U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Understanding Energy Audits for New Program Managers

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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 Monitoring/Oversight "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

Why we do an Audit

Big Picture – WAP Technical Requirements

The "Big Picture" is simple:

1. SIR ≥ 1.0

- SIR – The ratio of the present value savings to the present value costs of an energy or water conservation measure, i.e., the lifetime of the ECM and the cost of money

2. Health & Safety

- Measures that ensure the health and safety of clients and WAP workers

Why the “Big Picture” is Important

Let’s visit Grandma’s House

The “Big Picture” concept

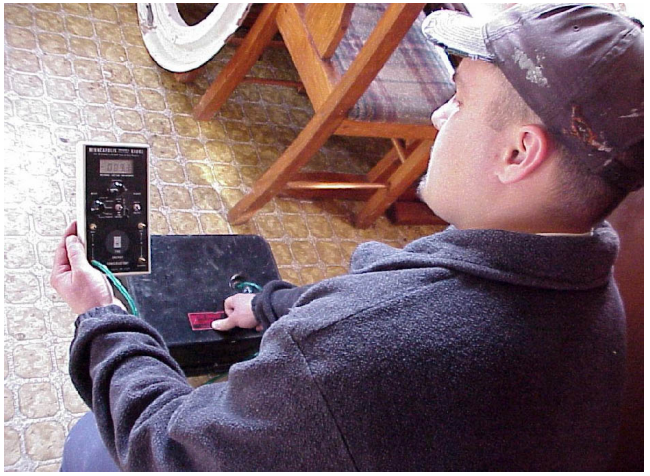
The “House is a System”

- 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?

When is an Energy Audit Required?

