

National Association for State Community Services Programs



2023

WINTER TRAINING CONFERENCE

April 3 – 7 | Arlington, VA

MISSION POSSIBLE

Restoring Hope

**Audit-Related Quality Assurance Issues and
Remedies**

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Top 10 Audit Related Quality Assurance Issues and Remedies

Prepared for 2023 NASCSP Winter Training
Conference

Bill Eckman – Oak Ridge National Laboratory

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

Intro: Bill Eckman

- Program Manager – ORNL-SCEP
- Structural design/construction since 2001
- Building performance/efficiency since 2008
- Former: crew member, energy auditor/inspector, trainer, curriculum developer, business owner, consultant, multifamily auditor, operations and maintenance trainer....



Image 1: Bill Eckman photo – January 2019

Learning Objectives

- List common audit data gathering and input errors
- Define strategies for identifying common audit errors using audit software
- Define strategies for limiting common audit data errors through standardized processes

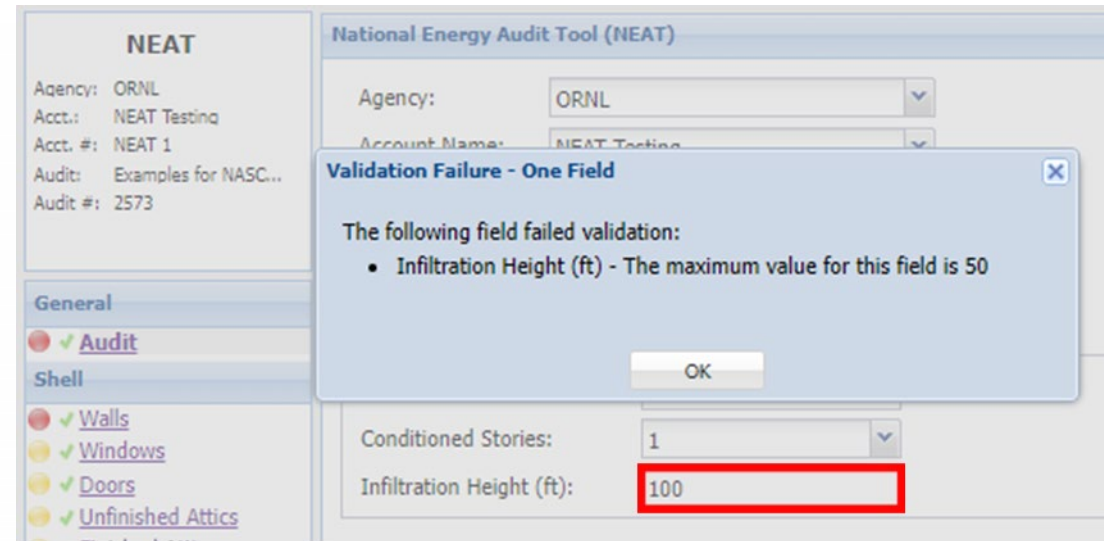


Figure 1: Error message resulting from likely input error in WAV10

The Bigger Purpose of This Session

Improve QA Performance

- **>80% of reviewed audits scoring low (0) in THREE or more categories**
- Cost-effective energy-conservation retrofits are the foundation of the WAP
- **Computerized energy audits** analyze the cost-effectiveness of *multiple retrofit and package options*
- ~50% of reviewed audits exhibit issues with HVAC systems modeling
- >50% of reviewed audits exhibit issues with building envelope modeling

Purpose of QA Processes

- Accurate energy audits
- Technical program compliance
- Statutory program compliance
- The right retrofits
- Cost-effective retrofits

No Work Order(s) provided

- Why it is an issue:
 - Provide details and instructions
 - Link to SWS or other specs
 - Clear communication with installation staff

Measures on WO not in Audit

- Why it is an issue:
 - Measure not tested for compliance (cost-effective)
 - Whole package cost-effectiveness not checked
 - Regulatory requirements not met

Funding Source(s) unclear

- Why it is an issue:
 - Different requirements by funding source
 - Programmatic compliance not met

Work Orders help direct field work and track actual costs

Work Order

WORK ORDER INFORMATION
 Work Order Name: WO0001 Single wide mobile home a1
 Work Order Type: Weatherization
 Audit Name: Sample single wide

CLIENT INFORMATION
 Client Name: Doe, John
 Client ID: 00001 Single wide mobile home
 Alt. Client ID:
 Doe, John

AGENCY INFORMATION
 Agency: Sample Agency
 Address:
 Agency Phone:
 Fax:
 Email Address:

COMMENT

Measures

Measure 1: Repair door

#	Material / Labor	Description / Comment	Units	Estimated		Actual	
				Qty	Unit Cost	Qty	Unit Cost
10	Unspecified	Misc/Material	Each	1	\$20.00	\$20.00	
				Measure Sub Total:		\$20.00	Sub Total:

Measure 2: General Air Sealing

#	Material / Labor	Description / Comment	Units	Estimated		Actual	
				Qty	Unit Cost	Qty	Unit Cost
1	Insulation	General air sealing (setup only)	Each	1	\$0.00	\$0.00	
10	Miscellaneous Su	Infiltration Reduction	Each	1	\$20.00	\$20.00	
				Measure Sub Total:		\$20.00	Sub Total:

Figure 2: Example Work Order from WAv8.9

HSM not entered

- Why it is an issue:
 - Total weatherized unit costs not captured
 - Materials may not be allocated/order
 - Health & Safety non-energy impacts not captured

Measures miscategorized as HSM instead of IRM

- Why it is an issue:
 - Different requirements for HSM vs. IRM
 - Whole package cost-effectiveness not checked
 - Potential disallowed costs

HSM requirement not met

- Why it is an issue:
 - Possible disallowed costs
 - Potential non-energy impacts not realized

HSM not included in whole-building SIR

NEAT Recommended Measures

Agency: [WA] Conversion Training State: [WA] Run On: [9/20/2011 2:26:56 AM] RunID: [97826645]
 Client ID: [Brimm-NEAT Audit] Version: [8.0.5 (2/19/2010)] AuditID: [24819005]
 Audit Name: [NASCIP-APC 202] Audit Date: [9/20/2011]
 Client Name: [] Auditor: []
 Weather File: [LUBBOCKTX.WX] Setup Library Name: [WA] Conversion

Comment

Annual Energy and Cost Savings

Index	Recommended Measure	Component	Heating (MMBtu)	Heating (\$)	Cooling (MMBtu)	Cooling (\$)	BaseLoad (MMBtu)	BaseLoad (\$)	Total (MMBtu)	Total (\$)
1	Infiltration Health		14.3	204	-15	-2	0	0	14.3	202
2	DHWH Pipe Insulation		0.0	0	0	0	203	15	1.0	15
3	DHWH Tank Insulation		0.0	0	0	0	205	14	1.0	14
4	Lighting Retrofit	LT1	0.0	0	0	0	1372	151	4.7	47
5	Smart Thermostat		1.2	18	0	0	0	0	1.2	18
6	Window Replacement	WD1	1.4	20	-3	0	0	0	1.4	20

