

Understanding Energy Audits for New Program Managers

May, 2021



First and Foremost

Please ask questions!



Learning Objectives

- **Understanding why we do an audit**
 - Answering whether this is all about saving energy
 - Knowledge about what is a good energy audit
- **Identifying “spot checks” help determine if the energy audit is reasonable**
 - Understanding options/resources to access if something seems wrong
- **Resources related to the Audit Approval Process (every 5 years)**
 - Gain background on why this is required and what can make this easier

The Big Picture

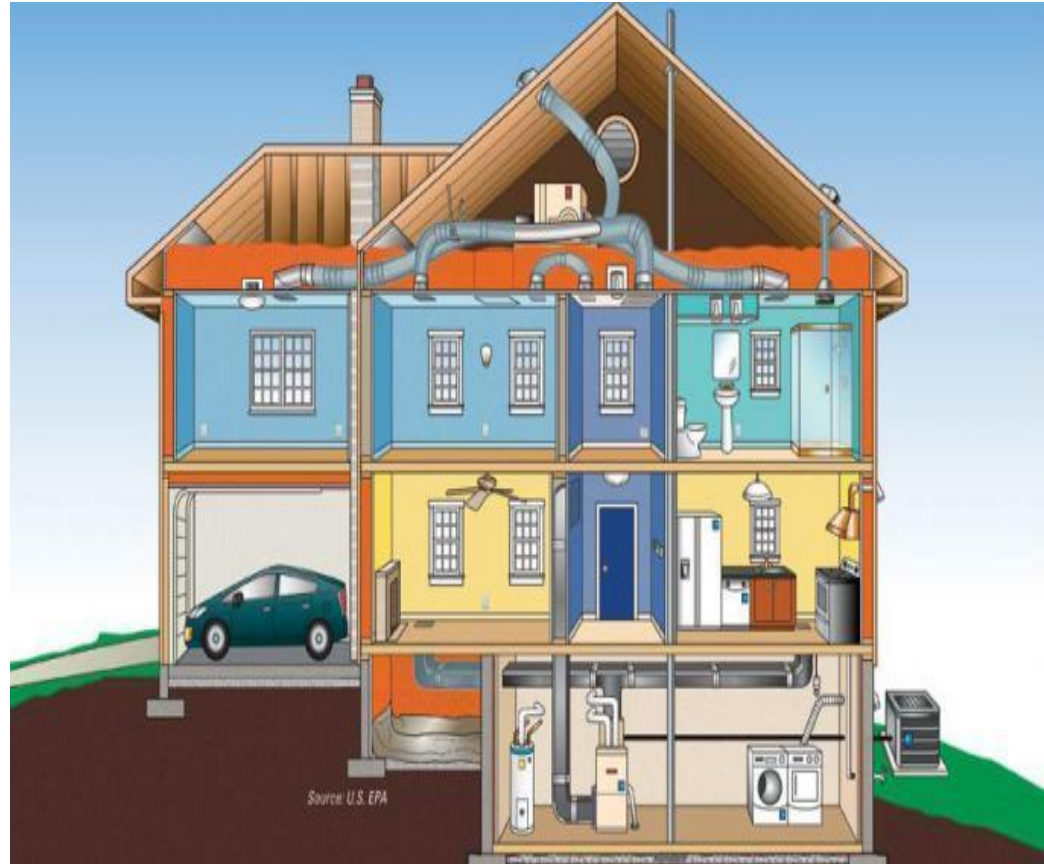
The “Big Picture” is simple:

- **Savings to Investment Ratio (SIR) \geq 1.0**
 - SIR – The ratio of the present value savings to the present value costs of an energy conservation measure (ECM), i.e., the lifetime of the ECM and the cost of money
- **Health & Safety**
 - Measures that ensure the health and safety of clients and Weatherization Assistance Program (WAP) workers

The Big Picture

The “House as a System”

- Each component of the house interacts with other components of the house.
- If you change one thing, other things are affected within the house.



What is an Energy Audit?



What is an Energy Audit?

- **Energy Audit:** A comprehensive assessment of the energy needs and efficiency of a building or buildings.



When is an Energy Audit Required?