- .. For Every Home Weatherized

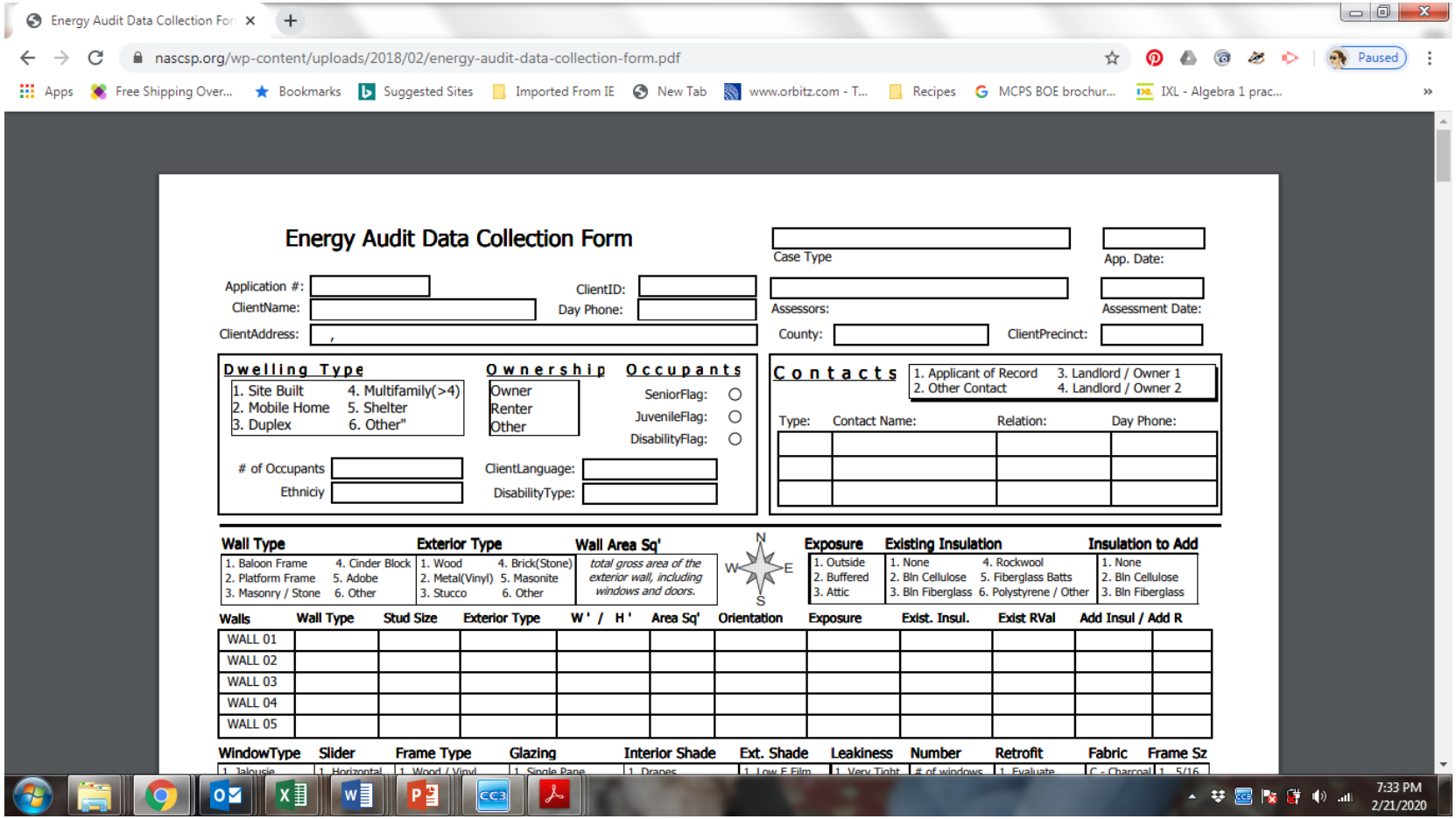


What is an Energy Audit?

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

Energy Audits Require A LOT of Data Points

- https://nascsp.org/wp-content/uploads/2018/02/energy-audit-data-collection-form.pdf



Energy Audit Data Collection Form

Case Type | App. Date:

Application #: | ClientID:
ClientName: | Day Phone:
ClientAddress: ,

Assessors: | Assessment Date:
County: | ClientPrecinct:

Dwelling Type
1. Site Built
2. Mobile Home
3. Duplex
4. Multifamily(>4)
5. Shelter
6. Other"

Ownership
Owner
Renter
Other

Occupants
SeniorFlag:
JuvenileFlag:
DisabilityFlag:

# of Occupants | ClientLanguage:
Ethniciy | DisabilityType:

Contacts
1. Applicant of Record
2. Other Contact
3. Landlord / Owner 1
4. Landlord / Owner 2

Type:	Contact Name:	Relation:	Day Phone:

Wall Type
1. Baloon Frame
2. Platform Frame
3. Masonry / Stone
4. Cinder Block
5. Adobe
6. Other

Exterior Type
1. Wood
2. Metal(Vinyl)
3. Stucco
4. Brick(Stone)
5. Masonite
6. Other

Wall Area Sq'
total gross area of the exterior wall, including windows and doors.

N W E S

Exposure
1. Outside
2. Buffered
3. Attic

Existing Insulation
1. None
2. Bln Cellulose
3. Bln Fiberglass
4. Rockwool
5. Fiberglass Batts
6. Polystyrene / Other

Insulation to Add
1. None
2. Bln Cellulose
3. Bln Fiberglass

Walls	Wall Type	Stud Size	Exterior Type	W ' / H '	Area Sq'	Orientation	Exposure	Exist. Insul.	Exist RVal	Add Insul / Add R	
WALL 01											
WALL 02											
WALL 03											
WALL 04											
WALL 05											

WindowType	Slider	Frame Type	Glazing	Interior Shade	Ext. Shade	Leakiness	Number	Retrofit	Fabric	Frame Sz
1. Jalousie	1. Horizontal	1. Wood / Vinyl	1. Single Pane	1. Drapes	1. Low E Film	1. Very Tight	# of windows	1. Evaluate	C - Charcoal	1. 5/16

Energy Audit Data Collection Form

- **Client/Contact Information**
- **House Specifics (beyond type)**
  - Walls (balloon, cinder, platform, adobe, masonry…)
  - Window (Slider, type, glazing, shade, leakiness…)
  - Door (H-Core, S-core, insulated steel, sliding…)
  - Attics (unfloored, floored, cathedral, flat)
  - Foundation (conditioned, unconditioned, vented…)
  - Heating system (gravity, forced air, boiler…)
  - Cooling system (central, window, heat pump…)
  - Infiltration – BD/Ducts (before-initial; after-target)
  - Baseloads (water heater, refrigerator…
  - Health & Safety
  - Equipment (Worst Case Draft)

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…
  - (in WAP) 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.**
  - How audit tools get approved, coming later in presentation!

