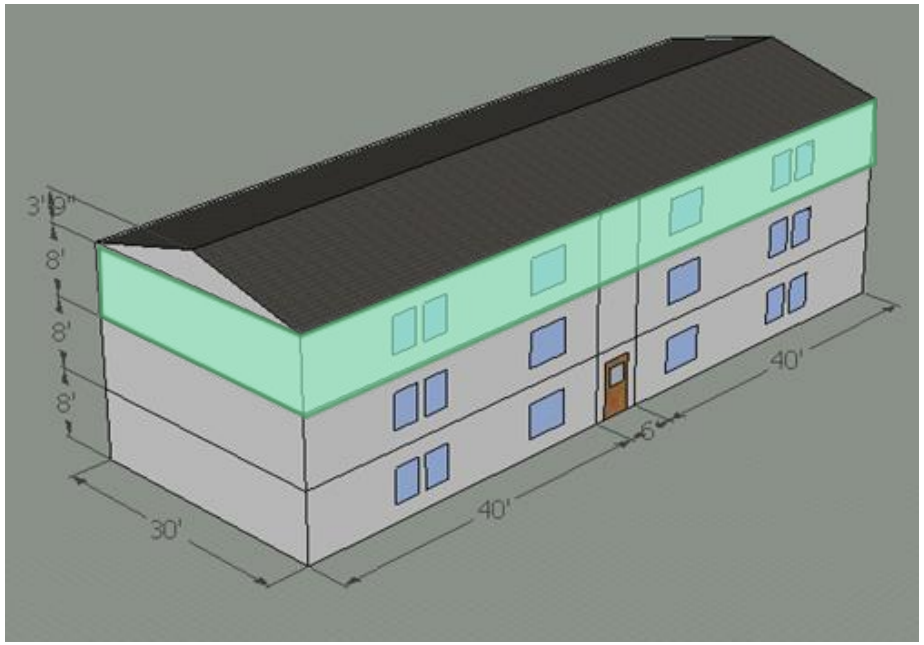


Image source: Manuals and Training Material page on weatherization.ornl.gov

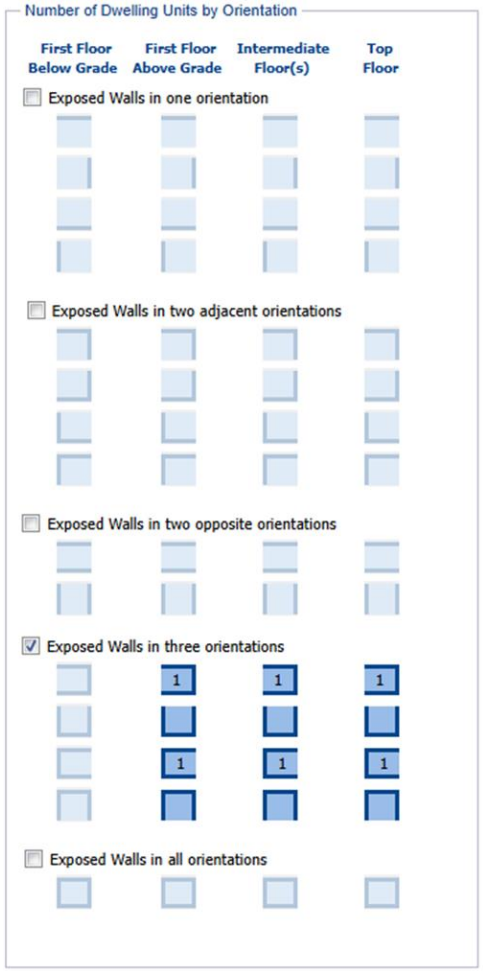
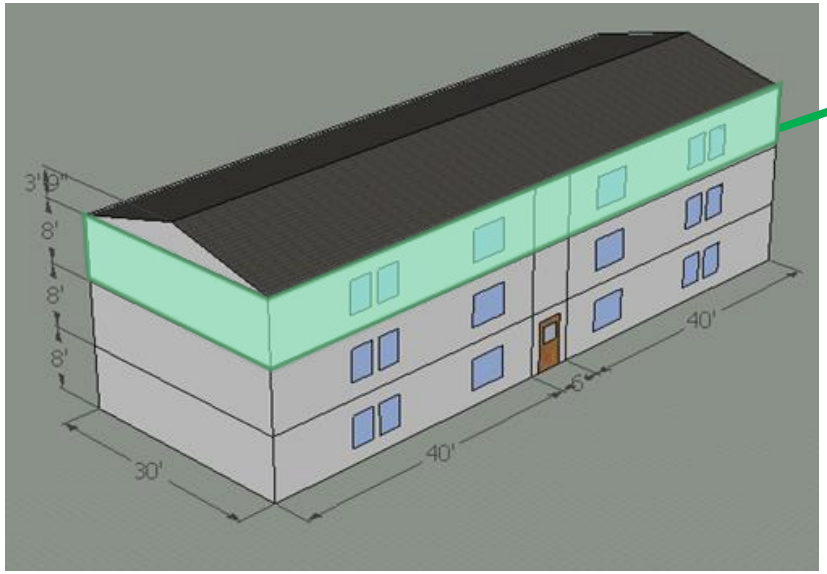


Image source: Web-based Weatherization Assistant (ORNL)

The top-floor units are separated by an enclosed hallway.



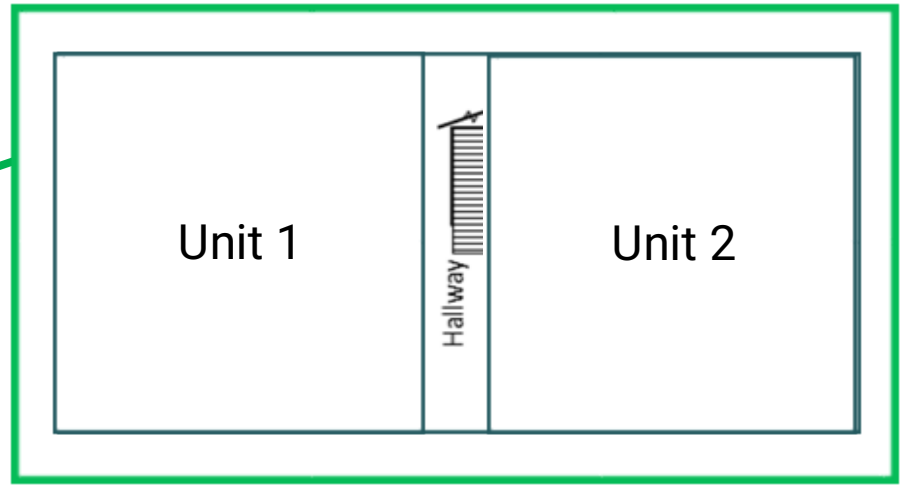


Image source: Manuals and Training Material page on weatherization.ornl.gov

Due to the enclosed hallway, three walls are exposed to ambient conditions in two different orientations.

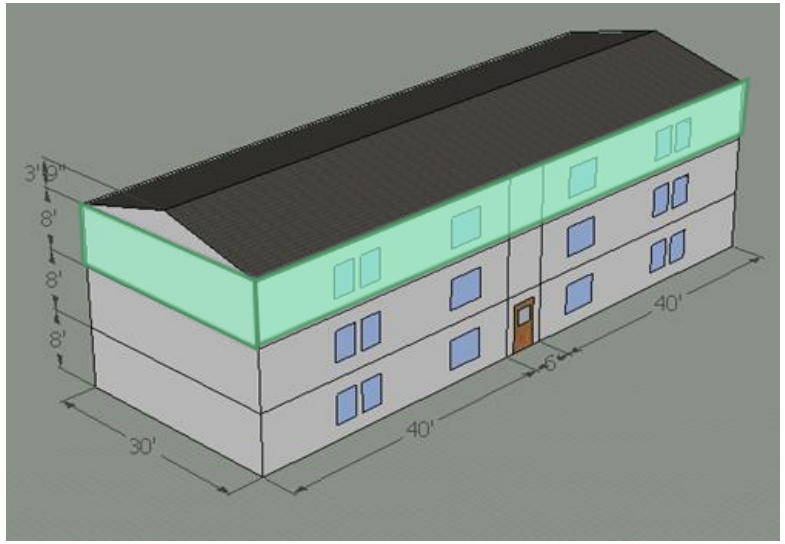
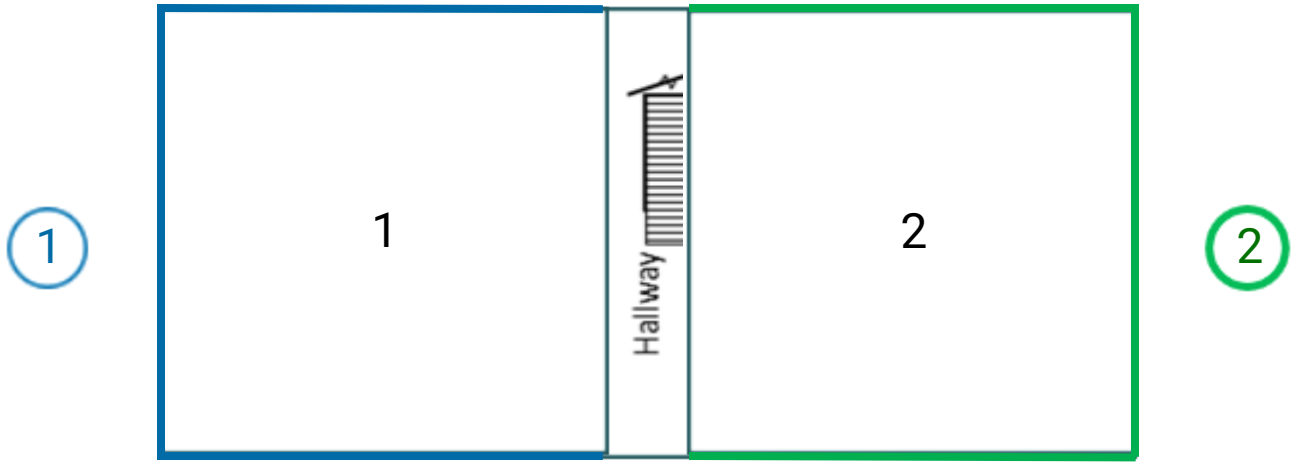
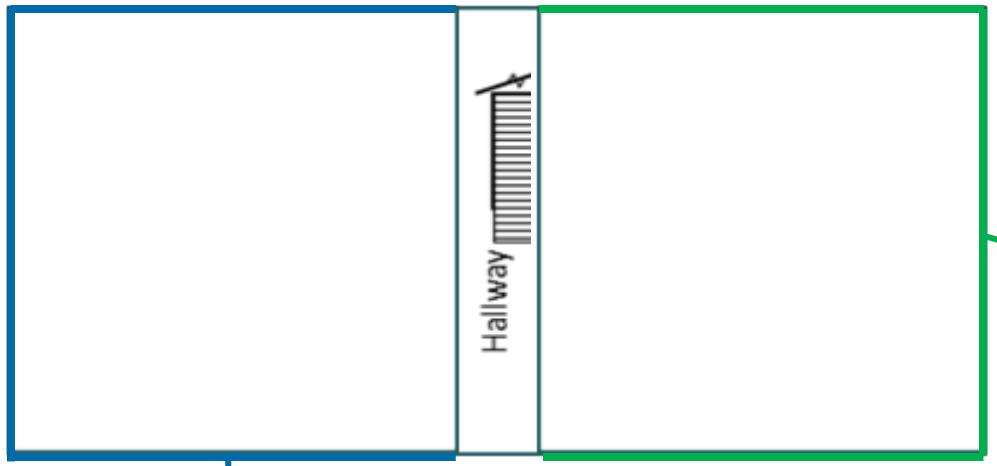


Image source: Manuals and Training Material page on weatherization.ornl.gov



We input the number of units using each wall orientation in the Building Form.