- .. For Every Dwelling Weatherized



What is an *Electronic Energy Audit*

- ***Electronic Energy Audit***: A software *tool* that applies engineering and economic calculations to an energy audit which assists users in the selection of ECMs...
 - That meet regulatory criteria for cost-effectiveness.
 - That are approved (in Appendix A or individually approved by DOE) to be installed in homes of low-income families enrolled in the Program.

What is an *Electronic* Energy Audit

- A DOE-approved WAP energy audit Tool is used to:
 - Select and rank ECMs for individual houses OR
 - Establish a priority list of weatherization measures for nearly identical housing types.
- **Weatherization Program Notice (WPN) 19-4**
 - Describes approval criteria to determine an energy audit's compliance with rule 10 Code of Federal Regulations (CFR) Part 440.21
 - How audit tools get approved, coming later in presentation

KEY Purpose/Outputs of the Electronic Energy Audit Tool

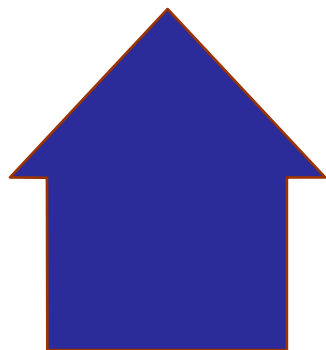
- Calculate Individual SIRs first.
- Rank Measures by SIR – Higher is at top of the list.
- Building is modified and re-simulated with higher ranked measure, i.e. measures are "interacted"*
 - Completes this for all appropriate measures in the Library Measures
 - Reduces energy savings of the total package of measures
 - Diminishing energy savings of lower ranked measures
 - Low energy saving measures with moderate to high costs will fail if other measures are possible and have lower cost

***Examples of interactivity** (see next slide)

1) if a low efficiency heater is replaced by a higher efficiency heater then the same level of added insulation will save less energy

2) added insulation or a higher efficiency furnace will save less energy in a well sealed structure than in a very leaky structure