KEY Purpose/Outputs of the Electronic Energy Audit Tool

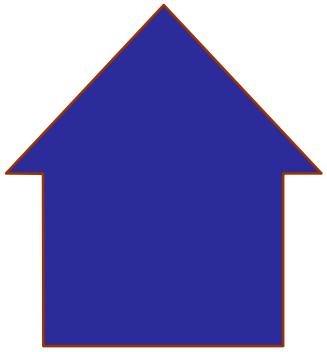
- Calculate Individual SIRs first.
- Rank Measures by SIR – Higher is at top of the list.
- Building is modified and re-simulated with higher ranked measure, i.e. measures are ”interacted”*
  - Completes this for all appropriate measures in the Library Measures
  - Reduces energy savings of the total 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

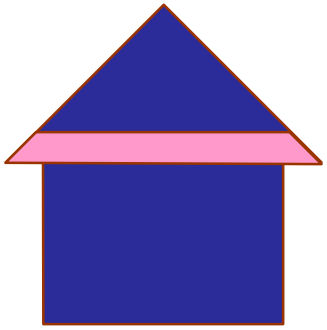
Measure Priority and Interaction



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

Monitoring/Oversight

- 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!

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

Index	*Recommended Measure*	*Components*	*Measure Savings ($/yr)*	*Measure Cost ($)*	*Measure SIR*	*Cumulative Cost ($)*	*Cumulative SIR*
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 1a

Do the recommended ECMs make sense?

Energy Saving Measure Economics

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12	Refrigerator Rplcmnt		66	656	1.2	5623	4.1

And energy usage…

Quick, Important Spot Checks 1B

Do these recommended ECMs (in HEAT) make sense?

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

Infiltration ECM lifetime set at 15 years.

Is that right?

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

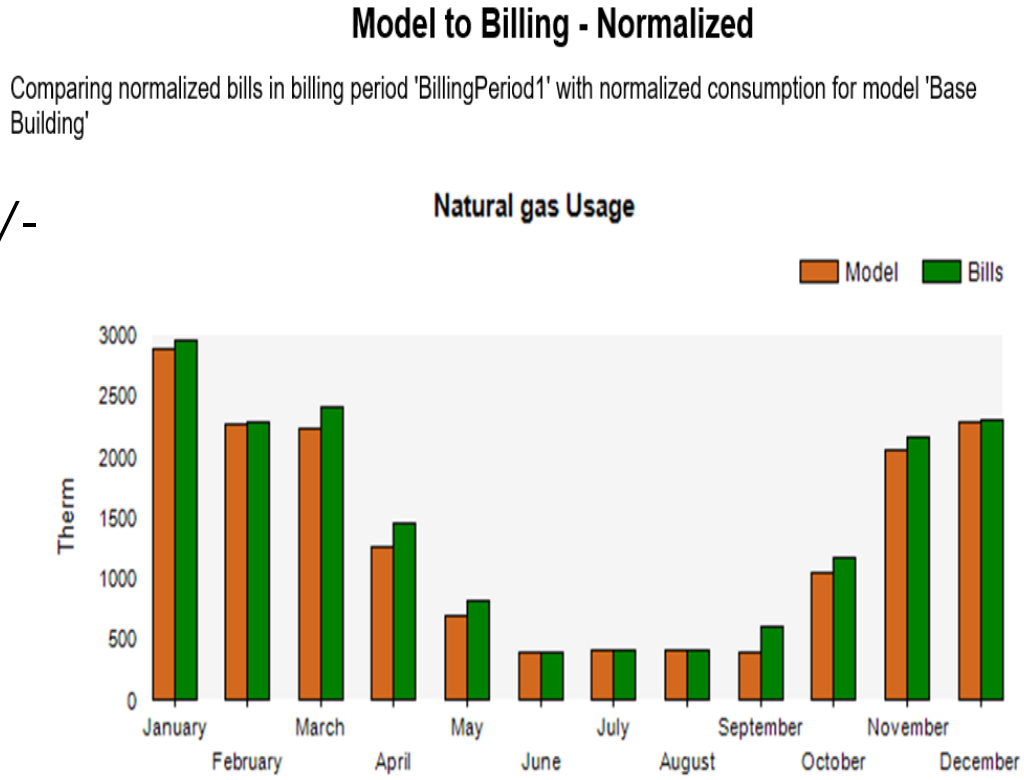
- SIR above 10 for anything besides General Heat Waste (GHW) measures…
- SIR = 0.999 or lower. No, SIR = 1 is generous
- HVAC replacement SIR > 4+
- Window replacement SIR > 3.5 in SF or MH
- No info – or incomplete – blower door testing
- Partial audits, e.g. separate audit just for HVAC
- No HVAC diagnostics

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 are required by DOE to include modeled vs. actual energy use.
  - That means actual billing data for affected buildings must be gathered.