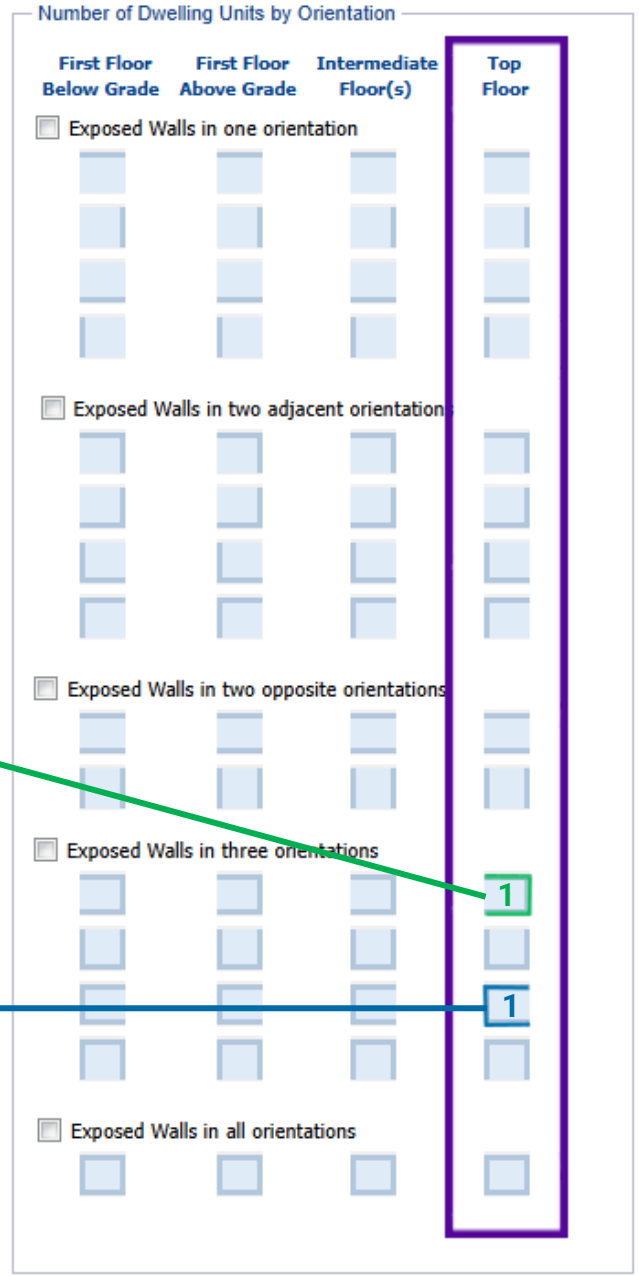


Image source: Web-based Weatherization Assistant (ORNL)

We repeat this process for all three building floors.

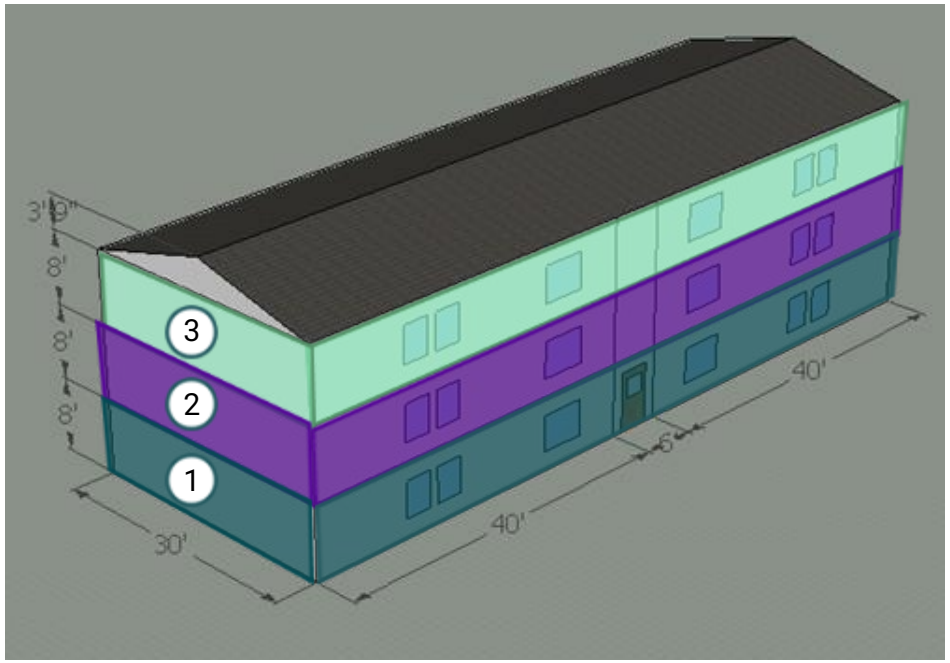


Image source: Manuals and Training Material page on weatherization.ornl.gov

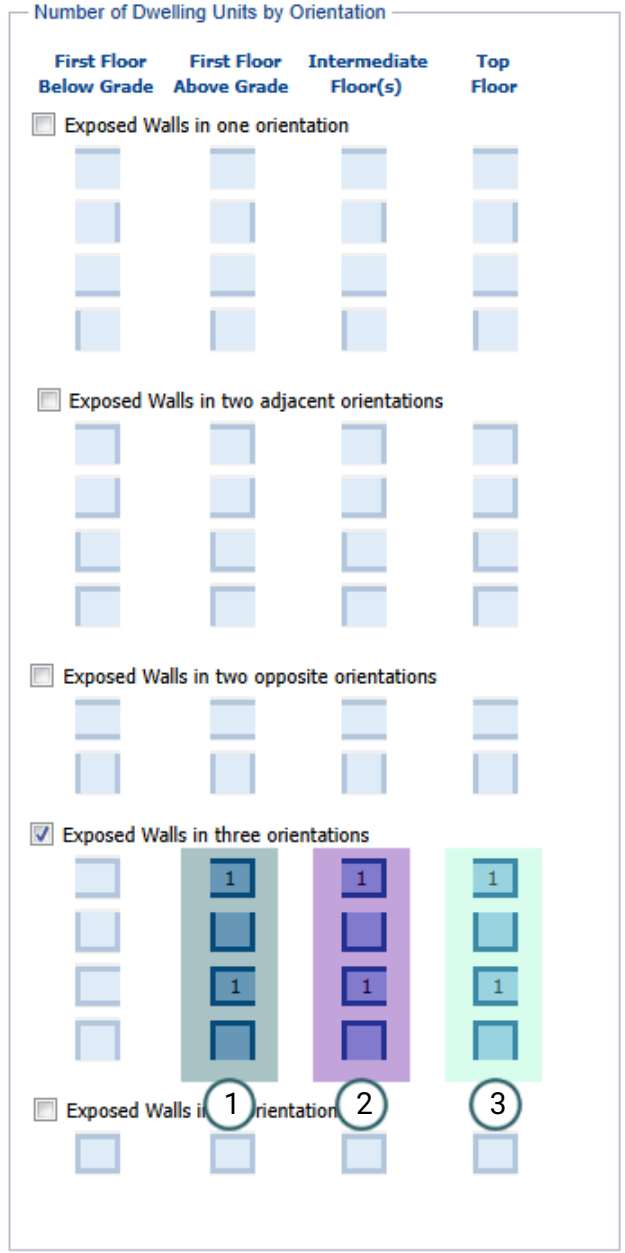


Image source: Web-based Weatherization Assistant (ORNL)

To complete the Configuration table in MulTEA's Building Form, calculate and enter the area (sq ft) of all enclosed space types for each above and below ground floor.

Floors

A: above ground

B: below ground

Configuration

Floor Area of Enclosed Spaces

Floor	Area (sq ft)				
	Units	Hallways	Other Conditioned Spaces	Other Unconditioned Spaces	Floor Sum
A3	0	0	0	0	0
A2	0	0	0	0	0
A1	0	0	0	0	0
B1	0	0	0	0	0
B2	NA	0	0	0	0
Bldg Totals:	0	0	0	0	0

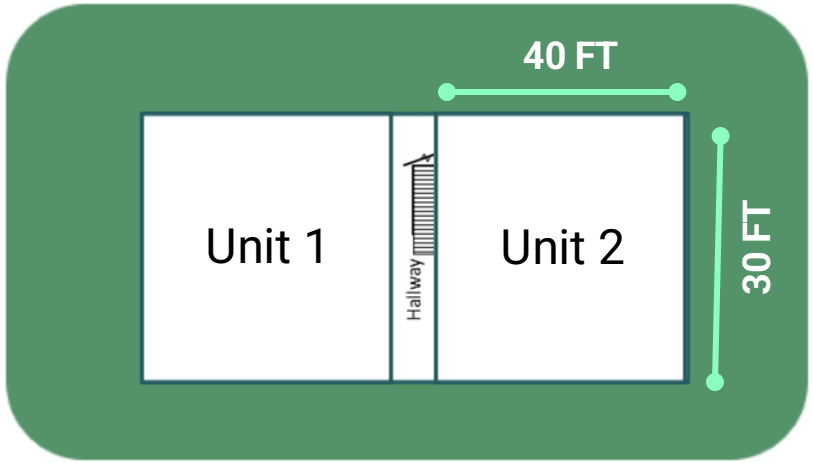
Bldg totals include no floor multipliers.

Type of Enclosed Space

Maximum of 4 space types per floor

Image source: Web-based Weatherization Assistant (ORNL)

Use provided dimensions to calculate and enter the floor area of units on each floor.