Measure Priority and Interaction



Pre-Weatherization

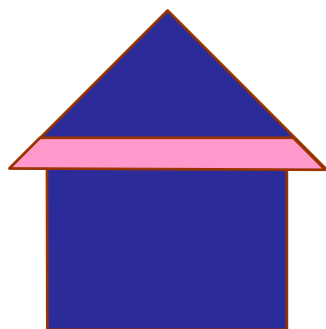
Design heating load = 50 kBtu/hr

Annual heating load = 100 MMBtu/hr

Annual heating energy use = 167 MMBtu/hr

Attic insulation: SIR=8

High-efficiency furnace: SIR=5



After Attic Insulation

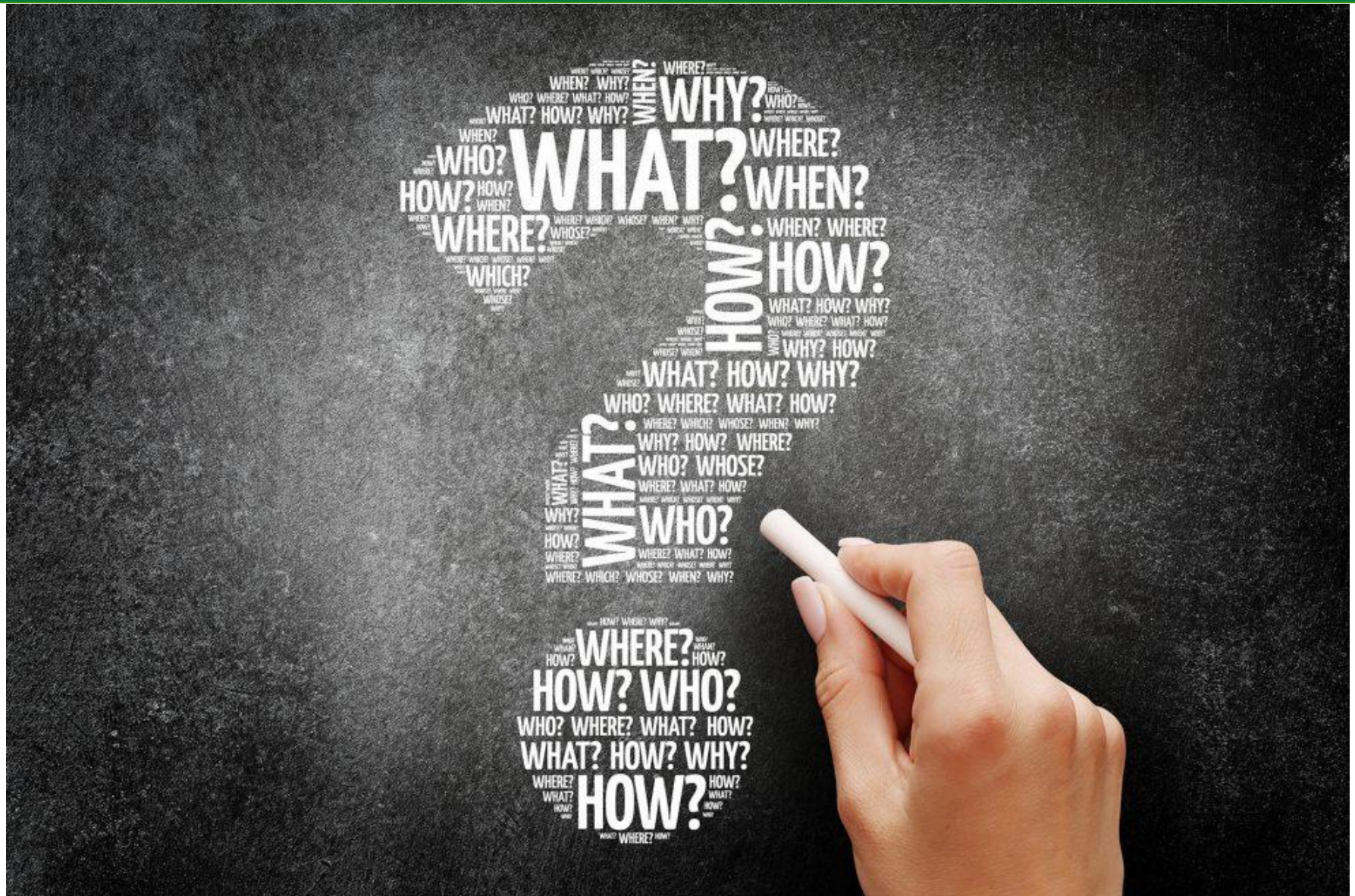
Design heating load = 40 kBtu/hr

Annual heating load = 80 MMBtu/hr

Annual heating energy use = 133 MMBtu/hr

Interacted SIR of furnace replacement: SIR=4

Questions on Energy Audit/Tool



Spot-checks

- Weatherization Program Managers are expected to provide monitoring and oversight of the technical program (even if they don't have a technical background)
- How?
 - To start, Spot Checks!



Quick, Important Spot Checks

Recommended Measures Report: Are the big 5 ECMs there?

- Air sealing
- Duct sealing of ducts outside the thermal boundary
- Attic insulation
- Wall insulation
- Floor or belly insulation

Energy Saving Measure Economics

<i>Index</i>	<i>Recommended Measure</i>	<i>Components</i>	<i>Measure Savings (\$/yr)</i>	<i>Measure Cost (\$)</i>	<i>Measure SIR</i>	<i>Cumulative Cost (\$)</i>	<i>Cumulative SIR</i>
1	Incidental Repairs		0	500	0.0	500	0.0
2	Seal Ducts		108	488	2.1	988	1.0
3	Infiltration Redctn		109	530	2.0	1518	1.4
4	Low Flow Showerheads		88	27	38.4	1545	2.0
5	Duct Insulation		282	285	17.6	1830	4.4
6	Lighting Retrofits	LT1	41	30	14.8	1860	4.6
7	DWH Pipe Insulation		19	15	13.3	1875	4.7
8	Floor Ins. R-30	F1	289	978	5.3	2853	4.9
9	Wall Insulation	WL1,WL2,WL3, WL4,WL5	295	1037	4.9	3890	4.9
10	Attic Ins. R-38	A1	188	1027	3.2	4917	4.5
11	DWH Tank Insulation		13	50	2.7	4967	4.5
12	Refrigerator Rplcmnt		66	656	1.2	5623	4.1

Quick, Important Spot Checks

- Do the recommended ECMs make sense?
- Does the Measure SIR's make sense?