Spot Checks – Where to start, digging deeper

- **When something doesn't feel right, where do you look first?**
  - Insulation
  - Shell characteristics and measurements
  - Window/Door dimensions
  - Infiltration estimates
  - Shell orientation
  - Heating Entries
  - Cooling Entries
  - DWH Entries

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

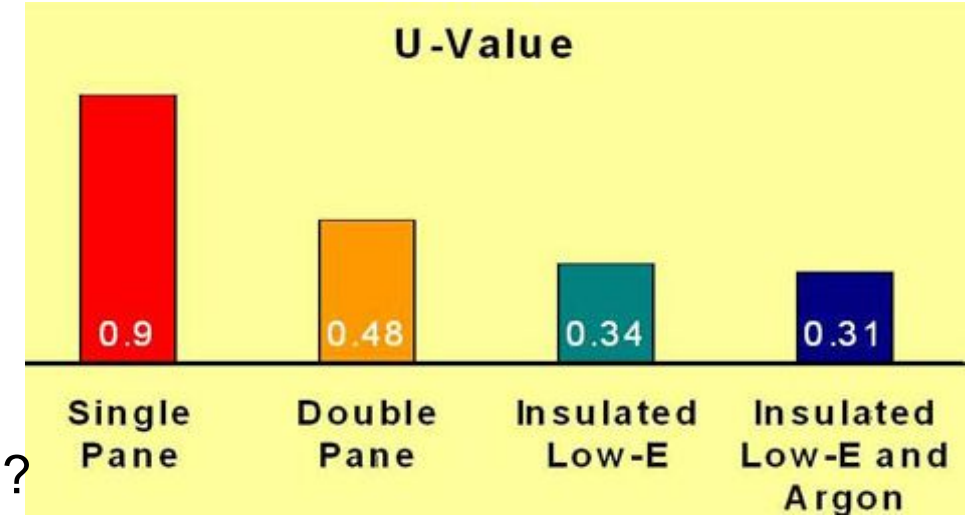
If Spot Check Raises a Red Flag – Dig Deeper

- **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!
      - » Another 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 Window and Door U-Values

Are U-values of existing windows correct? Are the efficiencies of modeled replacement windows and doors beyond the specs of the contract or work scope.



Does the work scope accurately reflect the modeled replacements? e.g., a double-glazed Low-E window is not the same as a standard double-glazed window

If Spot Check Raises a Red Flag – Dig Deeper

Check Infiltration Estimates – Proper estimating is key to ensure the best 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≤ [conditioned area + ~400] cfm50

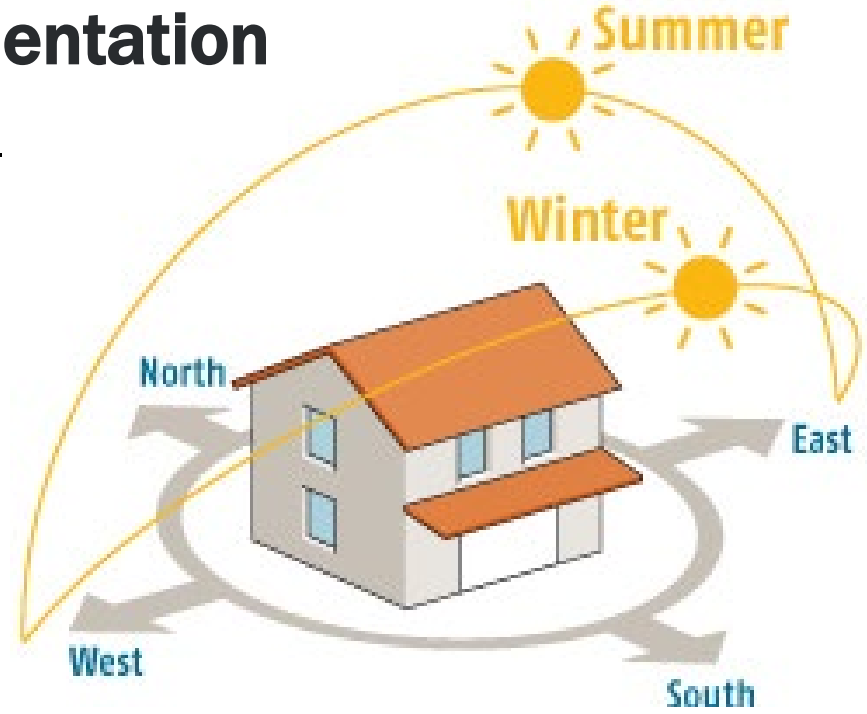
- When using "rule of thumb," recognize thumbs may be different
  - Sometimes, post-blower door target = [2x conditioned area] cfm50 or more
  - Sometimes, even 1/3 or 30% infiltration reduction still looks "high"
    - Square footage can play a role in this