(40ft x 30ft) x 2 units = 2,400FT

Configuration

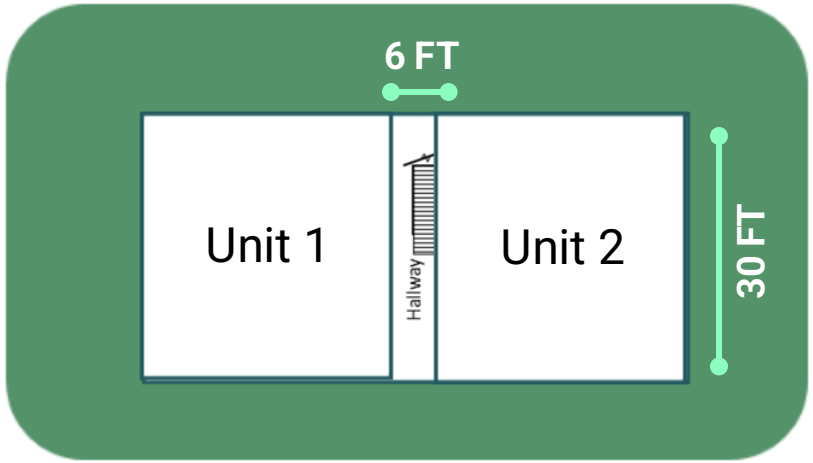
Floor Area of Enclosed Spaces

Floor	Area (sq ft)				
	Units	Hallways	Other Conditioned Spaces	Other Unconditioned Spaces	Floor Sum
A3	2400	0	0	0	2400
A2	2400	0	0	0	2400
A1	2400	0	0	0	2400
B1	0	0	0	0	0
B2	NA	0	0	0	0
Bldg Totals:	7200	0	0	0	7200

Bldg totals include no floor multipliers.

Image source: Web-based Weatherization Assistant (ORNL)

Use provided dimensions to calculate and enter the floor area of the hallway on each floor.



(6ft x 30ft) x 1 hallway
= 180FT

Configuration

Floor Area of Enclosed Spaces

Floor	Area (sq ft)				
	Units	Hallways	Other Conditioned Spaces	Other Unconditioned Spaces	Floor Sum
A3	2400	180	0	0	2580
A2	2400	180	0	0	2580
A1	2400	180	0	0	2580
B1	0	0	0	0	0
B2	NA	0	0	0	0
Bldg Totals:	7200	540	0	0	7740

Bldg totals include no floor multipliers.

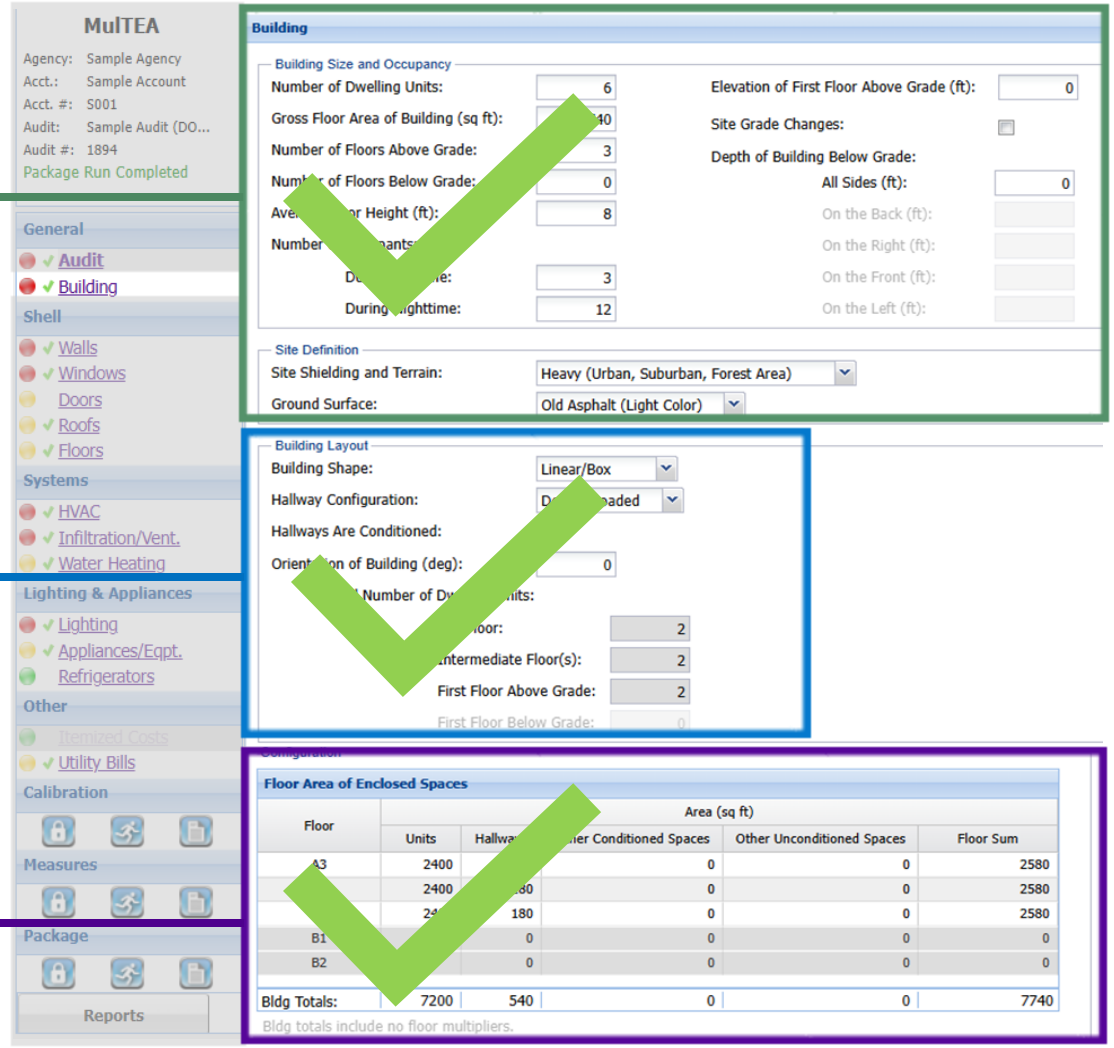
Image source: Web-based Weatherization Assistant (ORNL)

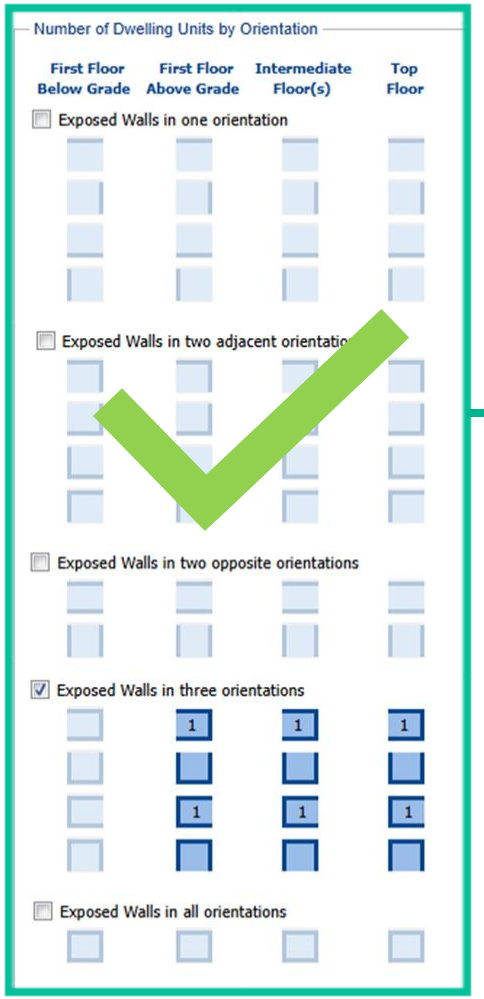
We have now completed MulTEA's Building Form for the sample building.

General Building Details

Building Configuration

Define Areas of Building Spaces



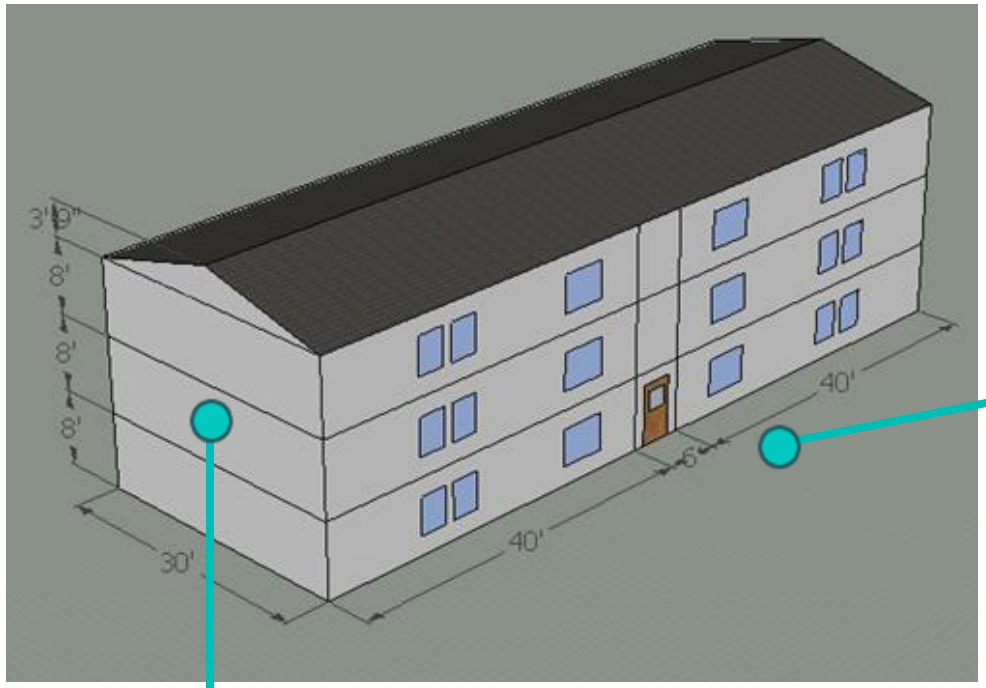


Define dwelling units and orientations

Image source: Web-based Weatherization Assistant (ORNL)

OAK RIDGE National Laboratory

Our sample building is a three-story walkup with slab-on-grade floor.