Energy Saving Measure Economics

<i>Index</i>	<i>Recommended Measure</i>	<i>Components</i>	<i>Measure Savings (\$/yr)</i>	<i>Measure Cost (\$)</i>	<i>Measure SIR</i>	<i>Cumulative Cost (\$)</i>	<i>Cumulative SIR</i>
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Quick, Important Spot Checks

- Does the estimated load reductions (in HEAT) make sense?
- Does the measure lifetime make sense? (WPN 19-4)?

Peak Heating Load(BTU/Hr)	289312.72	Peak Heating Load(BTU/Hr)	248783.17
Peak Cooling Load(BTU/Hr)	306619.34	Peak Cooling Load(BTU/Hr)	306619.34
Heating Thermostat Setting	68.00	Heating Thermostat Setting	68.00
Cooling Thermostat Setting	78.00	Cooling Thermostat Setting	78.00
Heating Design Temperature	5.00	Heating Design Temperature	5.00
Cooling Design Temperature	95.00	Cooling Design Temperature	95.00
Tolerance	0.00	Tolerance	0.00
Total Heating Load(MMBTU)	N/A	Total Heating Load(MMBTU)	N/A
Total Cooling Load(MMBTU)	N/A	Total Cooling Load(MMBTU)	N/A

Weatherization

Section	Pre R	Post R	Measure	Savings (mmbtu/year)	Savings (mmbtu/lifetime)	Measure Cost (\$)	SIR	Life Year
Unfloored	2.76	21.56	R-38 Blown Cell-open	64.26	1285.20	1789.76	7.90	20

Spot Check - Red Flags

- SIR above 10 for anything besides General Heat Waste (GHW) measures...
- Measure and or Cumulative SIR = <1.0
- Heating Ventilation and Air-Conditioning replacement SIR > 4.0
- Window replacement SIR > 3.5 in Single Family Homes or Manufactured Housing
- Missing or incomplete – blower door testing
- Partial energy audits, e.g., separate audit just for HVAC or refrigerators
- No HVAC diagnostics

Spot Check - Red Flags

- **Recommended measures with unrealistic savings characteristics.**
 - True example: predicted savings of \$13,800 per year on a 985sf house where previous energy bills were \$1,050 per year
 - True example: Insulate 1 door, save \$11,335 per year
 - True example: Complete window replacement SIR = 25
- **Energy savings of 40% without replacing HVAC and without significant air sealing.**

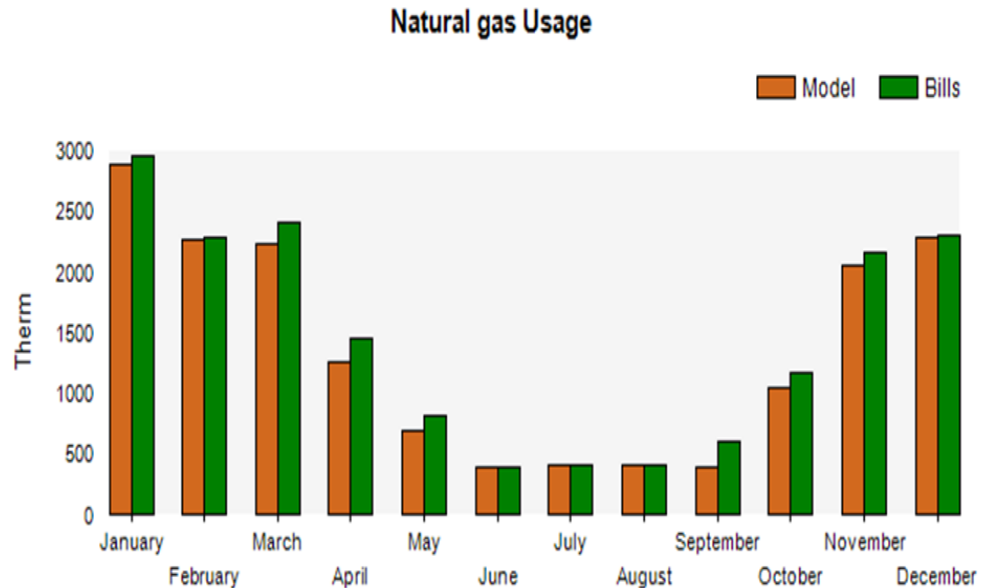
Spot Check - Red Flags - Multifamily

- Audit not trued up, or modeled and actual energy use does not match within +/- 20%

- All large multifamily buildings (25+ units) are required by DOE to include modeled vs. actual energy use.
- That means actual billing data for affected buildings must be gathered.