Energy Saving Measure Economics

Index	Recommended Measure	Component	Measure Savings (\$/yr)	Measure Cost (\$)	Measure SIR	Cumulative Cost (\$)	Cumulative SIR
1	Infiltration Health		0	15	0.0	15	0.0
2	Sheetrock Repair		0	300	0.0	300	0.0
3	Infiltration Health		202	470	3.5	866	2.0
4	DHWH Pipe Insulation		15	15	1.0	881	2.1
5	DHWH Tank Insulation		14	40	3.7	921	2.2
6	Lighting Retrofit	LT1	151	240	3.7	1170	2.5
7	Smart Thermostat		18	75	2.9	1285	2.6
8	Window Replacement	WD1	20	151	1.3	1451	2.8
9	2 Carbon monoxide detector		0	130	0.0	1544	0.0
10	2 Smoke detector		0	55	0.0	1599	0.0
11	CRACKER VENTING		0	400	0.0	2099	0.0
12	MECHANICAL VENTILATION		0	800	0.0	2999	0.0
13	REPLACE WATER HEATER		0	3000	0.0	5999	0.0
14	WATER HEATER		0	1370	0.0	7369	0.0

Audit Name: [NASCIP-APC 202] Client: [Brimm-NEAT Audit] Date: [9/20/2011] Page 1 of 3

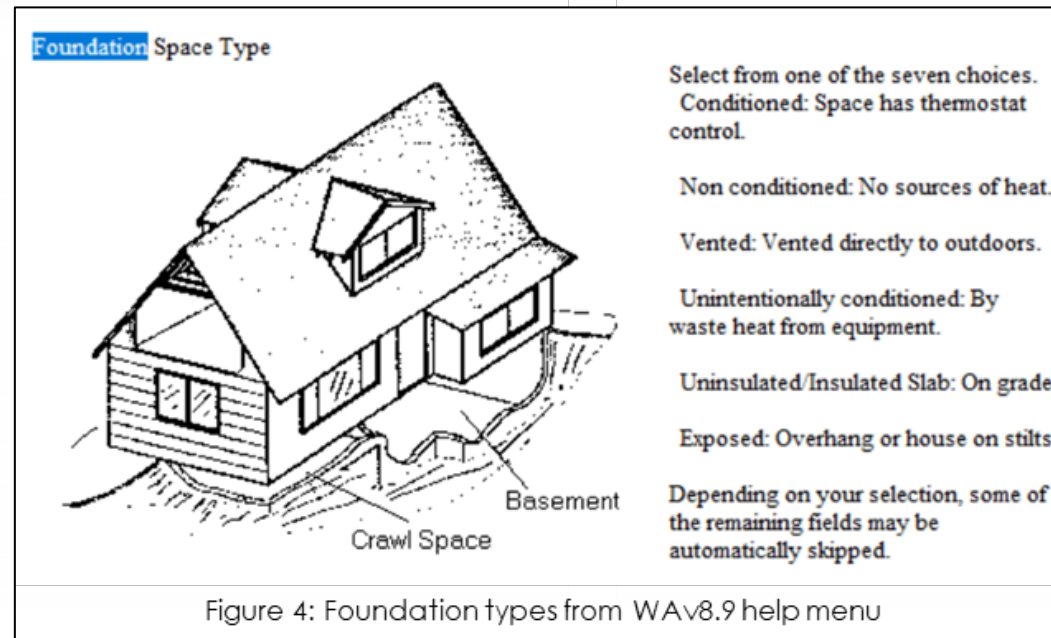
Figure 3: WA v8.9 Recommended Measures report with Health and Safety measures

Foundation type confusion and double entry

- Why it is a concern:
 - Miscalculation of existing space conditioning (heating/cooling) energy use
 - Inaccurate savings for foundation and/or HVAC retrofits
 - Inaccurate cost and materials estimates

Examples:

- Floor over a conditioned basement entered as non-conditioned (insulation added)
- Perimeter and/or area do not agree with footprint
- Less exposed wall than modeled



Attic area larger than conditioned area

- Why it is a concern:
 - Miscalculation of existing space conditioning (heating/cooling) energy use
 - Inaccurate savings for attic insulation and/or HVAC retrofits
 - Inaccurate cost and materials estimates

Examples:

- Total attic area not within +/-10%
- Incorrect existing insulation depth/R-value input
- Missing finished attic elements

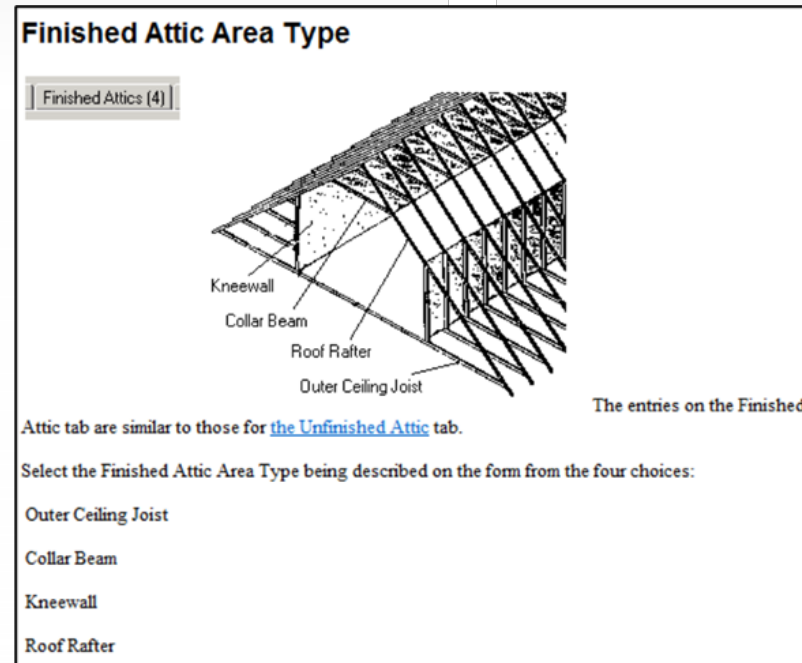


Figure 5: Finished Attic area types from WAv8.9 help menu

Window Shading %

- Why it is a concern:
 - Miscalculation of solar exposure
 - Inaccurate solar gain (summer/winter)
 - Inaccurate savings from window retrofits and/or HVAC retrofits

Examples:

- Summer vs. winter shading
- Auditor adjustment for orientation (e.g. North)