Dimensions

40’ x 30’ x 8’ units
6’ hallway

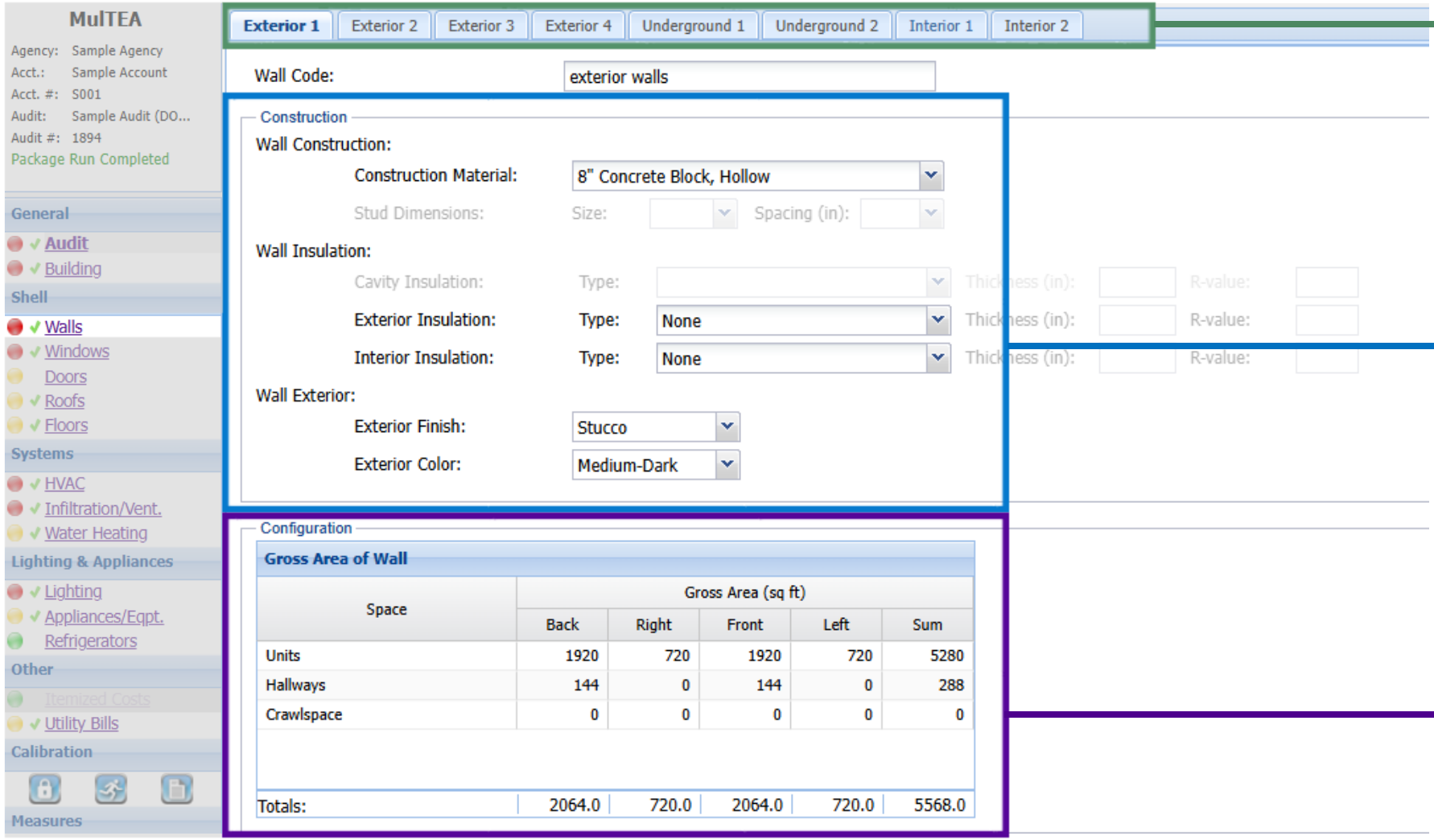
Walls

8” hollow concrete blocks (exterior and partition)

Stucco finish with medium-dark color (exterior)

Image source: Web-based Weatherization Assistant Getting Started Guideline (ORNL)

This represents the sample building's completed Walls Form for its exterior walls. The configuration table will be covered in detail next.



Components / Wall Type

Type: Exterior

Construction

8" hollow concrete block

Stucco finish - medium dark color

Configuration

Image source: Web-based Weatherization Assistant (ORNL)

To complete the exterior wall's Configuration table in MulTEA's Walls Form, calculate and enter the area (sq ft) of each exterior wall type by orientation.

Configuration

Gross Area of Wall

Space	Gross Area (sq ft)				
	Back	Right	Front	Left	Sum
Units	1920	720	1920	720	5280
Hallways	144	0	144	0	288
Crawlspace	0	0	0	0	0
Totals:	2064.0	720.0	2064.0	720.0	5568.0

Wall Type

Orientation

Image source: Web-based Weatherization Assistant (ORNL)

Use provided dimensions to calculate and enter the exterior wall area of the front and back of the building.

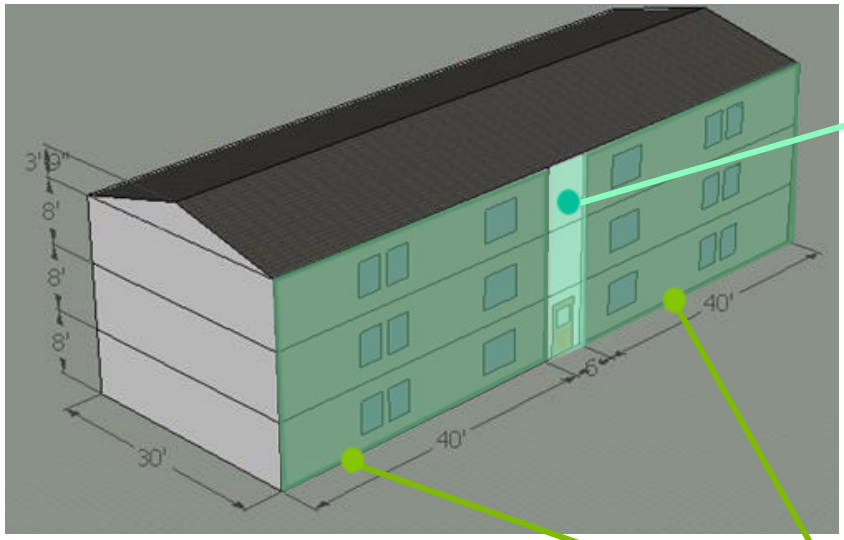


Image source: Manuals and Training Material page on weatherization.oml.gov

Hallways:

8ft ceiling x 3 floors x 6ft long = 144 sq ft

Units:

8ft ceiling x 3 floors x 2 units x 40ft long= 1,920 sq ft

Configuration

Gross Area of Wall

Space	Gross Area (sq ft)			
	Back	Right	Front	Left
Units	1920	720	1920	720
Hallways	144	0	144	0
Crawlspace	0	0	0	0
Totals:	2064.0	720.0	2064.0	720.0

Image source: Web-based Weatherization Assistant (ORNL)

Use provided dimensions to calculate and enter the exterior wall area of the right and left of the building.

Units:

8ft ceiling x 3 floors x

30ft long = 720 sq ft

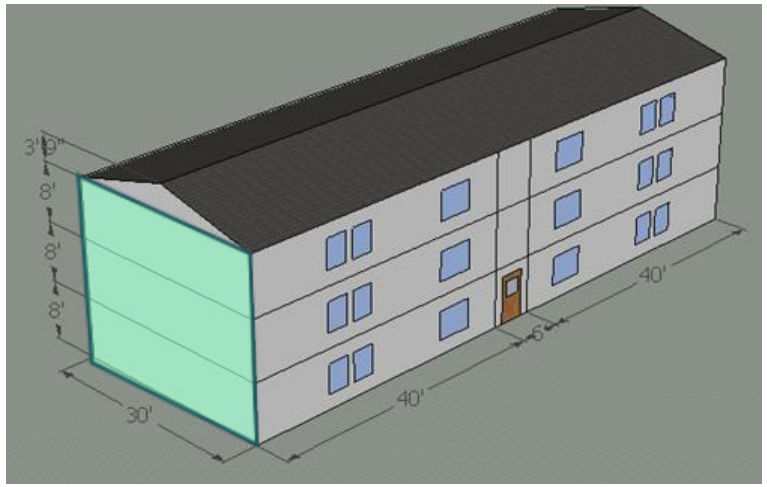


Image source: Manuals and Training Material page on weatherization.ornl.gov

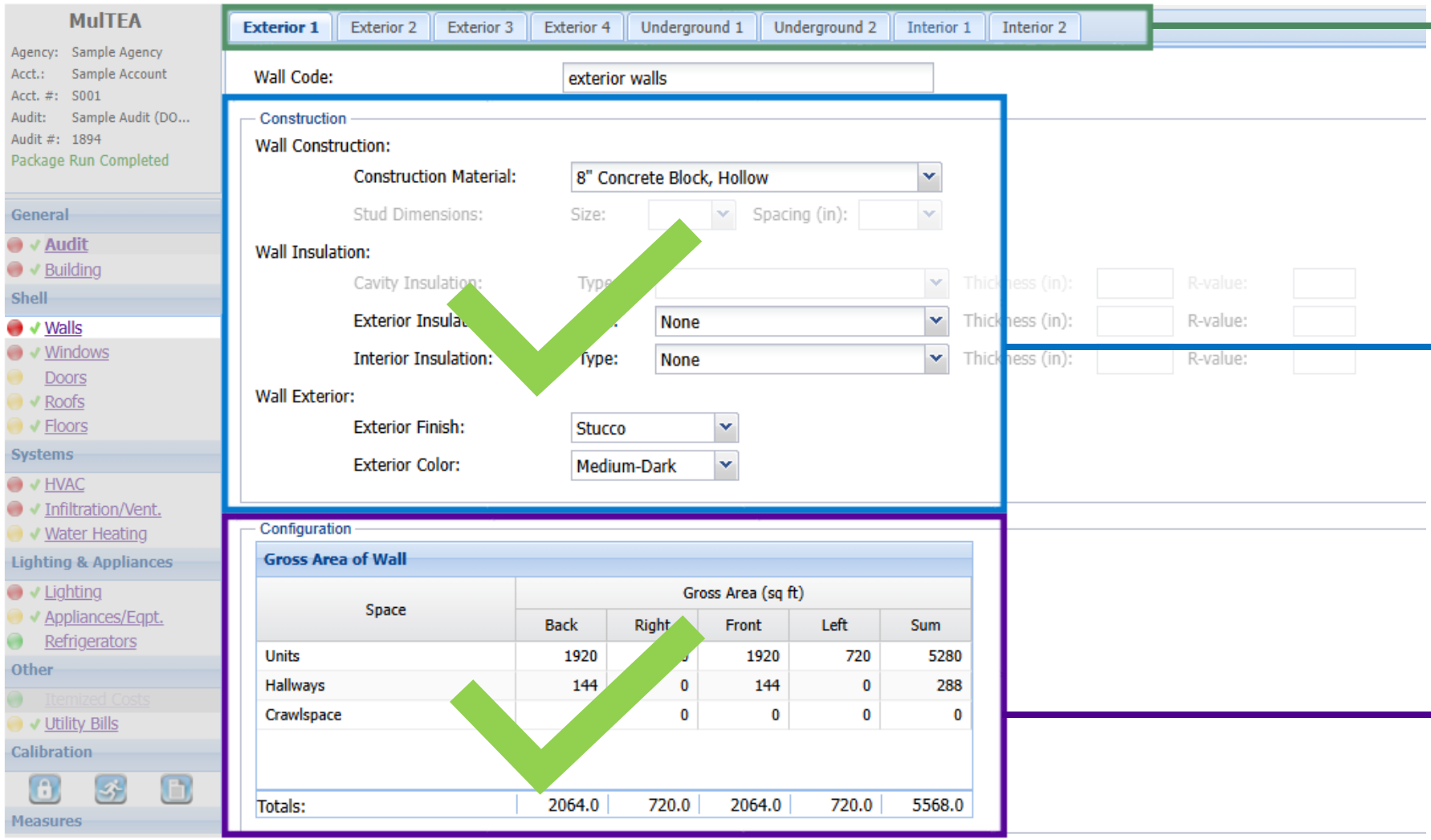
Configuration

Gross Area of Wall

Space	Gross Area (sq ft)			
	Back	Right	Front	Left
Units	1920	720	1920	720
Hallways	144	0	144	0
Crawlspace	0	0	0	0
Totals:	2064.0	720.0	2064.0	720.0

Image source: Web-based Weatherization Assistant (ORNL)

We have now completed the Walls Form for the sample building's exterior walls. The process would be repeated for interior walls.