Model to Billing - Normalized

Comparing normalized bills in billing period 'BillingPeriod1' with normalized consumption for model 'Base Building'



If Spot Check Raises a Red Flag – Dig Deeper

- **Check Insulation Values** – Verify actual insulation types and R-values or depths.
 - Is 10” of fiberglass attic insulation existing...or is it R-10?
- **Check Insulation Measurement** – Was insulation measured in just one place, or throughout?
 - Always VERY important, especially in remodeled buildings or with additions, where wall insulation differences are very common but not obvious.
- **Check Assumptions** – age/original plans, especially in an older building, are just guesses.
 - These assumptions affect insulation measures, which affect recommendations for heating/cooling replacements and HVAC sizing

If Spot Check Raises a Red Flag – Dig Deeper

- **Check shell characteristics and dimensions**
 - Are shell components missing?
 - Windows?
 - Walls?
 - Does model include surfaces, windows, or doors that don't exist?
 - Are dimensions correctly entered?
 - Are feet supposed to be feet; are inches supposed to be inches?
 - True story: A single-family home modeled with 16 attic hatches!
 - True Story: Insulating an existing 24"x 32" attic hatch saved \$300/yr! (Hatch modeled incorrectly as 24 feet x 32 feet)
 - Errors most frequently affect HVAC sizing and replacement measures.
 - Errors affect insulation savings and/or the numbers of window and door replacements and repairs.

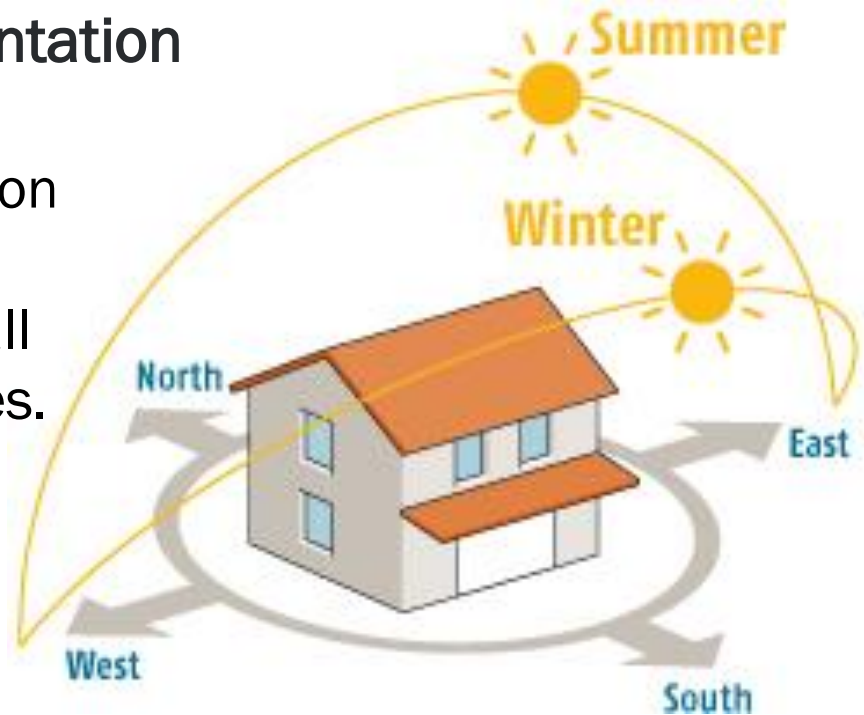
If Spot Check Raises a Red Flag – Dig Deeper