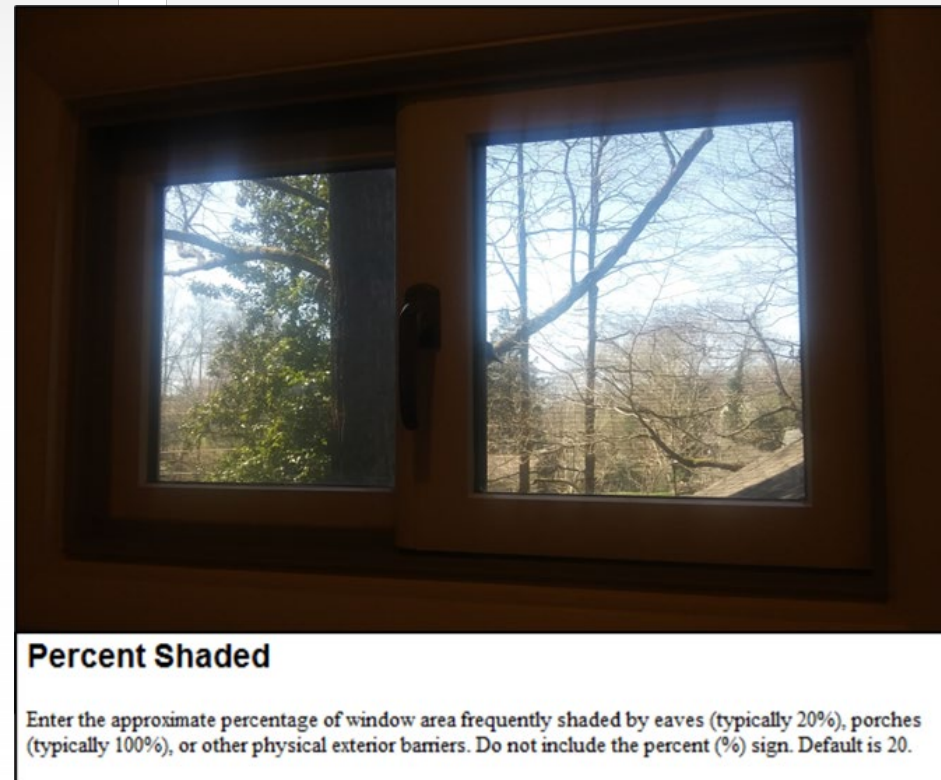


Figure 6: Example window with shading by trees (winter)

Duct sealing included with air sealing

- Why it is a concern:
 - Less funds available for air and duct sealing
 - Miscalculation of energy use and savings
 - May impact HVAC delivered efficiency

Duct sealing/insulation on WO but not audit

- Why it is a concern:
 - Miscalculation of energy use and savings
 - Missing total unit costs/savings in cost-effectiveness test



Figure 7: Example of duct sealing

Sealing/Insulation in conditioned space

- Why it is a concern:
 - Possible overstatement of savings
 - Potential disallowed measures/costs
 - Miscalculation of HVAC energy/savings

Uninsulated ducts not input

- Why it is a concern:
 - Miscalculation of HVAC delivery efficiency
 - Missed energy savings opportunity
 - Potential unintended moisture/durability concerns when paired with cooling system changes

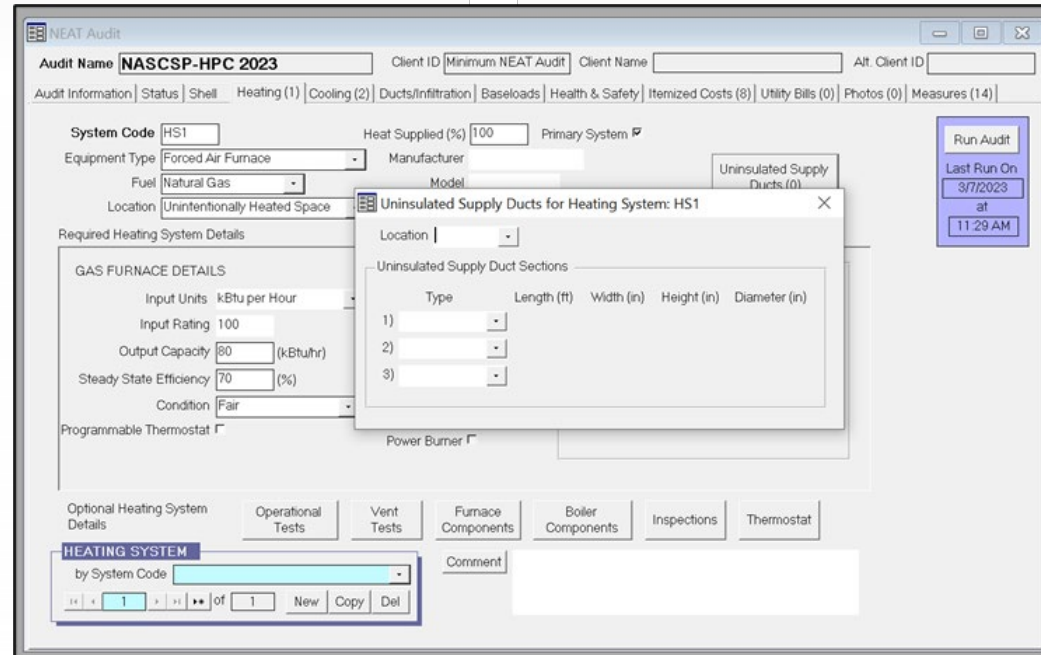
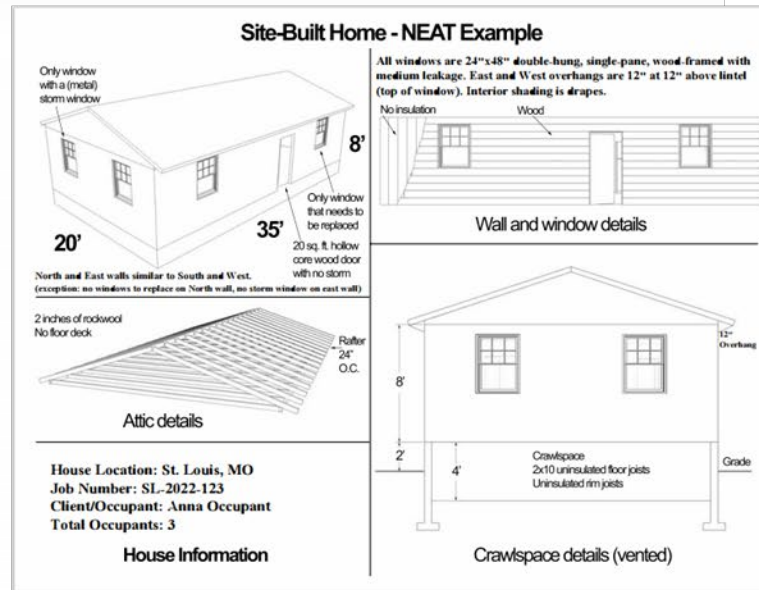