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

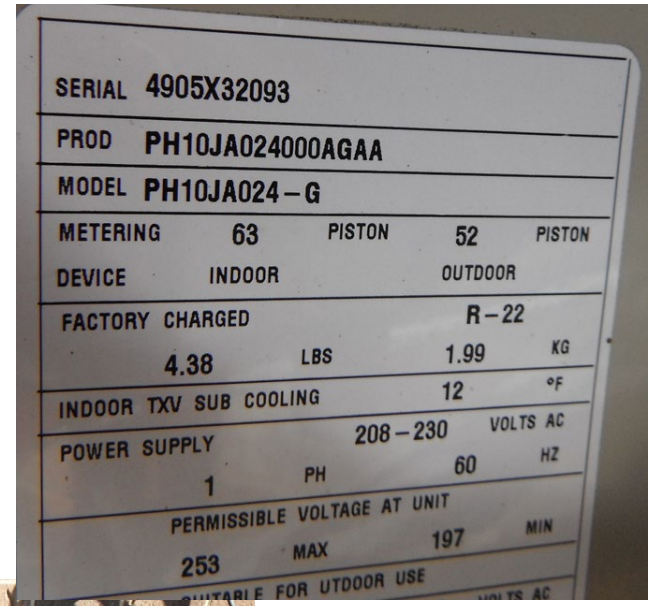
Verify Heating Entries

- Does the energy auditor have documentation of the existing equipment model and serial numbers?
- A steady state efficiency (SSE) should always be measured in the field on a working system.
- Verify metrics and units: HSPF, COP, SSE, BTU, KBTU, MBTU, kW, etc.
- Verify proper fuel type was selected

If Spot Check Raises a Red Flag – Dig Deeper

Verify Cooling Entries

- Verify metrics and units: SEER, COP, BTU, KBTU, MBTU, kW, etc.
- Does the auditor have documentation of the existing equipment model and serial numbers.

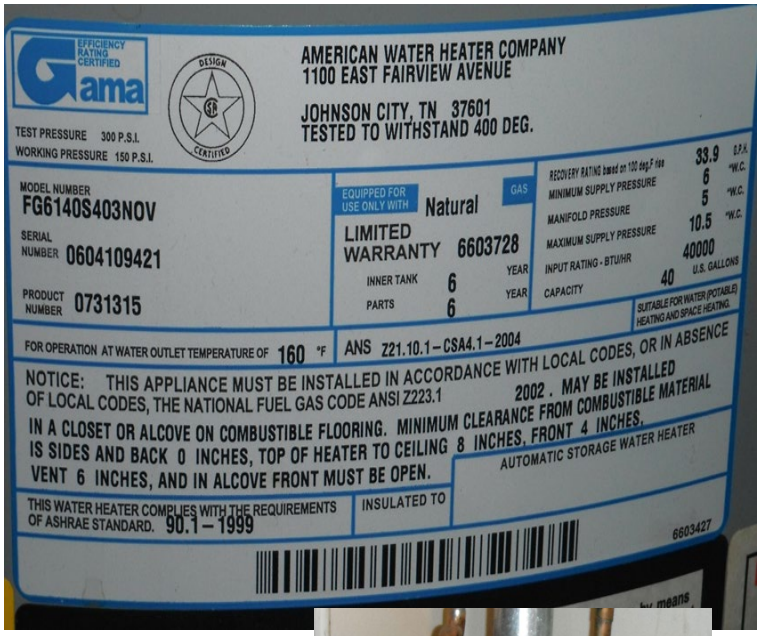


If Spot Check Raises a Red Flag – Dig Deeper

Verify DHW Entries

- Check the metrics for water heater input (BTU vs. KW/h), size (gallons), or using the wrong fuel types in conjunction with the wrong metrics.