- **Check Infiltration Estimates**
 - Proper estimating is key to ensuring the most cost-effective package of measures is selected
- **Methodology commonly used:**
 - Real data (infiltration reduction results) to develop infiltration targets for your network
 - These targets can be network-wide or developed to be Subgrantee specific
 - Post-blower door target \leq [conditioned area + ~400] cfm50
- **When using “rule of thumb,” recognize thumbs may be different**
 - Sometimes, post-blower door target = [2x conditioned area] cfm50 or more
 - Sometimes, even 1/3 or 30% infiltration reduction still looks “high”
 - Square footage can play a role in this

If Spot Check Raises a Red Flag – Dig Deeper

- **Verify Shell Exposure & Orientation**

- Attic location, type, and exposure - the most common forms of this mistake are incorrectly entering kneewall exposures or attic exposures.
- A hot attic in summer might be over 140 degrees F, but a buffered kneewall space might stay below 100 degrees depending on quality of air and thermal barriers.
- These errors usually affect attic and kneewalls insulation measures, as well as heating and cooling system sizing and replacements.



If Spot Check Raises a Red Flag – Dig Deeper

- **Verify Heating Entries**
 - Does the Energy Auditor have documentation of the existing equipment model?
 - Steady State Efficiency (SSE) should always be measured in the field on a safely operable system
 - Verify metrics and units
 - SSE
 - British Thermal Unit (BTU)
 - Kilowatt (kW)
 - Verify proper fuel type was selected



If Spot Check Raises a Red Flag – Dig Deeper

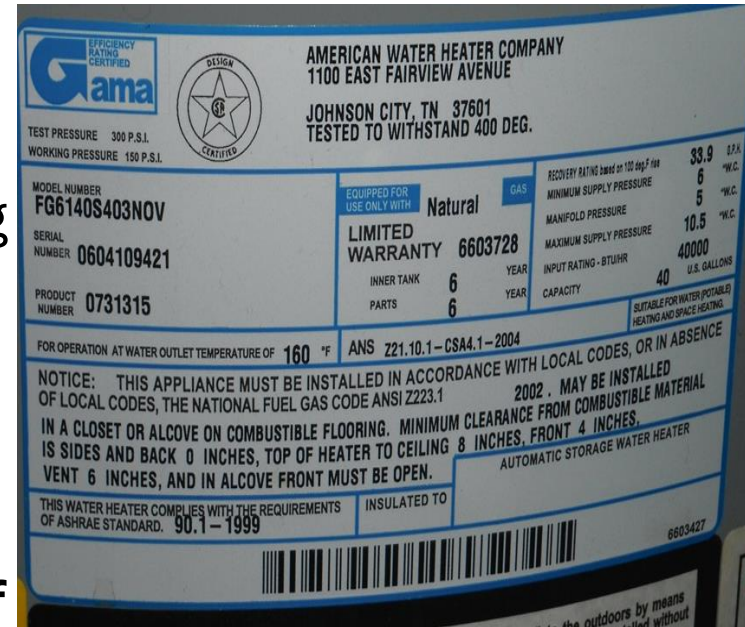
- **Verify Cooling Entries**
 - Verify metrics and units: Seasonal Energy Efficiency Rating (SEER), BTU, kW, etc.
- Does the auditor have documentation of the existing equipment model and serial numbers.



SERIAL 4905X32093				
PROD PH10JA024000AGAA				
MODEL PH10JA024 - G				
METERING	63	PISTON	52	PISTON
DEVICE	INDOOR		OUTDOOR	
FACTORY CHARGED			R-22	
	4.38	LBS	1.99	KG
INDOOR TXV SUB COOLING			12	°F
POWER SUPPLY		208 - 230	VOLTS AC	
	1	PH	60	HZ
PERMISSIBLE VOLTAGE AT UNIT				
	253	MAX	197	MIN
SUITABLE FOR OUTDOOR USE				