Figure 8: Blank uninsulated ducts input in WAv8.9

Inaccurate wall surface area(s)

- Why it is a concern:
 - Miscalculation of heating/cooling loads
 - Miscalculation of insulation measure savings and costs
 - Miscalculation of HVAC retrofit savings



Examples:

- Wall areas not within +/-10% of actual

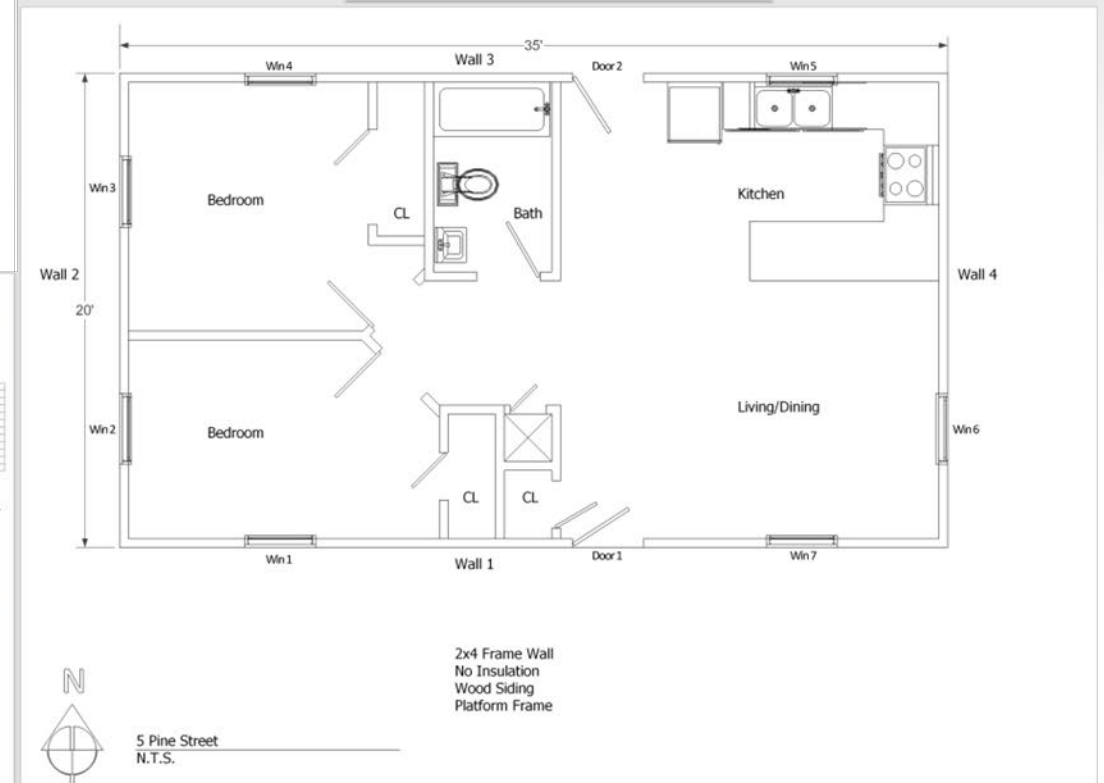


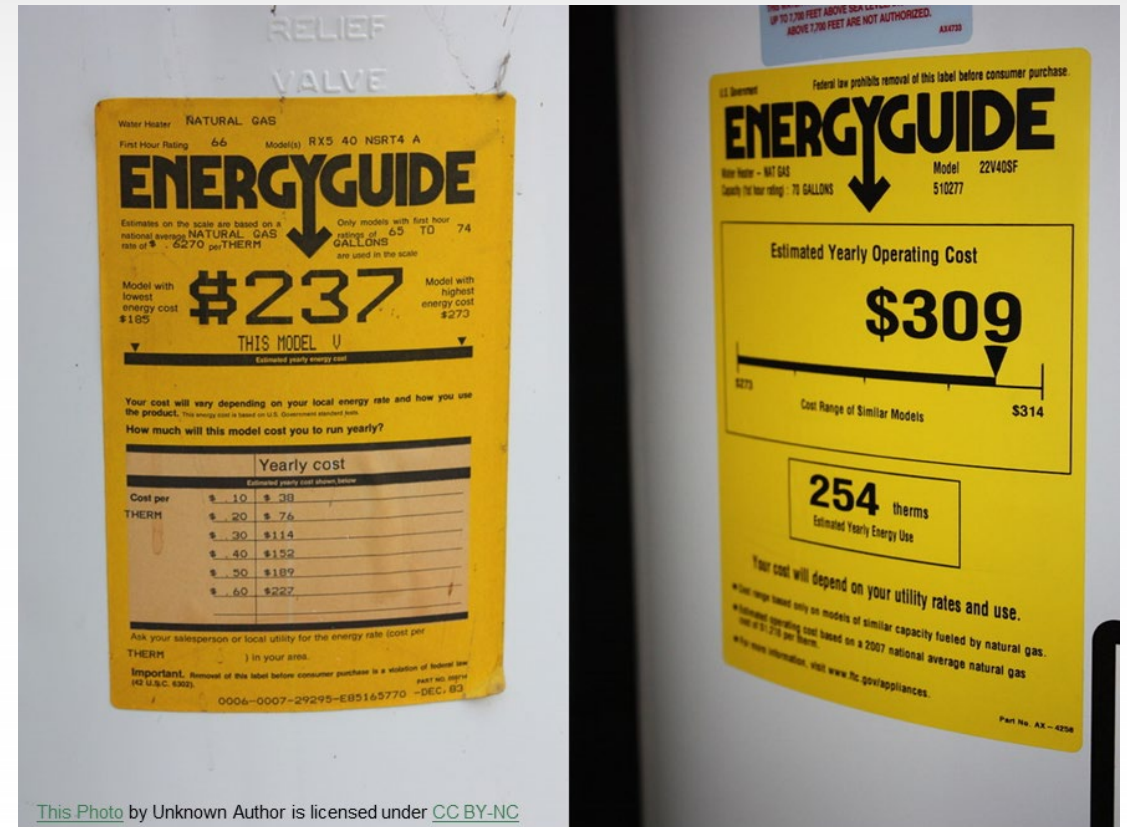
Figure 9: Example simple ranch house layout and elevations

Elec DHW input and EF not appropriate

- Why it is a concern:
 - Miscalculation of existing energy use
 - Miscalculation of energy and cost savings
 - Equipment replacement
 - Other DHW baseload measures
 - If paired with social cost of carbon, miscalculation of emissions savings and added non-energy impacts

Examples:

- Input 4500kW vs. 4.5kW
- EF = 0.45 vs. 0.93



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Figure 10: Example water heater energy guide labels