Components / Wall Type

Type: Exterior

Construction

8" hollow concrete block

Stucco finish - medium dark color

Configuration

Image source: Web-based Weatherization Assistant (ORNL)

This represents the sample building's completed Floors Form for its first floor. The configuration table will be covered in detail next.

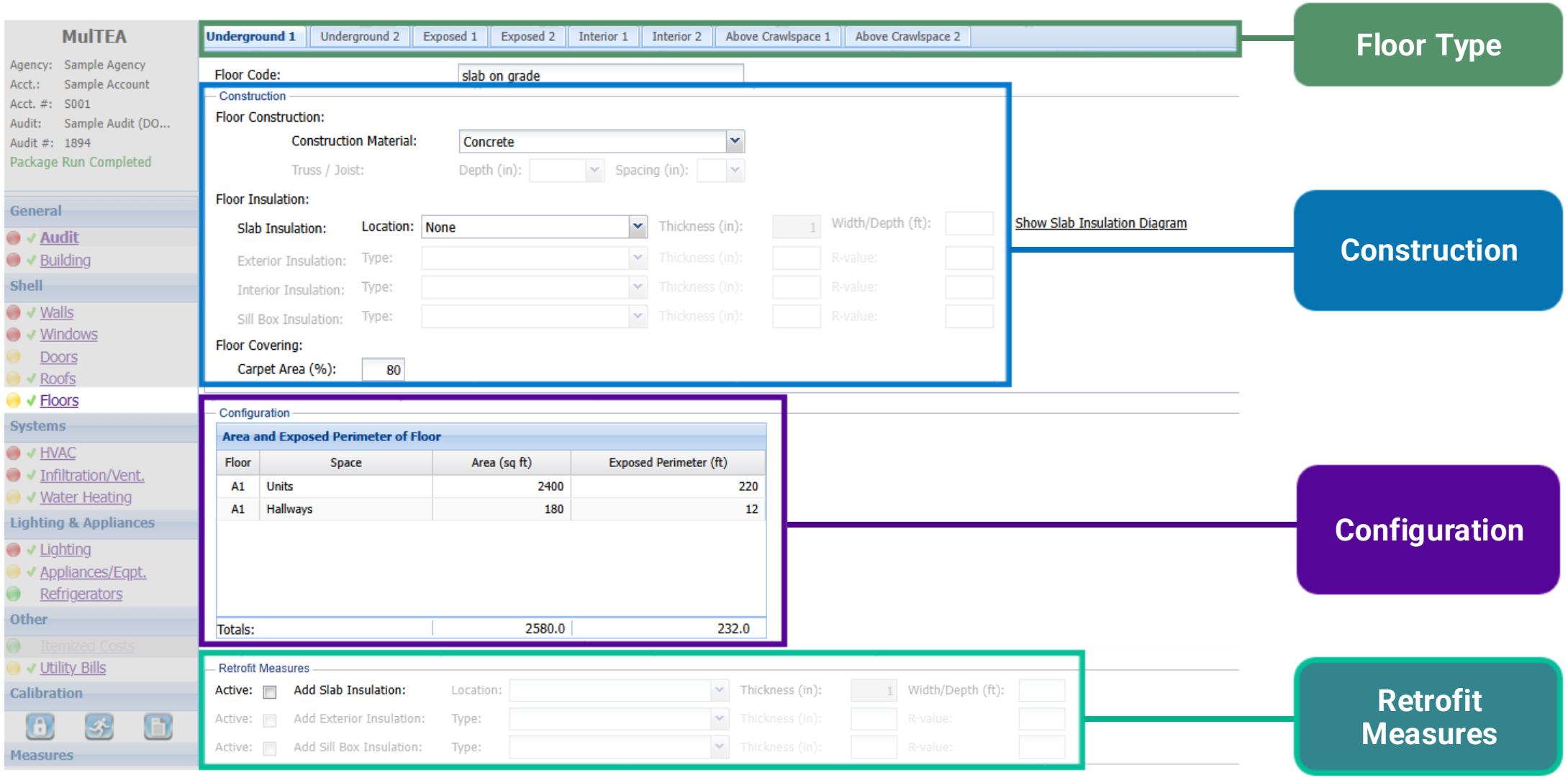


Image source: Web-based Weatherization Assistant (ORNL)

Provided specifications of the sample building foundation and floors.

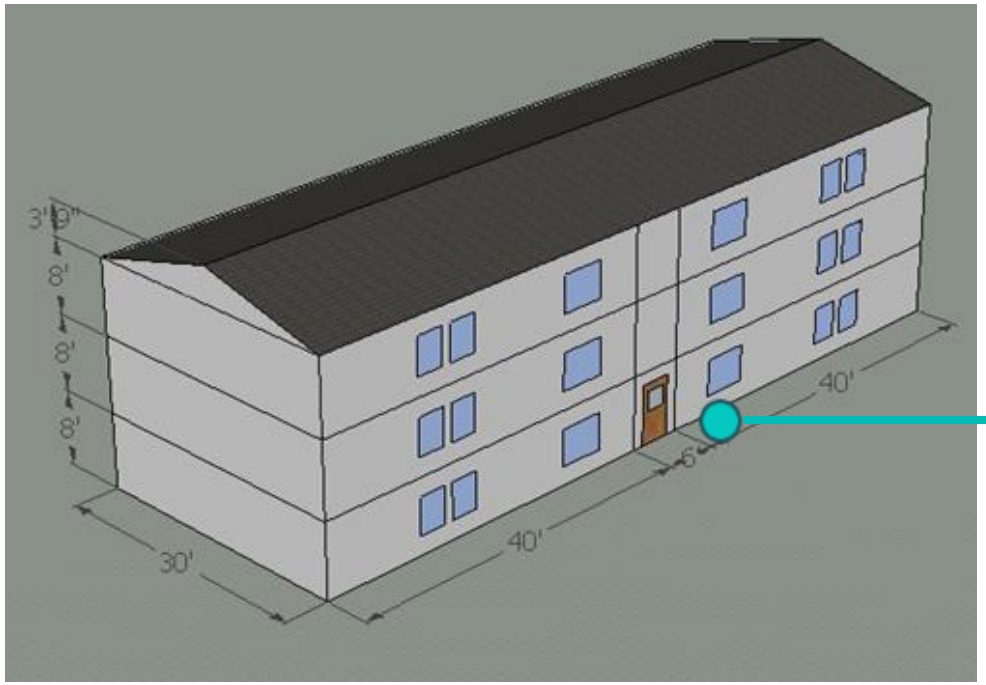


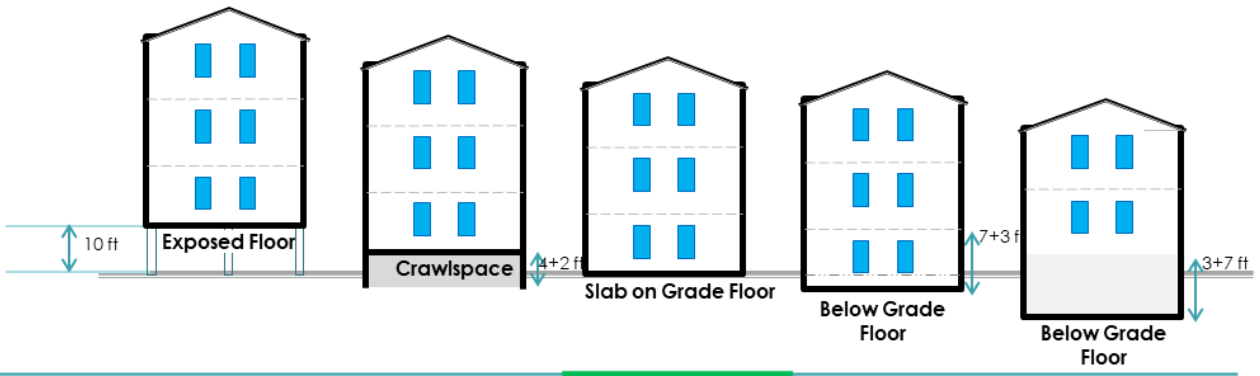
Image source: Manuals and Training Material page on weatherization.ornl.gov

Slab-on-grade

Uninsulated concrete

80% carpet

Reminder- our sample building is slab on grade, but other building types can be reflected on the Building Form.



	Exposed Floor	Crawlspace	Slab on Grade Floor	Below Grade Floor	Below Grade Floor
Number of Floors Above Grade	3	3	3	2	2
Number of Floors Below Grade	0	0	0	1*	1*
Elevation of First Floor Above Grade	10	4	0	7	3
Depth of Building Below Grade	0	2	0	3	7

* Only "partially" below grade floors may have dwelling units

Image source: Web-based Weatherization Assistant Getting Started Guideline (ORNL)

Image source: Web-based Weatherization Assistant Getting Started Guideline (ORNL)

Entries in the Building Form determine the layout of the Floors form.

Building

Building Size and Occupancy

Number of Dwelling Units:	6	Elevation of First Floor Above Grade (ft):	0
Gross Floor Area of Building (sq ft):	7740	Site Grade Changes:	☐
Number of Floors Above Grade:	3	Depth of Building Below Grade:	
Number of Floors Below Grade:	0	All Sides (ft):	0
Average Floor Height (ft):	8	On the Back (ft):	
Number of Occupants:		On the Right (ft):	
During Daytime:	3	On the Front (ft):	
During Nighttime:	12	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
Hallway Configuration:	Double-Loaded
Hallways Are Conditioned:	☐
Orientation of Building (deg):	0
Total Number of Dwelling Units:	
Top Floor:	2
Intermediate Floor(s):	2
First Floor Above Grade:	2
First Floor Below Grade:	0

Configuration

Floor Area of Enclosed Spaces

Floor	Area (sq ft)				
	Units	Hallways	Other Conditioned Spaces	Other Unconditioned Spaces	Floor Sum
A3	2400	180	0	0	2580
A2	2400	180	0	0	2580
A1	2400	180	0	0	2580
B1	0	0	0	0	0

Floors Form

Configuration

Area and Exposed Perimeter of Floor

Floor	Space	Area (sq ft)	Exposed Perimeter (ft)
A1	Units	2400	220
A1	Hallways	180	12
Totals:		2580.0	232.0

Images sourced from the Web-based Weatherization Assistant (ORNL)

This represents the sample building's completed Floors Form for its first floor.