If Spot Check Raises a Red Flag – Dig Deeper

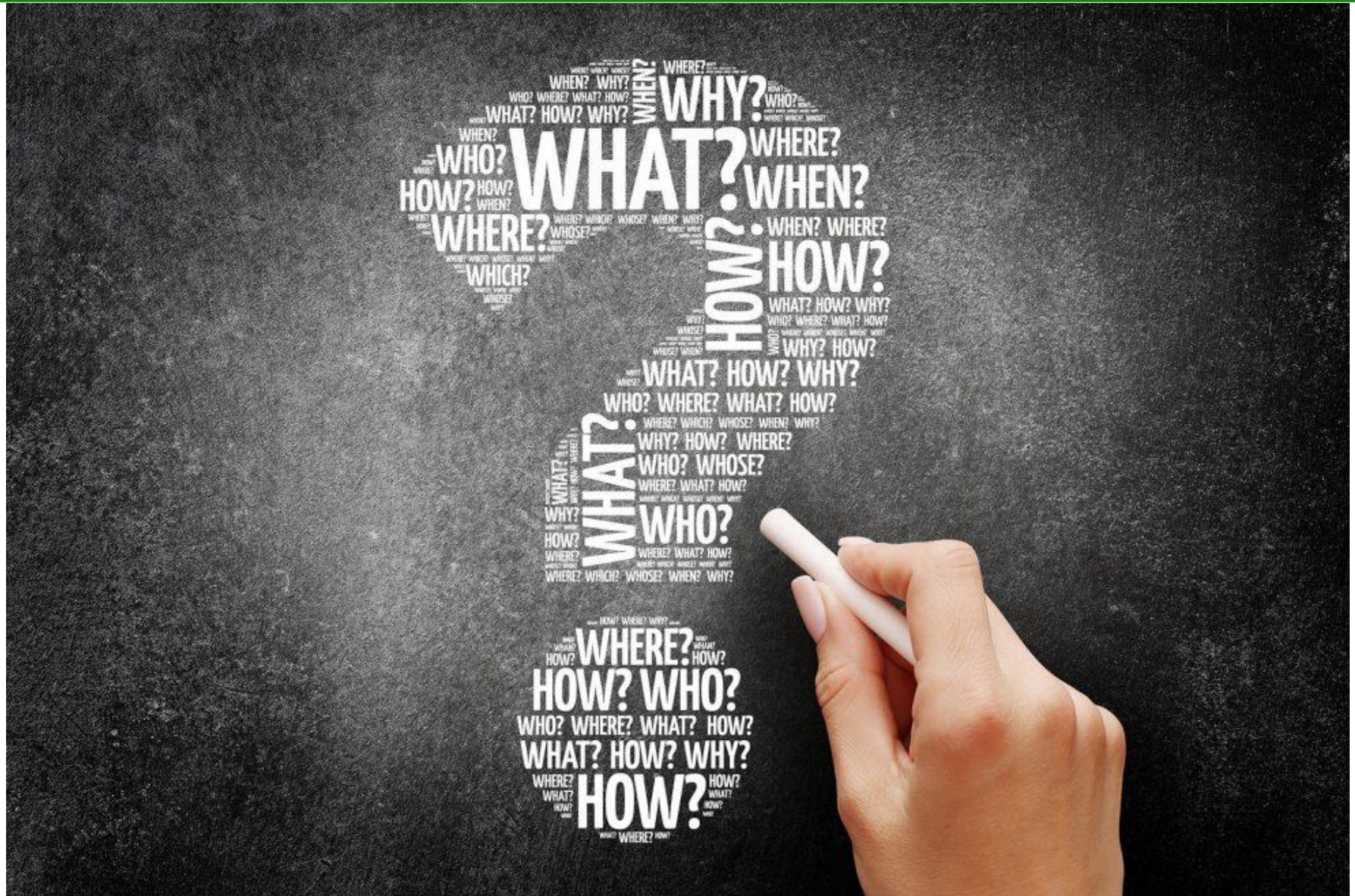
- **Verify DHW Entries**
 - Check the metrics for DHW input (BTU vs. KW/h, size, or using wrong fuel types)
 - Does the energy audit have documentation of the existing equipment model numbers?
- Mistakes can affect replacement of DHW systems and baseload measures like tank and pipe insulation or low-flow fixture installations



Still not sure? Where to go next?