- Does the energy auditor have documentation of the existing equipment model and serial numbers?



- Mistakes can effect replacement of hot water systems and baseload measures like DHW tank and pipe insulation or low-flow fixture installations.

Still not sure? Where to go next?

- **Resources/Opportunities for Program Managers (non-technical) to learn more/ask questions**
  - DOE Technical Project Officer – can connect you to viable resources
  - NASCSP – 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

How Training and Monitoring/Oversight Fit?

- **DOE allocates monies specifically for Training and Technical Assistance (T&TA)**
  - Each year, many Grantees take unspent T&TA dollars and "reprogram" into program operations.
- **Training is rarely "one and done"**
  - Habits form -- some good, some bad.
  - Regular training opportunities allow the practitioner to "reset" and/or deepen understanding of why we do what we do.
- **There is benefit in having a strong training plan**

Training - Timeline

Training Plans must ensure that all Weatherization field staff receives regular Comprehensive (Tier 1) training.

Each Grantee will decide on the regularity of training based on workforce needs and availability of funds.

Training – Basic Requirements

- Analysis of training needs.
  - These needs are often identified during the monitoring/oversight process
- Plan to meet those needs.
  - What is needed to address quality issues?
- Comprehensive training on Grantee-determined schedule.
  - Ensuring workforce has opportunity to “reset”

Questions on Monitoring/Oversight

Energy Audits and Priority Lists - Requirements

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 an energy audit's compliance with rule 10 Code of Federal Regulations (CFR) Part 440, 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 – Lists 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 – Outlines process rules of 10 CFR 440
- Attachment 8 – Clarification on measure skipping
- Attachment 9 – Maximum lifetime of weatherization measures

Criteria Used to Approve Energy Audit Procedures

- **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

Criteria Used to Approve Energy Audit Procedures

- **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 forms
      - SWS-aligned field guide (and any SWS variances)
      - Technical standards
      - Installation guidelines
      - Audit software user's manual
      - Monitoring protocols

Field Procedures – Components

Waiting (6 months ahead) …

Updating routinely…

Criteria Used to Approve Energy Audit Procedures

- **Field Procedures**
  - Weatherization Materials Installed
    - Appendix A plus anything the Grantee wants approved that is not on Appendix A
  - General Heat Waste Reduction List
    - 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 H/S Plan and alignment with the operations manual, field guide, standards, guidelines, protocols

Energy Audits – Submittal

- Start ~1 year beforehand to gather and update all the pieces.
  - Get the submission to DOE, at a minimum, 6 months beforehand.
    - 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!

Field Guides | Where to Learn More

- WPN 15-4, Sections 1 & 2 – Describe SWS alignment and distribution requirements
- State Plan Section V.5.1 – Technical Guides and Materials
- EERE site – Training Resources: https://energy.gov/eere/wipo/downloads/training-resources
  - SWS tool navigation training
  - Field Guide and Variance Request Review Process webinars
- SWS - https://sws.nrel.gov
- Variance Request form:
  - https://goo.gl/forms/GeLNgwYWEgK2aNup2