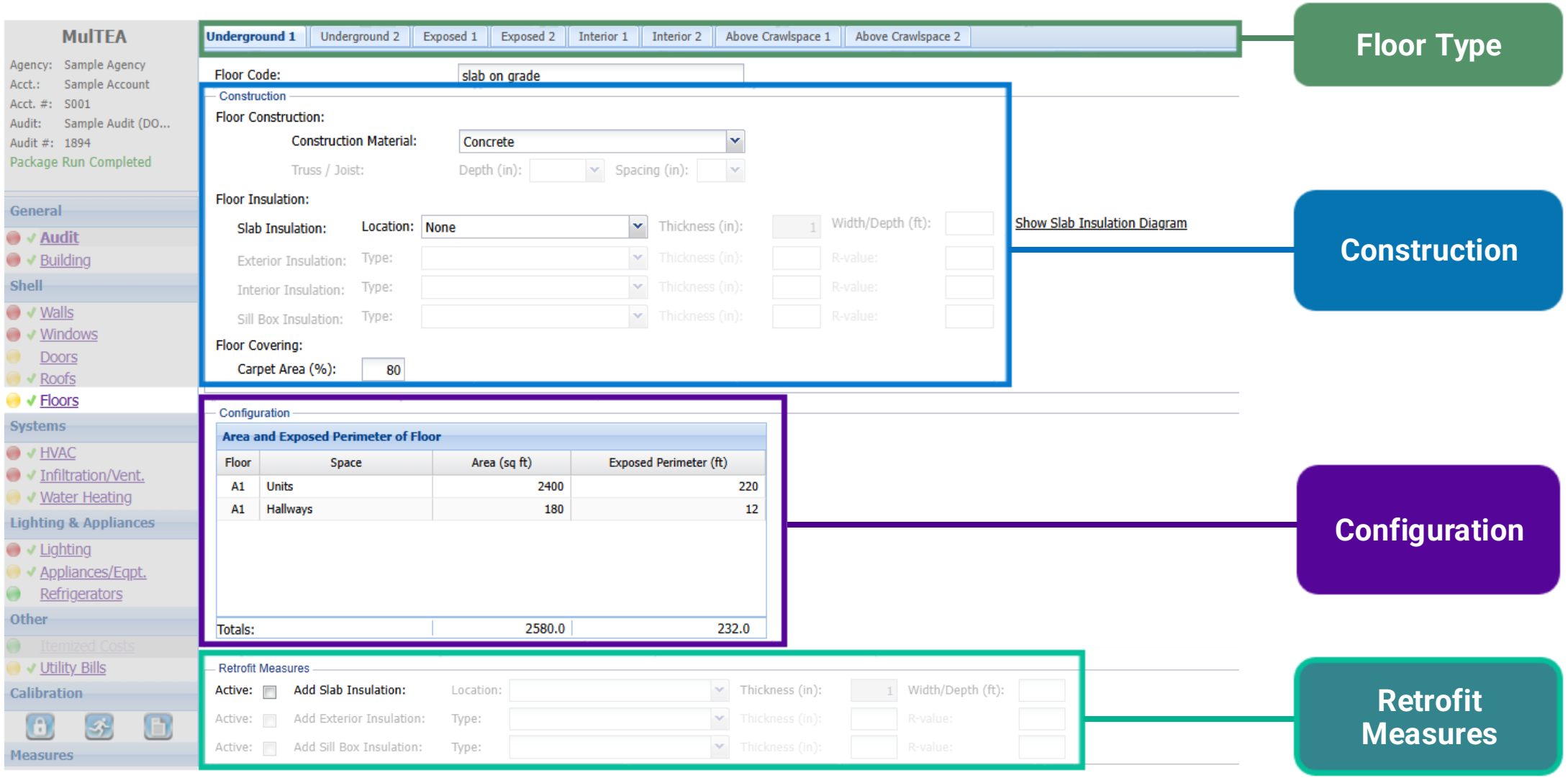


Image source: Web-based Weatherization Assistant (ORNL)

We have now completed the sample building's Floors Form for its first floor.

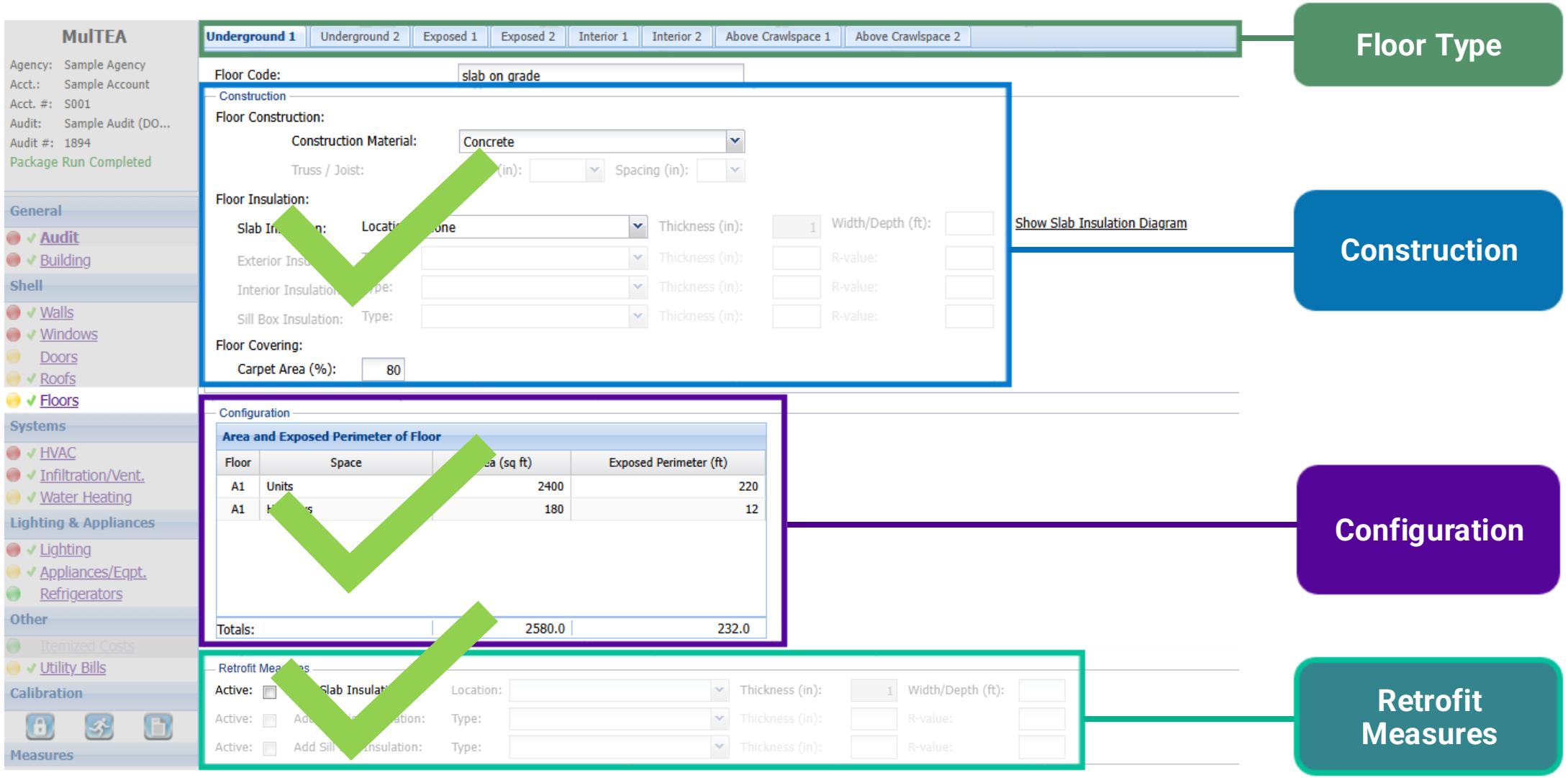


Image source: Web-based Weatherization Assistant (ORNL)

This represents the sample building's completed HVAC Form for its baseboard heaters.

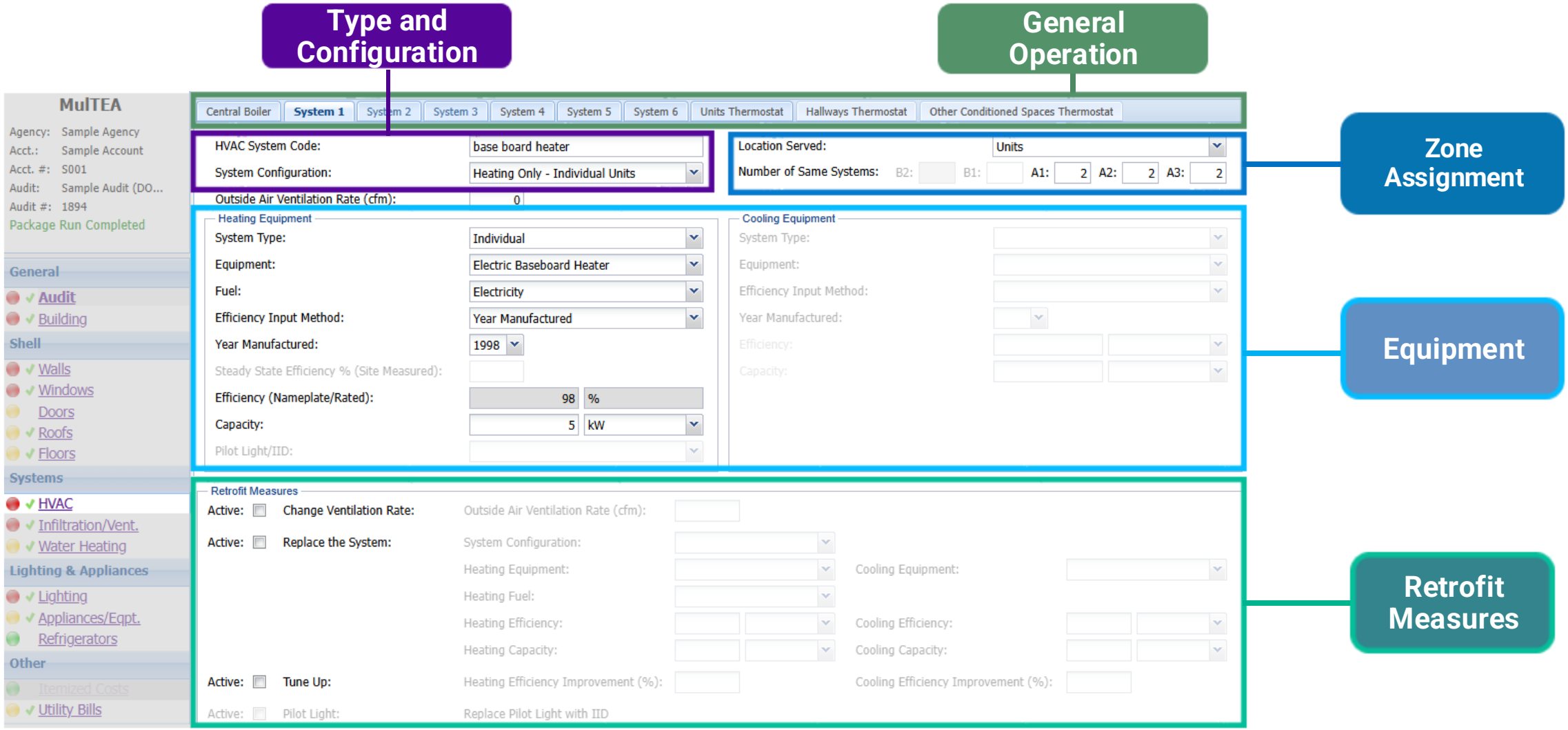


Image source: Web-based Weatherization Assistant (ORNL)

Provided specifications of the sample building HVAC systems.