No ASHRAE calc or details do not match

- Why it is a concern:
 - Unable to show/ensure programmatic compliance
 - May violate “do no harm” principle
 - Costs may be missed and/or disallowed

Examples:

- No calculation
- Occupants and/or other details don't match audit inputs

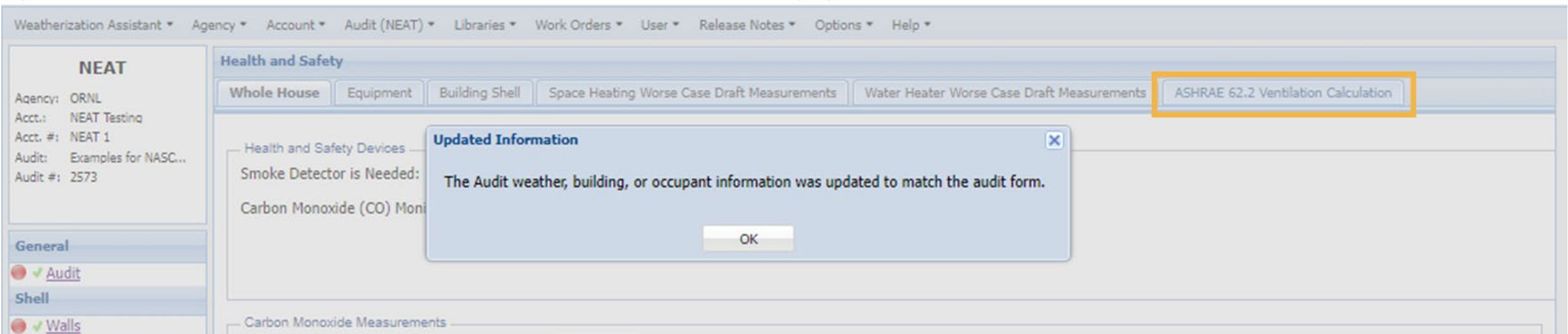


Figure 11: Mismatched data error message for ASHRAE 62.2 Ventilation Calculation in WAv10

Cooling not included in model

- Why it is a concern:
 - Missing cooling energy savings for envelop retrofits
 - Missing cooling energy savings for air and/or duct sealing
 - Miscalculated existing energy use (additional problems with utility bill adjustment functions)

Examples:

- Window air-conditioners present, but not entered in model
- Central air-conditioner shown in photos, but not entered in model



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Figure 12: Window/room air conditioners installed in residential building

Required photos/documents missing

- Why it is a concern:
 - Unable to verify existing conditions
 - Difficulty getting second opinion on inputs and/or retrofit additional costs
 - Unable to properly identify incidental repairs and health and safety conditions/costs

Examples:

- No photos of existing condition provided
- Missing Grantee-required combustion testing forms



Figure 13: Example detail photos documenting existing conditions

Issue

- Work Orders not included or mismatched
- Health and Safety Measures not eligible
- Foundation entry confusion/doubled
- Attic area larger than conditioned area
- Window shading %
- Duct sealing/insulation not modeled
- Wall surface area not accurate
- Electric Water Heater low efficiency input
- ASHRAE 62.2 calculation details do not match
- Cooling not included in model
- Photos/forms/documents missing

Importance

- Provides details, specifications, and costing
- Program compliance and allowed costs
- Incorrect load, savings, and costs
- Increased load, cost, and savings
- Inaccurate solar gain, load, savings, etc.
- Incorrect load, cost, and savings
- Incorrect load, savings, and costs
- Increased savings for retrofits
- Incorrect calculations and retrofits
- Decreased load/savings, missed opportunity
- Verification of details and compliance

No Work Order(s) provided

- Why it is an issue:
 - Provide details and instructions
 - Link to SWS or other specs
 - Clear communication with installation staff

Measures on WO not in Audit

- Why it is an issue:
 - Measure not tested for compliance (cost-effective)
 - Whole package cost-effectiveness not checked
 - Regulatory requirements not met

Funding Source(s) unclear

- Why it is an issue:
 - Different requirements by funding source
 - Programmatic compliance not met

Use audit tool workflow →
Generate WO(s) directly

The screenshot shows the NEAT Audit software interface. At the top, there are fields for 'Audit Name' (NASCSP-HPC 2023), 'Client ID' (Minimum NEAT Audit), 'Client Name', and 'Alt Client ID'. Below these are navigation tabs: 'Audit Information', 'Status', 'Shell', 'Heating (1)', 'Cooling (2)', 'Ducts/Infiltration', 'Baseloads', 'Health & Safety', 'Itemized Costs (8)', 'Utility Bills (0)', 'Photos (0)', and 'Measures (15)'. The main area contains a table with 15 rows of audit measures. Each row includes a measure number, measure name, components, a checkbox, contractor, cost center, estimated cost, and estimated SIR. At the bottom right, there is a 'Run Audit' button and a 'Last Run On' timestamp of 3/7/2023 at 2:28 PM. Below the table are buttons for 'Select All', 'UnSelect All', and 'Invert Select', and a 'Create Work Order(s)' button with a checked option for 'Include Details for Materials'.

#	Measure Name	Components	WO	Contractor	Cost Center	<Est. Cost>	Est SIR	
1	1 Aerator		<input checked="" type="checkbox"/>	cc1	DOE-WAP Formule	\$16.00	0.0	Costs
2	SHEETROCK REPAIR		<input checked="" type="checkbox"/>	cc2	DOE-WAP Formule	\$380.00	0.0	Costs
3	Infiltration Redctn		<input checked="" type="checkbox"/>	asc	DOE-WAP Formule	\$470.00	3.9	Costs
4	DWH Pipe Insulation		<input checked="" type="checkbox"/>	insc	DOE-WAP Formule	\$15.00	10.6	Costs
5	Smart Thermostat		<input checked="" type="checkbox"/>	cc1	DOE-WAP Formule	\$75.00	4.7	Costs
6	DWH Tank Insulation		<input checked="" type="checkbox"/>	insc	DOE-WAP Formule	\$40.00	3.7	Costs
7	Lighting Retrofits	LT1	<input checked="" type="checkbox"/>	cc2	Utility Funds	\$249.00	3.7	Costs
8	Window Replacement	WD1	<input checked="" type="checkbox"/>	cc2	DOE-WAP Formule	\$269.00	1.3	Costs
9	Window Sealing	WD1 (3),WD1 (4),WD1	<input checked="" type="checkbox"/>	cc2	DOE-WAP Formule	\$90.00	1.1	Costs
10	2 Carbon monoxide detector		<input checked="" type="checkbox"/>	asc	DOE-WAP Formule	\$130.00	0.0	Costs
11	2 Smoke detector		<input checked="" type="checkbox"/>	asc	DOE-WAP Formule	\$54.94	0.0	Costs
12	DRYER VENTING		<input checked="" type="checkbox"/>	cc1	DOE-WAP Formule	\$450.00	0.0	Costs
13	MECHANICAL VENTILATION		<input checked="" type="checkbox"/>	cc1	DOE-WAP WRF	\$850.00	0.0	Costs
14	REPLACE HEATER		<input checked="" type="checkbox"/>	cc1	Other HSM Fundinc	\$3,000.00	0.0	Costs
15	WATER HEATER VENTING REP		<input checked="" type="checkbox"/>	cc1	Other HSM Fundinc	\$1,370.00	0.0	Costs