- **Resources/Opportunities for Program Managers (non-technical and technical) to learn more/ask questions**
 - DOE Technical Project Officer – can connect you to viable resources
 - National Association for State Community Service Programs (NASCCSP) – Community of Practice, Regional Calls
- **Resources/Opportunities for Technical Staff**
 - WAP Trainers Consortium, monthly calls
 - Online resources
 - Weatherization Training Centers – training, certifying bodies
 - Statewide Technical Committees – Networking

Questions on Spot-checks?



Energy Audits and Priority Lists - Requirements

- Grantees Must have Single Family & Manufactured Housing approved Energy Audit Tool (or Priority lists*)



What is a DOE-Approved Energy Audit?

- Weatherization Program Notice [\(WPN\) 19-4](#) describes approval criteria to determine compliance with rule 10 Code of Federal Regulations (CFR) Part 440.21, including:
 - Attachment 1 – Criteria used to approve energy audit procedures
 - Attachment 2 – Details if the Grantee chooses to submit a priority list
 - Attachment 3 – The list of DOE-approved (expedited) audit tools
 - Attachment 4 – List's standards audit tools and applicable buildings
 - Attachment 5 – Guidance on fuel switching
 - Attachment 6 – Process to add materials not listed in “Appendix A”
 - Attachment 7 – Outline's process rules of 10 CFR 440
 - Attachment 8 – Clarification on measure skipping
 - Attachment 9 – Maximum lifetime of weatherization measures

Submittal Requirements

- **Analytic Methods**
 - Measures Considered
 - Complete list of measures “enabled” for evaluation
 - Includes material and labor costs, representative of conditions across entire Grantee service area
 - Includes expected lifetime of each measure
 - Sample Audits (10 of each housing type)
 - All data, assumptions, audit results (recommended measures).
 - Should be typical of those weatherized in Program

Submittal Requirements

- **Field Procedures**
 - Audit Procedures and Field Protocols
 - Grantee must provide a detailed description of the energy audit procedures used for data collection and audit tool inputs
 - Field operations manual
 - Field data collection process and forms
 - DOE approved Field Guide
 - Technical standards
 - Audit software user's manual
 - Monitoring protocols

Submittal Requirements

- **Field Procedures**
 - Weatherization Materials Installed
 - Appendix A plus anything the Grantee wants approved that is not on Appendix A
 - General Heat Waste Reduction List (limited to \$250 per unit)
 - Water heater wrap and pipe insulation, faucet aerators and low-flow shower heads, limited weatherstripping and caulking, furnace and air conditioner filters
 - Health and Safety
 - Grantee Health and Safety Plan and alignment with the operations manual, field guide, standards, guidelines, protocols

Submittal Requirements

- **Begin 1 year beforehand to gather and update all the requirements.**
 - Required submission to DOE at a minimum 6 months prior to current approved Energy Audit Tool expiring.
 - If there are missing pieces, DOE will advise but sometimes, those pieces take time for the Grantee to pull together.
 - Often, this is an iterative process, so again, give yourself plenty of time.
- **WPN 19-4 includes everything you need to include and when the time comes, review this:**
 - <https://www.energy.gov/eere/wipo/energy-audits-and-priority-lists-training-resources>

Energy Audits – Summary

- Gathering all the information is challenging
- Process happens every 5 years
 - If nothing changes, why do we have to go through this process?
 - Allows to “reset,” identify patterns/habits that may not have been observed in monitoring
- **Biggest Barriers**
 - Updated procedure documents that align with implementation process
 - Ensuring Field Guides and other materials are aligned!

Additional Resources

Energy Audits

- [WPN 19-4 and Attachments](#)
- State Plan section V.5 Type of Weatherization Work to be Done
 - V.5.1
 - V.5.2

Inspections and Monitoring:

- WPN 20-4
- WPN 15-4, Section 3
- State Plan section V.8.3 Program Management
 - V.8.3

Where to go for help

- DOE Project Officers – Ready/able to assist Grantees with any questions and help identify resources
- NASCSP – Reliable partner with DOE and works to ensure Grantees have the tools and information necessary
- Grantee Program Managers Toolkit
 - <https://www.energy.gov/eere/wipo/weatherization-assistance-program-grantee-manager-training-toolkit>

Thank you!

- Thank you, please feel free to contact me at
 - Derek Schroeder - Derek.Schroeder@ee.doe.gov