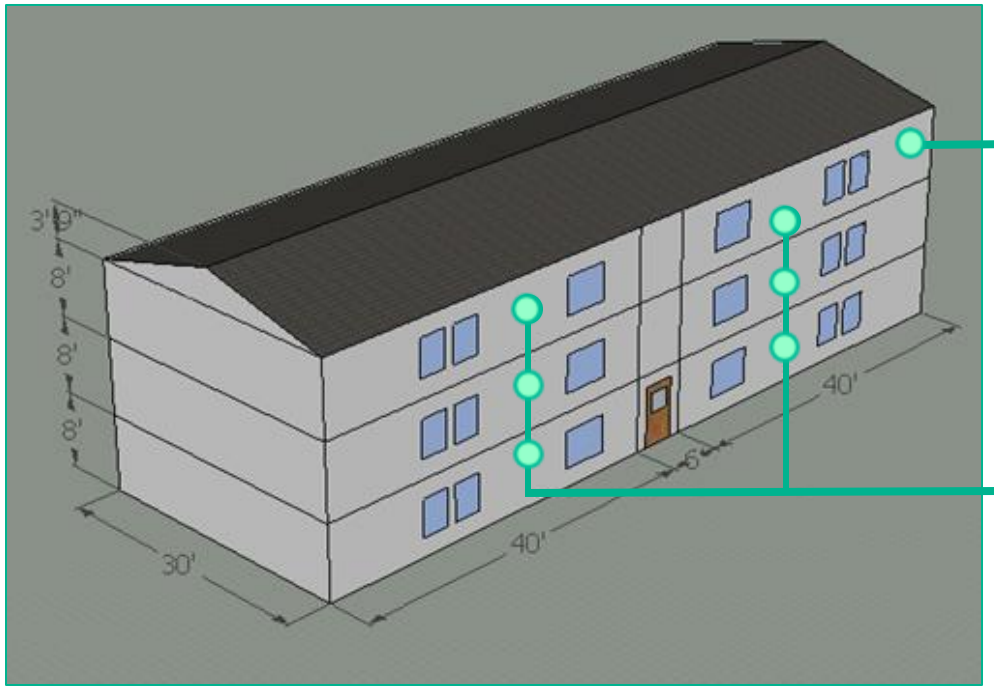


Image source: Manuals and Training Material page on weatherization.ornl.gov

No outside air ventilation

5-kW electric baseboard heater

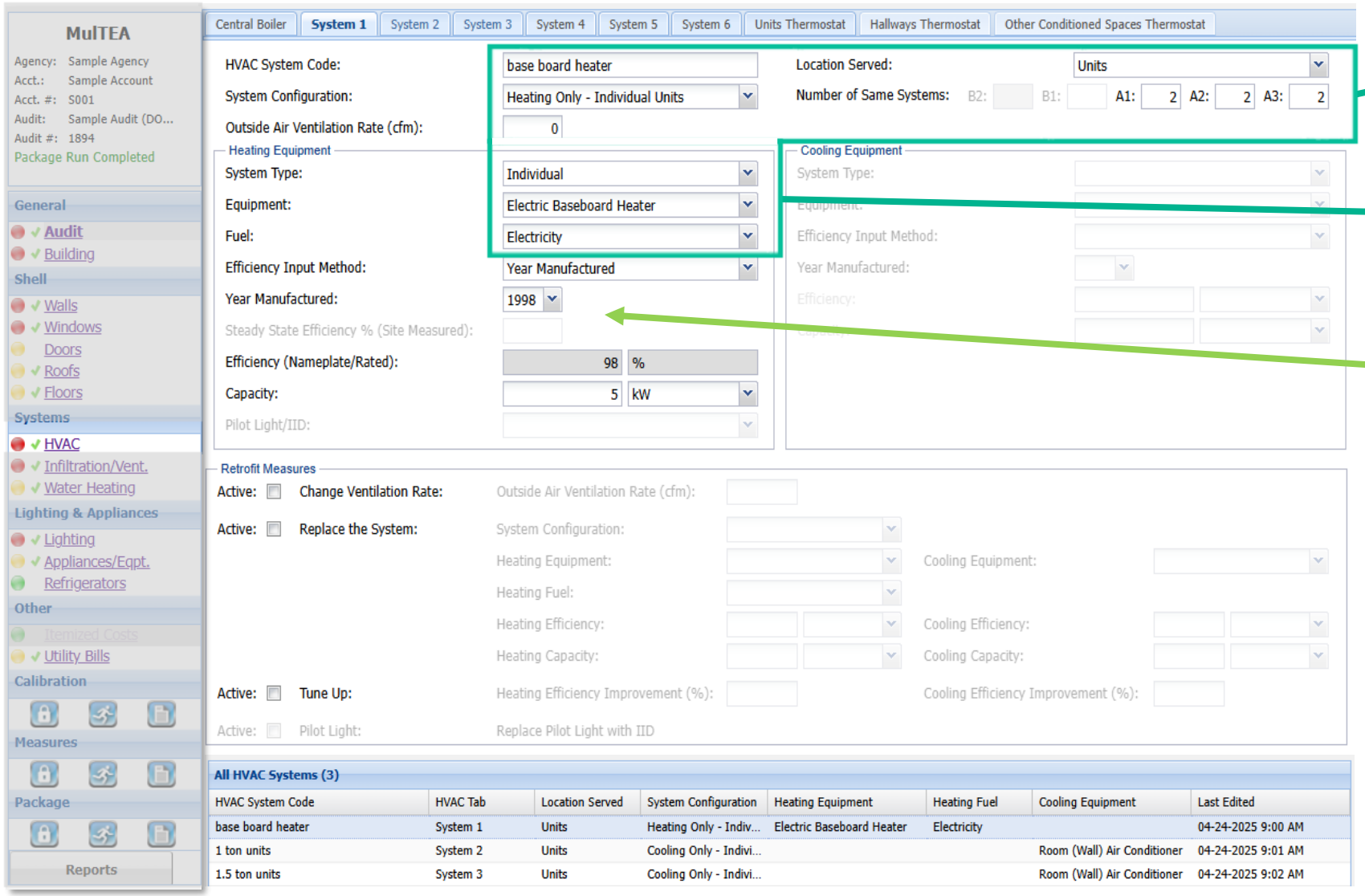
1.5-ton room AC in each unit

1-ton room AC in each unit

All systems manufactured and installed in 1998

Image source: Web-based Weatherization Assistant Getting Started Guideline (ORNL)

We utilize one of the System tabs to input the 5-kW electric baseboard heaters.



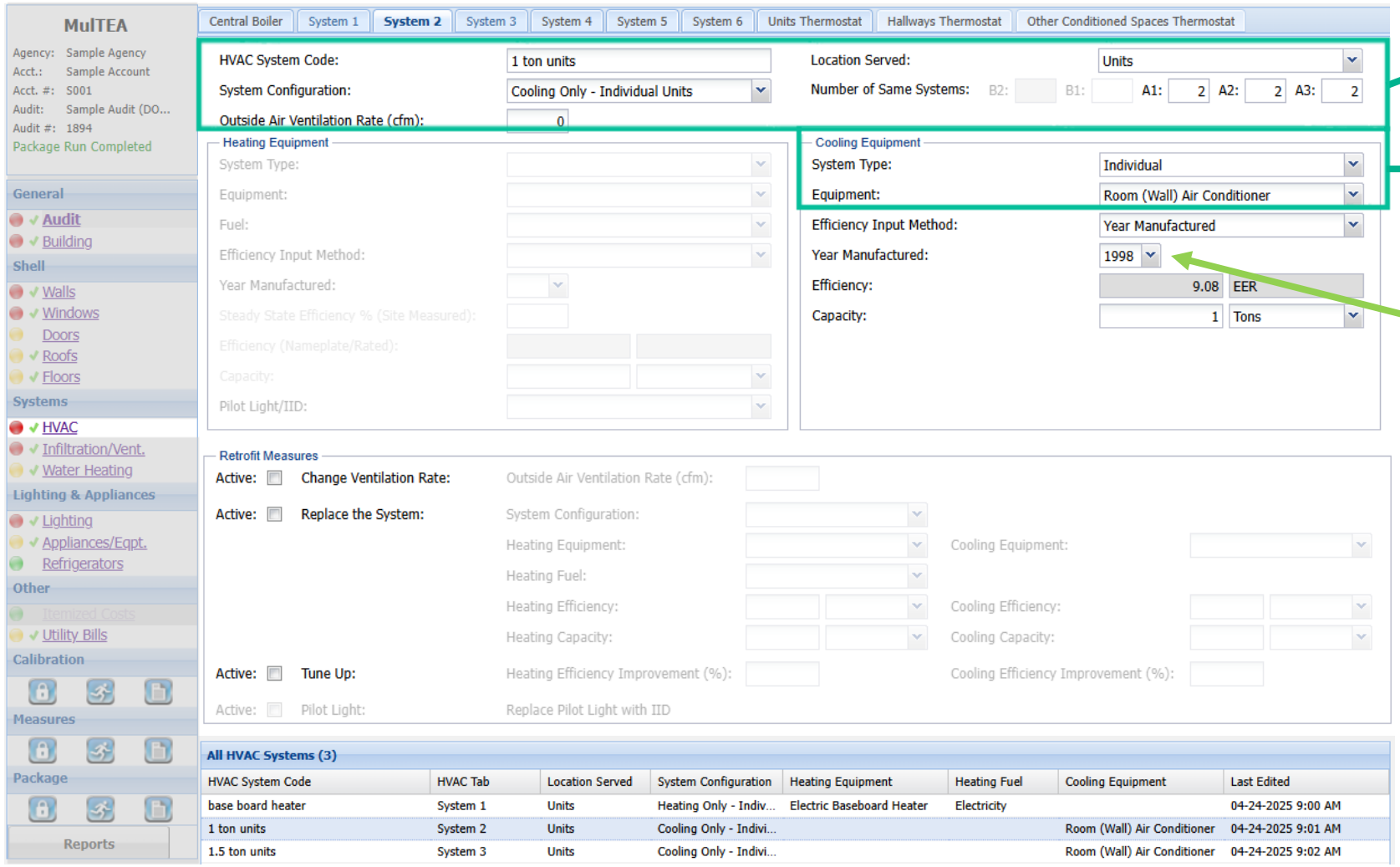
No outside air ventilation

Electric baseboard heaters in each unit

All systems manufactured and installed in 1998

Image source: Web-based Weatherization Assistant (ORNL)

We utilize a second System tab to input the 1-ton room air conditioners.