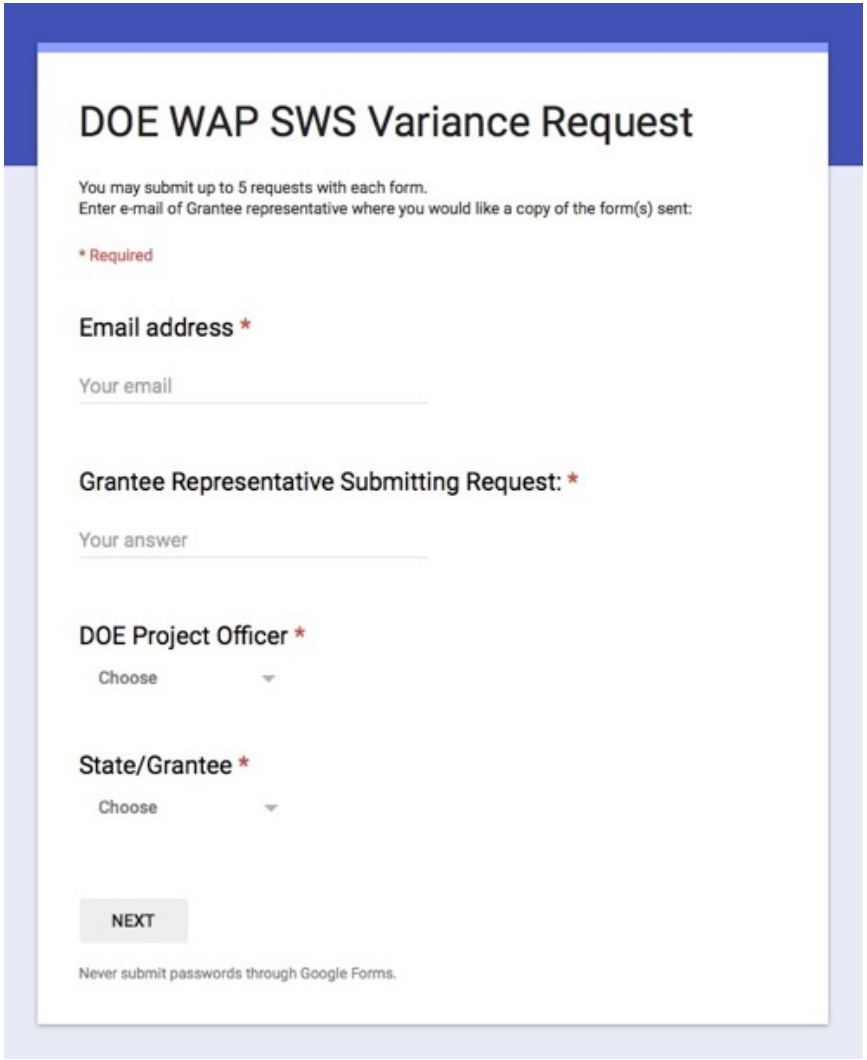
Field Guides – SWS and Variance Requests

A Conundrum:

- Field guides must align with the SWS (WPN 15-4).
- Sometimes the SWS don't work for you.

The Solution:

- Submit a Variance Request



Field Guides | Summary

- 3-year update cycle.
- Must align with SWS, unless you have an approved…
- Variance Request. Webinar provides tips.
- Must be available to your entire network.

Resource Review

Energy Audits

- WPN 19-4 and Attachments

Field Guides

- WPN 15-4, Sections 1 & 2
- State Plan section V.5.1
- https://energy.gov/eere/wipo/downloads/training-resources
  - SWS tool navigation training
  - Field Guide and Variance Request Process
- **SWS on-line tool:** https://sws.nrel.gov
- New Variance Request form:
  - https://goo.gl/forms/GeLNgwYWEgK2aNup2

Training Accreditation:

- WPN 15-4, Sections 3 & 4
- State Plan section V.8.4
- Sortable list of accredited centers:
  - https://irecusa.org/credentialing/credential-holders/
- Learn more about accreditation:
  - https://irecusa.org/credentialing/accreditation/training-providers/
- JTAs https://energy.gov/eere/wipo/guidelines-home-energy-professionals-accredited-training#jta

Resource Review

HEP Certifications

- BPI - http://bpi.org/certified-professionals
- JTAs https://energy.gov/eere/wipo/guidelines-home-energy-professionals-accredited-training#jta
- DOE WAP Standardized Training Curricula http://www.waptac.org/Training-Tools/WAP-Standardized-Curricula.aspx

Inspections and Monitoring:

- WPN 20-4
- WPN 15-4, Section 3
- WPN 13-4
- State Plan section V.5.3
- State Plan section V.8.3
- Annual Grant Guidance (XX-1)
- DOE WAP Standardized Curricula module: Quality Control Inspector 2.0:
  - http://waptac.org/WAP-Standardized-Curricula/Quality-Control-Inspector-2.0.aspx

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
- EERE Website – https://www.energy.gov/eere/wipo/program-updates-training-resources
- Grantee Program Managers Toolkit – https://www.energy.gov/eere/wipo/weatherization-assistance-program-grantee-manager-training-toolkit
- Derek – (do you want to be listed)?