Figure 15: WAv8.9 Work Order Generation Form

HSM not entered

- Why it is an issue:
 - Total weatherized unit costs not captures
 - Materials may not be allocated/order
 - Health & Safety non-energy impacts not captured

Measures miscategorized as HSM instead of IRM

- Why it is an issue:
 - Different requirements for HSM vs. IRM
 - Whole package cost-effectiveness not checked
 - Potential disallowed costs

HSM requirement not met

- Why it is an issue:
 - Possible disallowed costs
 - Potential non-energy impacts not realized

Use audit tool Defined Measures Library (or similar)

The screenshot displays the 'NEAT/MHEA Defined Measure Set Library' interface. At the top, there are fields for 'Defined Measure Set Name' (Inactive Initial Defined Measures), 'Supply Library' (No Supply Library Selected), 'Agency' (ORNL), and 'Active' (checkbox). Below this is the 'Defined Measure Details' section, which includes a 'Measures List' dropdown (201 - Fire Extinguisher (Solid Fuel ONLY)), 'New', 'Copy', and 'Delete' buttons, and checkboxes for 'Active for: NEAT' and 'MHEA'. The 'Measure #' field is 201, with an 'Include in SIR' checkbox. The 'Measure Type' is 'Health and Safety', and the 'Measure Name' is 'Fire Extinguisher (Solid Fuel ONLY)'. The 'Default Contractor/Crew' is 'Test Company'. The 'Measure comments' field contains the text 'Applicable to homes with solid fuel appliance(s) only.' The 'Energy Savings' dropdown is set to 'No Energy Savings'. A 'Materials/Labor Details' section is partially visible at the bottom.

Figure 16: Example custom Health and Safety Measure in WAv10 Defined Measure Library

Foundation type confusion and double entry

- Why it is a concern:
 - Miscalculation of existing space conditioning (heating/cooling) energy use
 - Inaccurate savings for foundation and/or HVAC retrofits
 - Inaccurate cost and materials estimates

Examples:

- Floor over a conditioned basement entered as non-conditioned (insulation added)
- Perimeter and/or area do not agree with footprint
- Less exposed wall than modeled

Use help to define foundation spaces/assemblies prior to entry

Chapter 9: NEAT Building Description

- **Foundation Type** – Select what type of foundation space this is. The choices are Conditioned, Non Conditioned, Vented Non Conditioned, Unintentionally Conditioned, Uninsulated Slab, Insulated Slab, and Exposed Floor. The first four choices are used to describe basements, crawlspaces, and any other type of enclosed foundation space. Conditioned means that the space is purposefully heated (or more rarely cooled) by a heating or cooling system to maintain a temperature at or near the rest of the dwelling. For example, a basement heated by supply registers or radiators in the space would be conditioned, as would a basement heated continuously by a space heater. Unintentionally Heated means that there is a heat source in the space that adds heat unintentionally to the space so that the temperature of the space is maintained above the outside temperature or ground temperature. For example, a basement that is heated because a furnace or water heater is located in the basement or because uninsulated ductwork runs through the basement would be unintentionally heated. Non Conditioned means that there are no sources of heat in the space other than conduction through walls, floors, and perhaps insulated ductwork. Vented Non Conditioned means that there are no sources of heat in the space other than conduction through walls, floors and perhaps uninsulated ductwork, and the space is vented directly to the outdoors. For example, a crawlspace with foundation vents would be Vented Non Conditioned. An Exposed Floor is used to describe a floor that is exposed directly to the outside air. For example, a second-story floor overhang would be an Exposed Floor, as would the floor of a house built on stilts or using pier and beam construction such that ambient air can freely flow beneath the house. *Required.*

Foundation Space Type

Select from one of the seven choices.

- Conditioned: Space has thermostat control.
- Non conditioned: No sources of heat.
- Vented: Vented directly to outdoors.
- Unintentionally conditioned: By waste heat from equipment.
- Uninsulated/Insulated Slab: On grade.
- Exposed: Overhang or house on stilts.

Depending on your selection, some of the remaining fields may be automatically skipped.

Figure 17: Example WAV10 Tool-tip, WAV8.9 Help, and WAV8.9 User Manual

Window Shading %

- Why it is a concern:
 - Miscalculation of solar exposure
 - Inaccurate solar gain (summer/winter)
 - Inaccurate savings from window retrofits and/or HVAC retrofits

Shading % no longer used in WAv10 –
now defined by directly confirmable/measurable details

Exterior Shading: Overhang or Awning

Overhang/Awning

Horizontal Projection (in):

Distance from Lintel (in):

Examples:

- Summer vs. winter shading
- Auditor adjustment for orientation (e.g. North)

Windows

* New Window *

Existing Window

Window Code: Window 1

Window Type: Slider

Frame Type: Wood

Glazing Type: Single Pane

Storm Window: None

Interior Shading: None

Exterior Shading:

Overhang/Awning

Horizontal Projection (in):

Distance from Lintel (in):

Leakiness:

Width (in):

None

Overhang or Awning

Carport or Porch

Low-e Film

Sun Screen Fabric

Sun Screen Louvered

Figure 19: WAv10 Windows Form with exterior shading details

Duct sealing included with air sealing

- Why it is a concern:
 - Less funds available for air and duct sealing
 - Miscalculation of energy use and savings
 - May impact HVAC delivered efficiency

Duct sealing/insulation on WO but not audit

- Why it is a concern:
 - Miscalculation of energy use and savings
 - Missing total unit costs/savings in cost-effectiveness test

Use standard workflow and separate duct sealing inputs

NEAT Audit

Audit Name: **NASCSP-HPC 2023** Client ID: Minimum NEAT Audit Client Name: []

Audit Information | Status | Shell | Heating (1) | Cooling (2) | **Ducts/Infiltration** | Baseloads | Health & Safety | Itemized Costs (8) | Utility B

Air and Duct Leakages | Optional Blower Door and Zonal Pressures (0) | Optional Pressure Balance (0) | Optional Pressure Pans (0)

Evaluate Duct Sealing Duct Leakage Method: []

Whole House Blower Door Measurements

	Before Weatherization (Existing)	After (Target or Actual)
Air Leakage Rate (cfm)	3500	1000
at House Pressure Difference (Pa)	50	50