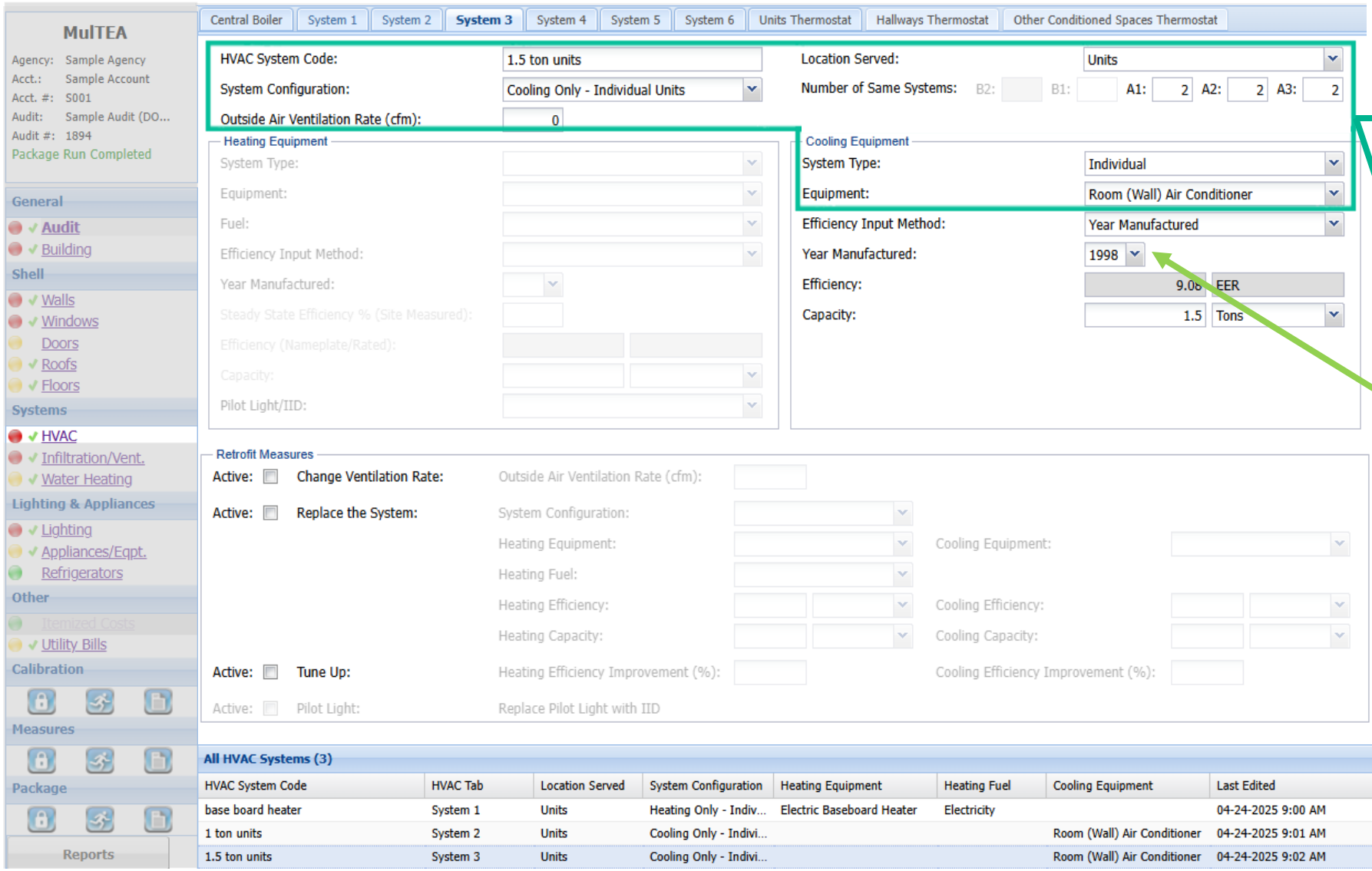
No outside air ventilation

1-ton room air conditioner in each unit

All systems manufactured and installed in 1998

Image source: Web-based Weatherization Assistant (ORNL)

We utilize a third System tab to input the 1.5-ton room air conditioners.



No outside air ventilation

1.5-ton room air conditioner in each unit

All systems manufactured and installed in 1998

Image source: Web-based Weatherization Assistant (ORNL)

We have now completed the sample building's HVAC Form for all heating and cooling systems.

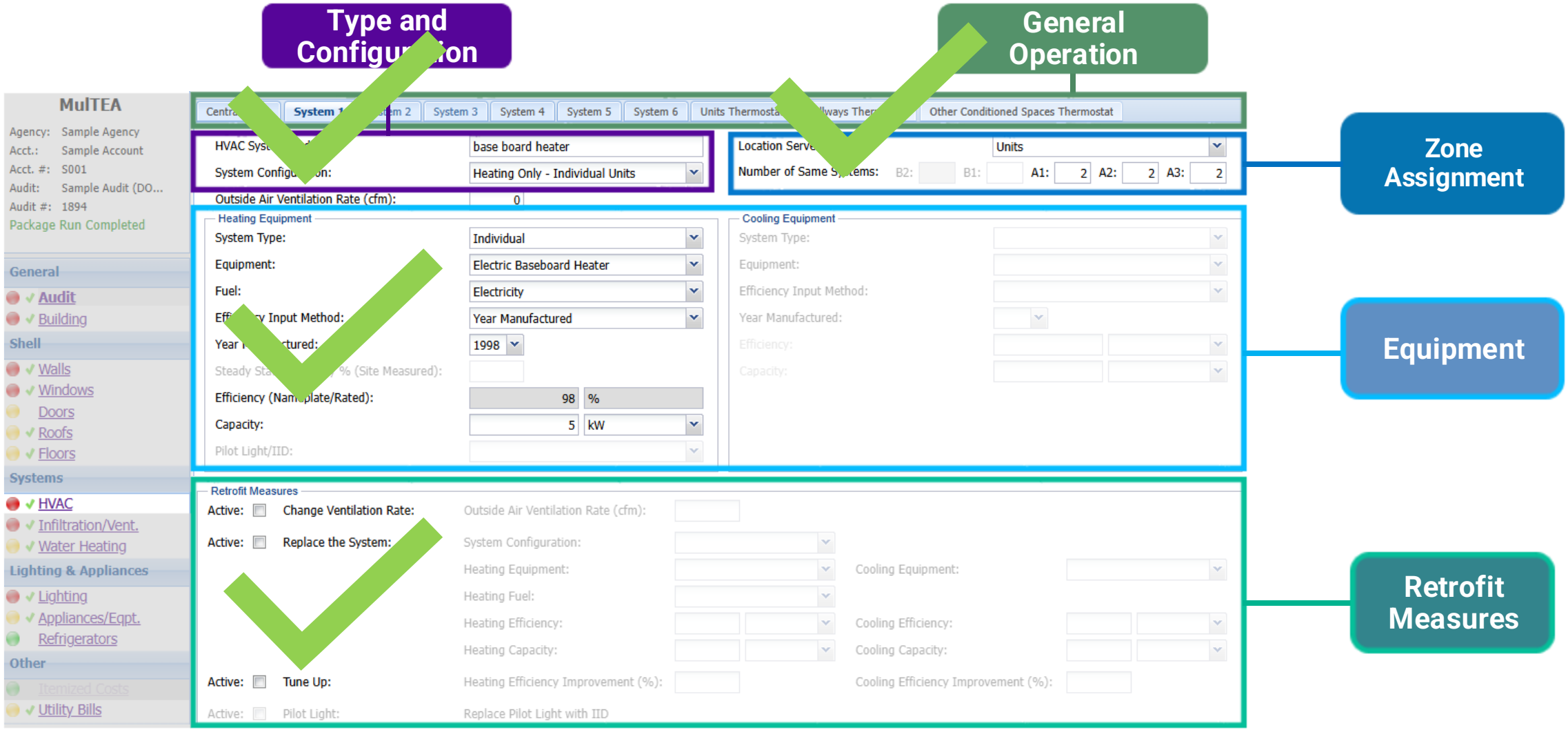
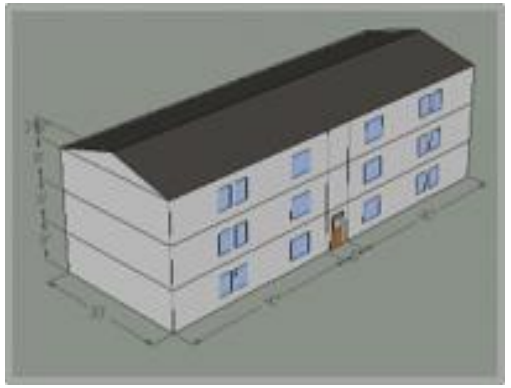


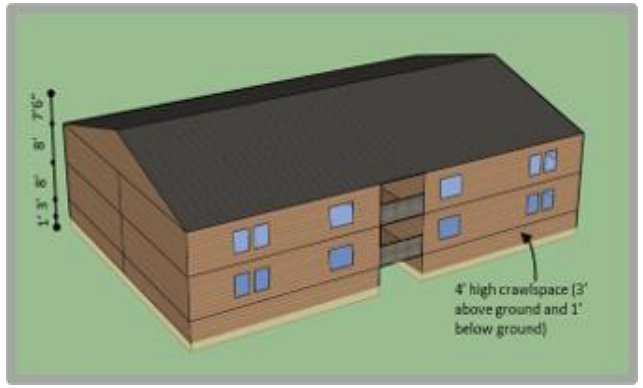
Image source: Web-based Weatherization Assistant (ORNL)

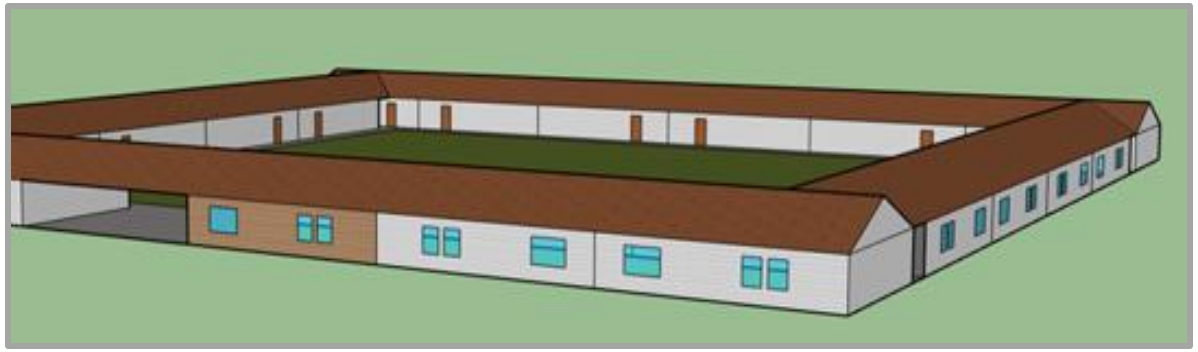
MulTEA allows WAP implementation on common multifamily building types.

WAP-focused	Flexible, multizone simulation tool	Easy configuration and deployment

Questions?







Images sourced from the 1) Web-based Weatherization Assistant Getting Started Guideline (ORNL) and the 2) Manuals and Training Material page on weatherization.ornl.gov

Need Assistance?

Contact our Weatherization Assistant Helpdesk at:

https://weatherization.ornl.gov/contact-us/

or

wahelpdesk@ornl.gov

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