Weatherization Assistant Agency Account Audit (MHEA) Libraries Work Orders User Release Notes Options Help

MHEA

Agency: IL State WAP Office
Acct.: MHEA Examples
Acct. #: MHEA Example 001
Audit: MHEA Example 1
Audit #: 2576

Ducts and Infiltration

Evaluate Duct Sealing: Duct Leakage Method: Pressure Pan Measurements

Whole House Blower Door Measurements

	Before (Existing)	After (Target or Actual)
Air Leakage Rate (cfm)	3000	1900
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)	28	7

Costs

Infiltration Reduction (\$): 250
Duct Sealing (\$): 300

Figure 20: Example Duct sealing input options - WAv8.9 (NEAT) and WAv10 (MHEA)

Sealing/Insulation in conditioned space

- Why it is a concern:
 - Possible overstatement of savings
 - Potential disallowed measures/costs
 - Miscalculation of HVAC energy/savings

Uninsulated ducts not input

- Why it is a concern:
 - Miscalculation of HVAC delivery efficiency
 - Missed energy savings opportunity
 - Potential unintended moisture/durability concerns when paired with cooling system changes

Ducts form provides added flexibility/QC options (WAv10)

The screenshot displays the 'Duct Systems' form with the following inputs:

- Supply** (tab selected)
- Existing Equipment: Duct System Code: Supply
- Duct Type: Supply Return
- HVAC Systems Served: Heating: Furnace, Cooling: AC
- Duct Location: Unconditioned Crawlspace/Belly
- Duct Insulation: Below Duct
- Use Defaults:
- Surface Area (sq ft): 226.8
- Insulation R-value: 7
- Number of Return Registers: (empty)

Two dropdown menus are shown with their options:

- Duct Location:** Conditioned Space, Unconditioned Attic/Ceiling, Unconditioned Garage, Unconditioned Basement, Unconditioned Crawlspace/Belly
- Duct Insulation:** Below Duct, Above Duct, Around Duct or Ductboard, No Insulation

The 'Duct Dimensions' dialog box is open, showing the following table:

Duct Section	Shape	Length (ft)	Width (in)	Height (in)	Diameter (in)
Section 1	Round	30			6
Section 2	Rectangular	30	16	8	

Figure 21: Example inputs on the WAv10 Ducts Form

Inaccurate wall surface area(s)

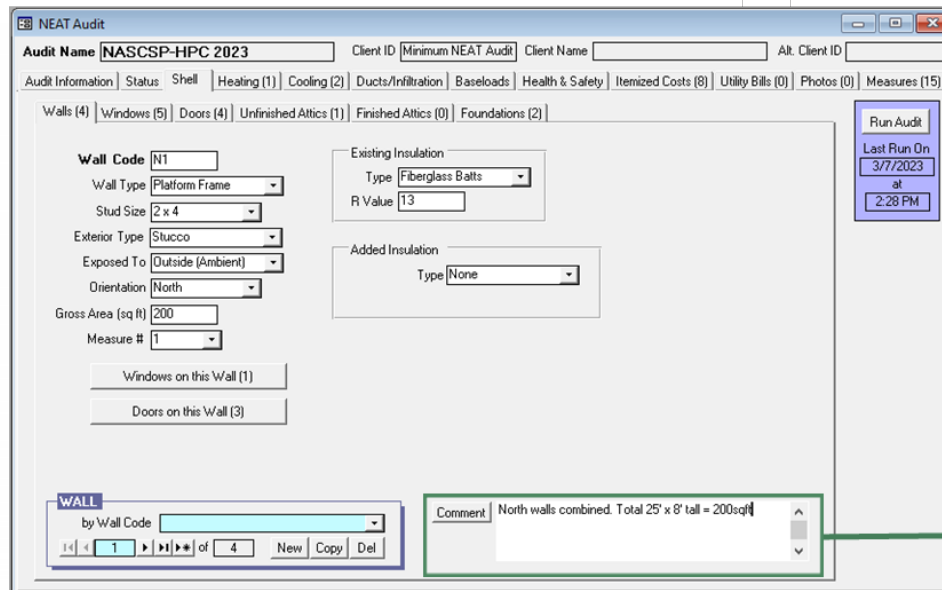
- Why it is a concern:
 - Miscalculation of heating/cooling loads
 - Miscalculation of insulation measure savings and costs
 - Miscalculation of HVAC retrofit savings

Include details in Comments

Use summary spreadsheet for QC check

Examples:

- Wall areas not within +/-10% of actual



input		result		Data Collection Form				
Feet	Feet	Oriented	ft2	Feet	Feet	Oriented	ft2	
12	8	N	96	100	8		800	
10	8	N	80					
2	8	N	16					
1	8	N	8					
25	8	W	200					
25	8	S	200					
25	8	E	200					
			800	Total ft2			800	Total ft2
			200	N				N
			200	S				S
			200	E				E
			200	W				W
								% variation

North walls combined. Total 25' x 8' tall = 200sqft

Figure 22: Examples of WA Wall Comments and Area Calculator

Elec DHW input and EF not appropriate

- Why it is a concern:
 - Miscalculation of existing energy use
 - Miscalculation of energy and cost savings
 - If paired with social cost of carbon, miscalculation of emissions savings and added non-energy impacts

Use default and/or input range check for QC

M-I-40L***S-13	Electricity	40	4.5	0.88	0.98
M-I-40S***S-13	Electricity	40	4.5	0.88	0.98
M-I-40T***N-13	Natural Gas	40	40	0.54	0.76
M-I-40T**CX-13	Propane	40	38	0.54	0.76

Water Heating

Existing Equipment
 Manufacturer: Fuel: Electricity
 Model: Input Units: KW
 Equipment Type: Storage Rated Input: 4500
 Location: Conditioned Space
 Rated Storage Capacity (gal): ! The maximum value for this field is 150
 Energy Factor:
 Uniform Energy Factor:
 First-Hour Rating (gal):
 Recovery Efficiency: Estimate

Replacement
 Pick from Supply L
 Manufacturer:
 Model:
 Rated Input:
 Rated Storage Cap (gal):

Water Heater Wrap Present:
 Water Heater Pipe Insulation Present:

Examples:

- Input 4500kW vs. 4.5kW
- EF = 0.45 vs. 0.93

Water Heating

Existing Equipment
 Manufacturer: Bradford White Corporation Fuel: Electricity
 Model: Input Units: KW
 Equipment Type: M-I-40T**CX-13 Propane 40 48 0.56 0.76
 Location: M-I-40L***S-13 Electricity 40 4.5 0.88 0.98
 M-I-40S***S-13 Electricity 40 4.5 0.88 0.98
 M-I-40T***N-12 Natural Gas 40 40 0.54 0.76
 M-I-40T***N-13 Natural Gas 40 40 0.54 0.76
 Water M-I-40T***S-13 Electricity 40 4.5 0.88 0.98
 Water Heater Pipe M-I-40T**CX-12 Propane 40 38 0.54 0.76
 M-I-40T**CX-13 Propane 40 38 0.54 0.76
 Original Tank Ins R Val M-I-503***N-10 Natural Gas 50 40 0.55 0.77
 M-I-503**CX-10 Propane 50 40 0.55 0.77
 M-I-504S***N-10 Natural Gas 50 50 0.54 0.76
 M-I-504S***N-11 Natural Gas 50 50 0.55 0.76
 M-I-504S**CX-10 Propane 50 48 0.54 0.76
 M-I-504S**CX-11 Propane 50 50 0.55 0.76
 Showerheads
 Number of Showerheads: Flow Rate (gpm):

Rated Input: 4500 Model:
 Values are ! The maximum value for this field is 150

Figure 23: Examples of Water Heater input range check and Default Values in WA10

No ASHRAE calc or details do not match

- Why it is a concern:
 - Unable to show/ensure programmatic compliance
 - May violate “do no harm” principle
 - Costs may be missed and/or disallowed

Examples:

- No calculation
- Occupants and/or other details don't match audit inputs

Use included calculator with linked datapoints (WAv10)

The screenshot shows the 'ASHRAE 62.2 Ventilation Calculation' window. It includes tabs for 'Whole House', 'Equipment', 'Building Shell', 'Space Heating Worst Case Draft Measurements', 'Water Heater Worst Case Draft Measurements', and 'ASHRAE 62.2 Ventilation Calculation'. The 'ASHRAE Standard 62.2 Version' is set to 2016. The 'Weather State' is 'TN' and 'Weather Station' is 'Knoxville Mcghee Tyson Ap'. 'Floor Area (sqft)' is 3200 and 'Infiltration Height (ft)' is 31. 'Number of Bedrooms' is 4 and 'Number of Occupants' is 5. A checkbox for 'Use number of occupants for ventilation calculation' is checked. The 'Kitchen and Bath Exhaust Information' table shows 'PreWx', 'Target', and 'PostWx' values for various spaces. 'Blower Door Measurements' include 'Air Leakage Rate (cfm)', 'House Pressure Difference (Pa)', and 'Continuous Ventilation Needed (cfm)'.

Space	Operable Window	PreWx CFM Deficit	Target CFM Deficit	PostWx CFM Deficit
Bathroom 1	<input type="checkbox"/>			
Bathroom 2	<input type="checkbox"/>			
Bathroom 3	<input type="checkbox"/>			
Bathroom 4	<input type="checkbox"/>			
Bathroom 5	<input type="checkbox"/>			
Kitchen 1	<input type="checkbox"/>			
Kitchen 2	<input type="checkbox"/>			

Linked datapoints shown in Gray

This callout box displays the following linked datapoints in gray:

- Weather State: TN
- Weather Station: Knoxville Mcghee Tyson Ap
- Floor Area (sqft): 3200
- Infiltration Height (ft): 31
- Number of Bedrooms: 4
- Number of Occupants: 5
- Use number of occupants for ventilation calculation (i.e., if exception to ASHRAE 62.2 occupant density calculation applies)

Figure 24: ASHRAE 62.2 Ventilation Calculator in WAv10 with linked datapoints grayed out

Cooling not included in model

- Why it is a concern:
 - Missing cooling energy savings for envelop retrofits
 - Missing cooling energy savings for air and/or duct sealing
 - Miscalculated existing energy use (additional problems with utility bill adjustment functions)

Use HVAC/Cooling inputs whenever applicable

Without AC entered:
Total Annual Savings = \$358

Economics					
Index	Recommended Measure	Components	Measure Savings (\$/yr)	Measure Cost (\$)	Measure SIR
Weatherization Measures					
1	Wall Insulation	WL1	\$241	\$2,020	1.88
2	General Air Sealing	Ducts/Infiltration	\$117	\$2,000	0.51
Total			\$358	\$4,020	1.20

Examples:

- Window air-conditioners present, but not entered in model
- Central air-conditioner shown in photos, but not entered in model

The screenshot shows the 'HVAC Systems' software interface. The 'Existing Equipment' section is set to 'AC1' (Air Conditioner - Room). The 'Economics' table is overlaid on the interface, showing two scenarios:

Economics					
Index	Recommended Measure	Components	Measure Savings (\$/yr)	Measure Cost (\$)	Measure SIR
Weatherization Measures					
1	Wall Insulation	WL1	\$241	\$2,020	1.88
2	General Air Sealing	Ducts/Infiltration	\$117	\$2,000	0.51
Total			\$358	\$4,020	1.20

Below the table, a callout box states: "With AC entered: Total Annual Savings = \$519 (+\$161)".

Figure 25: WAV10 simple AC input and results comparison

Issue

- Work Orders not included or mismatched
- Health and Safety Measures not eligible
- Foundation entry confusion/doubled
- Attic area larger than conditioned area
- Window shading %
- Duct sealing/insulation not modeled
- Wall surface area not accurate
- Electric Water Heater low efficiency input
- ASHRAE 62.2 calculation details do not match
- Cooling not included in model

Solution

- Software WO generation workflow
- Create standard HSM in Defined Measures
- Use Help/tips to define spaces before entry
- Record dimensions in notes - verify
- Use updated inputs in WAv10
- Use Duct inputs in WAv10
- Record dimensions in notes – verify
- Use defaults and/or tool tip for sanity check
- Use embedded ASHRAE 62.2 calculator and linked datapoints
- Input Cooling equipment whenever applicable

The Bigger Purpose of This Session

Improve QA Performance

- **>80% of reviewed audits scoring low (0) in THREE or more categories**
- Cost-effective energy-conservation retrofits are the foundation of the WAP
- **Computerized energy audits** analyze the cost-effectiveness of *multiple retrofit and package options*
- ~50% of reviewed audits exhibit issues with HVAC systems modeling
- >50% of reviewed audits exhibit issues with building envelope modeling

Purpose of QA Processes

- Accurate energy audits
- Technical program compliance
- Statutory program compliance
- The right retrofits
- Cost-effective retrofits

Missing documentation/photos

- Why it is a concern:
 - Unable to verify existing conditions
 - Difficulty getting second opinion on inputs and/or retrofit additional costs
 - Unable to properly identify incidental repairs and health and safety conditions/costs

Who is using a photo management service/software?
What are you using?

Examples:

- No photos of existing condition provided
- Missing Grantee-required combustion testing forms



Figure 13: Example detail photos documenting existing conditions

Top 10 Audit Related Quality Assurance Issues and Remedies

Prepared for NASCSP 2023 Winter Training
Conference

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